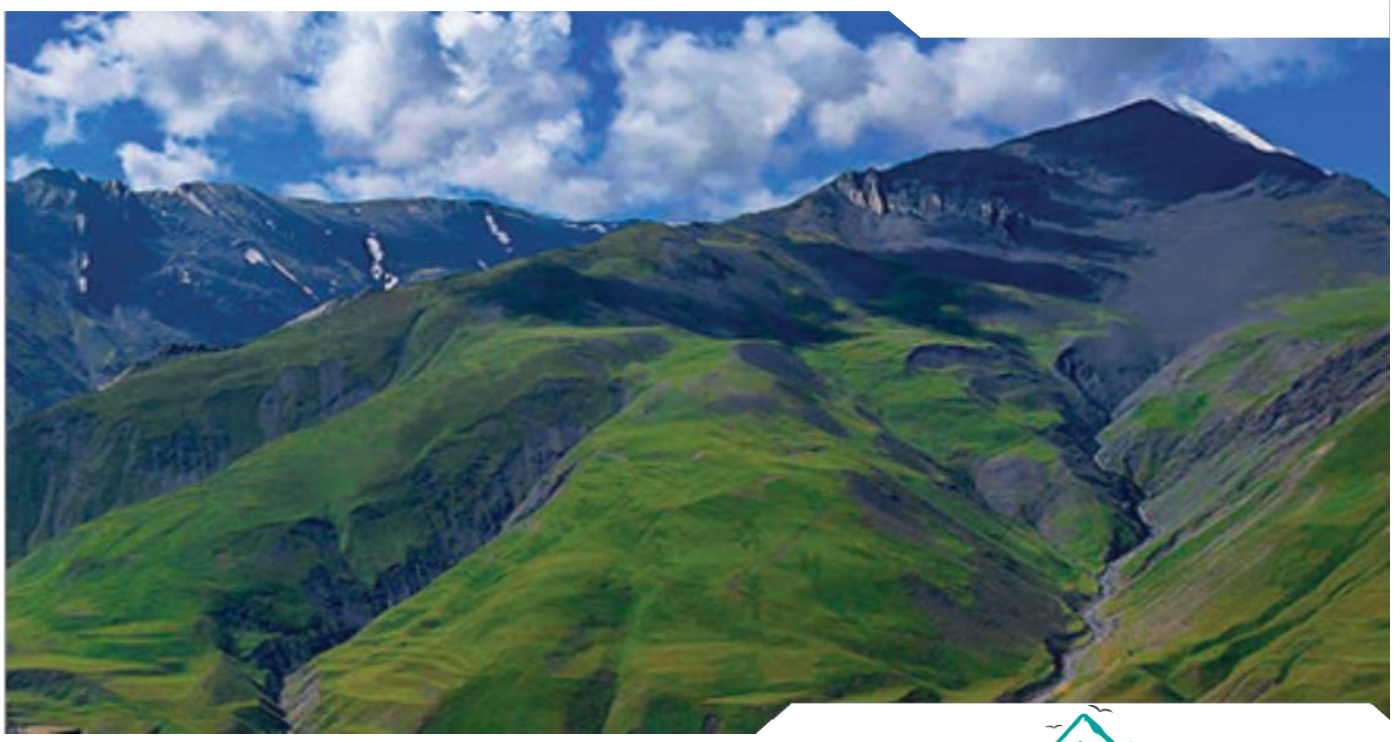

II INTERNATIONAL CONFERENCE
MOUNTAINS: BIODIVERSITY, LANDSCAPES AND CULTURES

# PROCEEDINGS

## VOLUME I

## II INTERNATIONAL CONFERENCE

### "MOUNTAINS: BIODIVERSITY, LANDSCAPES AND CULTURES"

***November 5-6, 2024. BAKU. AZERBAIJAN***

TASHKENT INSTITUTE OF IRRIGATION & AGRICULTURAL MECHANIZATION ENGINEERS' NATIONAL RESEARCH UNIVERSITY (UZBEKISTAN)

CAUCASUS NETWORK FOR SUSTAINABLE DEVELOPMENT OF MOUNTAIN REGIONS

Institute of Radiation Problems of the Ministry of Science and Education of the Republic of Azerbaijan

"DENDROLOGY GARDEN" PUBLIC LEGAL ENTITY UNDER THE AUTHORITY OF THE HEAD OF THE EXECUTIVE POWER OF BAKU CITY

"INSTITUTE OF GEOGRAPHY NAMED AFTER ACAD. H.A.ALIYEV MINISTRY OF SCIENCE AND EDUCATION OF THE REPUBLIC OF AZERBAIJAN

# PROCEEDINGS

of 2nd International conference “Mountains: Biodiversity, Landscapes and Cultures”

5-6 November 2024
Baku/Azerbaijan

VOLUME 1

***Global ecological problems***
***Global mountain biodiversity assessment***

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# Contents

# GLOBAL ECOLOGICAL PROBLEMS

# Monitoring the state of the South Caucasus Mountain systems from the standpoint of preserving landscapes and biodiversity

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**Abstract**

The paper provides an overview of the importance of landscape diversity, biodiversity of mountain systems. For poorly studied mountain ecosystems, the most important criterion for sustainable development is the preservation of landscape diversity, biodiversity, landscapes ensured the preservation of the culture and identity of indigenous peoples. One of the main factors of climate change in the mountain ecosystem is the state of snow cover. Studies of snows that extend over the boundaries of mountain forests were carried out. The study was based on the method of assessing the snow cover. The paper provides a rationale for snow cover indicators to determine the contribution of climate change to the state of mountain systems and biodiversity. It also provides the results of seasonal measurements of the state of snow cover on the slopes of the Southern Caucasus mountains made during a certain period. The data confirm the impact of climate change on the state of snow cover, as well as on the hydrology of river bed changes, and the susceptibility of mountain slopes to erosion processes. On the other side paper confirms anthropogenic impact as well as technogenic load on the landscape diversity, biodiversity by the conducted monitoring and local community survey.

**Keywords**: climate change, landscape diversity, biodiversity, erosion, snow cover, mountain ecosystem

## Introduction

The importance of mountain regions for global biodiversity was indicated by authors of the work [1]. In their global analyses of regional-scale hotspots of plant endemism, Myers and co-workers identified mountain regions as among the richest in the world.

Mountains are home to more than 85% of the world's amphibian, bird and mammal species. Rugged, high-elevation environments play key role in maintaining mountain’s biodiversity [2]. High mountains receive a lot of rain and experience low rates of evaporation at high elevations. They contain large stores of water as snow and ice which are the foundation for biodiversity in the surrounding catchment. Mountain environments are warming faster than the global average. This is accelerating the rate of change in these ecosystems vulnerable to both climate change and human intervention.

The paper [3] shows the importance of landscape diversity in the system of regional indicators of sustainable development. An algorithm for formation has been developed, and a database structure has been proposed that allows for systematization and use in the context of environmental planning of the territory of quantitative and qualitative information on various properties of geosystems. A description of a block of indicators reflecting certain qualities of mountain systems, such as vulnerability potential and landscape change, has been proposed. The main features of calculated vulnerability indicators creates the possibility of using the state of snow cover of mountain slopes, as well as the state of mountain rivers and runoffs as indicators of changes in mountain ecosystems under the influence of climate change.

The diverse landscapes of Azerbaijan include mountains, rivers, wetlands, lakes, semi-arid low-lying plains, and an 800-kilometer coastline. The Greater Caucasus Mountains in the northeast and the Lesser Caucasus Mountains in the southwest have nonliving high alpine zones, alpine meadows, high mountain forests, middle and lower forest belts, and foothills [4].

Country Development Cooperation Strategy for 2020-2025 indicated lack of accessible and reliable data to effectively manage natural resources and biodiversity in Azerbaijan [5]. Therefore, the indicators characterizing the ecological state of mountain systems are an urgent task.

Due to changes of climate and land use the potential risks of soil erosion and landslides may increase. Soil and slope stability are a crucial precondition to preserve the functions of the mountain environment, for example water supply, nutrient production, biodiversity, aesthetics, and cultural heritage. Landslides endanger slope stability and the resource soil in mountains areas all over the world, as one extreme event can constitute a great proportion of total soil loss while recovery of soil characteristics is very slow [6].

Topographic and climatic extreme conditions make the mountain environment vulnerable to changes of climate and land use [7].

Greenhouse Gas emission's atmospheric concentration as one of the important factors of climate change, a number of climatic extreme conditions influence atmospheric temperature, humidity change, that provokes rainy clouds formation, precipitations localization displacement. This is followed to soil, rock intense flushing. Climate warming causes the increased oceans, sea surfaces evaporation which is resulted in steady rains. As a result of the displacement of localization, precipitation provokes the mountain river-bed overflow, river flow direction is changed and consequently flushing down each and all along the path by generating rocks erosion, soil erosion as well as valley, canyon forming. The mountain affected by erosion has been settled.

On the other side warming is caused by the forest's drying and disafforestation that also provokes the rapid erosion. (8.)

## Materials and methods

Most studies evaluate specific services or types, and as a consequence there are difficulties in integrating results. Any summary assessment on a general scale raises significant difficulties: how to define a coherent structure; how to deal with data limitations; how to aggregate values to estimate global impacts from large-scale changes in ecosystems [9].

One of the main factors of climate change in the mountain ecosystem is the state of snow cover. Snow reflects much of the incoming solar radiation back out to space. But climate change is increasing rates of snow melt, exposing large areas of dark mountain surface to the sun. This is leading to rising solar absorption rates and significant warming.

Increased warming in mountain environments will further amplify snow melt and reduce snow accumulation. Less snow and ice will result in a reduced availability of water downstream in the future, affecting the functioning of habitats in the mountain catchment.

The authors of the paper carried out the studies of snows that extend over the boundaries of mountain forests. The study was based on the method of assessing the snow cover. The justification of the proposed indicators characterizing the state of natural conditions of mountain systems is presented in the works [10,11]. The main structural unit of the snow cover model is considered as the snow layer.

Snow covers are recorded during geological expeditions on the hydrological state of mountain flows on the slopes of the South Caucasus. In Azerbaijan studies were carried out in the Balakan and Zagatala regions at altitudes of 2300-2500 m in the period from 1995 to 2005 in the summer months. During this period, the snow caps were measured, their quantity was accounted [12].

Based on the results of the expeditions also in 2010, it was concluded that rapid disappearance and decrease in the snow cover size in the high zone is associated with global warming. Snow cover in high areas is the best indicator of climate change.

At the same time in the summer expeditions, it was studied drainage state of the mountain systems. According to the results of observations until 2005, there were fixed changes in the rivers state, the volume of water decreased by almost 2 times, and in 2010 the water flow in mountain rivers was reduced to the state of runoff.

Research on hydrochemical and hydrobiological state in the mountainous sections of the rivers, conducted by Institutes of Fisheries and Zoology of AS Uzbekistan [13], resulted in conclusion, that good water quality is characteristic of background watercourses, which does not imply direct anthropogenic impact, and takes place for mountain water bodies, where changes in hydrological reserves are natural and depend mainly of the climatic factor's dynamics.

Taking into account the results obtained by scientists it was concluded that irreversible changes in the channels of some small high mountain rivers occurred as a result of the decrease and disappearance of snow cover.

## Discussion

Leave no mountain behind: the synthesis series – Migration, mobility and immobility in the mountains.

Humboldt's enigma: What causes global patterns of mountain biodiversity? [14]

The heavy rains caused the anomalous summer of 2024 in the South Caucasus and such a summer happens very rarely, once every 50 years. In some regions such precipitation was almost daily, while in other regions it rained with pauses of 3-7 days. These rains greatly affected the environment, the

landscape of the regions, the flora of the mountains and plains. Since August, we began monitoring these regions and these are the results we came to. Conversations were held with mountaineers and geologists who were in these regions a year ago, with shepherds who grazed their flocks there, expeditions were also organized to these areas and the conclusions were disappointing. Soil erosion in the mountains this summer was 20%, while usually during the summer season this figure is 1-5%. This led to the destruction of rocks, which usually happens during an earthquake. But in this case, this role was taken on by heavy rainfall, which washed away the mountain paths along which animals living in the South Caucasus usually walked. The paths in turn became overgrown with grass, the collapse of rocks led to the formation of small lakes, the water level in which rose every time after the rains. Heavy rains also affected forest rodents, which are the food source for both mammals and birds living in the Caucasus. These include forest and field mice, which live in burrows. The rains filled their burrows with water, which led to the death of their offspring, which they were unable to save. These rodents were forced to leave their habitats, i.e. they migrated. In nature, everything is interconnected, the migration of rodents and the death of their offspring leads to a reduction in the food supply of predatory animals such as foxes, wolves, jackals, badgers and wild cats. This also applies to birds of prey living in the South Caucasus, with the exception of eagles and vultures. Lack of food for predatory animals will lead to their starvation, and hungry predators are a source of diseases and pose a danger to villagers and rural residents, in search of food they increasingly attack domestic animals and the villagers themselves. If in normal times 4 colonies of rodents lived on 1 hectare of land, then as a result of heavy rains there are already 2 colonies per 1 hectare of land. Due to soil erosion and the appearance of small lakes, the mountain landscape begins to change. Mountain rivers overflow, washing away their terraces, the washing away of mountains by rain leads to the appearance of large boulders in the rivers, all this leads to a very rapid change in the landscape. Bears, badgers and raccoons also feed on plant food, especially bears. Climate change has led to the fact that blackberries, which bears eat, remain red on the bushes even in September, although at the end of August they should be black. Many wild berries and fruits were destroyed by hail, meaning the bear was left hungry and this would eventually lead him to the village. Wild berries are also eaten by birds living in the Caucasus, and the climate has deprived them of food. Hail, which occurred much more often this summer than in the last 50 years, destroyed the nests of large birds of prey, such as the golden eagle, the bearded eagle and the griffon vulture. Erosion also destroyed the hanging cliffs under which large birds of prey usually built their nests. Previously, it was believed that hanging rocks were destroyed by tectonic phenomena, but now it has become clear that this can also happen due to increased soil moisture. The above is the result of observations of changes occurring in nature. For a more thorough study of the problem, it is necessary to make a map of each section, each hectare of changes occurring in the mountains as a result of climatic cataclysms for each year. These changes include flora, landscapes, geology, agriculture, forestry, etc. It is necessary to monitor certain areas of the South Caucasus Mountains to understand how certain climate changes affect nature, flora and fauna, and the landscape of this region over a year, 5 years, or 10 years. Only then can we come to a specific decision on how to influence these processes. For example, in the Zagatala region, the nature, flora, and fauna differ significantly from the Guba-Shamakhi zone. This is due to the fact that there have always been heavy rains here, much more than in other areas of Azerbaijan. This has led to the rapid growth of vegetation in this zone in the alpine and subalpine meadows and in the forest zone. Therefore, the vegetation in the Zagatala and Gakh zones is very different from all other zones of Azerbaijan. It should be noted that it is the climate that makes nature and landscape. Nature is an ideal designer; it creates it out of nothing. Any traveler, walking around Azerbaijan, will choose Zagatala or Belokan, thanks to the climate and nature of these areas. If you look at Gobustan, where the sun is constantly shining, it is a plain, 720 sq. km. and is a wintering ground for flocks, but this year the grass in this region remained green until August. This has never happened in the history of the region, at least in the last 50-60 years. The fact is that in the summer, all the flocks go up to the mountains for food, and in Gobustan all the grass burns out in the sun and the region turns into a hot desert. From mid-August, the flocks usually begin to descend from the alpine meadows, since in the mountains the grass begins to burn out from the heat, and in Gobustan, with the approach of autumn, it begins to rain, the humidity provides food for all the herds, both domestic and wild. And now something incomprehensible is happening, until the beginning of August there was grass in Gobustan, and now it is already September and it is hot, what October will be like - it is not known, it may also be hot. And in the mountains there is still green grass, thanks to the rains. We are witnessing all these changes in nature. In Gobustan, about 200 lakes are formed in autumn, thanks to

which animals quench their thirst, ducks and other migratory birds swim in them. It is quite possible that this year there will not be enough rain for the formation of these lakes. Natural landscapes are not transformed as a result of human activity, they are subject to the laws of natural self-development of natural ecological systems, but human activity significantly affects the natural landscape. One of the main factors of human activity that significantly affects climate and landscape change, which we prefer to remain silent about, is nanotechnology. Radio frequency radiation affects all living things, including humans and plants, which has attracted considerable attention from researchers in recent years. A major factor in the expansion of radio frequency radiation is the globalization of telecommunications networks. The increase in the number of mobile phone towers poses a threat to local flora and fauna in both urban and rural areas. Few scientists have studied how mobile phone radiation affects the yield of certain crops.

In today's world, most people rely on their mobile phones as their primary means of communicating with others. One of the many benefits of owning a mobile phone is the convenience it provides for maintaining personal and professional relationships regardless of location. Mobile phones are electrical gadgets that use radio frequency electromagnetic radiation to operate. The number of people who own mobile phones and the number of places where they can be used have increased dramatically since the first phones were introduced in the 1980s. It is known that there are currently 8.4 billion users worldwide and this number is expected to grow to 9.2 billion by 2028. Although there are many advantages to using a mobile phone, there are also significant disadvantages. The rise in mobile phone use has been accompanied by increased awareness of the potential dangers created by electromagnetic fields emitted by nearby cell phone towers. The mobile phone and the base station are two-way radio frequency waves. Television systems, radio transmitters, and radar are just a few of the many examples of way radio frequency waves. In addition, shared cell phone towers are now being installed in developing and developed countries, where many cellular service providers share a single tower to install high-gain antennas. Further research has shown that when many frequency fields are simultaneously exposed, the overall radiation must be taken into account, as the radiation density level can easily exceed permissible values. The increasing prevalence of shared cell phone towers is expected to increase the sensitivity of plants to such radiation. Cell phones and towers use radio frequency energy. Cell phone radiation is radio frequency energy. Both ionizing and non-ionizing radiation exist in the environment. By removing electrons from atoms and molecules, ionizing radiation can harm a wide range of substances, including air, water, and biological tissue. Radio waves emitted by antennas of mobile phones and smartphones are easily absorbed by the body or any object located close to the antenna and convert this energy into heat, which can change the local water temperature, which can have a negative impact on the coastal ecosystem. All new stationary antennas of mobile communications began to be installed in all areas, even in the highlands, and near villages and towns. This led to the fact that bees began to die out and beekeepers were the first to sound the alarm. The search for the causes of their extinction did not lead to any results, since diseases associated with their disappearance were not found. It turned out that electromagnetic waves emitted by antennas lead to the fact that bees lose their bearings and go to other places, not finding their hives, they die there. Bees are insects directly associated with humans and therefore it is easier to notice changes in their behavior than in the behavior of other insects. And how many other insects - butterflies and beetles in forests and fields die out for the same reason, in fact, we cannot say for sure. The blow dealt to bees extends to a thousand other insects. It is known that everything big starts with small things. Sometimes great commanders lost wars only because a nail got stuck in a horse's hooves. And when we close our eyes to such a trifle as the disappearance of insects, this ultimately leads to such a tragedy in nature as a change in the landscape. And this happens in the following way. Every summer, thousands of insectivorous birds fly to Azerbaijan to nest, which nest in our forests and anthropogenic zone and naturally feed exclusively on insects, thereby saving trees from many diseases. Birds, as everyone knows, are the orderlies of forests, fields and all nature. The appearance of stationary mobile phone antennas leads to the disappearance of insects, birds that arrive for wintering remain hungry in the first year, then they find new places for food and gradually forests and bushes begin to get sick. In addition, pollination of trees and flowers, which occurs due to insects, is reduced, the natural balance is sharply disturbed, forests and fields gradually turn into semi-desert, the landscape has changed. Cellular antennas can also potentially change the DNA of living beings, causing nuclear damage and have a harmful effect on both flora and fauna in the vicinity. This is already confirmed data and this is happening not only in Azerbaijan and not only in the Caucasus.

## Conclusions

By the result of conducted monitoring of landscapes and biodiversity state of mountains in Southern Caucasus region it was confirmed the climate change dinamic’s impact, anthropogenic impact as well as technogenic load on the landscape diversity, biodiversity state, mountain water bodies. It was concluded that indicators of mountain ecosystems under the influence of climate change are:

- change in the state of snow cover on mountain slopes;
- changing the state of mountain rivers, reducing the flow of water in high-mountain water arteries;
- erosion of mountain slopes;
- deforestation;
- species change in the biodiversity of animals in mountain areas.

## Recommendations

- to share experience of climate change adaptation mechanisms concerning biodiversity safety, ecosystems conservation, particularly soil, rocks erosion and desertification prevention;
- to discuss and exchange opinions in paleoenvironmental data impacts on climate change and mitigation processes development under Kyoto Protocol subject;
- to be acquainted with best available technologies and best environmental practices (BAT/BEP) related to climate change for project proposals using Clean Development Mechanism (CDM) preparation purposes;
- to provide cost effective tools to reduce climate change impacts by presenting examples of national Pollution Release and Transfer Registers (PRTR) development to be used as educational and public awareness facilities.

We in cooperation with the authors of proposals [15] therefore urge that ecosystem products and services and areas of natural surface cover be given the same priority as anthropogenic greenhouse gases in climate change mitigation procedures.

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# Prevention of salt precipitation in oil recovery

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**Abstract**

New compositions were developed for the purpose of preventing salt precipitation formed during oil and gas extraction from carbonate and terrigenous layered wells. These compositions consist of inorganic acid, difunctional surfactant polyether, surface-active dispersant solution and water. Physicochemical properties of the prepared compositions were studied. Protection efficiency of the inhibitor compositions against inorganic salt precipitation was determined using a known methodology in a formation water model. The results prove that high protection efficiency was observed in the inhibitor compositions by adding them to calcium sulfate solution at doses of 30 mg/l and especially at 40 and 50 mg/l. The active ingredient content in the composition's ranges from 19.55% to 26.0%. Additional compositions with varying amounts of active ingredients were prepared to demonstrate the successful range of high protection efficiency. Tests proved that these additional compositions show weak protection efficiency against inorganic salt precipitation.

**Keywords**: inhibitor, composition, salt precipitation, protection efficiency, active ingredient.

## Introduction

The formation of salt during the development and operation of oil fields is a complex problem that remains insufficiently studied. Inorganic salt precipitation, particularly in the downhole pumping equipment, is observed in virtually all regions of oil production. This phenomenon significantly reduces the inter-repair periods of well operation and increases downtime, resulting in decreased oil flow rates, worsened technical and economic outcomes, and increased production costs. Salt precipitation is one of the many problems encountered during oil production. The precipitation of salts on the walls of pipelines reduces effective diameter and decreases throughput, often leading to complete blockages. The precipitation of various acids leads to contamination of wells, equipment failure, reduced fluid flow, and the emergence of various ecological problems. The main source of salt separation is formation water produced alongside oil. Changes in temperature and pressure result in an excess of inorganic substances, such as calcium carbonate, sulfate, as well as poorly soluble salts of alkaline-earth metals like magnesium, barium, and strontium. Mixed deposits can contain iron sulfide, solid hydrocarbon compounds from oil, quartz, and clay particles from the rock [1,2]. The resulting salt precipitation sharply reduce the productivity of technological processes in oil production, leading to overheating of chimney materials, equipment failures, and increased downtime. Consequently, environmental pollution and, in some cases, complete equipment failure occur [3]. Currently, there is a tendency to increase the number of wells and oil processing facilities complicated by salt precipitation [4].

Long-term experiences in combating inorganic salt precipitation have shown that the most effective methods are based on preventing salt precipitation [5]. The correct selection of methods can only be achieved through a careful study of the hydrochemical and thermodynamic conditions of the operating facilities. The reasons for the extreme saturation of produced formation waters with salt-forming ions must also be clarified. The separation and precipitation of inorganic salts depend on the disruption of the system's chemical equilibrium, that is, the transition of formation waters into a state of excessive saturation.

The main difficulties in clarifying the causes of salt precipitation arise from the lack of systematic and accurate information regarding hydrochemical and hydrogeological changes in the operating facilities over long periods [6]. Among the known

methods to prevent inorganic salt formation during oil production, the most effective is the use of chemical reagents - inhibitors [5]. The chemical methods of combating salt precipitation are based on the application of reagents that prevent the deposition of salts on the surface of mining equipment. Global practices in the oil production industry show that the use of chemical reagents allows for the effective and sustainable protection of equipment against salt precipitation at relatively low costs. Thus, the creation of effective salt precipitation inhibitors remains a pressing issue. Despite the stringent requirements placed on wastewater, opportunities for the use of inhibitors arise [7].

The objective of the study is to develop new salt precipitation compositions (inhibitors) based on inorganic acid, difunctional surfactant polyether, dispersant solution, and water, and to conduct tests on their effectiveness in preventing calcium sulfate precipitation in a formation water model.

## Experimental part

The study reveals that prevention of inorganic salt precipitation during the processing of carbonate and terrigenous productive layers can enhance the productivity of the layers. In this case, the extraction of insoluble salts that lower the productivity of the layer and well equipment is excluded. It’s achieved by the development of the compositions to prevent salt precipitation during oil and gas production from carbonate and terrigenous wells. The compositions consist of inorganic acid (25-30wt.%), difunctional surfactant polyether (8-12wt.%), surface-active dispersant solution (18-22wt.%), and water (the remainder). The densities of the developed compositions are 1020-1050 kg/m³ (at 20°C), kinematic viscosities are 30-40 mm²/s (at 20°C), freezing points range from -5 to -15°C, and pH values are 2-3. The compositions are dark brown transparent liquids.

It is known that oil-bearing rocks exhibit various wetting and sorption properties. As a result, it is necessary to use reagents reducing interfacial tension at the "oil-inhibitor solution interface" to improve the adsorption-desorption properties of salt inhibitors. These reagents allow for an increased contact area with both silicate and aluminosilicate, as well as carbonate mixtures.

The developed reagent-inhibitors are highly effective as long-lasting salt inhibitors due to their adsorption-desorption properties. The inorganic acid included in the composition cleans the wellbore area and pump-compressor pipes from salts and paraffin-resin deposits. Addition of difunctional surfactant polyether into the solvent reduces the interfacial tension at the boundary. The polyether adsorbs onto asphalt-resin-paraffin deposits (ARPD), leading to a reduction in interfacial tension between it and the solvent. The inclusion of polyether positively affects the inhibition effect, increasing the removal rate of ARPD by 5-30% [8]. The dispersant solution, as a surfactant, significantly reduces interfacial tension at the phase boundary, thereby aiding the action of the polyether. The dispersant consists of ethoxylated alkyl sulfate (10-30wt.%), propan-1,2-diol (10-20wt.%), and ethoxylates of C10-16 alcohols (0.1-1.0wt.%). The results of the study conducted on the development of the compositions are set in Tab. 1.

**Table 1.** Results of the studies on the development of compositions for the prevention of salt precipitation

| Composition No. | Amount of the substances in compositions, wt.% | | | |
|---|---|---|---|---|
| | inorganic acid | dispersant | polyether | water |
| 1 | 25 | 18 | 8 | 49 |
| 2 | 30 | 18 | 8 | 44 |
| 3 | 25 | 20 | 8 | 47 |
| 4 | 30 | 20 | 8 | 42 |
| 5 | 25 | 22 | 8 | 45 |
| 6 | 30 | 22 | 8 | 40 |
| 7 | 25 | 18 | 10 | 47 |
| 8 | 30 | 18 | 10 | 42 |
| 9 | 25 | 20 | 10 | 45 |
| 10 | 30 | 20 | 10 | 40 |
| 11 | 25 | 22 | 10 | 43 |
| 12 | 30 | 22 | 10 | 38 |
| 13 | 25 | 18 | 12 | 45 |
| 14 | 30 | 18 | 12 | 40 |
| 15 | 25 | 20 | 12 | 43 |
| 16 | 30 | 20 | 12 | 38 |
| 17 | 25 | 22 | 12 | 41 |
| 18 | 30 | 22 | 12 | 36 |

The protection efficiency tests of the developed inhibitor compositions were carried out in a model of layer waters to prevent calcium sulfate precipitation. The following solutions were used to model the formation of precipitation:

| | |
|---|---|
| CaCl2 | 13.6 g/dm3 |
| MgCl2·6H2O | 1.24 g/dm3 |
| Na2SO4 | 13.0 g/dm3 |
| NaCl | 18.8 g/dm$^3$ |

According to the methodology of the tests [9], both the samples with the reagent and those without it were kept in a thermostat at 80°C for 5 hours after adding the inhibitor to the layer water model. After the samples cooled down, the precipitate was filtered. The residual amount of calcium cations remaining in the solution was determined by the trigonometric titration method. The protective efficiency of the inhibitor (%) is calculated using the formula E=[(Ci-Ck)/(Co-Ck)•100, where Ci is the amount of calcium cations remaining in the sample with the inhibitor after being kept in the thermostat, mg/dm³; Ck is the amount of calcium cations in the sample without the inhibitor, mg/dm³; Co is the amount of calcium cations in the initial solution, mg/dm³.

The results of the tests carried out for the purpose of determining the protection efficiency of the developed inhibitor compositions against inorganic salt precipitates are presented in Tab. 2.

**Table 2.** Results of the studies conducted to determine the protection efficiency of inhibitor compositions against inorganic salt precipitates.

| Test No. | Inhibitor composition | Inhibitor consumption, mg/l | Inhibitor protection efficiency, % |
|---|---|---|---|
| 1 | 19.55 % active substance 80.45% water | 30<br>40<br>50 | 90.4<br>93.1<br>96.3 |
| 2 | 20.6 % active substance 79.4% water | 30<br>40<br>50 | 91.7<br>94.4<br>97.5 |
| 3 | 20.26 % active substance 79.74% water | 30<br>40<br>50 | 94.4<br>96.7<br>98.7 |
| 4 | 21.3 % active substance 78.7% water | 30<br>40<br>50 | 94.4<br>96.3<br>98.4 |
| 5 | 20.95 % active substance 79.05% water | 30<br>40<br>50 | 91.3<br>03.7<br>96.1 |
| 6 | 22.0 % active substance 78.0% water | 30<br>40<br>50 | 92.4<br>93.7<br>96.1 |
| 7 | 21.55 % active substance 78.45% water | 30<br>40<br>50 | 95.4<br>97.3<br>99.5 |
| 8 | 22.6 % active substance 77.4% water | 30<br>40<br>50 | 96.1<br>98.0<br>99.6 |
| 9 | 21.55 % active substance 78.45% water | 30<br>40<br>50 | 97.3<br>99.5<br>100.0 |
| 10 | 23.3 % active substance 76.7% water | 30<br>40<br>50 | 98.1<br>99.6<br>100.0 |
| 11 | 22.95 % active substance 77.05% water | 30<br>40<br>50 | 96.3<br>98.4<br>99.5 |
| 12 | 24.0 % active substance 76.0% water | 30<br>40<br>50 | 95.3<br>97.4<br>99.2 |
| 13 | 23.55 % active substance 76.45% water | 30<br>40<br>50 | 92.7<br>95.1<br>97.0 |

| | | | |
|---|---|---|---|
| 14 | 24.6 % active substance 78.7% water | 30<br>40<br>50 | 91.2<br>93.7<br>95.8 |
| 15 | 24.25 % active substance 75.75% water | 30<br>40<br>50 | 94.6<br>96.5<br>98.8 |
| 16 | 25.3 % active substance 74.7% water | 30<br>40<br>50 | 95.1<br>97.4<br>99.0 |
| 17 | 24.95 % active substance 75.05% water | 30<br>40<br>50 | 90.3<br>93.4<br>95.8 |
| 18 | 26.0 % active substance 74.0% water | 30<br>40<br>50 | 91.7<br>94.2<br>96.8 |

As is evident from Tab. 2, high protection efficiency is achieved by the addition of inhibitor compositions to calcium sulfate solution at doses of 30 mg/l, and especially at 40 and 50 mg/l. The amount of active substance in the composition's ranges from 19.55% to 26.0%. Additional compositions containing less and more active substance than the specified amounts were developed to provide the demonstration of the effectiveness of this selected range of high protection efficiency. The results of the studies carried out on the development of these compositions are set into Tab. 3.

**Table 3.** Results of the studies conducted on the development of additional compositions for preventing salt precipitation.

| **Composition No.** | **Amount of the substances in compositoion, wt. %** | | | |
|---|---|---|---|---|
| | inorganic acid | dispersant | polyether | water |
| 1 | 20 | 5 | 10 | 65 |
| 2 | 30 | 30 | 12 | 28 |
| 3 | 25 | 20 | 5 | 50 |
| 4 | 30 | 20 | 17 | 33 |

Protection efficiency tests of the developed additional inhibitor compositions were conducted in a model of layer waters to prevent calcium sulfate precipitation. The previously mentioned solutions were used to model the formation of precipitation. The tests were carried out according to the methodology provided in [9]. The results of the tests carried out to determine the protection efficiency of the developed additional compositions against inorganic salt precipitates are presented in Tab. 4.

**Table 4.** Results of the studies conducted to determine the protection efficiency of additional inhibitor compositions against inorganic salt precipitates

| Composition No. | Inhibitor composition | Inhibitor consumption, mg/l | Inhibitor protection efficiency, % |
|---|---|---|---|
| 1 | 15.95 % active substance 84.05% water | 30<br>40<br>50 | 65.8<br>67.4<br>69.7 |
| 2 | 28.8 % active substance 71.2% water | 30<br>40<br>50 | 64.3<br>66.7<br>69.1 |
| 3 | 17.3 % active substance 82.7% water | 30<br>40<br>50 | 64.3<br>67.0<br>69.6 |
| 4 | 30.3 % active substance 69.7% water | 30<br>40<br>50 | 65.7<br>67.3<br>69.4 |

As is evident from Tab.4, the amount of active substance in the developed additional compositions of the inhibitor ranges from 15.95% to 17.3% and from 28.3% to 30.3%. The inhibitor activity of the

lower concentration solutions (15.95%-17.3%) is weak (64.3%-69.7%), while the higher concentration solution (28.3%-30.3%) cannot be compatible with highly mineralized waters.

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# The impact of patentability automation on ecology and environment

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**Abstract**

Automating the process of finding patentability would involve using technology and tools to assist in patent search and analysis. Patentability searches are performed to determine whether an invention is novel, non-obvious and industrial application or utility. The requirements for patentability could differ from country and IP office. Patent search is a critical step that precedes the determination of patentability. During the patent search examiner finds relevant documents. Which could affect novelty, non-obvious and industrial applications or utility. The automation would check for if the invention is applicable in the industry. This process would be done before the automation conducts a patentability search. If the invention is not applicable then the application would be refused, and if it's applicable then the automation would go into the second step. Starting with the second step the automation would start conducting a patentability search. The second step is checking the novelty. Later, the automation would find if the application is or is not obvious. About the connection between automation of patentability and ecological studies. Automation can expedite the patent search and approval process for eco-friendly technologies, such as renewable energy, waste reduction, and sustainable materials. Automating patentability may encourage inventors to focus on green technologies by making the patenting process more accessible and less costly.

**Keywords:** Patentability, patent search, patent law, automated search, AI, artificial intelligence, patents, inventions, machine learning, text mining, automation, ecology, environment.

## Introduction

Automating the process of finding patentability would involve using technology and tools to assist in patent search and analysis. Patentability searches are usually performed to determine whether an invention is novel, non-obvious and industrial application or utility, which are key criteria for obtaining a patent. The requirements for patentability and the subject of the patent could differ from country to country, from IP office to IP office.

There are many ways to automate the process of finding patentability. It would depend on the level of automation of patent search. Since there are many different ways of the process of patent search.

One of the ways would use keyword-based searches. During the patent search, human examiners could open patent databases and search for patents using the keywords. The examiner examines the given application and finds the keywords. After that examiner searches with keywords on the patent databases like PATENSCOPE or USPTO. The search most of the time gives many documents and the examiner needs to open and inspect them one by one. Which only creates partial automation.

Another option would be using more advanced patent search software or using AI. There are many patent search software tools. Examples would be PatSeer, InnovationQ, TotalPatent, etc. AI (artificial intelligence) and machine learning algorithms can help automate the process further. Some AI-driven platforms, such as PatSnap and Innography, can analyze large patent datasets to identify relevant prior art and assess patentability. Those ways would create better automation because those would make patent searches more simple and less time-consuming.

I believe automation of patent search would make the process of finding patentability more efficient. When automating patentability searches, it's also important to know that while technology can assist in the search process, human expertise is often essential to interpret search results and make the final determination of patentability.

One of the subjects of patents is invention. With more inventions in any industry, it gets more innovative. Considering this we could say more

inventions in the field of ecology and environment would have a positive impact. One of the main things that could be achieved with the automation of patentability is acceleration. Automation could do things faster than human examiners. Therefore, we would achieve an acceleration. It could also motivate the inventors to file more patent applications. In a way, we could say that automation would play a significant role in global ecological problems because it could accelerate the discovery, protection, and commercialization of environmentally beneficial technologies.

Automating patentability searches would also benefit Azerbaijan since it could make examination easier and less time-consuming. Which could increase the efficiency of the organization. It is also, worth mentioning that ecological and environmental innovations would also affect Azerbaijan.

Numerous conditions must be met to obtain a patent. One of the key substantive conditions is novelty. The invention must show some new characteristic which is not known in the body of knowledge that existed prior to the filing date (or the priority date) [1].

Another substantive condition is inventive step or non-obviousness. The invention must involve an inventive step. It could not be obviously deduced by a person with ordinary skills in the relevant technical field [1].

Another condition is industrial application or utility. The invention must be capable of being used for an industrial or business purpose beyond a mere theoretical phenomenon [1].

A similar condition could be found in the patent law of the Republic of Azerbaijan. According to the law, the subjects of patents can be inventions, utility modes and industrial designs. The first condition for the inventions is novelty. The inventions for this condition must have new characteristics. Another condition according to the law is an inventive step, which means the invention should not be obvious and the last condition is industrial application. If the invention can be made or used in any field of industry and economy, then the invention is considered applicable [2].

Another subject of the patent according to the patent of the Republic of Azerbaijan is the utility model. They have similar conditions to inventions with a few differences. According to the law utility model in Azerbaijan can only be a device. While the inventions have three conditions, utility models only have two. Which are novelty and industrial applicability. Meaning that utility models do not have the requirement of inventiveness [2].

Patent law can be different from country to country. For example, in some countries like Azerbaijan, Russian Federation, etc. subjects of the patent are inventions, utility modes and industrial designs. In other countries, the subject of patents could be inventions and utility modes. While some countries can only have inventions. According to the law of the European Patent Office, the patentability requirements are a bit different. The first criterion is an invention should belong to any field of technology. The second criterion is industrial applicability. Another criterion is the inventions must be new. The last criterion is the invention must have the inventive step [3].

As it was mentioned above the patent laws in Azerbaijan and Russia are similar. According to the Civil Code of the Russian Federation patents are granted for three subjects: inventions, utility models and industrial designs [4].

The patentability conditions for inventions are novelty, inventiveness and industrial applicability. Novelty would mean that the claimed subject would be new over the prior art. The second condition is inventiveness, which would mean to be patentable, the claimed invention must be inventive over its prior art. The last condition is industrial applicability. The inventions must be applicable to the claimed industry [4].

Similar conditions can be found for utility models, where everything is the same as inventions with only one difference. Utility models do not have to fulfil the patentability requirement of inventiveness [4].

Other data shows conditions of patentability. For an invention to be patentable, the invention must: consist of patentable subject matter; be novel; have utility; and not be obvious. A patent application must sufficiently describe the invention in enough detail to enable a person skilled in the invention’s field to make, construct, compound or use the invention [5].

As it was mentioned above the subject of patents and conditions could differ from country to country. But overall, the national laws of most countries are similar. The main conditions are that the subjects of patents should be new, involve an inventive step and be capable of industrial application. Exceptions to patentability are also similar in most countries. Those depend on the national law but mostly it is: Discovery, Scientific theories, mathematical methods; Aesthetic creations; Inventions contrary to morality or public order; Therapeutic and diagnostic methods; Plant or animal varieties Plants or animals (other than microorganisms) [6].

Sometimes as exceptions to patentability, they also involve software. However, software-implemented inventions might be patentable. The software also can be patentable in some countries such as the USA, Canada and some European

countries. However, it is not patentable in some other countries such as the Russian Federation, the Republic of Azerbaijan, etc [2], [6].

To overcome some of these disadvantageous aspects of current keyword-based search approaches, it is necessary to decrease the manual work of the examiner. It is also essential to increase the quality of the search results by avoiding irrelevant patents from being returned, as well as automatically accounting for synonyms to reduce false negatives. This could be achieved by comparing the patent application with existing publications based on their entire texts rather than searching for specific keywords. By considering the entire texts of the documents, much more information, including the context of keywords used within the respective documents, is taken into account. For humans, it is of course infeasible to read the whole text of each possibly relevant document. Instead, state-of-the-art text processing techniques can be used for this task [7].

The search for prior art for a given patent application is in general conducted by a single person using mainly keyword searches, which might result in false positives as well as false negatives. Furthermore, as different patent applications are handled by different patent examiners, it is difficult to obtain a consistently labelled dataset. A more reliably labelled dataset would therefore be desirable to properly evaluate our automatic search approach [7].

Search for prior art for a given patent application, and thereby the citation process, can be greatly enhanced by a precursory similarity scoring of the patents based on their full texts. With a natural language processing (NLP) based approach we would not only greatly accelerate the search process, but, as shown in their empirical analysis, their method could also improve the quality of the results by reducing the number of omitted yet relevant documents [7].

The search for a patent's prior art is a particularly difficult problem, as patent applications are purposefully written in a way that creates little overlap with other patents, as only by distinguishing the invention from others, does a patent application have a chance of being granted. By showing that the automated full-text similarity search approach successfully improves the search for a patent's prior art, consequently, these methods are also promising candidates for enhancing other document searches, such as identifying relevant scientific literature [7].

The automation in the intellectual property rights domain has been growing. It is time for organizations to adopt the technology for faster growth and explore various other opportunities in this field. It is also crucial to provide opportunities for employees to learn machine learning tools and innovate new ways for patent analytics, drafting, and prosecution [8].

Several countries are already implementing AI tools for examination. For example, in Australia Data Science techniques are being used to analyse profiles of a patent within the current stockpile and predict the level of manual intervention required from the examiner to progress a patent application to the outcome. The model is used to predict the effort required to conduct a high-quality examination. This approach facilitates the allocation of appropriate resourcing for each examination task thereby improving examination efficiency [9].

IP Australia's Family Member Analyser (FMA) tool provides patent examiners with direct links to family members and documents from their electronic dossiers (where available) during patent examination. Examiners would often consider observations made in Foreign Examination Reports (FERs) of closely related patent family members to improve examination quality and avoid duplication of work where appropriate [9].

Other countries such as Austria, Brazil and China also use AI for classifying patents. In Canada, they use semantic AI search engines. Semantic search is a set of search engine capabilities, which includes understanding words from the searcher's intent and their search context [9].

Some regional patent offices such as the European Patent Office (EPO) also use AI. The EPO has been active in developing business solutions using Machine Learning and AI to manage patent files at various degrees of implementation: Automatic annotation of patent literature; Automatic detection of problem/solution in the patent document; Automatic detection of exclusion from patentability [9].

We could also use text mining tools to investigate patentability. Text mining is also known as text data mining. It is a process of transforming unstructured text into a structured format to identify meaningful patterns. The tools apply advanced analytical techniques, such as Naïve Bayes, Support Vector Machines (SVM), and other deep learning algorithms. In this way, companies can explore and discover some relationships within their unstructured data [10].

Text mining is a process of getting high-quality information from text. With text mining tools like Angoss, DigitalMR, IBM SPSS and others, the patent examiner might analyse the document much faster. Patent documents usually have significant study results. The documents are usually lengthy and rich in technical terminology. That takes a lot

of human effort to analyse. Automatic tools like text mining might make the process faster and more efficient.

Text mining could be done in this order: Firstly, we could use text mining to identify other terms that define the universe of things we are interested in. Then we could identify the relevant areas and find where those terms fall in the patent classification. After that, we could filter the data to the terms and the patent classifications on the document. Later we could measure how frequently those terms and classifications appear in the text. In the end, we could use experimental visualisation along the way to test and refine our analysis [11].

Another option we could use for automating finding patentability would be machine learning. In recent years Artificial Intelligence (AI) have been the focus of discussion. In recent years AI improved and started to be used widely around the globe. Machine learning libraries will typically make a big difference in patent analytics. Identifying packages and models that are well documented and have active communities will allow us to get things done rather than navigating complex layers of documentation or puzzling over what the statistics from a model run mean [11].

Any company, patent office, or academic institution that works with patents would benefit from doing patent analytics and machine learning. Patents represent great business value to many organizations, with corporations spending much money a year developing patentable technology and transacting their rights and patent offices around the world spend much money a year reviewing patent applications. AI or machine learning might help patent offices and companies working with patents [12].

Patent document collections are an immense source of knowledge for research worldwide. The rapid growth of the number of patent documents creates challenges for retrieving and analysing information. There are different patent analysis tasks that have been automated at least partially in the past [13].

As we move toward this new era of patent practices, the future is not bleak but full of opportunities. With automation taking over a significant chunk of the production work, law firms can focus more on complex tasks that require human expertise and judgment [14].

Embracing change and adapting to the new technological landscape will be key for law firms looking to thrive in this era of transformation. By understanding and leveraging these emerging trends, firms can position themselves at the forefront of the IP industry [14].

The integration of automation in the patent process can reduce the occurrence of human errors, help to optimize time and enable more efficient operations. Patent professionals often need to submit an Information Disclosure Statement (IDS) to the United States Patent and Trademark Office (USPTO), along with their patent application, to fulfil their "duty of candour." This duty requires patent applicants to provide their patent examiners with any information they have come across that could affect patentability. Completing an IDS form is basically just a matter of data entry, it can be quite daunting and time-consuming to input information for each material prior art reference that is known. The development of patent prosecution strategies will likely never be a completely automated activity. Automation in the patent process, patent professionals can conduct research to find viable office action rebuttals and produce drafts of office action responses in less time without sacrificing quality [15].

In patent practice, the industry is experiencing an explosion in new technologies that let examiners process their work efficiently with fewer errors, make data-driven decisions, and, overall, provide more value while respecting existing budget constraints [16].

Document automation has been on the rise for years across many industries and is now becoming mainstream in legal. Stanford's LegalTech Index lists about 250 legal document automation companies with more and more being added regularly [16].

Technology has long played an important role in the patent examination process. The modern examination system makes extensive use of technology, but the final decisions as to patentability are still made by humans. Automated patent examination technologies will have profound effects regardless of how they are integrated into the patent system. It is thus important to carefully plan for their development and implementation. When new technologies are adopted, they are often designed to fit into existing systems and complement existing practices [17].

Many advanced technologies might help to automate the process of finding patentability. One of the tools could be text mining. Text mining is a process of transforming unstructured text into structured data. With the data, the application does an easy analysis. It uses natural language processing (NLP), allowing machines to understand human language and process it automatically. With the help of it, patentability could be automated [18].

Patents on environment technologies is the number of environment-related inventions as a ratio of all domestic inventions in all technologies. Indicators of technology development are

constructed by measuring inventive activity using patent data across a wide range of environment-related technological domains including environmental management, water-related adaptation, and climate change mitigation technologies [19].

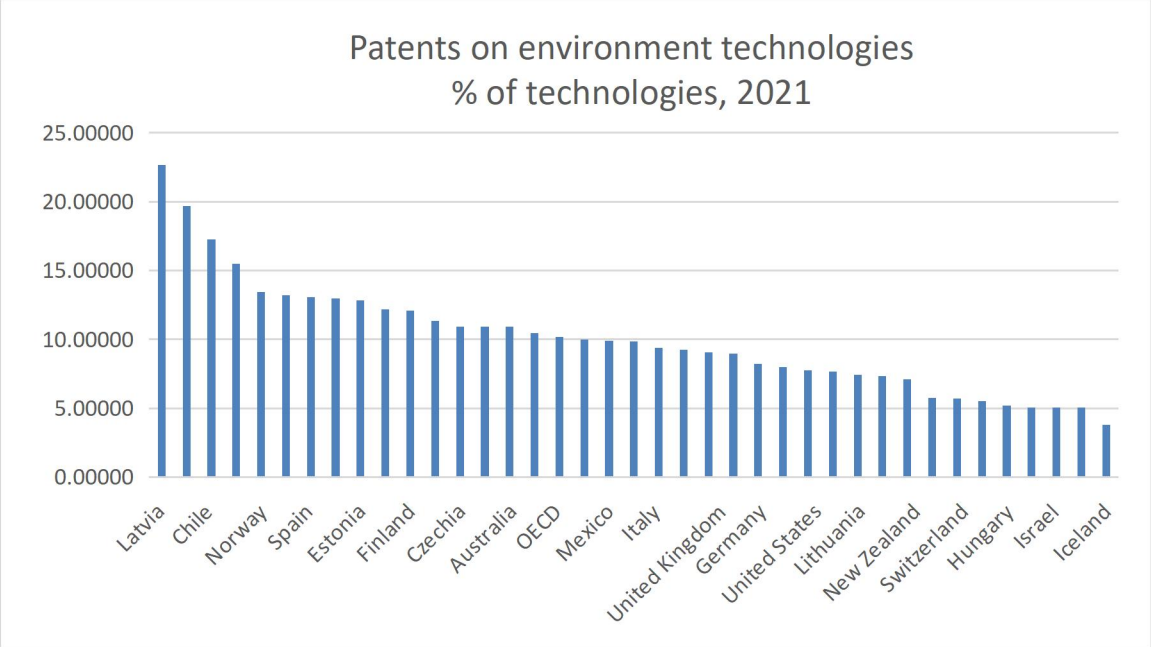


**Fig. 1 – Percentage of patents on environmental technologies, 2021 [19].**

According to the OECD (Organisation for Economic Co-operation and Development) for 2021 the best percentage for environmental patents were Latvia with almost 22.7 %. Worse one was Iceland with 3.8 % [19].

Another data article is about ecology patents. Ecology patents could be improvement patents granted to or applied for by ecology. In a way, it is an invention that would benefit ecology [20].

Another source also writes about the importance and the role of innovations in ecology. In this paper, the authors made a survey from patent offices and some patent searches using CPC and IPC. They found that patents could help to identify ecologically innovative firms. Two characteristically different samples from Germany and Italy were used to gain more insights and to receive a more generalizable result. The firms were asked in surveys about their ecological innovations, which functioned as a benchmark [21].

## Automation

The way of finding patentability is shown in the scheme below. According to the Patent Law of the Republic of Azerbaijan, inventions should have novelty and inventive steps and they should be applicable in the industry. While the utility models only require novelty and industrial application. That would mean the inventions lacking the inventive step could be protected as utility model patents [2].

In the figure (2) above we took the industrial applicability as our first condition for patentability. AI or machine learning with the help of advanced tools like text mining could find relevant documents to the application.

Firstly, the automation would check for if the invention is applicable in the industry. This process would be done before the automation conducts a patentability search. Here using laws of physics and logic the automation would decide whether the device is usable or not. If the invention is not applicable then the application would be refused, and if it's applicable then the automation would go into second step.

Starting with the second step the automation would start conducting a patentability search. The second step is checking the novelty. The automation would check novelty. Again, if the invention is not novel the application would be refused.

Lastly, the automation would find if the application is or is not obvious. In case, the device is obvious it could be protected under the utility model. The utility models only require novelty and industrial application. Whether the application would be converted from an invention to a utility model is up to the applicant. In case, where the invention has an innovative step then the application would be granted, and if it doesn't then the invention could be granted as a utility model.

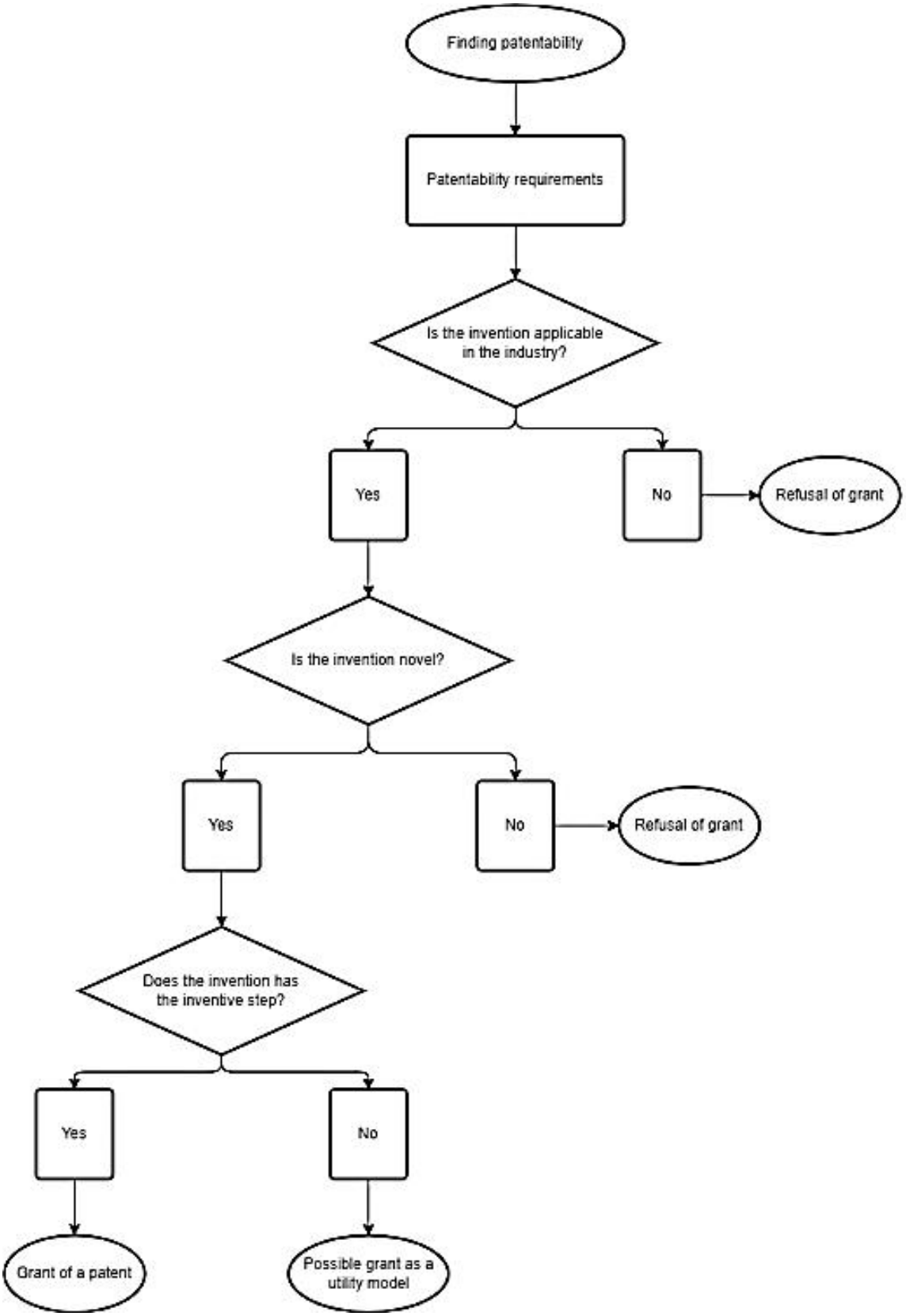


**Fig. 2 –** Algorithm of finding patentability for device

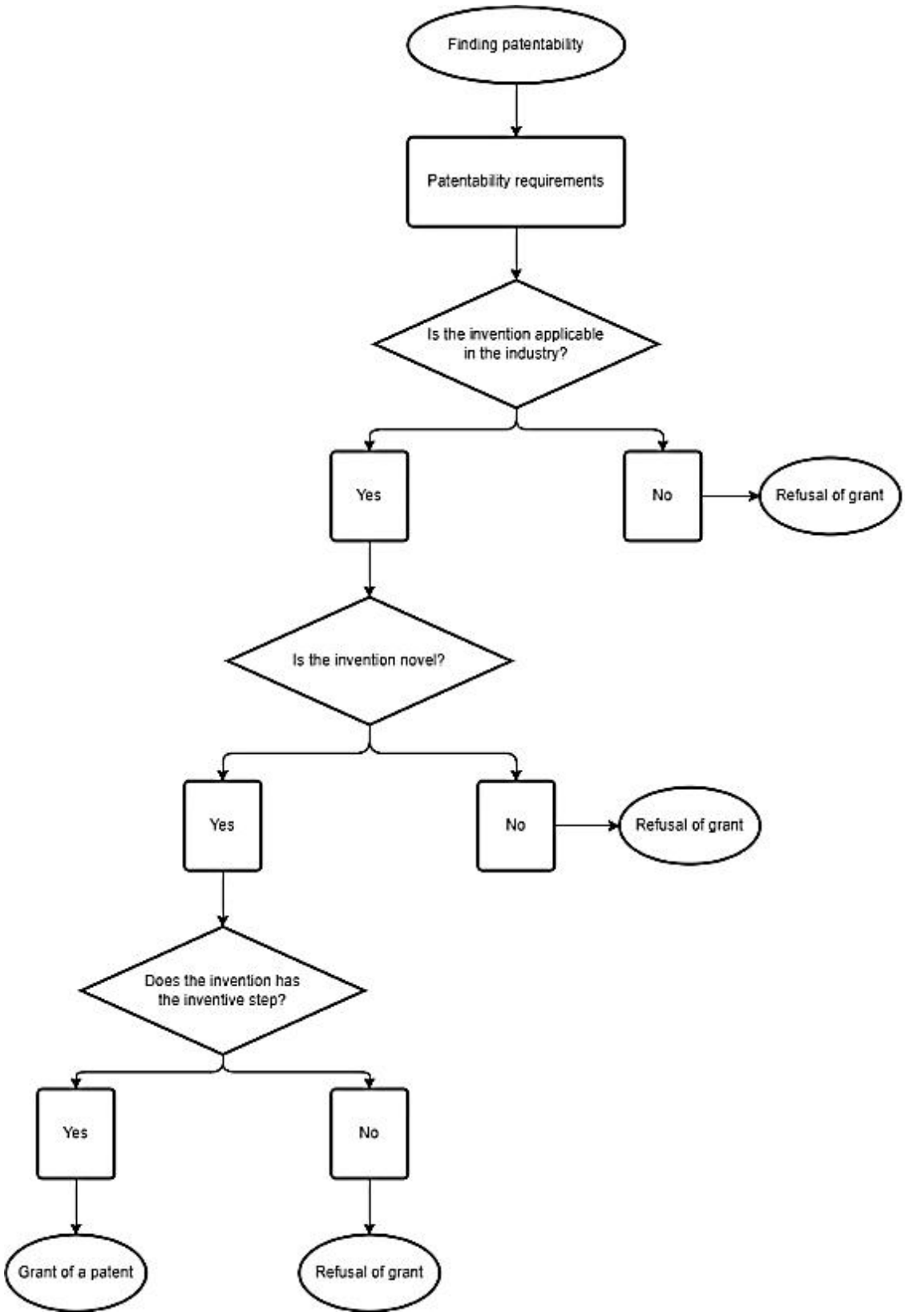


Fig. 3 – General algorithm for finding patentability for invention

Again firstly, the automation would check for if the invention is applicable in the industry. This process would be done before the automation conducts a patentability search. Here using laws of physics and logic the automation would decide whether the device is usable or not. If the invention is not applicable then the application would be refused, and if it's applicable then the automation would go into the second step.

Starting with the second step the automation

would start conducting a patentability search. The second step is checking the novelty. The automation would check novelty. Again, if the invention is not novel the application would be refused.

Lastly, the automation would find if the application is or is not obvious. In case, where the invention has an innovative step then the application would be granted, and if it doesn’t then the invention would be refused.

We can see many countries already implementing AI and new technologies in their national office examination of patentability. Which increases efficiency and saves time.

Patent search is a critical step that precedes the determination of patentability. During the patent search examiner finds relevant documents. Which could affect novelty, non-obvious and industrial applications or utility. Regarding that examiner decides whether the invention should be patented or not. With the automation of patent search the process of finding patentability could be automated too.

## Patent search

Now, we should look into patent search-related ecological or environmental inventions and utility models. For conducting a patent search we will look into FIPS, EAPATIS, Patentscope, Espacenet, and USPTO databases using IPC (international patent classification) and keywords.

Firstly, we would start with IPC. Unfortunately, there is no specific classification for ecological or environmental inventions or utility models. Which means we would have to use every single possible classification related to our topic. Chosen classifications are F01 – machines or engines in general; engine plants in general; steam engines, F03 – machines or engines for liquids; wind, spring, or weight motors; producing mechanical power or a reactive propulsive thrust, not otherwise provided for, F03D – wind motors and H02 – generation, conversion, or distribution of electric power.

## Search by IPC:

Search № 1 – F01. The lowest number of documents were found on the FIPS database with 21,005 documents. The highest number was in the Espacenet database with 688,559 patent documentations. Other databases: EAPATIS 33,231; Patentscope 648,328; USPTO 143,131.

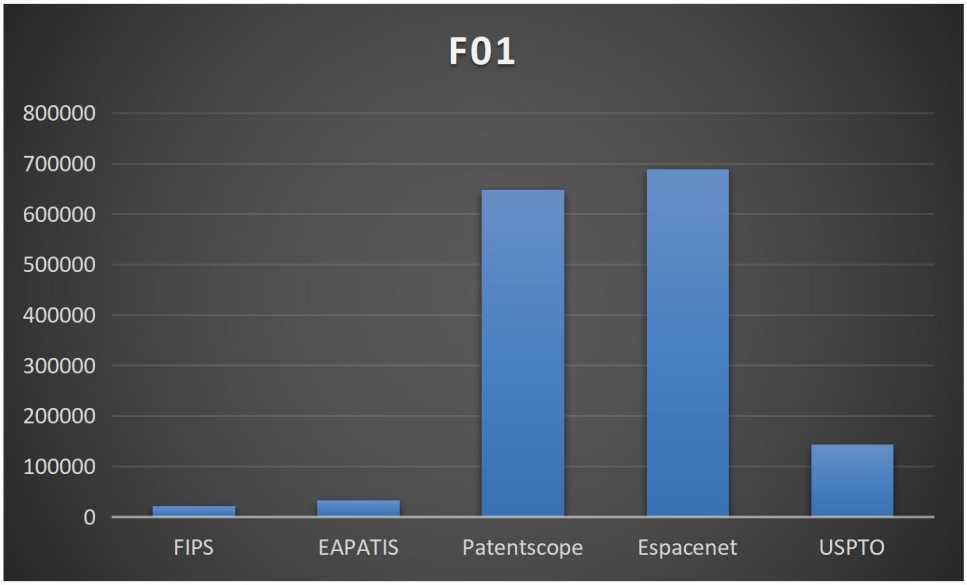


**Fig. 4 – Search 1, F01.**

Search № 2 – F03. The lowest number of documents were found on the FIPS database with 14,341 documents. The highest number was in the Espacenet database with 274,548 patent documentations. Other databases: EAPATIS 23,831; Patentscope 258,997; USPTO 34,653.

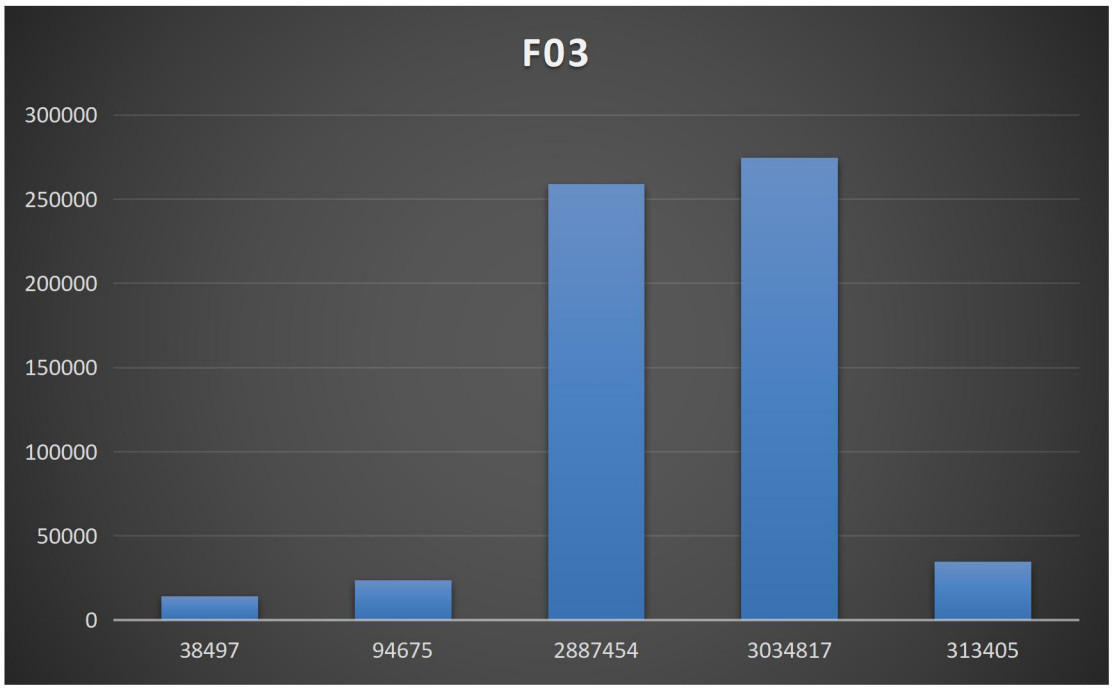


**Fig. 5 – Search 2, F03.**

Search № 3 – F03D. The lowest number of documents were found on the FIPS database with 4,637 documents. The highest number was in the Espacenet database with 127,117 patent documentations. Other databases: EAPATIS 9,092; Patentscope 122,625; USPTO 16,799.

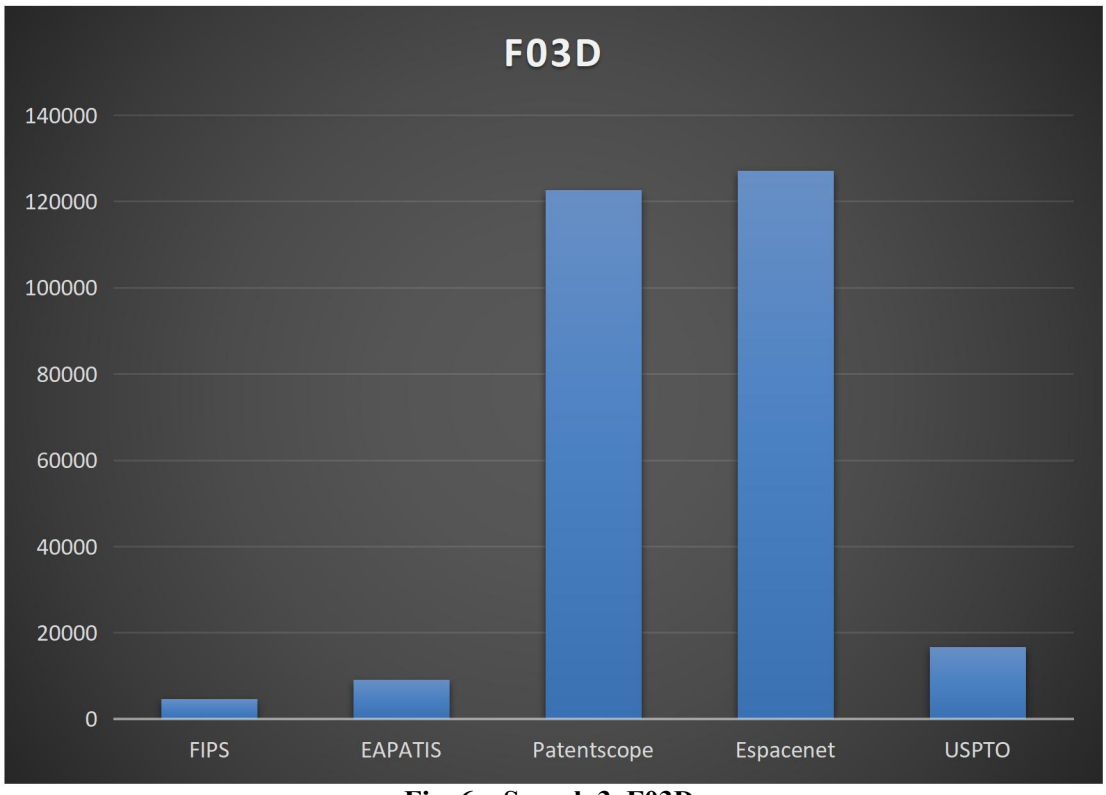


**Fig. 6 – Search 3, F03D**.

Search № 4 – H02. The lowest number of documents were found on the FIPS database with 38,497 documents. The highest number was in the Espacenet database with 3,034,817 patent documentations. Other databases: EAPATIS 94,675; Patentscope 2,887,454; USPTO 313,405. We could also use “OR” and “AND” operations.

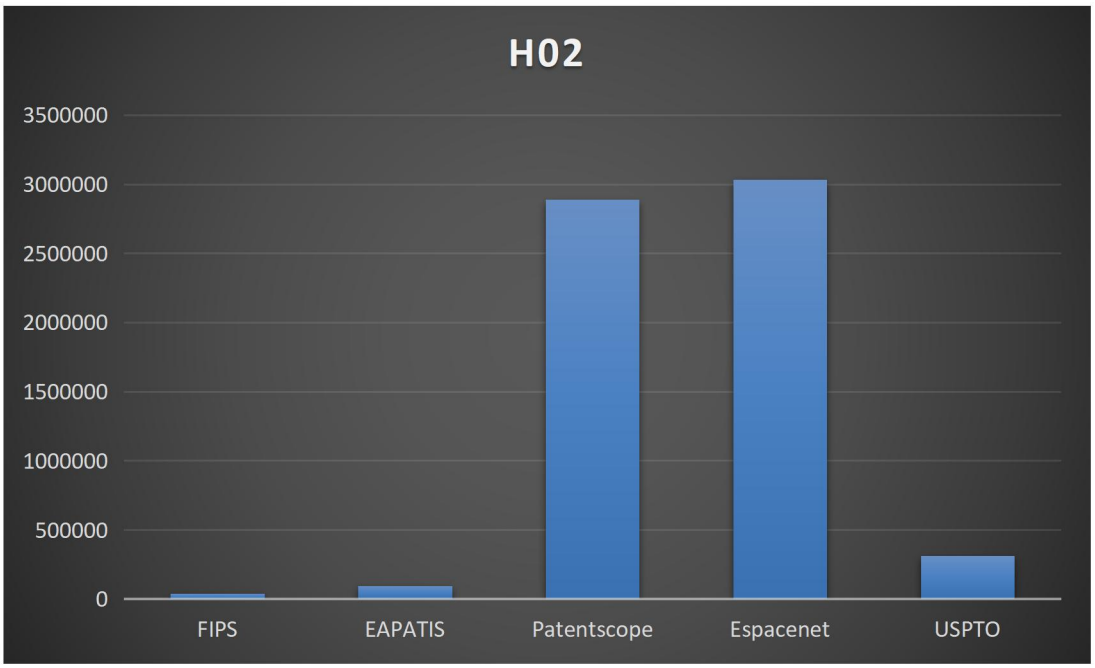


**Fig. 7 – Search 4, H02.**

Search № 5 – F01 OR F03. The lowest number of documents were found on the FIPS database with 35,157 documents. The highest number was in the Espacenet database with 944,147 patent documentations.

Search № 6 – F01 OR F03D. The lowest number of documents were found on the FIPS database with 25,621 documents. The highest number was in the Espacenet database with 812,246 patent documentations.

Search № 7 – F01 OR F03 OR H02. The lowest number of documents were found on the FIPS database with 73,155 documents. The highest number was in the Espacenet database with 3,933,022 patent documentation.

Search № 8 – (F01 OR F03) AND H02. The lowest number of documents were found on the FIPS database with 499 documents. The highest number was in the Espacenet database with 44,257 patent documents.

Search № 9 – F01 OR F03D OR H02. The lowest number of documents were found on the FIPS database with 63,783 documents. The highest number was in the Espacenet database with 3,816,319 patent documentations.

Search № 10 – (F01 OR F03D) OR H02. The lowest number of documents were found on the FIPS database with 335 documents. The highest number was in the Espacenet database with 29,389 patent documentations.

Search № 11 – F01 AND F03 AND H02. The lowest number of documents were found on the FIPS database with 4 documents. The highest number was in the Espacenet database with 1,277 patent documents.

Now, we should examine the documentation that we found. Here is an example of a device about ecology.

The utility model relates to renewable energy sources, namely, to combined solar-energy conversion units that provide hot water and electricity to premises for various purposes [22].

After searching with IPC, we should start searching with keywords. In this example, we will use keywords in two different languages. For databases in English, we would use English, and for the databases in Russian, we would use Russian.

Search by keywords (in English):

Search № 12 – Energy AND (wind OR solar OR (water OR hydro) OR geothermal) and power. The most number of documents were found on Espacenet with 261,292 documents, Patentscope had 46,823 and USPTO had 23,989 documents.

Search by keywords (in Russian):

Search № 13 – Энергия AND (ветер OR солнечная OR (вода OR гидро) OR геотермальная) AND электричество. The most number of documents were found on EAPATIS with 6,106 documents and FIPS had 395 documents.

We could also combine different search methods. Search by a combination of keywords with IPC:

Search № 14 – S7 AND S12. The most number of documents were found on Espacenet with 107,585 documents, Patentscope had 19,656 and USPTO had 9,611 documents.

We should look into some examples from found documents. Provided is a renewable energy power generation system. It also said that it is a renewable

energy power-generating device. Renewable energy sources include wind, solar, water, wave, geothermal and the like energy sources [23].

A hybrid geothermal electrical power generation system that utilizes the heat from a deep geothermal reservoir to vaporize a working fluid, such as steam, CO2 or an organic fluid. It is a hybrid solar-geothermal electrical power generation system for use with a high-temperature deep geothermal reservoir [24].

Search № 15 – S7 AND S13. The most number of documents were found on EAPATIS with 939 documents and FIPS had 121 documents.

Again we should look into some of the documents. The solar-fuel combined heat and power plant is an unconventional energy source and is designed to generate thermal and electrical energy [25].

The utility model relates to combined wind-solar power plants and can be used to obtain energy. The result of this device is the expansion of the technical means of the wind-solar power plant [26].

The connection between automation of patentability and ecological studies

The first connection is accelerated patent procedures. Automation can expedite the patent search and approval process for eco-friendly technologies, such as renewable energy, waste reduction, and sustainable materials. This helps bring innovative solutions to market faster, allowing for quicker adoption of technologies that mitigate ecological damage.

Automating patentability may encourage inventors to focus on green technologies by making the patenting process more accessible and less costly. More efficient patenting can stimulate innovations in fields like clean energy, water conservation, and sustainable agriculture, all of which would have a positive impact on the environment.

It could also highlight trends in patents related to the circular economy and expedite the patenting of technologies that reduce waste and promote sustainability. By making it easier to patent technologies that minimize resource use, automation indirectly supports efforts to reduce the ecological footprint of industries, contributing to more sustainable practices across sectors.

Findings and results: Automating the process of finding patentability offers several advantages, making the search more efficient and effective. Automation greatly reduces the time required for patent searches. Computers can scan vast databases of patents and publications much faster than humans, enabling quicker results. AI or machine learning with the help of advanced tools like text mining could find relevant documents to the application.

The automation would check for if the invention is applicable in the industry. This process would be done before the automation conducts a patentability search. Here using laws of physics and logic the automation would decide whether the device is usable or not. If the invention is not applicable then the application would be refused, and if it's applicable then the automation would go into the second step. Starting with the second step the automation would start conducting a patentability search. The second step is checking the novelty. The automation would check novelty. Again, if the invention is not novel the application would be refused. Lastly, the automation would find if the application is or is not obvious. In case, where the invention has an innovative step then the application would be granted, and if it doesn’t then the invention would be refused.

Lastly, about the connection between automation of patentability and ecological studies. Automation can expedite the patent search and approval process for eco-friendly technologies, such as renewable energy, waste reduction, and sustainable materials. Automating patentability may encourage inventors to focus on green technologies by making the patenting process more accessible and less costly.

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# Ekoloji problemlərin həlli yollarının bəzi aspektləri

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**Xülasə**

Müasir dünya ictimaiyyətini narahat edən, Yer üzündə sülhü qoruyub saxlamaq qədər zəruri olan problemlərdən biri də ekoloji problemdir. Belə ki, ekoloji tarazlığın pozulması Yer kürəsində bütün canlıların məhvinə səbəb ola bilər. İnsanın təbiətə təsiri lokal təsirinin biosferin bütün elementlərinə və resurslarına qlobal təsiri səviyyəsinə yüksəlməsi sivilizasiyanın bütün əsaslarına toxunur. Təbii resurslar tükənir, ətraf mühitin kəskinçirklənməsi baş verir ki, bu da ekoloji problem yaradr. Ekoloji problemin kəmiyyətcə dəyişməsi onun sosial əhəmiyyətinin artmasına səbəb olur. Əgər insanın ətraf mühitə mənfi təsiri əvvəllər təbiətin ayrı–ayrı obyektlərinə təsir göstərirdisə, müasir şəraitdə insan özü bu mənfi təsirləri hiss edir, onun sağlamlığı və həyatı təhlükəyə məruz qalır. Hazırda biosferin özünü bərpaetmə mexanizmi öz imkanlarının maksimal həddində işləyir. Biosferin genefondukasıblaşır ki, bu da gələcəkdə müəyyən olunmayan təkamül nəticələrinin baş verməsi təhlükəsini yaradır. Ekoloji uyğunsuzluqların bu halı elə bir vəziyyətə gətirib çıxarmışdır ki, onlar qlobal xarakter almış və insan cəmiyyəti qarşısında qlobal problemlər yaratmışdır. Qlobal problemlərin xarakteri onların bütün dünya ictimayyətinin birlikdə həlli zəruriliyindən ibarətdir. Təbii mühitin çirklənməsi və dağıdılması dövlət sərhədi ilə məhdudlaşmır. Bu qlobal problemlərin həlli və aradan qaldırılması bütün dünya ölkələrinin mütəxəssislərinin və ictimayyətinin birgə səyi ilə mümkündür. Son onillikdə insan cəmiyyəti tamamilə əmin olub ki, planetdə atmosfer havasını çirkləndirən əsas mənbələrdən biri avtomobil nəqliyyatıdır. Dünyanın inkişaf etmiş ölkələrində avtomobil nəqliyyatı tərəfindən atmosferin çirklənməsi 45–50 faiz təşkil edir, bu da digər sənaye növlərinin hər birindən daha çoxdur [1].

**Açar sözlər**: ekoloji problemlər, inkişaf, həlli yolları, qlobal problemlər, çirklənmə.

## Giriş

Heç bir ölkə ayrılıqda yaranmış qlobal problemi həll edə bilməz. Ona görə də bu problemin həlli məqsədilə dövlətlər öz səylərini birləşdirərək beynəlxalq təşkilatlar çərçivəsində fəaliyyət göstərirlər və bu sahədə təbii resurslardan səmərəli istifadə normalarını, qaydalarını və qanunlarını müəyyənləşdirirlər. Bir çox beynəlxalq ekoloji təşkilatlar Birləşmiş Millətlər Təşkilatının Baş Assambleyası çərçivəsində fəaliyyət göstərir və BMT–nin xüsusi təşkilatlarıdır.

Müasir cəmiyyətin qlobal ekoloji problemlərinə “istixana effekti”, Dünya okeanının səviyyəsinin qalxması, Yer kürəsinin ozon təbəqəsinin dağılması, turşu yağmurları, radioaktiv çirklənmə və planetinbioloji müxtəlifliyinin azalması aiddir [1,2].

## Metod

Dünyada ekoloji problemin kəskinləşməsinin əsas səbəbləri nəqliyyat, energetika, neft istehsalı və emalı sənayesi, metallurgiya, maşınqayırma, qaz sənayesidir və ətraf mühitin çirkləndirilməsidir. Göstərilən səbəblərdən ən başlıcası nəqliyyatdır.

Nəqliyyat—material texniki bazanın əsas elementlərindən biri olaraq ictimai istehsalın fəaliyyəti üçün vacib şəraiti təmin edir. Nəqliyyatın fəaliyyəti təbiətə güclü neqativ təsir göstərir. Nəqliyyatın əsas mənfi təsirlərindən biri ətraf mühiti çirkləndirməsidir. Nəqliyyatın ekosistemə təsiri nəticəsində atmosfer, su hövzələri və torpaq çirklənir, təbii resurslar intensiv istifadə olunur, yüksək səviyyəli səs–küy və titrəyişlər yaranır, xoşagəlməyən təbii proseslər sürətlənir, insanlar və heyvanlar xəsarət alır və ölür, qəzalar nəticəsində böyük maddi ziyan dəyir, istehsal tullantıları yaranır [3].

Hazırda insan cəmiyyəti qarşısında duran əhəmiyyətli ekoloji problemlərdən biri atmosfer havasının sənaye müəssisələrindən atılan zəhərli maddələrdir.

Sənayedə əmələ gələn bərk və maye tullantılarının tərkibində canlı orqanizmlərə toksiki təsir göstərən maddələr vardır. Məsələn, metallurgiya sənayesi tullantılarında əlvan və ağır metal duzları, maşınqayırma sənayesi tullantılarında sionidlər, arsen birləşmələri, berillium, plasmas və süni ipək istehsalında benzol, fenol, kağız-selliloz istehsalında metanol, fenol , qazanxana qalıqları, toxuculuq, gön-dəri müəssisələrində, sintetik fəal maddələrin

istehsalında alkil-sulfat, sulfanol, bəzi yuyucu-dezinfeksiyaedici maddələr əmələ gəlir.1 ton çuqun hazırlanarkən 4,5 kq toz: 2,7 kq kükürd qazı: 0,1-0,5 kq manqan, həmçinin arsen, fosfor, qurğuşun, civə, sürmə: nadir metallar və qətranlı maddələr, 1 ton marten poladından 3000-4000m3 qaz, 60 kq dəm qazı və 3 kq kükürd qazı ayrılır. Qara metallurgiya sənayesi ümumi çirklənmənin 15-20 faizini təşkil dir. İl ərzində 1 mln.ton məhsul istehsal edən qara metallurgiya zavodu atmosferə 350 ton/sutka toz, 200 t/sutk kükürd anhidridi, 400 t/sutk karbon oksidi və 42 t/sutk azot oksidi atır. Metallurgiya müəssisəsində çoxlu miqdarda tullantı (domna qazı və koks qazı) əmələ gəlsə də, onun cəmi 34 %-i utilizə edilir və ya zərərsizləşdirilir, qalanı ətraf mühitə yayılaraq atmosferi korlayır [4].

Azərbaycanda Ekologiya və təbii sərvətlər nazirliyinin müasir strukturda fəaliyyət göstərməsi ilə əlaqədar ölkədə və böyük şəhərlərdə ətraf mühitə monitorinq sistemi yaradılmışdır. Neft-kimya sənayesi də xalq təsərrüfatının inkişafında mühüm rol oynayır. Azərbaycanın neft-kimya və kimya müəsisələrinin çoxu özəlləşdirilməyə verilmiş və hazırda dövlət sektorunda “Azərikimya”dövlət şirkətinin tərkibində olmaqla4 əsas iri müəsisə qalmışdır. Bunlar, Etilen-polietilen, Sintezkauçuk, Səthi aktiv maddələr və Üzvi sintez zavodlarıdır [4].

Bir çox onilliklərdə neft istehsalında köhnəlmiş texnologiyalardan istifadə edilməsi, torpağın neft və minerallaşmış su ilə çirklənməsinə gətirib çıxarmışdır. Təkcə Abşeron yarımadasında çirklənmiş ərazilər 100 min hektardan artıqdır ki, bunun da 7.4 min hektarı kənd təsərrüfatı torpaqlarıdır.

Kimya və neft-kimya kompleksi müəsisələri tərəfindən atmosferə buraxılan zərərli maddələrin, qazların həcmi respublikada azalmışdır. Bunun başlıca səbəbi neft-kimya müəsisələrinin tam gücü ilə işləməsidir.

XIX əsirdən sürətlə inkşaf edən sənaye istehsalı artıq XX əsrin ortalarından başlayaraq ətraf mühütdə insan və biosfer üçün çox təhlükəli olan bir sıra dəyişikliklər yaratmağa başlamışdır. Elmi-texniki tərəqqi (ETT) əsrində isə vəziyyət xüsusilə kəskinləşmişdir. Aydındır ki, biz təbiətdən istifadə etmədən yaşaya bilmərik. Ondan müxtəlif cür istifadə etmək olar. Belə ki, təbiətdən düşünülməmüş şəkildə istifadə onu faydasız, cansız, insana qarşı yönəlmiş bir mühitə çevirə bildiyi halda, ondan düzgün istifadə bütünlükdə canlı aləmin təhlükəsizliyini, təbiətdəki proseslərin qaydasınca getməsini təmin edir. İnsanın tələbatı ildən-ilə artır, nəticədə istehsalın miqyası genişlənir, istehsal prosesinə cəlb olunan təbii sərvətlərin, enerji resurslarından istifadənin həcmi də durmadan artır.

Bununla əlaqədar olaraq ətraf mühitə atılan istehsal tullantılarının həcmi də artır. Bu tullantılar və zərərli kimyəvi birləşmələr atmosferin havasını, su tutarlarını, torpaqları xeyli dərəcədə çirkləndirir, bir cox yerlərdə bitki ortüyünün, meşə və yaşıllıqların azalmasına və ya tamamilə məhv olmasına səbəb olur. Sonda bu da öz təsirini nadir bitki və heyvan növlərinin azalmasaında və ya tamamilə yox olmasında göstərir. Hesablanmışdır ki, yanacağın yandırılmasından və istehsal prosesindən 100 il ərzində atmosferə 400 milyard tondan çox karbon 4-oksid (CO2) buraxılmışdır. Hazırda havaya hər il 200 milyon ton karbon 4-oksid, 50 milyon tondan çox azot oksidləri buraxılır. Təkcə hər il yanacağın istehsalı nəticəsində atmosferə təxminən 10 milyon tondan çox karbon qazı 700 milyon ton sulfat anhidridi, dəm qazı, kükürd qazı, azot oksidləri, karbohidrogenlər, 200-300 milyon ton aerozol, his və toz atılır. Müxtəlif sənaye müəssisələri atmosfer havasını, həmçinin çoxlu miqdarda karbon və kükürd qazları ilə zəhərləyir [5].

Ekoloji problemlərin aktuallığı müxtəlif ölkələrin liderlərinin bəyanatlarında dəfələrlə qeyd edilmişdir. BMT-nin Baş katibi Pan Gi Mun ötən ilin sentyabr ayında bu mötəbər təşkilatın mənzil-qərargahında keçirilmiş ekologiya məsələlərinə dair zirvə toplantısında Yer kürəsinin gələcəyi ilə əlaqədar narahatlığını konkret şəkildə belə ifadə etmişdir: “Bəşəriyyətin planetimizdə labüd iqlim dəyişikliklərinin qarşısını almaq üçün cəmi on ili vardır”. Azərbaycanda əhalinin gələcəkdə bioloji varlıq kimi mövcudluğuna aidiyyəti olan bu mühüm məsələ dövlət siyasətinin prioritet istiqamətlərindən biridir.

Torpaqda, havada, suda zərərli maddələrin toplanması ekoloji mühitin pozulmasına-meşə və otlaqların, kənd təsərüfatına yararlı torpaqların, yeraltı və yerüstü suların tərkibinin dəyişməsinə, bir sıra bitki və heyvan növlərinin bioloji müxtəlifliyinin azalmasıa, şəhərlərdə isə atmosfer hvasının çirklənməsinə səbəb olur[6].

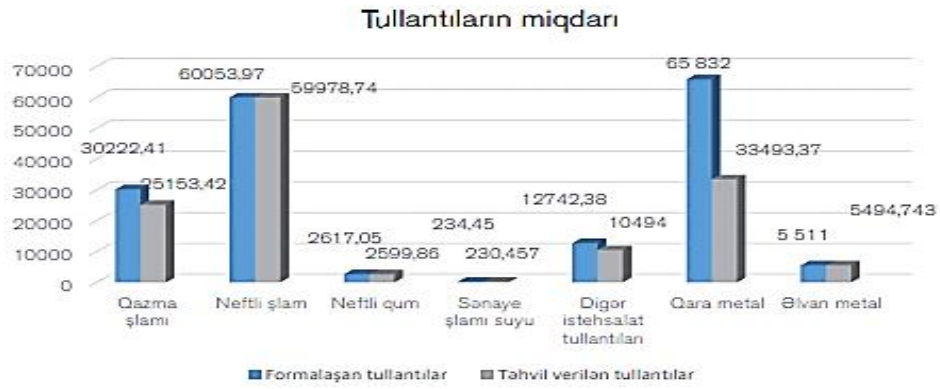
Nəqliyyat çirklənməsini azaltmaq üçün yüksək oktanlı benzindən istifadə, mühərriklərin vəziyyətinə daim nəzarət tövsiyyə olunur.Bundan əlavə nəqliyyat yollarının yaxınlığında ən azı 20 metr kənar olmaqla bostan və tərəvəz məhsullarının becərilməsi məsləhət görülmür.

Abşeron yarımadasında sənaye potensialının əsasən iki böyük şəhərdə Baki və Sumqayıtda mərkəzləşmişdir.İlkin hesablamalara görə müəyyən edilmişdir ki, sənaye tullantıları iıə çirklənən torpaq sahələri 1180 hektardan çoxdur.Bu torpaqlar çirklənmiş və deqratasiyaya məruz qalmışdır. Burada ağır çirklənmə daha təhlükəli xarakter daşıyır.Ağır metallar torpaq-bitki-insan yolu ilə orqanizmaya düşərək bir çox fəsadlar verir.Bu

metallar içərisində mis, sink, kadmion, vanadium,kobalt, molibden, nikel yüksək toksikliyə malikdir.Torpağa atmosferdən, çirkab suları ilə torpağı suvarımasından, neft məhsullarından, kadmiom ilə zəngin üzvi gübrələrdən, uran və qurğuşun qarışıqlı fosfor gübrələrindən, civə qarışıqlı pestisidlərdən ağır metallar daxil olur və qida zəncirinə nüfuz edir.Şəhər torpaqları daha çox çirklənməyə məruz qaldığından orada çirklənmə kənd torpaqlarına nisbətən daha çoxdur [7].

**Cədvəl 1.** Abşeron yarımadasının antropogfen təsir nəticəsində yararsız vəziyyətə düşmüş torpaq sahələri

| Antropogen təsir nəticəsində yararsız vəziyyətə düşmüş torpaq sahələri | Yararsız vəziyyətə düşmüş torpaqların ümumi sahəsi, ha | O cümlədən inzibati rayonlar üzrə, ha | | | | |
|---|---|---|---|---|---|---|
| | | Qaradağ | Binəqədi | Sabunçu | Suraqxanı | Xəzər |
| Mazutlaşmış torpaq sahələri | 1148,0 | 469,1 | 77,3 | 315,3 | 190,8 | 95,5 |
| Bitumlaşmış torpaq shələri | 1557,6 | 807,9 | 105,2 | 95,3 | 342,5 | 206,7 |
| Zəif bitki ilə örtülən bitumlaşmış torpaq sahələri | 1174,3 | 258,2 | 29,5 | 198,2 | 216,9 | 471,5 |
| Qazma suları ilə çirklənmiş torpaq sahələri | 1680,5 | 869,9 | 500,4 | 64,4 | 193,0 | 52,8 |
| Bataqlıqlaşmış torpaq sahələri | 1737,9 | 458,6 | 335,3 | 488,9 | 120,3 | 334,8 |
| Lay sualrı və məişət tullantıları ilə çirklənmiş torpaqlar | 3325,3 | 110,4 | 219,3 | 1593,4 | 403,7 | 8,5 |
| Neft sənayesi ilə əlaqədar sıradan çıxmış torpaqlar | 10623,6 | 3964,1 | 1267,0 | 2755,5 | 1467,2 | 1169,8 |
| Sənaye və məişət zibilləri altında qalan torpaqlar | 448,6 | 58,1 | 42,4 | 114,5 | 78,0 | 155,6 |
| Faydalı qazıntı karxanalarının istismarı nəticəsində sıradan çıxmış torpaqlar. | 1179,8 | 447,1 | 164,3 | 60,5 | 74,7 | 433,2 |




## Nəticə

Problemin həlli sadalanan tədbirlərin kompleks şəkildə yerinə yetirilməsilə mümkündür. Bu istiqamətdə bütövlükdə respublikamızda və xüsusilə də Bakı şəhərində kompleks texniki, təşkilati, iqtisadi və idarəetmə tədbirləri ardıcıl olaraq yerinə yetirilir.

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# Prospects for eliminating ecology's detrimental impact on Azerbaijan's economy

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**Abstarct**

There is a clear reason why the rate of climate change is outpacing the ability of both humans and other naturally occurring species to adjust. Forests, and salt marches, which absorb carbon dioxide, are destroyed when fossil fuels are burned. Unpredictable global warming is caused by carbon emissions, which in turn generate the greenhouse effect. Natural disasters such as droughts, floods, forest fires, and coral reef bleaching are impacting people and animals all across the globe.

A crisis with record-high living expenses is currently unfolding. For millions of people in Azerbaijan, finding affordable food and heating is a crisis. Rising oil and gas prices, as well as our reliance on fossil fuels, are contributing factors to the cost-of-living shortage. Summers without ice in the Arctic could occur once every hundred years and coral reefs could disappear altogether if temperatures rise by 1.5 degrees. The destruction of nearly all coral reefs and an increase in the frequency of summers without ice to once every ten years would result from a 2 degree warming.

Our next move is clear. Eliminating fossil fuels and transitioning to renewable energy sources are critical steps toward reducing emissions of greenhouse gases. Cutting down on energy consumption, tree cutting, and meat eating is a top priority. Nonetheless, we would still manage to achieve 2.8 degrees, if that every country honored its commitments. All of those promises will remain unfulfilled.

## Overall picture

An environment is the collection of conditions in which a person, animal, or plant lives and thrives. Environments may be found in all living things. This should make its relevance in the well-known life cycle quite evident to anyone who is paying attention. When humans engage in activities that are detrimental to the environment, environmental issues are inevitably going to occur. Among the many instances of such phenomena are things like excessive population growth, incorrect disposal of rubbish, pollution, climate change, global warming, the greenhouse effect, and so on. A great number of environmental preservation projects have recently been put into place at the individual, corporate, and governmental levels in an effort to achieve a state of equilibrium between human beings and the natural milieu in which they live. After years of environmental outcries, the long and winding road finally led to the establishment of ad hoc institutions tackling these pressing issues. It was in the early 1980s that the phrase “environmental security” came to light, marking a new chapter in the broader narrative of human security concerns. It wasn’t until 1994 that the United Nations Development Program’s (UNDP) Human Development Report introduced the term and concept of environmental security within the wider framework of human security. In the last twenty years, the meaning and reach of environmental security have really opened up, bringing food security, energy security, and water security into the fold, along with climate security, which also covers the nuts and bolts of adapting and bouncing back from hazards.

One of the most pressing environmental challenges in the modern world is climate change, and Azerbaijan has been an active participant in these instruments since its independence from the Soviet Union. In recent decades, this issue has become more apparent. Most of the change in our climate is caused by greenhouse gasses. Melting glaciers, shifting seasons, diseases, and other environmental disasters are only a few examples of the many negative effects of human-caused change. Azerbaijan is no exception to the rule; like the rest of the globe, the country might feel the effects of climate change in the form of an uptick in disease rates and devastating hydro meteorological disasters like heat waves and floods. Azerbaijan has seen record-breaking hot summer weather on occasion in recent years. As an example, the number of first aid calls increased by 21.5 percent from April to September in 2003–2006 in Baku city

as a consequence of a 1.5 C temperature change.

Another consequence of climate change is the expansion of the malaria epidemic zone, which is exacerbated by floods. Future years may see an extension of the epidemic season and a shift in the borders of endemic and epidemic malaria to higher elevations as a result of climate change, especially in mountainous regions. Thus, particularly in mountainous regions, a rise in temperature in Azerbaijan might have detrimental effects. Conversely, an uptick in infectious and parasitic illness cases is one way in which climate change is affecting human health. As a result of increasing air temperatures, flooding of human settlements and the collapse of a sewerage system, many diseases have recently made a comeback after being in decline for a long time. Heavy floods in seven areas along the Kura river in 2010 were a natural disaster that the local populace had to deal with because of the effects of climate change. The government's prompt and effective response has ensured that all preventative measures to lessen the disaster's harmful effects have been implemented, including rebuilding damaged infrastructure and building new ones.

One more issue related to global warming is the combustion of fossil fuels, emissions from vehicles, and chlorofluorocarbons, which contribute to the greenhouse gases in the atmosphere and pose significant threats. This has resulted in a rise in the Earth's temperature, leading to environmental alterations. Climate change poses a significant threat to the health rights and access to fundamental necessities, such as food and shelter, for individuals in Azerbaijan. Adverse effects resulting from floods, droughts, heat stress, and other calamities impede individuals from exercising their fundamental rights and obstruct governments from creating appropriate conditions for the enjoyment of such rights. The Constitution of the Republic of Azerbaijan guarantees fundamental human rights to live in safety and in a healthy environment. The relevant articles of the constitution stipulate that every individual has the right to live in safety and in a healthy environment; the right to access accurate information regarding the ecological situation; and the right to receive compensation for harm inflicted on their health and property due to violations of ecological regulations. Furthermore, the state is obligated to ensure the preservation of ecological balance. Climate change consequences clearly hinder the state's attempts to ensure all required conditions for human health and a suitable environment. Azerbaijan experienced a natural disaster in 2010 due to climate change, resulting in severe floods that impacted seven areas and around 70,000 residents near the Kura river. By that time, the government had taken all necessary efforts to mitigate the adverse effects of the tragedy and aided the affected populace by restoring wrecked infrastructure and constructing new facilities. Essential measures have also been implemented to safeguard the health of individuals residing in affected areas.

The third alarm signals the tipping point toward catastrophe as a result of water pollution. Water pollution is the term used to describe the introduction of hazardous substances into rivers, oceans, lakes, and ponds, which disrupts the physical, chemical, or biological properties of the water. This is a veritable can of worms. The water has turned sour, causing the small creatures to be left high and dry, gasping for oxygen as they meet their untimely demise. Water is the foundation of our existence, and it is our livelihood to safeguard it from any form of contamination. The issue is progressing to more severe phases as the continuous mining operations in Armenia contaminating the water resources of Azerbaijan which have resulted in the degradation of the ecosystem. This presents a substantial hazard to the environment of Azerbaijan and its neighboring countries. The trans-boundary impacts of environmental damage from mining activities are a threat to the health and well-being of communities in the region and beyond. The non-transparent and unaccountable exploitative activities in Armenia's mining industry are a threat to sustainable development, causing damage to both people and the environment. Almost all trans-boundary waters are contaminated by highly toxic chemical detritus from industrial enterprises. The health and welfare of humans, as well as the physical structures of soil, air, water, and flora and fauna, are all affected by this environmental impact.

The discharge of these wastes into the Araz river poses a substantial threat to the wildlife of the river and the extensive farms that depend on its water for irrigation. The potential damage to potable water supplies poses a threat to human health and water security, which could result in the transmission of infectious diseases in trans-boundary regions. This situation has the potential to lead to a severe public health crisis in Azerbaijan. Thus, Armenia contravenes the Basel Convention, the Convention on Long-Term Trans-boundary Air Pollution, the Convention of the European Economic Commission on Environmental Impact Assessment in a Trans-boundary Context (Espoo Convention), the UN Sustainable Development Goals, the UN Guiding Principles on Business and Human Rights, and other UN conventions. This includes the Protocol on Water and Health, the Convention on the Protection and Use of Trans-boundary

Watercourses and International Lakes, and the UN Convention on the Control of Trans-boundary Transportation and Disposal of Hazardous Waste of the European Economic Commission.

Air pollution, a byproduct of industrial processes, vehicle emissions, and the ever-increasing combustion of fossil fuels, is another cause for concern alongside water contamination. The earth's surface temperature has risen due in part to the gaseous emissions. In addition to this, it has also raised people's susceptibility to several ailments. After most industrial polluters halted after the USSR collapsed in Azerbaijan, hazardous chemicals discharged into the atmosphere dropped substantially. In 1987, 2.05 million tons of hazardous trash entered the republic's air basin. 0.25 million tons of particles (powder), 0.15 million tons of sulfur gas, 0.99 million tons of and tone were hydrocarbons. After the USSR disintegrated in 1991, the Ministry of Ecology and Natural Resources reported 2.6 million tons of toxic garbage in the atmosphere with 0.09 mln. tons of sulfur 2-oxide, 0.64 mln. tons of carbon dioxide, 0.08 mln. tons of nitrogen oxide, 1.67 mln. tons of carbon dioxide, 0.04 mln. volatile compounds.

When it comes to stationary waste, construction materials take the cake at a whopping 26.6 percent, while petrochemical and energy are neck and neck at 16.9 percent each. Gas is not far behind, holding its own at 15.7 percent, with oil trailing at 7.3 percent. Non-ferrous metallurgy and electrical engineering are the little fish in this big pond, coming in at 4.7 percent and 1.8 percent, respectively. There were red flags flying high in the major industrial cities. The harmful waste pressure in Sumgait was a staggering 1200 t/km², which is like comparing apples to oranges when stacked against the national figure, being 50 times higher, and a whopping 500 times the Union index. Shirvan wasn't far behind with 1000 t/km², while Ganja, Mingachevir, and Baku had their own share of the pie with 550, 480, and 400 t/km² respectively. Baku leads the pack with a hefty 66.1 percent, while Sumgayit trails behind at 4.5 percent. Ganja chips in with 3 percent, Mingachevir adds 2.5 percent, and Shirvan rounds it out with 5 percent. Together, these cities are the heavyweights, contributing over 80 percent of the republic's garbage emissions. Besides Baku, the air pollution in other industrial cities is a real can of worms, causing a whole host of negative eco-geographical effects. Once the aluminum production kicked back into gear in Ganja, the air quality took a nosedive, and the noxious pollution spread its wings over the city and the neighboring Samukh, Goygol, Shamkir, and Goranboy regions, soaring past the allowed limits. This holds water in Shirvan and its neighboring areas as well.

The crux of the matter with the air pollution in the cities boils down to the fact that the equipment and facilities have been stuck in a time warp for almost half a century. Nature protection measures for the atmosphere were left by the wayside, and when it comes to environmental protection funds, they were either as scarce as hen's teeth or simply not allocated at all. Rather than relying on natural gas, thermal power plants and heating centers are turning to fuel oil, and at times, high-sulfur fuel oil, which is a recipe for increased atmospheric pollution. Though many businesses bit the dust in the early days of independence, air pollution continued to soar since the funds for repairing and rebuilding air control facilities were nowhere to be found. In the years that followed, Azerbaijan's economy took off like a rocket, leading to a surge in vehicle imports that sent air quality in those cities plummeting. Back in the year 2000, a whopping 9,839 stationary sources were letting the air go to the dogs with pollution. A mere 18 percent of the waste was put to bed from stationary sources, totaling 111 thousand tons. In recent years, Baku and other bustling metropolises have been caught in a web of traffic-related air pollution, leaving residents gasping for fresh air. Some calm weather traffic jams can really throw a wrench in the works, making it tough to catch a breath, particularly for those under the weather and the older folks. The icing on the cake is that Azerbaijan churns out ethylated gasoline. Modern cars are like a horse that needs a good feed; that's why Baku oil refineries sprinkle a bit of lead powder into the gasoline mix. Cars are sending a mountain of 300,000 tons of hazardous pollutants into Baku's atmosphere every year. Lead in car waste is a ticking time bomb, a real double-edged sword that spells trouble and poses a serious threat to health. On calm days, low-level emissions drift like a feather in the wind, barely making a ripple.

In such weather, rising air masses dominate city center streets, preventing harmful waste from spreading far. Most city garbage accumulates between high-rise buildings and in low-lying communities. In our republic's car parks, 75-80 percent is light automobiles and 20-25 percent is buses and lorries. Auto waste pollutes Baku, Sumgayit, Mingachevir, Ganja, Shirvan, and Yevlakh's air basins more. Average daily concentration limits in Azerbaijan are 0.85 mg/m³ for nitrogen oxides, 0.035 mg/m³ for hydrocarbons.

Solid waste management is another Azerbaijani threat that warrants action posing with generation, storage, collection, transfer, transport, processing, and disposal of solid waste in an environmentally detrimental manner. Not only Azerbaijan, but also

all nations are affected by the growing "waste crisis". Underdeveloped nations have chronic it. Garbage sorting and processing should not hurt the environment. All household objects, including packaging, food, batteries, paint, lighting, natural or synthetic ready prepared products, paper and derivatives, electronics, and more, generate garbage over time. Sorting domestic trash is necessary for recycling. By source, solid household garbage, liquid household waste, hazardous household waste, domestic industrial waste (e.g., wall paint), medical waste used at home, public catering waste, and trade and enterprise waste are classified.

The absence of additives and cleanliness of separated garbage affects its economic worth and recycling suitability. Therefore, trash must meet recycling criteria to be considered raw material. Foreign practices usually sort garbage at the source, or at the point of collection. Consumers perform this process.

There are three main criteria that must be adhered to in order to reduce the detrimental effects that household solid waste has on ecosystems. Recovering trash and disposing of it in an environmentally responsible manner while producing as little waste as possible are among them. There is a plan in place to manage all of the services that are associated with waste, such as collection, storage, and disposal. First, the trash must be evaluated or recovered, and then the affects of the waste must be optimized. The inappropriate storage of trash can lead to a number of negative consequences, including the contamination of ground and surface water, the breeding of insects, the spread of odors, the pollution of aesthetics, and the transmission of carrier germs through a variety of animals. As an illustration, in 1951, a plastics plant that was located in close proximity to Minamata Bay in Japan began to discharge waste water into the bay, which caused a significant number of people to become ill. When mercury is coupled with the water that is found in waste, it is left on the floor, where bacteria begin to break it down. Following this, the mercury is absorbed by the plankton in the water. It makes its way from fish that consume plankton to us. The nutrients that are found in plankton are passed on to fish that consume them. The water that seeps into the ground from the rubbish fields and enters the earth when the rains is the source of groundwater pollution. The landfill site has a number of negative effects on the environment, one of which is the spread of unpleasant odors in the surrounding area. This is because the gasses that are produced by decomposition have a problem with odor. Garbage from households that cannot be neutralized and stored causes a moderate amount of disturbance to the environment and poses a threat to the health of the community. Chemicals are finding use in many other aspects of life, including cleaning, as technology continues to advance. In spite of the fact that these compounds can contribute to the preservation of cleanliness, it is essential to be aware of the kinds of adverse consequences that their waste causes for the environment. When they are no longer needed, the chemicals are discarded and end up in the natural environment. When it hits the ground, the foreign chemical that is contained within it causes the ground to become poisonous and limits its ability to provide a habitat for plant life.

There is a lot of harm that these compounds may do to people and the environment, particularly old batteries. The soil and groundwater are contaminated with chemicals like nickel, cadmium, lead, zinc, lithium, and mercury due to both intentional and unintentional disposal of battery trash. This leads to the soil being toxic and useless. Diseases of the neurological system, cancer, kidneys, and liver are the most common illnesses caused by discarded batteries.

The ecology is also affected by liquid home garbage, just as it is by solid trash. A large portion of the waste water is liquid. This water is contaminated from a variety of sources, including wastewater from cities, mines and ore processing facilities, and various industrial, agricultural, and household uses.

## Solution

- The following procedures are suitable for home waste, as each category has its own sorting method:
- Solid domestic waste must be collected and transported separately according to waste codes, where it is created by household members. Due to its nonhazardous nature, home garbage is usually sorted manually. However, a magnetic separator separates metal from rubbish.
- Fractional collection must sort domestic waste from restaurants, offices, universities, schools, and markets.
- General sorting includes home garbage sorting in integrated processing plants. Manual sorting and device-based classification must be used.

Sorting household trash is an indicator of environmental culture, and everyone should do it. The country's economic and environmental improvement will advance simultaneously. Additionally, environmental funds allocate monies for proper filtering. Waste processing is an important part of the green market, drives recycling industry growth. Because glass and plastic are recyclable, waste has a slow environmental impact.

Waste should be placed in containers with distinct codes and colors to make sorting cost-effective and easy. Waste bins are colored by the waste management system, which differs by country. No specific color or trash categorization must be disposed of.

The following guidelines must determine proper classification:

- Collecting non-recyclable waste in designated containers after sorting;
- Separating hazardous waste collection, such as medical, e-waste, batteries, and accumulators;
- Using a container for organic trash disposal;
- Storing glass and mirrors in a single container;
- Separating oily or watery rubbish from paper and cardboard;
- Collecting recyclables separately.

In this regard an action plan should be drawn up to:

- Expand recycling businesses and factories;
- Implement effective waste management in Baku, major cities, and provinces;
- Implement integrated waste management methods in Azerbaijan;
- Compost biological waste instead of burial;
- Adopt advanced processing technologies;
- Create or improve industries using recycled materials;
- Promote sorting culture in the public;
- Teach recycling methods in schools and holding events.

To encourage the establishment of new remanufacturing factories in Azerbaijan, stimulate their development, and reduce waste in terms of natural resource consumption, energy savings, technological, ecological, and economic evaluation, the product of another industry should be evaluated as a raw material. For environmental protection and sustainable development, EU

Environmental Legislation comprises 8 subcategories:

- air quality;
- waste management;
- water quality;
- industrial pollution and risk management;
- chemical pollution;
- Physical contamination;
- Protection of nature and noise pollution.

Some countries excel at waste management, whereas others suffer with recycling. As new industries expand, difficulties increase, hence waste processing systems should be improved and priorities set:

Plastic garbage photo degradation takes hundreds of years and harms local ecosystems and fauna. Bans on foam containers, plastic bags, and plastic bottles are crucial to trash management. Biodegradable polymers are gaining popularity in the environmental industry. Mandatory composting: Some countries, like Azerbaijan, disregard the enriching soil resource of food and green waste by composting and burying it in landfills. The economic and ecological study shows that the lithosphere has abundant resources and is economically efficient. While innovation and technology are commendable, neglecting the environment can lead to frontal development. Development and innovation should consider economic growth and the environment. 3D printing has enabled manufacturing in new facilities and methods, including home use. 3D printing can build a house in a day. Of course, this technology could increase plastic dependence. In this regard, a) developing biogas from organic waste, b) obtaining fuel from waste and c) buying waste gasoline should be focused.

Any business, home, or hotel that generates food waste is a major issue. Food waste is harder to process than other household waste. You can make secondary items from glass, plastic, aluminum, and metal. Not so with food waste.

Composting turns dry material into fertilizer, reducing waste without landfilling. Sebastián Vicuña, Associate Researcher of Stockholm Environment Institute notes that the plastic garbage generated in residences, restaurants, offices, and anywhere else where people live is recyclable. Daily pet bottle consumption accounts for most plastic trash. Water, milk, all types of liquids, and gasoline are stored in pet bottles and glass, so they are eaten and discarded virtually daily. If appropriately assessed ecologically, it can be recycled economically and ecologically. Poor waste management harms the environment and humans. All businesses and nations should adopt an integrated waste management strategy to improve this predicament. Hazardous and medical waste harms developing country garbage collectors, who are rarely protected from direct touch and injury. Waste collectors should wear garments based on the waste's danger to avoid such situations.

In light of the aforementioned environmental disasters, deforestation, or the cutting down of trees and forests is happening at a breakneck pace. The trees are the lungs of our planet, serving up oxygen on a silver platter, while also dishing out raw materials and keeping the earth's temperature in check like a well-tuned thermostat. With the ax falling on trees for profit, the earth’s climate has taken a turn for the worse. Forests are a treasure trove for a myriad of wild animals and plants. The chopping down of trees has thrown a wrench in the works, wiping out a host of plant and animal species and throwing biodiversity into a tailspin.

Deforestation in its turn opens way to

desertification. Desertification ranks high among the world's most pressing environmental crises. Azerbaijan is situated in a dry climate, and experts from the Ministry of Ecology and Natural Resources believe that desertification is a very serious concern for the country.

At now, 3.7 million hectares of land in our country are at risk of erosion, and up to 1.2 million hectares are at risk of salinization, according to data from the Ministry. The impact of floodwaters has rendered 300 square kilometers of land unusable, while mining exploitation has rendered 30,000 hectares of land unproductive.

Overgrazing of existing pastures and forest areas causes desertification as a result of widespread land usage, insufficient fodder for animal husbandry, and the rapid proliferation of animals. Not only that, but chemical pollution, salinization, inadequate adherence to the irrigation regime, hydro technical facility failure, erosion process acceleration, and increasing influence of flood waters are other major contributors to desertification.

Chemical contamination is one of the key causes of land deterioration, according to the scientists who work for the Ministry of Environment and Forestry. In addition, the Armenians have significantly reduced the amount of forest stock in the 24,000 hectares of forestland that they control. This has led to a rapid acceleration of the desertification process and a reduction in the amount of forest cover across the entirety of Azerbaijani territory. As a result of the fact that desertification is going to become a global concern, environmentalists have no alternative but to demand rapid action in order to safeguard humanity from impending disasters. Azerbaijan has adopted the international agreement known as "Combating Desertification" in order to solve these concerns. This is due to the fact that Azerbaijan's national interests include a better ecological situation as well as the responsible and effective use of natural resources. As a means of addressing the issues that have been brought about by the crisis, our administration has developed suitable measures to combat the phenomenon of desertification. A number of projects, including "On increasing and restoring forests," "On ecologically sustainable socio-economic development," and "On effective use of summer-winter pastures, hayfields, and prevention of desertification in the Republic of Azerbaijan," are now being implemented by the government. Through the implementation of these projects, the nation is able to restore around 10,000 hectares of forest area on an annual basis. The creation of a land cadaster and registration system, the investigation of the current condition of summer and winter pastures, and the identification and mapping of locations that are impacted by severe erosion and salinization are all among the endeavors that are now being undertaken. Efforts are being made to increase designated natural areas in order to decrease the impact of human activities. This is being done with the goal of protecting the natural cover of our nation and preventing desertification. According to the relevant decrees issued by the president of state, the overall area of the country's highly protected natural areas increased by 4.5 percent, or 478 thousand hectares, from 2003 to 2009. This brought the total area to 778 thousand 464.7 hectares. This accounts for around nine percent of the entire land area that the nation constitutes.

Since 2006, the project titled "Creation of potential for joint and sustainable use of land" has been operating with the assistance of technical assistance from the United Nations Development Program and the Azerbaijani delegation of the Global Environmental Fund. The effect of this was that attempts to combat desertification in Azerbaijan were given a new lease on life. The Kurdemir and Goygol regions were the focus of the researchers' attention as they investigated the condition of the winter and summer pastures in those areas. A total of two hundred hectares of winter pastures were brought back to life in the Goygol district. According to the opinions of many experts, measures are made within the framework of government programs and in collaboration with international donors in order to prevent land from being decertified. On the other hand, the per hectare of land that is no longer useful remains the same from one year to the next. It would appear that the specialists are concentrating their efforts on eliminating the impact rather than the cause. That is to say, cattle continue to graze in forested areas even when there is no stable source of grain for animal husbandry when it comes to grain production. In addition, the replacement of the irrigation system will cost millions of dollars. As a result, our lands are rendered useless. In the territory that has been recaptured from the enemy, there are currently the beginning stages of the rapid rehabilitation process. A restoration of the ecological equilibrium that was thrown off by Armenia's encroachment is currently taking place. Acknowledging the fact that our historical, cultural, and religious landmarks, infrastructure, and even the very soil and stones of Karabakh were subjected to Armenian terrorism over the course of thirty years is a crucial step to take. The bulk of the 460 different types of trees and bushes that were found in Azerbaijan were eradicated by Armenians during their thirty years of control of Azerbaijani territories. The ecological system of Karabakh has

been completely obliterated as a result of environmental terrorism throughout the course of these years. Armenians were responsible for vandalizing over 261,000 hectares of Azerbaijan's forest fund area while they were occupying the country. There has been a degradation of the Topkhana forest as a result of the felling of thousands of trees in the forest since the year 1988.

In the liberated regions of Azerbaijan, nature reserves including a total area of 43,000 hectares—specifically the Basitchay and Karagöl reserves, as well as the Lachin, Gubadli, Arazboyu, and Dashalti reserves—were obliterated by Armenians. Throughout the occupation, the adversary Armenians deliberately and systematically harmed the ecosystems of Karabakh and Eastern Zangezur, perpetrating acts of terror on the flora and animals. Prior to the occupation, numerous rare flora and fauna listed in the "Red Book of the Republic of Azerbaijan" were safeguarded in this area, the majority of which have since been eradicated. In the territory of Azerbaijan occupied by Armenia, 13,000 hectares of precious forest land, including red oak and sycamore trees, have seen unparalleled vandalism. Over 460 types of wild trees and plants were eradicated by the Armenians in the seized lands. Armenians employed banned phosphorus munitions during combat to contaminate water sources and incinerate woods. All was obliterated in the regions impacted by these bombs. Throughout the 30-year occupation, Armenians exhibited animosity against the natural characteristics of Karabakh and Eastern Zangezur. They attempted to eradicate subterranean and terrestrial resources, vegetation and wildlife, plentiful water supplies, ancient cultural and religious sites, and rare natural treasures. It is regrettable that the Armenians subjected those exquisite and fertile forests, rivers, and natural landmarks to ecological devastation. Regrettably, the subterranean and terrestrial resources of the territories inside the Karabakh and Eastern Zangezur economic zones were plundered by Armenian vandals and thereafter taken to Armenia.

Another alarming factor is colossal number of landmines placed by Armenia in the territories of Azerbaijan from 1992 through 2023. Among the most dangerous and threatening remains of Armenian occupation in Karabakh region of Azerbaijan are mines, unexploded devices and booby traps. Armenia's over three-decade occupation has resulted in countless deaths and contamination of the great expanses of territory. 361 of our people, predominantly civilians, have fallen victim to my detonation since the end of the conflict in 2020, causing 68 deaths and 293 severe injuries. Since Armenia's assault against Azerbaijan started, over 3400 of our people have suffered from mines overall; among them are 38 women and 358 children. The first estimates indicate that 1.5 million mines and an unknown number of unexploded ordnances contaminate about 12 percent of the nation's land. As observed, in terms of mine contamination, Azerbaijan's Karabakh is among the quite polluted areas on Earth. This seriously jeopardizes ecosystems of the South Caucasus region in general and Karabakh specifically.

These traces of the war still kill and injure Azerbaijanis. Following the November 10, 2020 trilateral declaration made, Armenian forces have mined the territory and supply routes of Azerbaijani armed formations. Following the end of the battle with Armenia in 2020, the Azerbaijani Ministry of Defense claimed to have removed 1,318 PMN-E antipersonnel mines from the Lachin area overall. Along with a video, the Azerbaijani MoD also issued a statement in September 2022 that they discovered ten anti-vehicle landmines, eight PMN-2 antipersonnel mines, and one hundred Armenian-made PMN-E antipersonnel mines. Reputable technical sources have verified their manufacturing in Armenia since these claims surfaced. Armenia reportedly bought the Pinaka multi-barrel rocket launcher from India, likewise intended for the distant deployment of anti-personnel and anti-tank minefields. It is unknown, meantime, if this sequence contained the antipersonnel mine laying variation of the device. An exact map of mined regions has been asked from Armenia repeatedly in order to remedy the issue. Armenia, under different pretense, sadly denies continually providing the precise map of the landmines created and planted by them by ignoring international law. Long after wars have stopped, as was already mentioned, landmines still cause problems. Though they were first created for military usage, landmines have had a significant and long-lasting effect on civilian population. Stated differently, it seriously affects the flow of refugees and makes their return difficult. Thus, safeguarding civilian life depends critically on the threat of mines and ERW being eliminated. For people as well as for communities, landmines have psychological, social, and financial effects in addition to physical ones. Landmines so seriously and continuously endanger people. Therefore, world community has to adequately handle the threat of landmine and ERW contamination. The combustion of fossil fuels for energy purposes releases a substantial amount of greenhouse gases into the atmosphere, which act as a blanket over the planet and absorb heat from the sun. More than three quarters of all greenhouse gas emissions and almost 90 percent of all carbon

dioxide emissions come from fossil fuels like coal, oil, and gas, making them the worst culprits when it comes to climate change.

To prevent the most severe consequences of climate change, it is necessary to cut emissions in half by 2030 and achieve zero emissions by 2050, according to the scientific data. To get there, we have to stop using fossil fuels and put money into green, accessible, inexpensive, long-term, dependable energy alternatives. Renewable energy sources, such as the sun, wind, water, garbage, and the earth's heat, are ubiquitous, replenish them naturally, and release almost no pollutants or greenhouse gases into the air. Cleaner energy sources are making strides, but fossil fuels still make up over 80 percent of the world's energy production. At now, renewable energy accounts for around 29 percent of the nation's electrical power.

In order to ensure that the earth remains habitable for present and future generations, it is imperative that we move swiftly toward renewable energy sources. According to Michael Kiparsky, founding Director of the Wheeler Water Institute within the Center for Law, nearly six billion people, or 80 percent of the global population, reside in nations that rely on foreign suppliers of fossil fuels for their daily energy needs. This makes them extremely susceptible to geopolitical crises and upheavals. Azerbaijan's favorable solar conditions present significant opportunities for harnessing solar energy effectively. The Ministry of Energy reports that the technical potential stands at approximately 23,000 MW. The nation boasts an impressive annual range of 2,400 to 3,200 sunshine hours, which positions it favorably on the global stage. The most valuable resources are concentrated in the central river valleys as well as the northern and northwestern regions. Azerbaijan experiences a notable level of wind, particularly in the coastal regions adjacent to the Caspian Sea. The Ministry of Energy reports that the nation possesses approximately 3,000 MW of technical wind power potential and 800 MW of economic wind power potential. This economic opportunity has the capacity to produce approximately 2.4 TWh and save around 1 Mt of conventional fuel, thereby preventing the associated CO2 emissions.

It has been determined by the Azerbaijan Scientific-Research and Design Institute of Power Engineering, in conjunction with the Japanese corporation Tomen, that the yearly average wind speed in Absheron falls somewhere in the range of 7.9 to 8.1 meters per second (m/sec). Because the average wind speed in the country is six meters per second, the country's economic and technical potential for capturing wind power is strengthened. Additionally, despite the fact that hydropower is currently Azerbaijan's leading source of renewable energy, there is still a significant amount of potential in this area that has not been utilized. According to the Ministry of Energy, the country has a technical potential for small hydropower that is 520 megawatts (MW), which means that it is capable of producing up to 3.2 thermowatt hours (TWh) year. As Anita Milman, Professor of Environmental Governance, University of Massachusetts Amherst notes, reducing reliance on electricity generation from other countries, diversifying national economies, and protecting nations from the huge swings in the price of fossil fuels are all possible outcomes that can be achieved through the usage of renewable energy. Additionally, it encourages economic growth that is inclusive, the creation of jobs, and the reduction of individuals living in poverty. It is now the case that renewable energy sources are the most cost-effective in the majority of places across the globe. Technologies that use renewable energy sources are experiencing significant price reductions. There was a 56 percent decline in wind power generated by onshore sources, while there was a 48 percent decrease in wind power generated by offshore sources. Low- and middle-income countries, which are already exhibiting signs of rising interest in renewable energy sources as prices continue to fall, will be the source of a significant amount of the spike in demand for additional power. It is possible that low-carbon sources may play a significant role in the generation of new power in the coming years, particularly as the prices of these sources continue to fall.

## Conclusion

The climate has been undergoing a continuous process of change, but the actions of humans have exacerbated these changes over the past 200 years. The primary factor that influences climate change is the ongoing increase in greenhouse gas emissions. The earth's surface and lower atmosphere are warming as a result of the greenhouse effect, which is causing an increase in the average temperature of the Earth. This has resulted in the thawing of glaciers, rising sea levels, and other natural changes. Changing temperatures, rising sea levels, periods of abnormal heat in winter or cold in summer, heat waves, week-long torrential rainfall, droughts and fires, floods, and the extinction of plant and animal species are just a few of the adverse effects of climate change. It has an impact on nearly every aspect of human existence, including agriculture, economics, and health. The impoverished and vulnerable, as well as women, children, and the elderly, will be particularly affected by this issue, which will impact everyone from a small farmer to

a businessman.

The undeniable fact that climate change is occurring is already being confronted by every nation. The widespread consumption of all types of mineral fuels has led to an increase in the amount of greenhouse gases that are released into the atmosphere, which in turn has contributed to an increase in the average temperature of the planet. A consequence of climate change is an increase in both the frequency and intensity of natural disasters and other types of extreme weather events. There has been an increase in the frequency of natural disasters such as hurricanes, landslides, floods, and droughts. There are a great number of animal species that are in danger of becoming extinct as a result of the rapid pace at which the climate is changing, which is damaging to the health of humans. The holding of the COP, which is the largest event in the world, is obviously not a problem that is a one-sided issue for all of these reasons. Every nation and every member of the international community bears a significant portion of the responsibility for addressing the issue of climate change.

Taking into consideration the fact that all nations joined together for the first time in 2015 to sign the Paris Agreement, which was intended to combat climate change, it is important to have this information. In the Paris Agreement, nations made a historic commitment to limit the increase in the global average temperature relative to the pre-industrial period to no more than two degrees Celsius and no more than 1.5 degrees Celsius. This agreement was reached amidst the Paris Agreement. Thereafter, discussions have proceeded in accordance with the roadmap and the objectives of the Paris Agreement. Few governments are genuinely taking action to address this global issue, despite the fact that there has been a lot of discussion about it. There are a great number of countries that are not in compliance with this requirement at all. Nevertheless, Azerbaijan will achieve its goal at a high level and develop a new Azerbaijani model in the fight against climate change, as it always does. This is something that could happen. In contrast to the linear economic model, the Azerbaijani model allows for the reuse and recycling of materials, which guarantees that natural resources and goods will continue to be rewarded in the future. Through the implementation of the United Nations Sustainable Development Indicators in the fight against climate change, this closed-loop economic model in Azerbaijan will make it possible to create sustainable consumption and production patterns, stimulate innovation and new business activity, and combat pollution, resource depletion, and biodiversity loss, all of which are critical factors that impact the environment. All of these factors are important in ensuring the preservation of the environment.

In the upcoming Conference of the Parties (COP29), which will take place in our country, we are hoping to witness new ideas for combating climate change as well as more collaboration between various groups. It is of the utmost importance that Azerbaijan and all other nations collaborate in order to find a solution to this problem. In the fight against climate change, funding is becoming an increasingly important component on an annual basis. The debates on climate change that are going place over the long term can be interpreted in a number of different ways. One view is that governments are looking for financial assistance to assist with adaptation, improvement of the climate, and mitigation of the effects of climate change. Both rich and developing nations have committed to pooling a total of one hundred billion dollars in order to address this issue. On the other hand, this is merely a concern that is being voiced at this time. It is possible to encourage developed nations to fulfill their commitments to provide financial support during the COP29 conference.

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# Protecting the environment with artificial intelligence

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Təkrar gedib. Bu məqaləyə təkrar baxmaq!!!

**Abstract**

Artificial Intelligence (AI) has emerged as a transformative tool in environmental protection, addressing critical challenges such as climate change, pollution, and biodiversity loss. This article explores the application of AI in environmental monitoring, resource management, and wildlife conservation. AI technologies enhance data collection and analysis through advanced sensors, satellites, and drones, enabling real-time monitoring and predictive analytics of environmental changes. In resource management, AI optimizes water use and agricultural practices while improving waste management through automated sorting. AI also plays a crucial role in wildlife monitoring and ecosystem protection by tracking animal populations and detecting illegal activities. Despite its potential, the application of AI in environmental protection faces challenges, including ethical concerns about data privacy and equity, as well as technical limitations related to data quality and model accuracy. The future of AI in environmental protection is promising, with ongoing advancements expected to improve effectiveness and efficiency in addressing ecological issues. The article concludes with a call to invest in AI research, promote interdisciplinary collaboration, and ensure ethical practices.

**Keywords:** Artificial Intelligence (AI), Environmental Monitoring, Predictive Analytics, Resource Management, Precision Agriculture, Smart Irrigation, Waste Management, Wildlife Conservation, Ecosystem Protection, Climate Change, Data Privacy, Ethical Concerns, Technological Limitations

## Introduction

### The Urgency of Environmental Protection

The environmental challenges facing our planet today are unprecedented in scale and complexity. Climate change, characterized by rising global temperatures, more frequent extreme weather events, and shifting weather patterns, poses significant risks to ecosystems and human societies. Pollution—whether it’s air, water, or soil—continues to threaten both natural habitats and public health. Additionally, the ongoing loss of biodiversity is alarming, with many species facing extinction at an accelerated rate.

Addressing these issues requires innovative solutions and a multifaceted approach. Traditional methods of environmental management, while valuable, often fall short in dealing with the scope and urgency of contemporary environmental challenges. In this context, technology offers new opportunities for more effective and efficient environmental protection strategies. Artificial Intelligence (AI), with its advanced data processing capabilities, has emerged as a promising tool in this endeavor.

### Artificial Intelligence as a Tool for Environmental Protection

Artificial Intelligence refers to the capability of a machine to imitate intelligent human behavior. AI systems can analyze large datasets, recognize patterns, and make predictions with remarkable accuracy. These capabilities make AI an invaluable asset in environmental management. By leveraging AI, we can enhance our ability to monitor ecosystems, predict environmental changes, optimize resource use, and protect wildlife.

### Application of AI in Environmental Monitoring

#### Data Collection and Analysis

AI has revolutionized the way we collect and analyze environmental data. Advanced sensors, satellites, and drones equipped with AI technology provide real-time insights into various environmental parameters. For instance, AI algorithms can process data from remote sensing satellites to monitor deforestation rates, track changes in land use, and assess the health of vegetation.

#### Case Study: Google Earth Engine

Google Earth Engine exemplifies how AI can be harnessed for environmental monitoring. This

platform uses machine learning algorithms to analyze satellite imagery and generate valuable insights into environmental changes. For example, it has been instrumental in tracking deforestation in the Amazon rainforest and monitoring the impacts of climate change on polar ice caps. By providing detailed and up-to-date information, Earth Engine helps researchers and policymakers make informed decisions.

**Predicting Environmental Changes**

Predictive analytics powered by AI can forecast environmental changes with high precision. Machine learning models can analyze historical climate data, satellite images, and other relevant datasets to predict future weather patterns, sea-level rise, and other climatic phenomena. These predictions are crucial for preparing for and mitigating the impacts of natural disasters.

**Case Study: AI in Flood Prediction**

AI-based flood prediction systems use data from weather forecasts, river gauges, and historical flood records to predict flood events. For instance, IBM's Green Horizons initiative uses AI to model and predict air quality and weather conditions, helping communities prepare for extreme weather events and reduce the risk of flooding. Such systems enable timely warnings and better preparedness, potentially saving lives and reducing economic losses.

**AI in Resource Management**

**Optimizing Resource Use**

AI technologies are increasingly employed to optimize the use of natural resources. In water management, AI algorithms analyze data on water consumption, weather patterns, and soil conditions to predict water demand and supply. This enables more efficient water distribution and helps prevent shortages.

**Case Study: Smart Irrigation Systems**

Smart irrigation systems powered by AI can significantly reduce water usage in agriculture. These systems use sensors and weather forecasts to determine the optimal amount of water required for crops. By adjusting irrigation schedules based on real-time data, farmers can minimize water waste and improve crop yields. For example, systems like the CropX platform leverage AI to provide precise irrigation recommendations, contributing to more sustainable farming practices.

**Sustainable Development and Waste Reduction**

AI also plays a critical role in promoting sustainable development and reducing waste. In waste management, AI systems can improve recycling processes by sorting materials more efficiently than traditional methods. AI-powered robots and sorting machines use computer vision and machine learning to identify and separate different types of waste, enhancing recycling rates and reducing landfill use.

**Case Study: AI in Recycling**

One notable example is the use of AI in automated recycling facilities. Companies like AMP Robotics have developed AI-powered robots that sort recyclable materials with high accuracy. These robots can distinguish between various types of plastics, metals, and paper, ensuring that more materials are recycled and less end up in landfills. This technology not only improves recycling efficiency but also reduces the environmental impact of waste disposal.

**AI in Wildlife and Ecosystem Protection**

**Monitoring Wildlife**

AI is transforming wildlife monitoring by providing tools to track and analyze animal behavior and movements. Camera traps equipped with AI can capture images and videos of wildlife, which are then analyzed by machine learning algorithms to identify species, monitor populations, and detect poaching activities.

**Case Study: AI for Elephant Conservation**

AI technology has been used to combat poaching and protect endangered species. For example, the organization Wildtrack employs AI to analyze footprints of endangered elephants. By comparing these footprints with a database of known individuals, AI can identify and track elephants, helping conservationists monitor their movements and detect potential threats. This approach has been effective in reducing poaching incidents and ensuring the safety of these majestic animals.

**Protecting Ecosystems**

AI also contributes to the protection of entire ecosystems. By analyzing data from various sources, such as satellite imagery, sensor networks, and environmental databases, AI systems can detect and predict threats to ecosystems, such as illegal logging, land degradation, and habitat destruction.

**Case Study: AI in Forest Conservation**

AI-powered systems are used to monitor forests and detect illegal logging activities. For instance,

the Global Forest Watch platform uses AI to analyze satellite images and identify deforestation patterns. This real-time monitoring enables timely interventions and supports conservation efforts to protect critical forest ecosystems.

**Challenges and Issues in AI Applications for Ecology**

Ethical and Social Concerns

The deployment of AI in environmental protection raises several ethical and social concerns. Data privacy and security are paramount, as the collection of environmental data often involves sensitive information. Ensuring that data is handled responsibly and protected from misuse is crucial.

**Ethical Considerations:**

Privacy: The use of AI for environmental monitoring may involve collecting data from private properties or sensitive areas. It is essential to balance environmental monitoring with respect for privacy rights.

Equity: The benefits of AI-driven environmental solutions should be distributed equitably, ensuring that all communities, particularly those vulnerable to environmental hazards, can access and benefit from these technologies.

**Technical Limitations and Risks**

Despite its potential, AI technology has limitations and risks. AI systems rely on high-quality data, and inaccuracies or biases in data can lead to erroneous predictions and decisions. Continuous refinement of AI models and validation against real-world conditions are necessary to ensure their reliability.

**Technical Challenges:**

Data Quality: AI algorithms require accurate and comprehensive data to function effectively. Inaccurate or incomplete data can lead to unreliable results.

Model Updates: AI models need regular updates and recalibration to account for changing environmental conditions and new data.

## Conclusion

## Future Prospects

The future of AI in environmental protection holds great promise. Advances in AI technology will continue to enhance our ability to monitor, predict, and manage environmental issues. Future developments may include more sophisticated AI models, greater integration of AI with other technologies (such as the Internet of Things), and improved methods for data collection and analysis.

**Emerging Trends:**

Integration with IoT: Combining AI with IoT devices will enable more comprehensive and real-time monitoring of environmental conditions.

Advanced Machine Learning: Innovations in machine learning techniques will improve the accuracy of predictive models and decision-making processes.

**Conclusion and Call to Action**

In conclusion, AI offers transformative potential for environmental protection. By leveraging AI technologies, we can enhance our efforts to conserve natural resources, protect wildlife, and manage environmental risks more effectively. Governments, businesses, and individuals must support and invest in AI-driven environmental solutions to address the urgent challenges facing our planet.

**Call to Action:**

Invest in Research: Support research and development of AI technologies for environmental applications.

Promote Collaboration: Encourage collaboration between tech companies, environmental organizations, and policymakers.

Advocate for Ethical Use: Advocate for ethical practices in the deployment of AI for environmental monitoring and protection.

## References

[Insert references to scientific articles, reports, and case studies on AI and environmental protection.]

[Include examples of successful AI projects and technologies.]

[List resources used for data collection and information.]

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appropriately thorough.

## Protecting the Environment with Artificial Intelligence

### Introduction

**The Urgency of Environmental Protection**

The 21st century has brought unprecedented environmental challenges that are increasingly affecting the planet's health and human well-being. Climate change is one of the most critical issues, with rising temperatures leading to melting ice caps, more frequent and severe weather events, and disruptions in global weather patterns. The consequences of climate change are widespread, impacting ecosystems, agriculture, and human health.

Pollution is another significant concern, with air, water, and soil contamination posing serious risks to both the environment and public health. Industrial activities, vehicle emissions, and agricultural runoff contribute to air pollution, while plastic waste and chemical pollutants degrade water bodies. Soil contamination from hazardous waste affects food security and ecosystem health.

Biodiversity loss is a third pressing issue, with many species facing extinction due to habitat destruction, climate change, and poaching. The loss of biodiversity undermines ecosystem services, such as pollination, water purification, and climate regulation, which are essential for human survival.

Addressing these complex and interrelated problems requires innovative and effective solutions. Traditional methods of environmental management are often inadequate due to the scale and urgency of the challenges. Artificial Intelligence (AI) offers a new approach by harnessing advanced data analysis and predictive capabilities to enhance environmental protection efforts.

### Artificial Intelligence as a Tool for Environmental Protection

Artificial Intelligence involves the use of computer systems to perform tasks that typically require human intelligence. These tasks include learning from data, recognizing patterns, making decisions, and predicting outcomes. AI encompasses various technologies, such as machine learning, natural language processing, and computer vision, which can be applied to environmental protection in numerous ways.

AI's ability to process and analyze vast amounts of data makes it an invaluable tool for addressing environmental issues. By leveraging AI, we can improve monitoring and data collection, enhance predictive models, optimize resource management, and protect ecosystems and wildlife more effectively. The integration of AI into environmental strategies represents a significant advancement in our ability to tackle ecological challenges.

### Application of AI in Environmental Monitoring

Data Collection and Analysis

AI has revolutionized the way environmental data is collected and analyzed. Traditionally, environmental monitoring relied on manual observations and limited data collection methods, which were often time-consuming and labor-intensive. AI technologies, including sensors, satellites, and drones, have greatly enhanced our ability to gather and analyze environmental data in real-time.

#### Sensors and IoT Devices

Sensors equipped with AI algorithms can monitor various environmental parameters, such as air quality, water quality, and soil conditions. These sensors collect data continuously and transmit it to central databases, where AI algorithms analyze the information to identify trends and detect anomalies. For example, air quality sensors use AI to predict pollution levels and assess the effectiveness of air quality management strategies.

Satellites and Remote Sensing

Satellites equipped with AI technology provide a comprehensive view of the Earth's surface, enabling large-scale monitoring of environmental changes. AI algorithms analyze satellite imagery to track deforestation, monitor vegetation health, and assess land use changes. The European Space Agency's Copernicus program, for instance, uses AI to process satellite data for environmental monitoring and disaster management.

#### Drones

Drones equipped with AI cameras and sensors offer high-resolution data collection for specific areas. They can be deployed to monitor wildlife, assess habitat conditions, and detect illegal activities such as poaching or logging. AI algorithms process the data captured by drones to identify species, track animal movements, and analyze habitat changes.

#### Case Study: Google Earth Engine

Google Earth Engine exemplifies the power of AI in environmental monitoring. This platform uses machine learning algorithms to analyze satellite imagery and generate insights into environmental changes. For example, it has been instrumental in monitoring deforestation rates in the Amazon rainforest and assessing the impacts of climate change on polar ice caps. Google Earth Engine provides researchers, policymakers, and conservationists with valuable data to inform

decision-making and enhance conservation efforts.

### Predicting Environmental Changes

AI's predictive capabilities enable us to forecast environmental changes with greater accuracy. Predictive modeling involves using historical data and machine learning algorithms to make informed predictions about future environmental conditions. This approach is particularly valuable for anticipating the impacts of climate change, natural disasters, and other environmental phenomena.

### Climate Change Projections

AI-driven climate models analyze historical climate data, atmospheric conditions, and greenhouse gas emissions to project future climate scenarios. These models help scientists understand the potential impacts of climate change on temperature, precipitation, and sea levels. For example, the Climate Impact Lab uses AI to project the economic impacts of climate change on different regions, providing insights into the potential costs and benefits of mitigation strategies.

Natural Disaster Prediction

AI algorithms can analyze data from weather forecasts, satellite imagery, and historical records to predict natural disasters such as hurricanes, floods, and wildfires. These predictions help communities prepare for and respond to emergencies more effectively. For instance, AI-based flood prediction systems use real-time data from river gauges and weather forecasts to provide early warnings and help manage flood risks.

Case Study: IBM Green Horizons

IBM's Green Horizons initiative leverages AI to model and predict air quality and weather conditions. By analyzing data from weather stations, satellite imagery, and pollution sources, Green Horizons provides forecasts of air quality and pollution levels. This information enables cities to implement measures to reduce pollution and protect public health.

AI in Resource Management

Optimizing Resource Use

AI technologies are increasingly being used to optimize the management of natural resources. By analyzing data on resource consumption, weather patterns, and environmental conditions, AI algorithms can help improve the efficiency of resource use and reduce waste.

### Water Management

In water management, AI algorithms analyze data from weather forecasts, soil moisture sensors, and water usage patterns to predict water demand and supply. This enables more efficient water distribution and helps prevent shortages. For example, the Aquasave platform uses AI to optimize irrigation schedules based on real-time data, reducing water waste and improving crop yields.

### Agriculture

AI-driven precision agriculture technologies use data from sensors, drones, and satellite imagery to optimize the use of water, fertilizers, and pesticides. These technologies help farmers make data-driven decisions to improve crop production and reduce environmental impacts. The CropX platform, for instance, provides AI-based irrigation recommendations to optimize water use and enhance agricultural sustainability.

Sustainable Development and Waste Reduction

AI plays a critical role in promoting sustainable development and reducing waste. By improving waste management and recycling processes, AI contributes to reducing the environmental impact of waste and promoting a circular economy.

### Waste Management

AI systems enhance waste management by sorting materials more accurately and efficiently than traditional methods. AI-powered robots and sorting machines use computer vision and machine learning to identify and separate different types of waste, improving recycling rates and reducing landfill use. The AMP Robotics platform, for example, uses AI to automate the sorting of recyclable materials, increasing the efficiency of recycling operations.

### Circular Economy

AI technologies support the transition to a circular economy by facilitating the reuse and recycling of materials. AI algorithms analyze data on product lifecycles, material flows, and recycling processes to identify opportunities for material recovery and reuse. For example, the Recyclebank platform uses AI to incentivize recycling behavior and track recycling rates in communities, promoting sustainable waste management practices.

## AI in Wildlife and Ecosystem Protection

### Monitoring Wildlife

AI is transforming wildlife monitoring by providing tools to track and analyze animal behavior and movements. AI-powered camera traps and sensors capture images and videos of wildlife, which are then analyzed using machine learning algorithms to identify species, monitor populations, and detect poaching activities.

### Camera Traps

AI-equipped camera traps capture high-

resolution images of wildlife and analyze them in real-time to identify species and monitor animal behavior. For example, the Wildlife Insights platform uses AI to analyze camera trap images from around the world, providing valuable data for wildlife conservation and research.

### Case Study: Elephant Conservation

AI technology has been used to protect endangered species such as elephants. The organization Wildtrack employs AI to analyze elephant footprints, which helps conservationists track and monitor individual elephants. By comparing footprints with a database of known individuals, AI can identify and track elephants, helping to prevent poaching and ensure their safety.

### Protecting Ecosystems

AI contributes to ecosystem protection by monitoring and predicting threats to ecosystems. AI systems analyze data from various sources to detect and assess threats such as illegal logging, land degradation, and habitat destruction.

### Forest Conservation

AI-powered systems monitor forests and detect illegal logging activities. For example, the Global Forest Watch platform uses AI to analyze satellite images and identify deforestation patterns. This real-time monitoring enables timely interventions and supports conservation efforts to protect critical forest ecosystems.

Case Study: AI in Coral Reef Monitoring

AI technology is also used to monitor coral reef health. The Coral Cay Conservation project employs AI to analyze underwater images of coral reefs, assessing coral health and detecting signs of bleaching or disease. This information helps researchers and conservationists develop strategies to protect and restore coral reefs.

Challenges and Issues in AI Applications for Ecology

### Ethical and Social Concerns

The use of AI in environmental protection raises several ethical and social concerns that must be addressed to ensure responsible and equitable deployment of technology.

### Data Privacy and Security

AI systems often involve the collection and analysis of large amounts of data, which can include sensitive information. Ensuring data privacy and security is essential to prevent misuse and protect individuals' rights. Data handling practices must be transparent and adhere to ethical standards to build trust and safeguard privacy.

### Equity and Accessibility

The benefits of AI-driven environmental solutions should be distributed equitably. Ensuring that all communities, particularly those vulnerable to environmental hazards, have access to AI technologies and can benefit from their applications is crucial for promoting social equity. Efforts should be made to address disparities in technology access and support underserved communities in adopting AI solutions.

### Technical Limitations and Risks

Despite its potential, AI technology has limitations and risks that must be addressed to ensure its effectiveness in environmental applications.

### Data Quality and Bias

AI algorithms rely on high-quality data to function effectively. Inaccurate or biased data can lead to erroneous predictions and decisions. Ensuring data accuracy and addressing potential biases in data collection and analysis are critical for the reliability of AI systems. Ongoing validation and refinement of AI models are necessary to improve their performance and address potential issues.

Model Updates and Maintenance

AI models require regular updates and maintenance to remain effective. Environmental conditions and data patterns can change over time, necessitating continuous adjustments to AI algorithms. Researchers and practitioners must invest in updating and maintaining AI models to ensure their relevance and accuracy in addressing evolving environmental challenges.

## Conclusion

### Future Prospects

The future of AI in environmental protection is promising, with ongoing advancements in technology likely to enhance our ability to address ecological challenges. Emerging trends, such as the integration of AI with the Internet of Things (IoT) and advancements in machine learning techniques, will further improve our capacity to monitor, predict, and manage environmental issues.

Integration with IoT

The combination of AI with IoT devices will enable more comprehensive and real-time monitoring of environmental conditions. IoT sensors, coupled with AI algorithms, will provide detailed insights into environmental changes and support more effective management strategies.

### Advanced Machine Learning

Advancements in machine learning techniques, such as deep learning and reinforcement learning, will improve the accuracy of predictive models and decision-making processes. These innovations will enhance our ability to address complex environmental issues and develop more effective solutions.

### Conclusion and Call to Action

AI offers transformative potential for environmental protection, providing new tools and approaches to address the urgent challenges facing our planet. By leveraging AI technologies, we can enhance conservation efforts, optimize resource management, and improve our ability to monitor and predict environmental changes.

### Call to Action

Invest in Research: Support ongoing research and development of AI technologies for environmental applications. Investing in innovation will drive progress and improve the effectiveness of AI solutions.

Promote Collaboration: Encourage collaboration between technology developers, environmental organizations, and policymakers to ensure that AI solutions are effectively implemented and address real-world challenges.

Advocate for Ethical Use: Advocate for ethical practices in the deployment of AI for environmental monitoring and protection. Ensuring data privacy, equity, and responsible use of technology is essential for building trust and achieving positive outcomes.

### References

Scientific Articles and Reports: Include references to relevant scientific articles, reports, and research studies that provide evidence and insights into the applications of AI in environmental protection.

Case Studies and Examples: Provide examples of successful AI projects and technologies that have contributed to environmental protection efforts.

Resources and Data Sources: List resources and data sources used for collecting information and supporting the content of the article.

# Sustainable management of water resources of the Karabakh Economic Zone

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## Abstract

This article aims to analyze the sustainable management of water resources of the Karabakh economic zone. The article examines sustainable water management adapted to artificial intelligence and smart urban projects. The capacity of rivers, reservoirs, water canals and their water-energy-soil (nexus) management mechanisms are being studied in Karabach region. Improving the quality of decision-making and management based on the formation, collection, storage, processing and analytical analysis of digital data through the use of integrated technologies creates the basis for sustainable management of water resources.

**Keywords**: Azerbaijan, Karabakh economic zone, sustainable water management, water resources.

## Method of the research.

The method of the research is based on an empirical and technical-legal analysis of the statistical data on water sector in Azerbaijan.

## Introduction

The pace of change in the world is so rapid that the planning of new projects must target the future and use goal, forecasting, diagnosis and adaptation techniques. This article analyzes the economy of the water resources in Karabach. One of the main focuses of this research is to study the Khachinchay, Gargarchay, Khachinchay reservoir and groundwater resources of Agdam, which provide the region with water resources. Further energy efficiency in the rivers supplying Aghdam city with water was assessed and proposed. For research and analysis of average annual water consumption, multi-observation data of water metering stations operating on Khachinchay and Gargarchay were collected and integrated into the SPSS Statistics program.

In the territory of Azerbaijan, potable water has limited resources and is unevenly distributed. Currently, the country's surface water reserves are 27 cubic kilometers, and in dry years this reserve decreases to 20-21 cubic kilometers. The sources of surface water resources are rivers, lakes, reservoirs and glaciers. 70-72 percent of our country's fresh water resources are formed outside the country's borders (“Azerbaijan Water” OJSC).

19-20.6 cubic kilometers of Azerbaijan's surface water resources are formed by transboundary rivers, and 9.5-10 cubic kilometers by local river flow. With the exception of the Samur River, the annual water supply of the rivers flowing directly into the Caspian Sea is 2.2-2.5 cubic kilometers, of which 1-1.1 cubic kilometers are from the northeastern slope of the Greater Caucasus, 1.2-1.4 cubic kilometers from the Lankaran natural region belongs to flowing rivers. The total water supply of the right and left tributaries of the Kura river basin is 7.5-7.8 cubic kilometers. (“Azerbaijan Water” OJSC).

Azerbaijan's water resources are formed due to rivers, lakes, reservoirs, glaciers and underground water resources.

The annual exploitation reserves of usable underground water of the Republic of Azerbaijan are close to 9 billion cubic meters. The main reserves of underground water are collected in Samur-Devachi, Sheki-Zagatala, Ganja-Gazakh, Mil-Karabagh, Jabrayil, and Nakhchivan foothills. About 60% of these reserves are located in the

territory of the Samur-Devachi, Sheki-Zagatala and Ganja-Gazakh foothill plains. The predominance of gravel and sandy rocks with high water permeability properties in the geological section, the well-developed river network, and the abundance of precipitation create favorable conditions for the feeding of underground water in these areas.

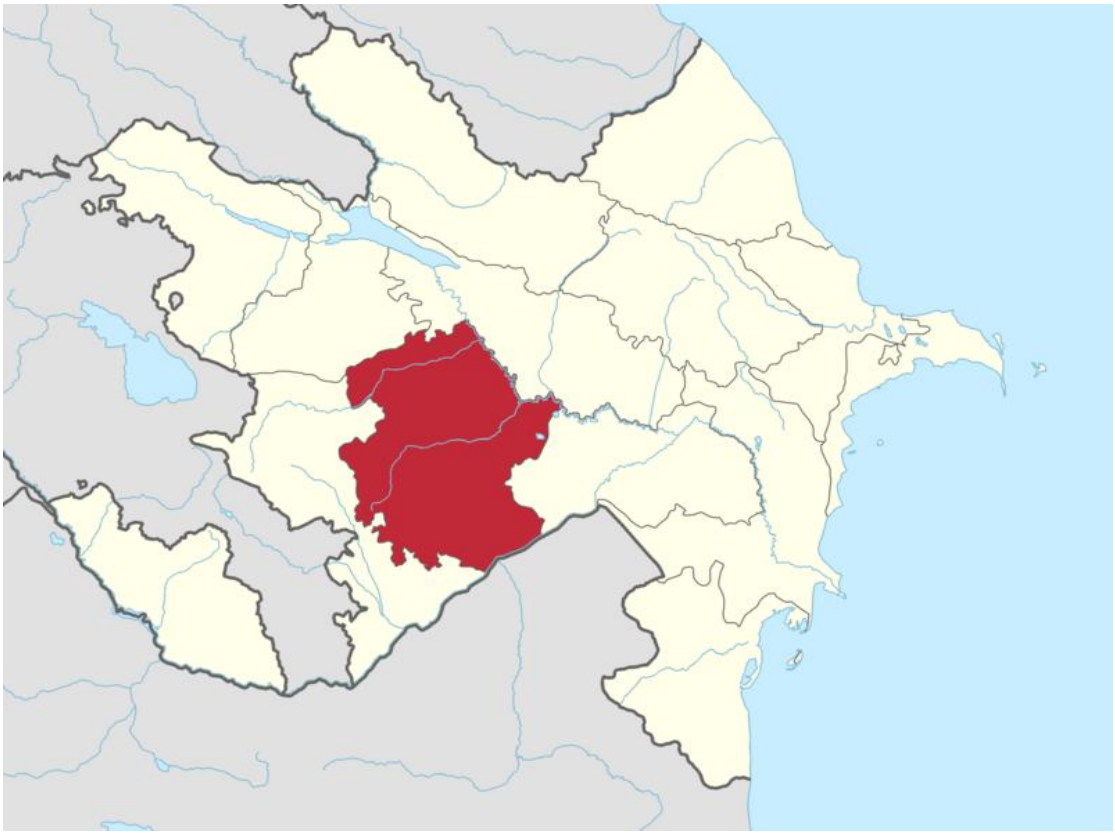
Within the foothill regions, the plains of Jeyranchol and Adjinohur are characterized by very limited underground water resources and relatively high levels of mineralization. Shamakhi-Gobustan area is distinguished by somewhat positive conditions.

In the mountainous parts of the Greater and Lesser Caucasus, Talysh, high-quality underground water mainly appears in the form of springs in connection with tectonic cracks. The consumption of the springs found at the foot of the slopes and in the valleys usually varies between 5-10 liters/second. Underground water with a daily consumption of 40-60 thousand cubic meters is also widespread in the bedrock of mountain rivers.

Despite being the "poorest" country in the South Caucasus due to limited water resources and the volume of fresh water resources, Azerbaijan is ahead of many countries in the world in terms of uninterrupted water supply in urban areas. (“Azerbaijan Water”).

## Karabakh economic region

One of the main tasks of the central and local executive authorities is to determine the water potential of the Karabakh economic region (Map 1) and the mechanisms of its sustainable impact on regional economic development while determining the economic and political priorities of Azerbaijan.



Map 1. Karabakh Economic Region in Azerbaijan

The water resources of liberated territories in Karabakh, including rivers, lakes and groundwater, are estimated at about 780 million cubic meters, and about 20 percent of local water resources of the Republic of Azerbaijan (Ahmadi et al, 2022).

Access to the occupied water resources of the Republic of Azerbaijan, where 72.7 percent of water resources are formed abroad, is very important in this country. These resources will be used for drinking water, land reclamation and electricity generation. The Kalbajar and Lachin districts are rich in fresh water resources. Even the Arpa and Bargushad rivers, which feed Lake Sevan, the source of fresh water in Armenia, are in these two districts (Ahmadi et all, 2022).

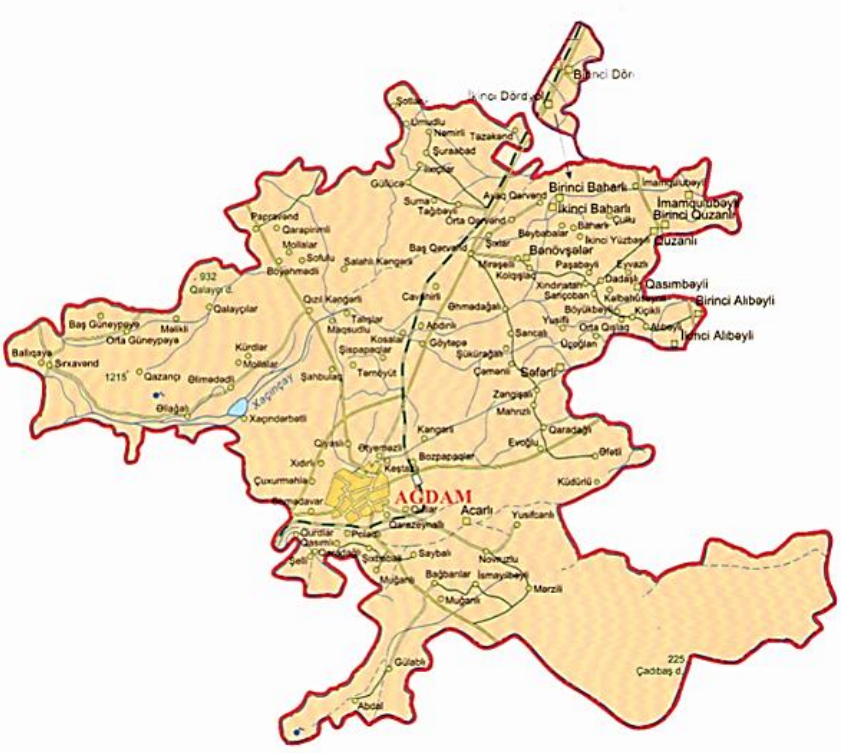
Up to 40 percent of the Republic of Azerbaijan's mineral water resources are in the occupied territories. It is possible to sell these waters both in

packages and to create resort-recreation zones on the springs. There is a great potential for the development of tourism on the basis of 2 occupied reserves, 4 sanctuaries and historical monuments. Azykh Cave, one of the oldest settlements in the world, has a wide range of tourism opportunities (Ministry of Energy of the Republic of Azerbaijan, 2020).

All these political and diplomatic efforts will play a decisive role in the future of the Karabakh economic district. Ensuring the sustainable and inclusive development of the regions, the rapid integration of Karabakh into transport and other economic spheres will contribute to the overall and sustainable development of Azerbaijan. In turn, this will lead to inclusive governance in all regions of Azerbaijan. Governance and public service have invaluable roles in the socio-political life of any country. At the center is the human factor and its development potential. Sustainable management of water resources includes human development, socio-economic, technological, environmental and political factors. Water management principles with a complex management structure can be successfully used in all other public and private sector projects in the future (Ahmadov, 2020). Sustainable water resource management throws economic, social and political challenges of the 21st century. Sustainable water resource management has most complicated structure as variability of horizontal and vertical governance, geographical transformation, biological constituents, social aspects, economic components and political system (Ahmadov 2018). Managing natural resources to aid in the transition to sustainable development involves more than just extensive education at all levels. It is also necessary to formulate and develop natural resources management theoretical models resulting national (economic, social and political) features, furthermore raise the general population awareness about sustainable development and the transitioning to an ecological civilization. As seen from the Table 1 Azerbaijan is one of the highest transboundary water dependant countries in the world (Table 1). Its sustainability and governance system is highly important due to achieving its effective use in economic fields as industry and agriculture as well as in social spheres and political system.

## Prospects of water supply of Aghdam region

The Aghdam region is considered to be the center of the Karabakh economic region. Region Aghdam borders on Aghjabedi, Tartar, Barda, Kalbajar, Askeran, Khojavend and Fuzuli regions. The area is 1,150 sq. km; population is 204,0 thousand people (01.01.2020). As a region it was established on 08.08. 1930. Region Aghdam consisted of 1 city, 2 settlements (Guzanli and Acharli) and 123 villages. (Map 4).




**Map 4. Aghdam city after 30 years of occupation completely destroyed**

Fig 5. Completely destroyed Aghdam city after Armenian occupation.

President of the Republic of Azerbaijan Ilham Aliyev noted that Aghdam was included in the "Smart City" project (Aliyev, 2021). Improving the quality, safety and efficiency of services provided in cities and villages of the Republic of Azerbaijan, the application of information technology in their provision, as well as ensuring the effective use and management of available resources for these services are among the main priorities of sustainable development in urban and rural areas. Hydro quality of groundwater sources is quite important to evaluate society’s development, particularly in regions suffering from surface water shortage (Laleh et al. 2022). The use of modern telecommunications, sensors, Big Data and other digital and artificial intelligence technologies, as well as innovation and knowledge, makes socio-economic relations more productive and efficient, creating new income opportunities in the overall value chain of the economy (Strategic Road Map, 2016). Improving the quality of decision-making and management based on the formation, collection, storage, processing and analytical analysis of digital data through the use of these technologies in an integrated manner opens up a wide range of opportunities for effective and quality services. These opportunities pave the way for the transition to functional, large-scale “Smart City” and “Smart Village” services in the next stage of development of services provided in cities and villages (Order of The President of the Republic of Azerbaijan on the development of the concept of "Smart City" and "Smart Village", 2021). One of water resources of Agdam region are the rivers flowing through the territory. On Table 4 see the basin area and the average height of the main rivers of the Agdam region.

Table 4. Water resources of rivers flowing through the territory of Aghdam region

| № | River-station | Basin area, km2 | Average height of the basin, m | Water resources | | |
|---|---|---|---|---|---|---|
| | | | | m3/s | km3 | l/s*km2 |
| 5 | Gargarchay | 783 | | 3,46 | 0,11 | 4,42 |
| 6 | Hachinchay | 175 | 1780 | 1,25 | 0,04 | 7,14 |
| Total | | | | 4,71 | 0,15 | 11,6 |

There is a need for water supply in the Aghdam region, which will have a population of 100,000, as well as the construction of a network of irrigation systems. For this reason it is also important to manage groundwater and surface water on the basis of sustainable and modern technologies. It should be noted that water in the Aghdam region is formed from two sources, ie both groundwater and surface water. The surface water of the region can be fed from Khachinchay and Gargarchay. Khachinchay reservoir is located on Khachinchay in Aghdam region. The reservoir was commissioned by the Azerbaijani government in 1964 to provide water for irrigation. As a result of the occupation of the Aghdam region by Armenian invaders in 1993, the operation of the reservoir by Azerbaijan was not possible until the end of 2020.

For research and analysis of average annual water consumption, multi-observation data of water metering stations operating on Khachinchay and Gargarchay were collected and integrated into the SPSS Statistics program.

This information is taken from the water cadastre, the fund materials of the Ministry of Ecology and Natural Resources, as well as the works of individual authors. Data from episodic observation stations were also used in the study. Using the SPSS Statistics program, the statistical parameters of the average annual flow series in the rivers flowing through the territory of Aghdam region were calculated (Table 5).

Table 5. Statistical parameters of the average annual flow series in the rivers flowing through the territory of Aghdam region

| № | River-station | The length of the line, (N) | Average perennial water consumption, m3/s | Coefficient of variation | Asymmetry coefficient |
|---|---|---|---|---|---|
| 23 | Garqarçay-Asgaran | 14 | 3,46 | 4,77 | 0,88 |
| 24 | Garqarçay-Lisogorsk | 4 | 0,02 | 0,0001 | 1,90 |
| 25 | Garqarçay-Hojalı | 26 | 3,25 | 2,90 | 1,15 |
| 26 | Garqarçay-Agakorpu | 49 | 1,72 | 0,47 | 0,61 |
| 27 | Hachınchay -Vangli | 24 | 1,25 | 0,09 | 0,18 |
| 29 | Hachınchay-Kolatak | 12 | 3,08 | 1,95 | 1,40 |

The density of the river network in the upper mountainous part of the Khachinchay basin is 1.3-1.4 km / km2, but for the whole basin it is 0.81 km / km2. There are many thresholds and small waterfalls upstream. The main phase of the Khachinchay river, water regime is flooding. The river is mainly fed by rainwater. Rainfall occurs in spring, summer and autumn, and floods are observed as a result of heavy rains.

Unlike Tartarchay, Khachinchay has low energy content due to low water content. The maximum capacity of the river is 626 kW / km from the confluence of the Ganzak branch to the confluence of the Churzan branch. In terms of energy efficiency, the description of this area is divided into two parts. Upper and Lower parts.

Upper part Q – 1,5 m3 / sec, Hp – 110 m, N – 1300 kW.

The lower part is located 1 km below the villages with water intakes. Sabitkechmez, an open diversion channel with favorable topographic conditions, has a concentrated drop at a flow rate of H - 120 m, and Q - will determine the capacity of a hydroelectric power plant with a consumption of 1.6 m3 / sec at a cost of 1,500 kW.

In rural areas, the possibility of building smaller hydropower plants is not ruled out. They can be located in the Churkhana and Kolotlag branches. It may be important to use these hydropower plants only as an energy source for local electrification of agriculture.

At present, there is a small-capacity reservoir in Khachinchay, which has a purely irrigation value. The geological features of the Khachinchay attract attention with the magnificence of the K-shaped eroded gorge. In the upper reaches, the surrounding water basins reach 2300-2500.

The Gargarchay is formed by the confluence of two main rivers; its tributaries are Khalfalichay and Dashaltichay. The energy value of the arms is negligible. The specific potential capacities of 171 and 187 kW do not indicate the prospect of creating large concentrations of power. A relatively favorable area here is the Gargarchay below the junction of the two main branches. The current energy consumption of the Gargarchay watercourse, which uses the Dashaltichay tributary, is limited to the electrification of Aghdam and Shusha. The parameters of this hydropower plant are as follows:

Q - 0,3 m3/ sec; H - 80 m; N - 190 kW.

There are also small water stations in Gargarchay - Askeran HPP with 60 kW branch of

Gargarchay and Balıcachay HPP with 35 capacity, another branch of Gargarchay. The average annual water consumption of the Khachinchay is 1.7 cubic meters per second, and that of the Gargarchay is 1.28 cubic meters. It is clear that the hydrological network of these two rivers is not very rich. If the population of Aghdam region increases to 100,000 over time, then there may be problems with water supply in the region. If we add irrigation systems, livestock and some industries, then the supply of water resources in the region may decline. Therefore, the use of groundwater as an alternative water source will be one of the key factors. Aghdam region is located in the groundwater zone of the Karabakh plain. The annual resource of this field is 1.9 billion cubic meters. If this water is used effectively, its exploitation resources may be sufficient for both the water supply of Aghdam and the irrigation of land. However, a nuance should be noted here. As the consumption of water in artesian wells is due to high energy consumption, there is a need for the application of energy water (nexus) combustion and more constructive and efficient use of water. For this purpose, underground artesian wells will be used to supply water to the city of Agdam. Because these waters are considered sustainable, dynamic and safe at the same time. Another alternative is to build a water canal from the Sarsang reservoir to the Khachin reservoir. If this project takes place, all categories of farms will be able to use water in a large area. It should also be noted that contamination or dangerous trends can occur at any time in surface waters, and in groundwater, although this factor is possible, it is partially safer. Therefore, on July 29, 2019, by the decision of the Cabinet of Ministers on some issues related to the structure of “Azersu” Open Joint Stock Company on the basis of Barda, Aghdam, Tartar, Agjabadi, Lachin, Beylagan, Fuzuli and Khojavend water supply departments under №5 “Azersu” OJSC regional water supply department has been established (Azersu, 2021). Therefore, on the basis of a new project, Azersu OJSC will use two water intakes with a total water resource of 40 cubic meters per second to supply water to the city of Agdam. Exploration wells have already been drilled in this direction, ie the stage of exploration and evaluation of resources for water supply of Aghdam city is underway. At the same time, it should be noted that there are more than 752 wells drilled in the eastern part of the Aghdam region before the 1990s, and although some of these wells have deteriorated, there is a need to restore and return them to operation. In order to reduce energy consumption, artesian wells will be operated using solar energy as an alternative energy source. It is expected that the surface and groundwater of Agdam will be used effectively in the construction of "smart cities" and "smart villages". There are enough resources here that can even help the surrounding areas.

Table 6. Volume of periodic and sequential water supply in individual cities (m3)

| | 1990 | 1993 | 1995 | 2000 | 2005 | 2008 | 2010 | 2013 | 2015 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Azerbaijan Republic | 1628 | 1477 | 1696 | 1875 | 2224 | 2485 | 1787 | 2184 | 2441 | 2398 | 2345 | 2358 |
| including by cities: | | | | | | | | | | | | |
| Baku | 530 | 557 | 245 | 189 | 711 | 414 | 335 | 419 | 489 | 431 | 550 | 554 |
| Ganja | 119 | 86 | 39 | 41 | 59 | 59 | 0,1 | - | - | - | - | - |
| Mingachevir | 10 | 10 | 7 | 1529 | 1283 | 1215 | 639 | 930 | 908 | 993 | 914 | 864 |
| Sumgayit | 867 | 782 | 151 | 89 | 160 | 166 | 366 | 215 | 414 | 437 | 402 | 404 |
| Shirvan | 55 | 17 | 5 | 20 | 1 | 622 | 437 | 614 | 614 | 521 | 458 | 516 |
| Azerbaijan Republic | 32 | 31 | 44 | 45 | 49 | 55 | 51 | 52 | 54 | 52 | 53 | 53 |
| including by cities: | | | | | | | | | | | | |
| Baku | 51 | 44 | 53 | 63 | 73 | 65 | 47 | 63 | 55 | 50 | 54 | 57 |
| Ganja | 77 | 84 | 89 | 87 | 88 | 88 | 13 | - | - | - | - | - |
| Mingachevir | 0,6 | 0,9 | 0,6 | 50 | 50 | 52 | 49 | 50 | 50 | 50 | 50 | 50 |
| Sumgayit | 67 | 76 | 60 | 59 | 84 | 89 | 62 | 50 | 67 | 65 | 65 | 65 |
| Shirvan | 7 | 1,9 | 0,9 | 3,6 | 0,1 | 50 | 50 | 50 | 52 | 50 | 50 | 50 |

**Source**: According to the Open Joint-Stock Company for Amelioration and Water Resources of Azerbaijan

Along with the liberation of Karabakh from occupation, the provision of water resources to the surrounding areas and meeting the need for water in agriculture is relevant to the current research. The main focus of the study is to study the Khachinchay, Gargarchay, Khachinchay reservoir and

groundwater resources of Agdam, which provide the region with water resources. Efficient and optimal use of water, supply of clean water to the population is possible with the use of the latest technologies. Sustainable management of water and energy resources is essential. Decreased water levels in rivers result in their unsuitability for irrigation. In such cases, reservoirs are needed as an alternative means of irrigation. As the economy of the Karabakh economic region is based on agriculture, the development of this sector is one of the main priorities for the economic region (SRM 2016).

In this regard, reservoirs are of special importance for the development of agriculture. Prior to Armenia's aggressive war against Azerbaijan, 97,000 hectares of fertile land covering the regions of Aran Karabakh were irrigated through the Sarsang and Madagiz reservoirs, the Right and Left Coast main canals built on the Tartar River (Law of the Republic of Azerbaijan, 2020). The occupation of reservoirs for more than 25 years has created difficulties in providing irrigation water to crops in Agdam, Agjabadi, Tartar, Barda, Yevlakh and Goranboy regions. Therefore, the state has taken consistent measures to meet the demand for irrigation water in these areas.

## Conclusion

Before the occupation of Karabakh, rivers, reservoirs and canals played a major role in the economic development of Azerbaijan, improving the welfare of the people. As a result of which the economic efficiency of Karabakh, industry and agriculture developed rapidly. Unfortunately, the Tartarchay, Khachinchay, Gargarchay, Khalfalichay, Dashaltichay and other rivers of great vital importance for our Republic; Sarsang, Sugovushan and Khachinchay reservoirs of strategic importance; The right and left coast of water canals and concrete-lined distribution canals, as well as a large number of medium and small hydropower plants, have been under occupation since 1992. In order to harm lands and the population of the frontline regions, the Armenians released water from the Sarsang and Sugovushan reservoirs in late autumn and winter, and cut off water in the spring and summer. As a result, there are difficulties in providing irrigation water to arable lands. Due to the fact that the water was transported through canals, the amount of losses was excessive. Currently, the potential for sustainable water supply to farmers, industry and agriculture in the entire region has increased. This, in turn, will soon have a positive effect on improving the well-being of people in Karabakh and adjacent regions. The use of economic potential, agriculture and other sectors of the economy will contribute to increase the welfare of the population.

For the government it is to arrange water governance research at all levels. To use theoretical and methodological concepts to figure out most suitable analytical frameworks, true planning and governance design. Not a sentence. As in most of the world, governments in the region have focused on large supply-side projects such as desalination and dam construction and less on an adaptive approach that emphasize important “soft” factors such as managing water demand and improving the efficiency of water use (Ahmadov 2020). So strengthening research at all category would decrease project mistakes and increase work efficiency bringing budget cuts. In this regard we mostly face with complicated system of water governance.

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# Management of natural disasters caused by climate change and development of new climate models

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**Abstract**

Climate change has become one of the global problems of our time. The development of scientific and technical progress, the industrial revolution, and the aggravation of the impact of anthropogenic processes on the atmosphere have led to the increase of greenhouse gases in the atmosphere, which in turn has caused global warming and climate changes. A number of natural disasters occur as a result of climate change, which in turn has a negative impact on the atmosphere. Thus, a sharp increase in temperature intensifies the melting of glaciers, the process of ocean acidification accelerates, the sea level rises sharply and causes floods in the surrounding areas. Also, the process of desertification is accelerating, which in turn leads to food shortages and an increase in infectious diseases. The fresh water supply is decreasing, and the result is the destruction of the ecosystem. Forest fires, volcanic eruptions, earthquakes, etc. natural disasters such as

Climate change is one of the most serious global problems of our time. Climate change includes both global warming driven by anthropogenic greenhouse gases and resulting large-scale changes in weather patterns. Although there have been climate changes in previous times, since the middle of the 20th century, humans have had an unprecedented impact on the Earth's climate system and caused it to change on a global scale. In the last 150 years, the temperature in the world has risen by 1 degree. If the temperature continues at this rate until 2050, it is expected to increase by 2-2.5 degrees, and by 2100 it will increase to 6 degrees.

Research in recent years has shown that rising air and water temperatures are leading to rising sea levels, stronger storms and increased wind speeds, more intense and longer droughts, wildfire seasons, and heavier rainfall and flooding. Global warming is the most important problem of our time, and its elimination requires significant social changes. The main goal of research is to protect the environment and its resources by using ways to mitigate climate change.

**Keyworsds:** Cimate change, global warming, climate models, biodiversity

## Introduction

They use models of the Earth system to predict how the climate will change in the future. Research in recent years has shown that rising air and water temperatures are leading to rising sea levels, stronger storms and increased wind speeds, more intense and longer droughts, wildfire seasons, and heavier rainfall and flooding. The evidence is overwhelming, and the results are devastating:

The bushfire season in Australia refers to the fires that have started from the east coast of the country since June 2019. Compared to 2019, from the first months of 2020, it is observed that the fires have accelerated significantly. Officials say the fire destroyed 8.4 million hectares of forest and injured 1.2 billion animals. One of the main reasons for the fire is abnormally hot weather on the eastern coast. In December 2019 , the New South Wales Government declared a state of emergency in the region following record-breaking heat and prolonged drought. About half a billion animals are said to have died as a result of the ongoing fires in New South Wales.

A number of studies have been conducted by scientists on what disasters climate change causes. For decades, social scientists have tried to unravel the real causes of disasters. Although some scholars have recently focused almost exclusively on human vulnerability, most recognize that disasters are caused by a combination of human choices and hazards. On the other hand, agencies and government officials downplay the political component of disasters (especially those related to global warming), preferring to focus on the technical and managerial aspects of climate response. This study examines how activists, scholars, and governments in informal settlements in the global South interpret climate-related risks and disasters.

## Methods

Climate change mitigation is critical to preventing extreme temperature increases, which are a major contributor to climate-related impacts. Even if net zero emissions were to be achieved immediately, carbon locked in the atmosphere would continue to affect ecosystems, people, settlements and infrastructure as seen over the past few decades. Despite the urgent need to minimize the effects of climate change, climate adaptation has not kept pace with increasing risks. Information about the occurrence and impact of disasters can direct action to where it is most needed.

Droughts and floods seriously affect agriculture around the world. Reducing the vulnerability of agriculture to disasters is of great importance to build climate-resilient agriculture. The article aims to investigate spatio-temporal changes in agricultural vulnerability to drought and floods in the world from 2003 to 2019. The study shows that the vulnerability of agriculture to drought and floods is low worldwide, so reducing exposure and increasing adaptive capacity have dual effects. identified as the most vulnerable areas, and spatio-temporal inconsistency of rainfall is the main factor causing floods and droughts. At the same time, better adaptation is useful to minimize the negative effects of disasters. Based on the analysis of drivers and spatial patterns of drought and flood risk at all dimensions, specific actions and policies are proposed to develop agricultural climate change adaptation strategies. [1]

Although the Earth's climate has been changing continuously for billions of years, human influence has accelerated the rate of change. While high latitudes suffer the most from rising temperatures, temperate latitudes are highly vulnerable due to hurricanes resulting in temperate-tropical rainstorms and extreme flooding events. We have shown that the occurrence and severity of these climate events are associated with the risk of adverse perinatal outcomes. In this review, we will discuss the data and consider the interaction of the immediate and intermediate consequences of natural disasters, including food shortages, degraded or damaged built environments and infrastructure, and the loss of communities through human migration. [2]

Climate changes cause extreme disasters such as floods, droughts, storms and tsunamis. Among all disaster mitigation strategies, climate forecasting and disaster management are among the measures that minimize both the risk and the harmful effects of disasters. For better forecasting, climate models are one useful tool for updating scientists' understanding of upcoming climate events so that they can predict climate behavior over time scales. Climate models will also provide information that can be fed into the disaster management cycle. In this way, the first objective of the present chapter is to propose the most common natural disasters affected by climate change and applicable climate models. Second, this study aims to discuss the extent to which the disaster management cycle plays a role in disaster mitigation. Qualitative data collection and secondary research method are applied to achieve the research objective. Therefore, a literature review, including a review of scientific articles, books, reports, and official websites, is the preferred methodology. The results show that although drought and floods are the disasters most likely to be caused by climate change, they can be one of the reliable tools in predicting drought and flood hazards to a certain extent. Increasing knowledge of the application of each available climate model has the potential to optimally quantify the magnitude of disasters. [8, pp. 181-207]

Climate of change effects unequivocal not Purpose extreme climate the change as a result arising natural with disasters connected of risks thoroughly overview present is to do . Alone extreme of the event and either numerous extreme of events the head to give disastrous to disaster can cause ; thus , this of events will come risks to evaluate for extreme climate changes done to fall it is important .. [ 9, p.177-193]

Humans are changing the Earth's surface mainly to create and expand more agricultural land. Currently, 34% of the Earth's land area is occupied by agricultural land, 26% by forests, and 30% by uninhabited areas (glaciers, deserts, etc.). Due to the conversion of forest areas to agricultural lands, their number continues to decrease rapidly. Deforestation is the most important factor in land surface change, which in turn has a direct impact on global warming. The main processes leading to deforestation are: conversion of forests to agricultural land for production of products such as beef and palm oil, logging for the production of forestry products (26%), short-term temporary cultivation (24%) and forest fires (23%). Deforestation affects the release of other chemical compounds into the air that affect aerosols and clouds, and can change wind patterns and cause temperature changes. While the main effect in the tropics and temperate climates is warming, at latitudes closer to the poles, albedo (as forest is replaced by snow cover) has a cooling effect.[16]

Major areas of climate change research include water, energy, ecosystems, air quality, solar physics, human health, wildfires, and land use. From meteorology to oceanography, epidemiology to agriculture, and even sociology and economics, many different fields of study play a major role in

studying both how the climate is changing and the effects of climate change. To visualize how the climate is changing and how these changes are affecting the Earth, scientists take direct measurements of the climate using aerial instruments. They also use models of the Earth system to predict how the climate will change in the future by looking at proxy data that give us clues about climate conditions from past periods.

First, the climate of any particular region is determined. By analyzing climatological variables, climate changes occurring in the region for 30 years or more are recorded. A number of parameters are measured at this time and the parameters measured include:

Temperature (maximum, minimum, low ground and soil), wind speed, relative humidity, atmospheric pressure, rainfall and sunshine hours.

The range of instruments used to observe and measure climate is quite diverse.

In our modern times, humanity is faced with devastating natural disasters caused by climate changes and other geophysical processes. The environmental problems of our world, which are changing faster than ever, are already causing serious concerns. According to the information provided by the World Meteorological Organization, 80-85 percent of natural disasters occurring in the world are related to hydrometeorological processes. Of course, the sharp increase in the dynamics of natural disasters of various origins that have occurred on the planet in recent years is primarily related to global climate changes as a result of the effect of warming in the Earth's atmosphere. The UN report on climate change states that the world temperature has risen by 1 degree in 150 years. This growth has mainly occurred over the last 25 years. According to experts, if warming continues at this rate, the temperature is expected to increase by 2-2.5 degrees by 2050, and by 6 degrees by 2100. Indeed, the disasters caused by global climate change on Earth are enormous. Thus, people lose their homes, diseases increase, the ecosystem is destroyed, etc.[17]

In fact, due to the amount of energy it receives from the Sun, the Earth's surface should be 20 degrees Celsius below zero. As we know, the Earth's surface has an average temperature of positive 20 degrees. The reason for this is water vapor, carbon dioxide, methane, ozone, etc. in the earth's atmosphere. the presence of a layer of gases. This layer is located approximately 25 kilometers above the Earth's atmosphere. The mentioned atmospheric layer allows the Sun's heat rays to reach the Earth unhindered, and at this time the heat rays pass through the Earth's atmosphere without being absorbed. Those gases located in this layer reflect the rays back to the Earth. The process is similar to the processes that occur in artificial greenhouses (greenhouses) created by humans. For this reason, the temperature on the surface of our planet rises to 39 degrees Celsius. Scientists say that the increase in temperature in the last 50 years has significantly affected human life, and that we are approaching a point of no return. If no action is taken, it is estimated that by the end of this century the global temperature will increase by an average of 2 degrees. Also, recent studies have reported that 2007 was the hottest year in the last 150 years. The effects of global warming, which has caused changes in the world's climate system, are felt everywhere in the world, from the highest peaks, to the depths of the oceans, from the equator to the poles. For example, since the late 1960s, there has been a 10 percent decrease in snow cover in the Northern Hemisphere. During the 20th century, it was determined that there was an increase in sea levels between 10-25 cm. Due to global warming, hurricanes, floods, and floods are increasing in intensity and frequency in many regions of the world, while in some regions, long, continuous, severe droughts and desertification are occurring. The number of natural disasters caused by climate changes has increased three times compared to the 80s of the last century. According to the information provided by the World Health Organization (WHO), 2.7 billion people suffered from natural disasters in 2000-2010 alone. According to the humanitarian organization "Oxfam", the number of natural disasters related to climate change has increased three times compared to the 80s of the last century. Statistics show that the number of geophysical disasters, including earthquakes and volcanic eruptions, has not changed much since the 1980s . However, at the same time, the number of earthquakes and hurricanes has increased significantly. According to experts from Colorado and Montana, especially earthquakes will occur more often than in previous years. The reason for this is that the length of the day increases by 1/10 of a second every year. This, in turn, leads to the discovery of underground energy. The institute, which studies earthquakes, predicts that aftershocks will be more frequent along the equator and also in tropical areas. Currently, scientists are trying to clarify what will cause global warming. England's "EDDI" Center has prepared a map of the world. The map shows Western Europe, the Indochina Peninsula, South Africa and America, the coastal zones of North America, island areas and Australia as the main dangerous areas. Nothing has been shown in the Caucasus zone, as well as in the territory of

Azerbaijan, which means that those effects will be at the minimal level.[15]

Destruction of species of fauna and flora as a result of a 2°C increase in global average temperature causes the danger of being accelerated. According to scientists' calculations, the global average if the temperature increase exceeds 3°C, there will be a threat of extinction of approximately 20-30% of known species. At present, climate changes it shows its negative effect mostly in sea and ocean ecosystems. As a result, it causes loss of biodiversity and ecosystems in coastal areas. [14] As a result 100 million people whose main source of income is fishing are malnourished and they face financial loss. The effects of environmental climate change are large-scale and affect the oceans, ice and air. The changes that occur can be gradual or rapid. Evidence of emerging impacts comes from studying past climate change, modeling and also modern observations. Since 1950, droughts and heat waves have been occurring simultaneously and regularly. During the monsoon period, the number of occurrences of extremely wet or dry nature has increased in India and East Asia. As a result of the melting of the Greenland and Antarctic ice sheets and thermal expansion, a rise in global sea level has been observed. This increase averaged 3.1 ± 0.3 mm per year during 1993–2017. High atmospheric carbon concentrations have led to changes in ocean chemistry. The process of increasing dissolved carbon dioxide has caused ocean acidification. Additionally, because oxygen is less soluble in warm water, oxygen levels decrease, higher temperatures, higher carbon levels, and hypoxic dead zones increase as a result of algal blooms driven by ocean eutrophication.

In winter, the temperature increases, spring comes early, autumn is late, and animal migration periods change. That is, climate change is happening. As a result, plant and animal species that cannot adapt to changes either decrease or are completely destroyed. Recent warming is causing aquatic and terrestrial organisms to move to the poles and higher altitudes. While higher atmospheric $CO_2$ levels have resulted in a global greening of the growing season, heat waves and droughts have reduced ecosystem productivity in some areas. Climate change has pushed the arid climate zones to become even more arid. Thus, the expansion of deserts in the subtropics can be an example of this. An increase in the magnitude and rate of global warming further increases the likelihood of abrupt changes in ecosystems. Overall, climate change is also expected to result in the extinction of many species.

Wildfires are the result of drier conditions in some areas caused by climate change. The wildfire season is longer than in previous years, and the number of wildfires each season has tripled compared to previous years. Extreme heat and drought increase fire risk in areas with drier soils and more flammable vegetation. Due to climate change, the risk and magnitude of wildfires in the western United States has increased. In spring, the snow melts earlier, as a result of which the soils and forests become drier and remain dry for a long time. Thus leading to wildfires that can spread hotter and faster. For much of the West, studies show that an average annual temperature increase of one degree Celsius could increase the area burned by 600 percent in a typical year. If greenhouse gas emissions continue to rise, more wildfires could occur for longer seasons. Forest fires have a significant impact on vegetation. Fires threaten the lives of many animals by destroying their food source and home. Plants and trees that do not burn, but are damaged by fire, lose their resistance and become more susceptible to fungi and insects. Landslides are also a rain-related process. Due to the effects of climate change on evaporation and precipitation, more frequent and intense precipitation can lead to more landslides .

## Discussion

Global warming is the most important problem of our time, and its elimination requires significant social changes. Despite years of public awareness of climate change, it has not been enough and global temperatures continue to rise day by day. Despite reduced emissions while at home due to COVID-19 $CO_2$ , the amount of carbon dioxide in the atmosphere is still at an all-time high. Additionally, climate change-induced disasters such as droughts, storms, and floods are becoming more severe and frequent, resulting in increased devastation. Because climate change is disrupting life and resources on our planet, we must take extreme measures to prevent climate change. There are different ways to reduce climate change:

Develop policies and agreements on climate change, implement clean energy projects, create social awareness on climate change, ban deforestation and logging. Keeping the environment clean Avoiding the use of chemical fertilizers. Reducing the wastage of water and other natural resources. Protection of flora and fauna. Purchase of energy-saving products and household appliances. Planting more trees in the neighborhood and surrounding areas. Reducing energy consumption.

These are ways to reduce climate change. If not implemented, worsening weather conditions, drinking water shortages, agricultural productivity and livelihoods will be affected.

## Conclusion

Earth's climate has changed throughout history. This change has been clearly caused by human activity since the mid-1800s and has continued at an unprecedented rate in recent millennia. Climate change is causing many natural disasters, which in itself do not affect the ecosystem. Climate change is caused by both anthropogenic effects. covers global warming driven by greenhouse gases and the resulting changes in weather patterns. Emissions of the greenhouse gases carbon dioxide (CO2) and methane account for more than 90% of the primary driver of warming . Climate change research spans multiple disciplines of Earth system science, as well as technology, engineering, and programming. From meteorology to oceanography, epidemiology to agriculture, and even sociology and economics, many different fields of study play a major role in studying both how the climate is changing and the effects of climate change. They use models of the Earth system to predict how the climate will change in the future. In our modern times, humanity is faced with devastating natural disasters caused by climate changes and other geophysical processes. In the last 150 years, the temperature in the world has risen by 1 degree. If the temperature continues at this rate until 2050, it is expected to increase by 2-2.5 degrees, and by 2100 it will increase to 6 degrees. Global warming - ocean acidification, floods, melting glaciers, rising sea levels, etc. resulting in such disasters.

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# Azərbaycan Respublikasının torpaq ehtiyatlarının ekoloji problemləri və onların mühafizəsi

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**Xülasə**

Məqalədə ölkəmizdə iqlim tipinə uyğun torpaqların yayılması, onların deqradasiyası, eroziyası, şoranlaşması, yaranma səbəbləri, mühafizə üsulları təhlil edilmişdir. Burada torpaq islahatlarının həyata keçirilməsi, yeni aqrar islahatların yaranması şəraitində torpaqların yenidən tədqiqi və təsərrüfat baxımından qiymətləndirilməsi də öz əksini tapmışdır. Həmçinin respublika torpaqlarında günü-gündən artan deqradasiyanın inkişaf edən proses olduğunu nəzərə alaraq mübarizə tədbirlərini həyata keçirməklə yanaşı, onlardan səmərəli istifadə etmək, mövcud ekoloji amillər, bərpa və mühafizə üsullarının yerinə yetirilməsi üçün müəyyən tövsiyyə və təkliflər verilmişdir.

**Açar sözlər:** torpaq örtüyü, deqradasiya, eroziya, şoranlaşma, iqlim şəraiti, ekoloji problemlər, mühafizə tədbirləri.

## Giriş

Azərbaycanın torpaq örtüyü tərkibinə görə çox mürəkkəbdir. Torpaq növlərinin müxtəlifliyinə görə bura dünyanın ən zəngin güşələrindən biridir. Respublikanın torpaq xəritəsində 90-a qədər torpaq tipi və yarımtipi göstərilmişdir. Yüksək dağlıqdan Kür-Araz ovalığına və Xəzər dənizinə kimi olan ərazidə dağ-tundra, dağ-çəmən, qonur-dağ meşə, qəhvəyi-dağ meşə, dağ-qara torpaqlar, boz-qəhvəyi (şabalıdı), sarı, boz və boz-qonur çəmən torpaqları, şoranlar, şorakət və s. torpaqlar yayılmışdır. Azərbaycanın ümumi torpaq fondunun sahəsi 8,641 mln. ha-dan artıqdır. Bunun 4,47 mln. ha-ı kənd təsərrüfatına yararlı, o cümlədən 1,43 mln. ha-ı suvarılan torpaqlardır. Respublika ərazisinin 3,240 mln. ha-ı və ya 37,4 %-i istifadə olunmayan (şoranlaşmış, bataqlıqlaşmış, güclü eroziyaya uğramış, daşlı çay yataqları, qayalıqlar və.s.) torpaqlardır. Ərazinin geoloji quruluşundan, relyefindən, iqlim şəraitindən, torpağın rütubətlənmə şəraiti və mexaniki tərkibindən, sukeçirmə qabiliyyətindən, strukturundan və s. asılı olaraq yaranan ekocoğrafi problemlər də müxtəlif olur.

Torpağın əsas xüsusiyyət və keyfiyyət əlaməti onun məhsuldarlığıdır. Torpağın həyatında böyük rol oynayan, onun mövcudluğunu, ehtiyacını ödəyən amillər su və qidadan ibarətdir. Torpağın tərkibində su çox olduqda qrunt sularının səviyyəsi qalxır, bataqlığa çevrilir, torpaqda aerasiya prosesi pozulur, şoranlaşır, əkin üçün yararsız olur, torpağın meliorativ vəziyyəti pisləşir.

Torpağın əsas xüsusiyyəti onun münbitliyi olub, bitkiləri su, qida maddələri və hava ilə təmin edir. Torpaq maddi nemətlərin əsası, kompleks təbii sərvət, kənd təsərrüfatında istehsal vasitəsi, yaşayıb-yaratmaq mənbəyi, əmək cismi üzərində mülkiyyət formalaşması, təsərrüfat, mədəni-məişət, sosial sahələrinin yerləşdirilməsində ərazi obyekti, zəngin xammal sərvətləri mənbəyi, istilik enerjisi, müalicə və termal suları daxilində saxlayan təbii xəzinə anbarıdır. O eyni zamanda müqəddəs və bərəkət mənbəyi sayılır. Elmi-coğrafi vəziyyətdə iqlim şəraiti, geomorfoloji və başqa xüsusiyyətlərlə əlaqədar olaraq, Azərbaycan Respublikasının torpaq örtüyü müxtəlif torpaq tiplərinin formalaşmasına zəmin yaratmışdır. Respublika ərazisinin 61%-ni dağ-dağətəyi və 39%-ni düzənlik təşkil edir. Aqrar təsərrüfata yararlı sayılan sahə - 41,66 min hektara bərabərdir ki, bununda 1,4 min ha-ı suvarılır. Mahiyyətcə dağlıq ölkə sayılan Azərbaycanda adambaşına 0,16 ha məhsuldar torpaq düşür ki, bu da kiçik rəqəmdir. Nəzərə alsaq ki, kəndli fermer təsərrüfatlarına verilən torpaqlar ekoloji baxımdan az sağlamdır, onda ölkədə torpaqların ekoloji sabitliyinin bərpası probleminin ümumi qayğıya cevrilməsi zərurətini asanlıqla dərk etmək olar. Başqa ölkələrdən fərqli olaraq, Azərbaycanda torpaq fondunun antropogen təsirlərdən qorunması daha vacibdir [3].

Relyef müxtəlifliyi, hündürlüyü ilə fərqlənən dağ silsilələri, geniş miqyaslı ovalıqlar, düzənliklər, çay vadiləri və başqa fiziki-coğrafi xüsusiyyətlər ölkədə müxtəlif iqlim şəraitinin formalaşmasına təkan vermişdir. Mülayim iqlim şəraiti respublikada iqlim qurluşuna müvafiq, əkinçiliyin inkişaf etdirilməsinə imkan verir. İqlim amillərindən mülayim, quru və rütubətli subtopik iqlim növlərinin üstünlük təşkil etməsi xüsusi qeyd edilməlidir. Məhz göstərilən iqlim şəraitləri respublikamızda dənli, dənli-paxlalı, texniki, yem bitkiləri, meyvə-tərəvəz, bostan, dərman

bitkiləri, üzümçülük, yağlı və başqa bitkilərin istehsalına imkan verir. Torpaqlarımızın səthində formalaşan başlıca sərvət onun zəngin bitki örtüyü - florasıdır.

Müasir dövrdə torpaq ehtiyatlarından səmərəli istifadənin müxtəlif aspektləri təsərrüfat komplekslərinin bir çox sahələrində tətbiq edilir və bu məsələ ilə bağlı bir çox təhlillər aparılmışdır.

Ölkəmizdə Muğan, Mil, Qarabağ və Şirvan düzləri, yəni Kür-Araz ovlağından tutmuş, Talış meşələrinə qədər 3 tip subtropik iqlimli torpaqlar vardır. Lakin torpaqlarımızın müasir vəziyyətini araşdırdıqda məlum olur ki, torpaqların deqradasiyaya uğramasına biganə münasibət hələ də qalmaqdadır. Məhsuldarlığı xeyli aşağı salan şorlaşmaya qarşı vaxtında tədbirlər görülmədikdə, onun sahəsi genişlənərək daha böyük ərazidə torpaq və həm də bitki örtüyünün deqradasiyasına gətirib çıxarır.

Suvarma qaydalarına düzgün əməl olunmadıqda əvvəlcədən şor olmayan, yaxud əsaslı yumadan sonra düzgün istifadə olunmayan sahələr şorlaşır. Bu prosesə təkrar şoranlaşma deyilir. Şoranlaşmış torpaqların meliorativ vəziyyətini yaxşılaşdırmaq üçün əsas vasitə onların su ilə yuyularaq duzlardan təmizlənməsidir. Yuma aparmaq və yuyulacaq sahələrdən duzları çıxarmaq üçün yeni kollektor-drenaj şəbəkəsinin yaradılması və köhnə şəbəkənin tam bərpa edilməsi əsas məsələdir. Kür-Araz ovalığında hələ XX əsrin ortalarında yaradılmış kollektor-drenaj şəbəkəsi demək olar ki, sıradan çıxdığından toplanan şor suları suvarılan sahələrdən uzaqlaşdıra bilmir. Nəticədə qrunt sularının səviyyəsi qalxaraq torpaqları şoranlaşdırır və bəzi sahələrdə səthə çıxaraq göl-bataqlıq landşaftı yaradır.

Məlumdur ki, torpaqların deqradasiyası, ilk növbədə, eroziya ilə əlaqədardır. Həmçinin torpaq ekosistemlərinin ekoloji sabitliyinin pozulmasında şoranlaşma, qurunt sularının səviyyəsinin yüksəlməsində müxtəlif xarakterli çirklənmələr, ifrat qatılıqda pestisidlərin, gübrələrin tətbiqi və s. kimi amillərin təsiri az deyildir. Torpaq örtüyünün deqradasiyası dünya torpaq səthinin erozyası “Planetin sakit böhranı” adlanır. Lakin torpağın məhsuldar qatının dağılması prosesinin miqyası son 50-60 ildə 8-10 dəfə artmışdir. Təəsüf ki, eroziya, çirklənmə və başqa səbəblərə görə baş verən torpaq itkisi respublikamızdan da yan keçməmişdir. Torpaqlarımıza antopogen təsirlərin çox ağır nəticələri vardir. Məsələn, neft çirklənməsi, su eroziyası, çəmən-otlaq səhralaşması, meşə itkisi və s. [3].

Dünyada insan artımı, qida-zülal çatışmazlığı, aclıq problemi və başqa ümumbəşər qayğılarla əlaqədar olaraq, torpaq ehtiyatlarının səmərəli istifadəsi torpaq itkisinin qarşısının alınması kimi vacib məsələləri, beynəlxalq miqyaslı elmi konfranslarda daim müzakirə edilir, müvafiq qərarlar qəbul edilir ki, bu da səbəbsiz deyildir. Çünki son 100-130 ildə eroziya və defilyasiya sayəsində dünyada 2 milyard ha-dan çox əkin sahəsi itirilmişdir. Hər il orta hesabla dünyada müxtəlif antopogen təsirlər nəticəsində 6-7 milyon ha münbit torpaq əkin dövriyyəsindən çıxarılır və yararsızlaşır. Ona görə də eroziya-torpaq itkisinə qarşı mübarizənin əhəmiyyəti bütün bəşəriyyət üçün vacib olmaqla yanaşı, məhsuldarlığın artması deməkdir və insanların tələbinin ödənilməsinin alternativsiz əsas mənbəyidir.

Qeyd etmək lazımdır ki, eroziyanı yaradan amillər çoxdur. Bununla belə torpaq eroziyasına səbəb mənbələrdə başlıca olaraq 2 amil qeyd edilir ki, bu da külək və su eroziyasıdır. Son məlumatlara görə, Azərbaycan Respublikasının ümumi sahəsinin 42%-ə qədəri eroziyalaşmışdır. Bundan başqa, suvarılan torpaq sahəsinin 64%-i, 1,54 min ha-ı bu və ya digər dərəcədə o cümlədən, 722 min ha-ı zəif (30%), 33 min ha-ı (12%) isə kəskin dərəcədə şorlaşmışdır. Dağ-dağətəyi, xüsusilə otlaq sahələrinin əksəriyyətində 80-85% torpaq eroziyalaşmış vəziyyətdədir. Eroziynın bütün növləri torpağın normal tərkibi, funksiyası, geomorfoloji və başqa xüsusiyyətlərini pozur. Başqa sözlə desək, erroziya torpağın ən təhlükəli xəstəliyidir və onunla mübarizə qlobal miqyaslı problemə çevrilmişdir [5].

Respublikamızda torpağın eroziysı, səbəbləri, mübarizə xidmətləri və s. ətraflı öyrənilmişdir. Xüsusilə indiki dövrdə torpaq islahatlarının həyata keçirilməsi, yeni aqrar islahatların yaranması şəraitində torpaqların heç olmasa, bundan sonra eroziyalaşmasına yol verilməməsi qarşıya qoyulan başlıca məqsəddir. Dağ-dağətəyi xüsusilə, dağ-çəmən, dağ-meşə, dağ-bozqır zonalarında torpaq eroziyazısının inkişafında başlıca amil bitki örtüyündə hər hansı sahədən seyrəkləşməsidir. Dağ-dağətəyi zonalarda torpaq eroziyasının intensivliyi həm də yamacın meyilliyindən asılıdır. Qeyd etmək lazımdır ki, dağ-çəmən zonalarında torpaq eroziyasının nəticələri daha acınacaqlıdır. Meşə torpaqlarının eroziyası birbaşa həm qiymətli sərvət, özünü bərpa edən, atmosfer havasını canlı aləmə lazım olan oksigenlə zənginləşdirən, karbon qazını mənimsəyib üzvi maddələr yaradan meşəliklərin məhv edilməsi deməkdir. Son 18-20 il ərzində ölkədə meşələrin 35-40%-i seyrəkləşmiş və ən azı 15-20%-i ixtisar edilmişdir. Meşə örtüyündən nisbətən kasad olduğumuz üçün respublika meşələrinin əhəmiyyətli qiymətləndirilməsi mümkün olmayan dərəcədə böyükdür. Meşə ilə örtülü sahə respublika torpaqlarının 10,8%-ni əhatə edir.

Azərbaycan Respublikasının geomorfoloji,

fiziki-coğrafi, iqlim və.s. xüsusiyyətlərinə görə meşələri bərabər paylanmışdır. Məsələn, Böyük və Kiçik Qafqazda meşə sahələri 18-25% təşkil etdiyi halda, Muğan, Mil, Naxçıvan və bir çox Aran bölgələrində bu göstəricilər 0,4-1%-dən çox deyildir. Əsas meşə fondu Böyük və Kiçik Qafqazın Azərbaycana məxsus yamaclarında yerləşir. Çünki meşə təkcə ağaclar birliyi deyil, o torpağı, suyu, onlar da öz növbəsində meşəni qoruyurlar və bu vəhdət öz zəruri enerji mənbəyini - üzvi maddələrlə təmin etməklə, canlı həyatın ardıcıl davam etməsinə zəmin yaradır [3].

Azərbaycanda meşələrin qorunmasının - torpaqlarımızın eroziya, səhralaşma və s. bu kimi hadisələrədən mühafizəsində, külək və qasırğalardan əkin sahələrinin qorunmasında, torpaqda nəmişliyin, atmosfer havasının tənzimlənməsində rolu əvəzsizdir. Qeyd etmək lazımdır ki, meşələrin qorunması təkcə ağacların kəsilməsinin qarşısının alınması ilə başa çatmır. Kütləvi meşə ətəklərində mal-qaranın otarılması, “meşə altı” kolluqların, bitki örtüyünün tapdalanması, xüsusilə meşələrimizdə yaradılan restoran-kafe, çayxanalar həmin sahələrdə meşələrin deqradasiyası üçün real təhlükə yaradır. Respublikada fauna və floranın qorunmasında qoruqlara, yaşıllıqlara və Milli parklara böyük ümidlər bəslənilir.

Qeyd etmək lazımdır ki, torpaq eroziyasının arzuolunmaz nəticəsi təkcə torpağın münbit qatının sıradan çıxması, flora itkisi ilə kifayətlənmir. Belə ki, eroziyalaşan torpaqlardan humusun, kimyəvi maddələrin, xüsusilə azot və fosfor birləşmələrinin yuyulması ərazidə yerləşən su hövzələrində hidroekosistemin sabitliyini pozur.

Su eroziyası ilə yanaşı, külək eroziyası da torpaqlara ziyan vurur. Onun ən çox yayıldığı yerlər Abşeron yarımadası, Qobustan, Samurçaydan başlamış Qızılağac körfəzinə qədər Xəzər dənizinin sahil zonası, Mil və Muğan düzləri, Ceyrançöl, Acınohur düzü və Bozdağ sistemidir. Buradakı təsərrüfat sahələrinə külək eroziyasının vurduğu ziyan çox böyükdür. Misal üçün küləklərin hakim olduğu ərazilərdə torpaq örtüyü sovrularaq öz münbitliyini itirir, məhsuldarlıq dəfələrlə azalır və bəzi hallarda tamamilə sıradan çıxır. Respublikada külək eroziyasına məruz qalan torpaqların ümumi sahəsi 200 min ha-dır. Külək eroziyası ilə yanaşı, küləyin gətirdiyi sovrulmuş qum və s. materialların əkin sahələrini, bağları, arxları, şose və dəmir yollarını, tikintiləri və s. örtməsi nəticəsində yaranan problemlərin qarşısını almaq o qədər də asan olmur. Bundan başqa dağ-dağətəyi zonalarda, meyilli yamaclarda torpağın bitki örtüyünün seyrəkləşməsinə yol vermək olmaz. Bunun üçün ilk növbədə ağac kollarınn qırılmasına, məhv edilməsinə, otlaq-çəmənliklərdə çox saylı heyvan sürüləri tərəfindən bitki ot köklərinin tapdalanmasına son qoyulmalı, həmin ərazilərin istifadəsi mövcud normativ qaydalara əsasən həyata keçirilməlidir. Torpağın bitki örtüyünün ixtisar edilməsi eroziyadan başqa torpaq sürüşmələrini də aktivləşdirir.

Çoxsaylı müşahidələrlə subut edilmişdir ki, Azərbaycanın müxtəlif bölgələrində yaranan torpaq-dağ sürüşmələri, ağacları kəsilən, kolluqları ixtisar edilən yamaclarda daha tez əmələ gəlir. Respublikada torpaq fondunun deqradasiyaya uğradan amillərdən olan torpaq çirklənmələri barədə onu demək olar ki, texnogen, kimyəvi, mexaniki, fiziki çirklənmə ölkənin bütün regionlarında baş verir və bol nemətlər yetirən münbit torpaq sahələri yararsızlaşır, əkin dövriyyəsindən çıxarılır və s.

Torpaq çirklənməsinin növündən asılı olaraq müxtəlif sanitar-gigiyenik, ekoloji fəsadlar yaranır. Bir qayda olaraq iri şəhərlərdə sənaye mərkəzləri ətrafında bərk məişət tullantıları müəyyən edilən sahələrdə dəfələrlə böyük ərazilər zibilxanalara çevrilir.

Şəhərlərdə fəaliyyət göstərən yüzlərlə zavod və digər müəssisələrın ətraf mühitə atdıqları sənaye tullantıları da müxtəlif yollarla torpağa qayıdır və əsas çirklənmə mənbələrindən birinə çevrilmiş olur. Ölkənin sənaye tullantıları ilə örtülmüş yararsız torpaqlarını zibilliklərdən, sənaye və məişət tullantılarından, neft atılmalarından təmizləmək yolu ilə əlavə olaraq yüz min hektarlarla, o cümlədən, Abşeron yarmadasında 50 min hektara yaxın torpaq sahələrini dövrüyəyə qaytarmaq olar. Düzdür, müasir dövrdə belə halların qarşısının alınması üçün lazımi tədbirlər həyata keçirilir. Balaxanı qəsəbəsində toplanmış çirkləndiricilərin emalı zavodu yaradılır və s. [2].

Respublikamızda texniki bitkilər əkilən torpaqlar, keçmiş Sovetlər dövründə yüksək məhsul naminə gübrə, dərman-pestisidlərlə o qədər zənginləşdirilmişdir ki, o torpaqlar indiyə kimi öz təbii sabitliklərini bərpa edə bilməmişlər. Muğan, Mil və Qarabağ düzündə əkilən pambıq sahələrinə səpilən müxtəlif çeşidli zəhərli maddələr, üzümçülük sahələrinə hopdurulan kükürd tozu torpaqların bioloji fəallığını əsaslı surətdə pozmuşdur. Kimyəvi çirklənmənin elə növləri vardır ki, həmin ziyanlı maddələrin neytrallaşması üçün 10 illər tələb olunur. Respublikada miqyasına görə texnogen çirklənmə, geniş sahədə Abşeron yarımadası və Gəncə-Daşkəsən bölgələrində baş vermişdir. Bu növ çirklənmədə də neft və neft mənşəli karbohidrogenlər üstünlük təşkil edir. Bu da onunla əlaqədardır ki, dünyada sənaye əhəmiyyətli neft çıxarılması birinci dəfə Azərbaycanda həyata keçirilmişdir. Abşeron yarımadası torpaqları dünyada yeganə sahədir ki,

160-170 ildir neftlə çirklənir. Heç də təsadüfi deyildir ki, Abşeron yarımadasının torpaq örtüyünün 50%-i (200 min ha) bu və ya başqa dərəcədə texnogen mənşəli deqradasiya olunmuşdur ki, bunun da 10-11 min ha-nı neftlə çirklənən torpaqlar təşkil edir. Abşeron yarmadasında irili-xırdalı 100-ə qədər süni göl, gölməçə yaradılmışdır. Bu kəskin dərəcədə çırkli, sağlamlıq üçün təhlükə mənbəyi sayılan göllərin bir çoxu yaşayış məntəqələri ətrafında yerləşir. Məsələn, Bülbülə gölü, Xocəsən, Böyük şor, Qanlı göl və.s. Təssüflər olsun ki, əhali bu göllərdə cimir, balıq tutur, quş ovlayır və s. [4].

Torpaqlarımızın ekoloji vəziyyətini gərginləşdirən torpaq səthinin morfoloji quruluşunu, sabitliyini pozan amillərdən biri də daş, çınqıl-qum karxanalarından düzgün istifadə edilməməsidir. Xüsusilə son 15-18 ildə onlarla torpaq örtüyündən, inşaat materialları ilə zəngin olan təkindən istifadə qaydalarına əməl edilmədən daş karxanaları yaradılmışdır.

Respublikada torpaqdan istifadə ekoloji sabitliyin bərpası üçün müvafiq qanunlar tətbiq edilmişdir. Bununla belə, Xəzərin Azərbaycan Respublikasına aid 800 km-ə bərabər sahələri başdan-başa qum, çınqıl, balıqqulağı karxanalarına çevrilmişdir.

Torpaqları qorumaq və onun münbitliyini yüksəltmək hər bir vətəndaşın, xüsusilə kənd təsərrüfatı işçilərinin vəzifəsidir. Torpaq mürəkkəb orqanizm kimi daimi inkişaf edir və dəyişir. Onda daimi yaranma və dağılma prosesi gedir. Hesablamalar göstərir ki, 2-3 sm qalınlığında torpağın əmələ gəlməsi üçün əlverişli şəraitdə 200-1000 il vaxt lazımdır. Lakin külək, su min illər ərzində əmələ gəlmiş torpağı 20-30 il ərzində məhv edir. Quruluşuna və kimyəvi tərkib xususiyyətiənə gorə torpaq hər hansı səbəb ucbatından ətraf muhitə duşən zərərli maddələri asanlıqla canına hopdurur və yığır. Bu birləşmələrin parcalanma muddəti torpağa, havaya və suya nisbətən daha uzun olduğuna gorə, torpağın cirklənməsi problemi illər boyu dərk olunmaya bilər. Sudan və havadan fərqli olaraq torpaq xususi mülkiyyət obyekti ola bildiyinə gorə bu amil bir sıra hallarda bu və ya digər təbiəti muhafizə tədbirlərinin həyata kecirilməsini cətinləşdirir, cunki torpaq sahibinin və ya onu istifadə edənin icazəsi lazımdır. Savadsız və həddindən artıq intensiv istifadə zamanı torpaq istismar edilir və keyfiyyəti pisləşir. Bunun baş verməməsi ucun daim səy və qayğı gostərilməlidir, əks təqdirdə, torpağın dağılması prosesinin qarşısı alınmasa o, oz funksiyalarını lazımınca yerinə yetirə bilməz.

Təbii sərvətlərdən su, bitki və heyvanlar aləmindən fərqli olaraq torpaq sərvəti bərpa olunmur və süni torpaq yaratmaq mümkün deyil. Buna görə də əhalinin artımı, onun xammala tələbatı, habelə gələcəkdə də ölkəni xammalla təmin etmək üçün torpağın mühafizə məsələləri böyük əhəmiyyət kəsb edir. Torpağın mühafizə məsələləri əsasən elmi əsaslarla işlənilmiş, vaxtında və düzgün görülən mübarizə tədbirlərindən ibarətdir.

Torpağın mühafizəsinin kompleks tədbirləri aşağıdakılardır: torpaqların hesaba alınması, onun səmərəli və düzgün istifadə edilməsi, üzərində nəzarətin olması, mövcud meşə zolaqlarının salınması torpağın çirklənmələrdən (tullantılar və zərərli kimyəvi maddələr) qorunması, heyvanların otarılmasının düzgün təşkil edilməsi, eroziyaya qarşı mübarizə tədbirlərinin təşkili, xüsusi maşınların tətbiqi, çeyilliklərin qurudulması, suvarmanın düzgün təşkili, qum hücumunun qarşısının alınması, suların tərkibinə nəzarət edilməsi, sanitariya-gigiyena mühafizə tədbirlərinin yerinə yetirilməsi, tikinti və yol işlərində, kimyəvi maddələrin tətbiqində mövcud tövsiyələrin gözlənilməsi, alaq otları ilə mübarizə və s. Belə olduqda torpağın məhsuldarlığı artır və xarab olmaqdan qorunur.

Torpaq plansız surətdə istifadə olunduqda, ona nəzarət edilmədikdə, çirkləndikdə şübhəsiz xarab olur, gücdən düşür. Torpağa xidmət edildikdə isə hər 100 hektar torpaq sahəsi 5-10 dəfə daha çox əhalini taxılla təmin edə bilər.

Torpaq ehtiyatlarından səmərəli istifadə məqəsədi ilə səhralaşma proseslərinin qarşısının alınması, iri sənaye və dağ-mədən obyektlərinin fəaliyyəti nəticəsində yararsız vəziyyətə düşmüş torpaqların bərpası, kənd təsərrüfatına yararlı torpaqlardan istifadə sisteminin təkmilləşdirilməsi, torpaqların antropogen çirklənməsinə qarşı mübarizənin gücləndirilməsi yönündə dövlət səviyyəsində işlər aparılmışdır.

Torpağı eroziyadan, şoranlaşmadan qorumaq üçün mövcud kompleks təsərrüfat, təşkilat, aqrotexniki, meliorasiya, meşəsuvarma, hidrotexnika və rekultivasiya tədbirləri görülməlidir. Gübrələrin, kimyəvi maddələrin işlədilməsi və saxlanılmasına da fikir verilməli, torpağın sanitariya-texniki mühafizə tədbirləri yerinə yetirilməlidir. Torpağı çirklənmədən qorumaq qanunu, təşkilatı və sanitariya-texniki tədbirlərin yerinə yetirilmə sistemi torpağın sanitariya mühafizəsi adlanır. Torpağı mühafizə etmək üçün vaxtaşırı onun çirklənmə vəziyyəti sanitariya-epidemioloji stansiyalar tərəfindən yoxlanılmalıdır. Bu zaman ərazidə torpağın fiziki, bioloji, kimyəvi göstəriciləri nəzərə alınmalıdır.

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**Abstract**

## Ecological problems of land reserves of the Azerbaijan Republic and their protection

In the article, the spread of soils according to the climate type in our country, their degradation, erosion, salinization, the causes of their formation, and methods of protection were analyzed. Here, the implementation of land reforms, new agrarian reforms, land re-examination and evaluation from the economic point of view are also reflected. Also, taking into account that the degradation of the republic's lands is a developing process, some recommendations and suggestions have been given for effective use of them, existing environmental factors, restoration and protection methods.

**Key words:** land cover, degradation, erosion, salinization, climatic conditions, ecologial problems, protective measures.

# Exploring strategic conservatism in family-owned tourism businesses in the Atlas Mountains of Morocco

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## Abstract

This study investigates strategic conservatism in family-owned tourism businesses in the Atlas Mountains of Morocco, focusing on how these firms balance tradition and innovation in strategic decision-making and financial management. Utilizing a qualitative approach, thematic content analysis was conducted on interviews with decision-makers from 15 family firms operating in Tourism and Hospitality, revealing a preference for incremental changes and risk aversion aimed at preserving socioemotional wealth and family legacy. Key findings include a tendency towards maintaining family control and avoiding exploratory risks, with firms prioritizing internal financing and reserve accumulation to ensure financial stability. This research contributes to the understanding of strategic conservatism in family businesses by highlighting the interplay between preserving traditional values and integrating selective innovations to achieve long-term success. The findings suggest practical strategies for family business leaders to manage tradition and innovation effectively, supporting sustainability and competitiveness. The study also notes the broader social implications of strategic conservatism, as these businesses significantly impact local economies and community stability. Given the qualitative nature of this research, future studies might expand the methodology to include quantitative data and a broader range of stakeholders, potentially offering a more comprehensive view of strategic conservatism across different cultural and economic landscapes.

**Keywords:** Family firm, Atlas Mountains, Tourism, strategic conservatism, Socioemotional wealth, risk aversion, financial safety, self-financing, Cash accumulation, long-term orientation, Resistance to change, Tradition and innovation, qualitative research.

## Introduction

The study of family businesses has garnered particular interest among researchers in management sciences, due to their role and impact on the global economy. According to the report by the Family-Owned Business Institute (2022), a significant portion of the world's wealth is generated by family businesses. Statistics show that firms predominantly owned by a single family contribute to 70 to 90% of the global GDP (Tharawat Magazine, 2014). Moreover, newly established enterprises are fueled by family involvement, with 85% of start-ups worldwide being created by family funds (FFI, 2017). Consequently, a recent study by the Family-Owned Business Institute (2023) reveals that these businesses make a significant contribution to global job creation. The Family Business Index 2023 by EY and the University of St. Gallen further demonstrates that the top 500 largest family businesses collectively generate $8.02 billion in revenue and employ 24.5 million people worldwide.

Furthermore, family businesses provide a fertile ground for entrepreneurship as they promote intergenerational transmission of knowledge and values within the company (De Massis et al., 2018). The involvement of the family within the business and the idiosyncratic goals of the family are what makes the family enterprise unique (Daspit et al., 2017). Their unique history, often marked by a succession of experiences and transformations, is a key factor in their resilience. This enables them to weather economic turbulence and adapt to market changes during crises. In fact, several recent studies have shown that family businesses, often characterized by conservatism, demonstrate greater resilience in times of crisis (De Ciantis & Lansberg, 2020; Costa, 2022; Eckey & Memmel, 2022; Le Breton-Miller & Miller, 2022).

In Morocco, family businesses have been gaining increasing attention from management researchers due to their prevalence and impact on socioeconomic growth (Nassiri & Sabbari, 2020). According to Allali (2012), approximately 12 prominent families in Morocco alone contribute to 25 to 30% of the national GDP. However, family

businesses in Morocco go beyond that. Small and medium-sized Moroccan enterprises (TPME) are primarily family-based, accounting for 93% compared to 7% for large enterprises (GE) (HCP, 2019). They are also characterized by a significant family influence on the business, leading the majority of Moroccan leaders to adopt an informal and tacit governance system. Family governance mechanisms, such as succession policies, are put in place to ensure a certain level of family involvement in the business. Diverse outcomes are contingent on the national institutional settings where firms are located (Aguilera & Crespi-Cladera, 2012). The Moroccan economy, characterized by macroeconomic stability, provides a favorable institutional context for family businesses. In terms of management, these businesses favor a top-down decision-making process and tend to conduct business with partners they know and respect. Decisions are not made hastily and require multiple negotiation cycles, underscoring the importance of caution and conservative thinking in the decision-making process. Thus, the conservative culture of Morocco significantly impacts the country's business landscape (Mdaghri and Korichi, 2022). Islamic values hold a strong influence on organizational culture, including within family businesses. Similarly, another study by Samara (2021) examined the characteristics of family businesses in the Middle East and Arab countries and found that family businesses are becoming increasingly risk-averse and adopting a conservative attitude in their investment decisions, which may limit their growth potential.

The strategic decision-making process in Moroccan family businesses is a complex interplay of socioemotional wealth preservation and business longevity. These firms often exhibit a preference for stability and continuity, manifested through strategic conservatism, which entails a cautious approach to change to minimizes the risk of losing independence (Moores & Mula, 2011). Understanding the dynamics of strategic conservatism in Moroccan family businesses is to comprehend the strategic behaviors of family businesses that dominate the Moroccan economic fabric.

This qualitative study aims to address a critical research gap by exploring the dynamics of strategic conservatism in Moroccan family businesses, providing insights into a relatively under-explored area of family business management literature.

## Literature review

Strategic conservatism refers to a preference for incremental changes and an aversion to radical changes in strategy. It is a common characteristic of family firms, driven by their focus on preserving socioemotional wealth, traditions and family legacy (Miller et al., 2013). They are reluctant to make changes that may dilute family control or influence.

Strategic conservatism offers an array of benefits that have long been cherished by family firms. One of its paramount advantages is the preservation of the family legacy, identity, and socioemotional wealth (Gudmundson et al., 1999). Moreover, conservatism leverages existing capabilities and resources, allowing families to build upon their strengths and accumulated knowledge, fostering resilience and adaptability (Lehrer & Schmid, 2019). This approach provides stability and continuity (Belling et al., 2021). It avoids risky changes that may threaten family control (Habbershon & Williams, 1999).

The continuity of family control is a crucial aspect of family firms, often leading to a conservative strategic orientation focused on maintaining family authority in management (Ward, 1988). Research indicates that family firms exhibit a more conservative strategic orientation compared to non-family firms. They tend to concentrate on their immediate family environment, which leads to more conservative strategic behavior (Donckels & Fröhlich, 1991; Neubauer & Lank, 1998). Balancing the desire for family control and the need for strategic flexibility and adaptability is crucial for family firms' long-term success (Kotlar & De-Massis, 2013).

One of the primary areas affected by strategic conservatism is the attitude towards change. A strong family culture can influence the ability to create and maintain an entrepreneurial orientation (Hall et al., 2001; Nordqvist et al., 2008; Zahra & Sharma, 2004). A centralized organizational structure combining ownership and management can lead to greater resistance to change and a conservative entrepreneurial orientation (Naldi et al., 2007; Zahra, 2005). Family firms often exhibit rigidity when it comes to paradigm shifts, as they prioritize internal succession, which is one of their key objectives, and emphasize loyalty, while new paradigms usually originate from external employees and executives. Internal successors, lacking external experience, might not be exposed to diverse experiences that could lead to new paradigms. Resistance to change can hinder organizational change by delaying or slowing down its initiation, making implementation difficult and costly, but it can also provide valuable information for developing a more successful change process (Tselyutina et al., 2019; Doroshenko et al., 2015).

Family firms' resistance to change and preference for maintaining successful routines of the past can lead to detrimental conservatism. This

can incline them to favor exploitation over exploration, negatively impacting long-term success (De Massis et al., 2014). Striking a balance between these two approaches is essential for family firms to thrive in dynamic market conditions. Family firms that achieve an optimal synergy between exploitation and exploration are more likely to succeed in the long run (March, 1991; Levinthal & March, 1993).

Existing research on family firms often highlights their risk-averse nature. While this risk aversion can promote longevity, it may also lead to behaviors endangering the firm's long-term existence (Chrisman & Patel, 2012). Family firms tend to be less open to risk-taking due to concerns about jeopardizing the family's socioemotional wealth and the wealth of future generations (Donckels & Fröhlich, 1991; Schulze et al., 2003; Block, 2012). However, family involvement in management can positively influence risk-taking, especially when the long-term strategic horizon and family control/governance structures are threatened (Ward, 2016; Gudmundson et al., 2003; Miller & Le Breton-Miller, 2005; Webb et al., 2010).

Flexibility and responsiveness, in the other hand, are integral concepts in contemporary organizational theory. Strong organizations are often characterized by shared values, a recognizable identity, and a strong relationship with key stakeholders. They benefit from continuity and predictability, ensuring understanding, trust, profitability, and continued investment (Biggart & Beamish, 2003). Some level of conservatism helps organizations avoid reinventing practices daily, which can be costly (Heclo, 2008; Terry, 1995; Thompson, 1967). However, constant adaptation might be necessary, yet challenging (Fernandez & Rainey, 2006; Gillon, 2000; Hood, 1976; Hood et al., 2004; Offe, 1996; Moore & Kraatz, 2011). Researchers have identified numerous factors for failure and suggested various adaptation strategies, but achieving constant and effective adaptation over the long term remains a puzzle. Balancing adaptation with the preservation of core values and competencies remains a theoretical and practical challenge (Ansell et al., 2015).

The following section presents the methodology applied in this study.

## Methods

### Data collection

The scarcity of studies on the dimensions of strategic conservatism calls for qualitative research. This approach is appropriate as it suits new studies where existing theory appears insufficient (Eisenhardt, 1989). Furthermore, Denzin and Lincoln (2000:3) state that qualitative research involves an interpretive and naturalistic approach, meaning that the researcher studies the phenomenon in its natural context, attempting to make sense of or interpret it based on the meanings attributed to it by participants.

Our research primarily aims to explore strategic conservatism in family businesses by conducting semi-structured interviews in fifteen family firms. This study is based on cases where the perspectives and experiences of participants are of great importance (Benbasat, Goldstein, & Mead, 1987).

Our qualitative study adheres to the criteria of theoretical representativeness, diversity, and balance (Yin, 1994), discovery potential, and consideration of the research objective (Hlady-Rispal, 2015). Regarding theoretical representativeness, it was important to specify the criteria for defining a family business to achieve case homogeneity. Specifically, determining whether there is an impact of conservatism on strategic decisions in the family business would require the family to hold full ownership of the company and actively engage in its management. The principle of diversity, on the other hand, is an integral part of the empirical saturation process (Pires, 1997) and is necessary to gather maximum information, avoid response redundancy, and prevent biased results.

Therefore, we opted for multiple case studies and targeted businesses operating in different sectors, sizes, establishment dates, generations, and geographical locations to obtain a comprehensive view of the construct within companies. Thus, we aimed to maintain a strict balance among cases, meaning each company profile is unique and, collectively, provides a balanced variety of different situations. For discovery purposes, the selected cases were rich in data on the phenomenon of strategic conservatism, and the participants were open to discussing it in depth.

### Data analysis

In qualitative research, transcription is generally considered the first step in the coding process (Creswell, 2003). Coding involves breaking down the transcribed texts into relevant pieces and reassembling them in a meaningful way. In this study, we adopted an iterative coding approach in multiple phases. The first phase involved free and open coding of the transcriptions, where each text segment was assigned a provisional code representing its meaning. Then, in the second phase, the most relevant or frequent codes were used to recode the transcriptions, employing constant comparison techniques to ensure code fidelity following Charmaz's recommendations (2006).

Finally, in the third phase, categories were formed from the targeted codes, creating the basis for an analytical framework.

For data analysis, we employed the technique of thematic content analysis. This method allows for analyzing both the manifest and latent content of participants' discourse by identifying recurring themes. The data were segmented into units and grouped into themes to better understand participants' concerns. An analysis grid was utilized to ensure reliability and validity of the results, as recommended by Andreani and Conchon (2005). The findings were discussed using both analytical and synthetic approaches, breaking down and reassembling the themes while comparing them to the existing literature review.

The results were presented using a descriptive synthesis of the themes, quantifying their frequency within the studied population. Interpretive analysis was conducted by comparing the data with the existing literature, leading to the generation of new items. Verbatim quotes were presented to provide selected citations for their relevance and representativeness. Finally, a concept tree was constructed in multiple steps, confronting the initial tree with the results of the qualitative study and continuously enriching it with new verbatim statements.

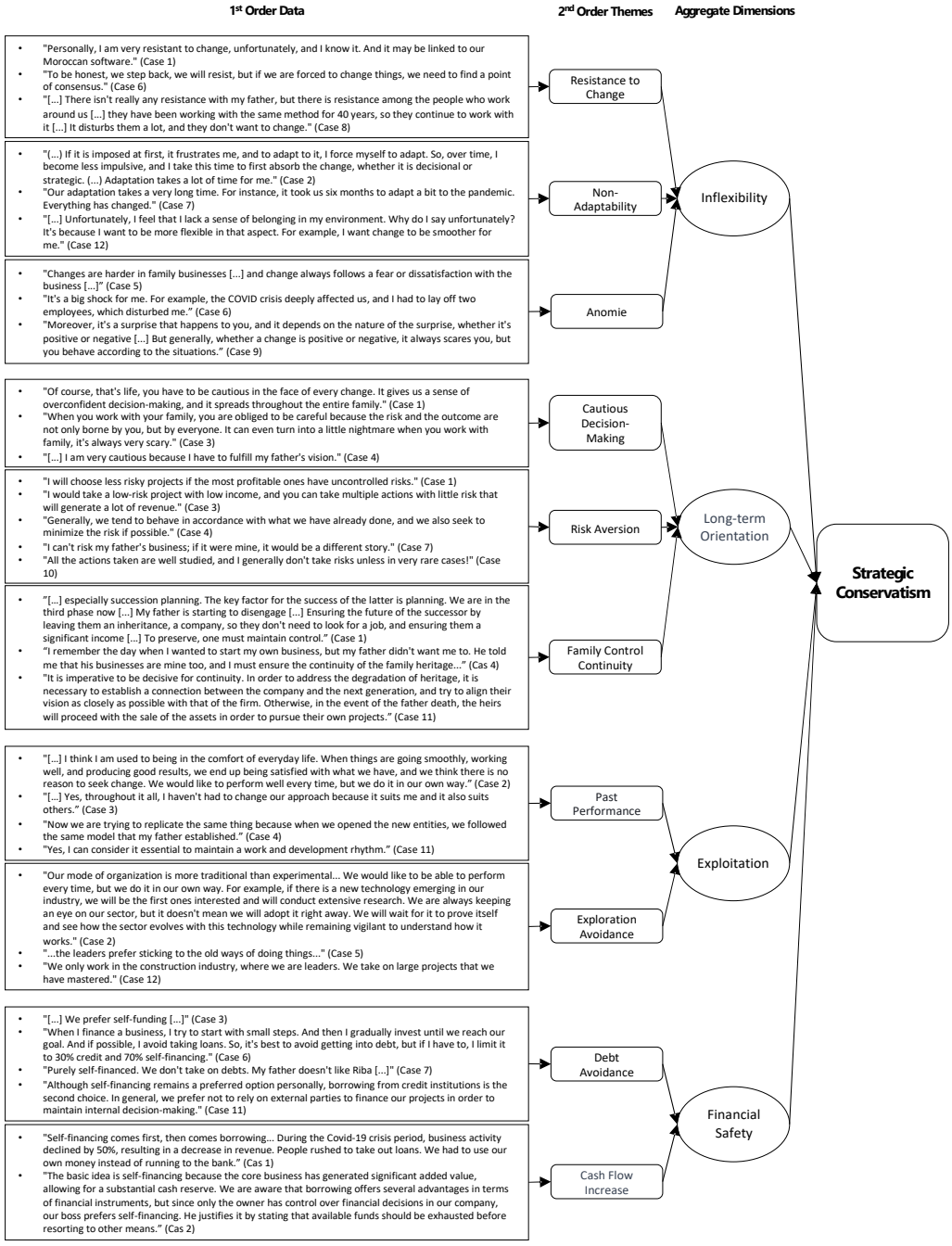


**Figure 1. Data structure**

## Results

The strategy represents an important sphere in

which the conservatism of the firm is exerted. Generally, family businesses are known for strongly adhering to a strategy that becomes a source of rigidity. This strategy, along with the pursued business objectives, inhibits the emergence of new strategies. The family system seeks to maintain cohesion that supports the family model by establishing assumptions, beliefs, and core convictions regarding its environment.

The results show that strategic conservatism is manifested through opposition to any information that does not align with the existing paradigm. This results in minimal changes within the companies, with little modification to their objectives, business scope, product lines, or markets. They maintain their differentiation through the same activities and policies, prioritizing a defensive position with niche protection. In the case of forced internal and external reconfigurations of the firm, the leaders experience a sense of demoralization.

From a strategic perspective, family businesses tend to become resistant to change, favoring routines that have led to past successes and suppressing divergent expressions and viewpoints from the majority family group. Strategic conservatism makes companies risk-averse and less innovative. This dimension is explained by the fact that families often invest the majority of their human and financial capital in their businesses. We have also found that the desire to maintain the business within the family is lacking in all surveyed family businesses.

This posture also influences the financial policy of the firm. We have observed a certain financial conservatism that translates into an economic philosophy of relative prudence regarding financial policy and budgetary responsibility, advocating for expense reduction and minimal debt while ensuring a certain budget balance.

Most of the studied family businesses adopt conservative financial strategies. We have noticed that this financial policy is persistent and has a low leverage effect. A firm is classified as financially conservative (i.e., having a low level of indebtedness) if its annual ratio of long-term debt to total assets falls within the lower 20% range of all companies for five consecutive years. Family businesses with a high degree of strategic passivity adopt a financial policy characterized as "selective order style."

Financially conservative leaders emphasize budget balance and debt reduction, considering not only that debt is economically dangerous and morally costly as it passes obligations to future generations who played no role in current tax and spending decisions, but also as a matter of independence and preservation of family wealth. They are willing to consider self-financing and expense reductions to avoid or decrease external financing. For instance, the leader of the fourth case states, "For this point, my father (founder) has a rule regarding this matter: we must pay through self-financing and avoid as much debt as possible." The leader of the first case declares, "Financial conservatism, yes, organizational conservatism, no. For example, during COVID crisis, there was a 50% decrease in activity and a decrease in revenue. People rush to take out loans. We had to use our own money instead of running to the bank."

They try to find innovative ways to do more with less (first, second, third, fourth, fifth, sixth, seventh, tenth, eleventh, thirteenth, and fourteenth cases). This means that when they have a surplus, they save it rather than squandering it. It is a way of protection and preparation for inevitable economic downturns.

The results show that strategic conservatism is reflected in a financial policy characterized by two aspects: low debt and high cash reserves. We have also observed this type of conservative behaviour in firms that do not hold loans or borrow short-term with very specific and well-defined objectives in mind. Regarding dividend payments, the reported evidence suggests that family businesses that pay dividends are cash-rich and have less debt.

Furthermore, the results show that despite their conservatism, some family businesses manage the challenge of being stable and responsive while avoiding potentially destructive tendencies of rigidity and opportunism. In other words, family businesses change to remain the same. They are fundamentally traditional businesses but with a willingness to embrace innovation and new experiences. These companies preserve institutional memory, integrity, impartiality, and a risk-averse tradition aimed at protecting the business.

When the founder of the second case states, "The company is characterized by family tradition," he explicitly places tradition as the foundation of the specific norms of the governance system, contrasting with the universalization of modernity. In fact, faced with the imperative of modernization, the company adopts a "dynamic" conception of tradition that does not equate to the spontaneous order of professionalization or the rigid order of traditionalism. "Conservatism does not mean stagnation. Conservatism means relying on traditional values to better aim for development."

The leader of the third case explains, "Tradition is not limited to preserving the old or reproducing things. It implies […] a continuous effort to fill gaps and breaches historically formed within the company's culture, including, if necessary, creating a blank page, producing something new. That is,

the most important aspect of tradition is its regenerative power, not the repetition of what happened in the past."

This dynamic is also explained by the ability to capitalize on the knowledge of newly integrated family members who become new leaders. "I establish norms, and this also impacts the norms of the rest of the group and changes them at the same time because the boss may have found that this way of doing things is rather good," expresses the CEO of one of the companies in the second case. Thus, due to sectoral requirements, "you have to improve in terms of accounting and quality. You are obligated because it's a condition of the sector. Otherwise, in other aspects, it's always about quality and services," states the leader of the eighth case. Similar to internationalized family businesses, being conservative at home while taking risks abroad is a competitive strategy suitable for strategic conservatism (e.g., thirteenth, fourteenth and fifteenth cases).

In the first, second, third, fifth, eighth, ninth, and twelfth cases, tradition is not conceived as an allegiance that constrains the will of the family head, but rather as a means to serve their vision of the company and the collective goals they define. The locus of authority is shifted in time: it does not reside in the past as the origin of tradition but in the present will to impose transmission to the future. "Export performance can only be achieved if the organization as a whole provides the necessary means for its development and adapts products to the requirements of new markets," declares the leader of the fourteenth case.

The main themes discussed are summarized in the following table.

**Table. 2.** Synthesis of themes

| Cases<br><br>Themes | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 | C15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Resistance to Change | X | X | X | X | | X | X | | X | | | X | X | | X |
| Non-Adaptability | X | X | X | X | | X | X | | X | | | X | | | |
| Anomie | | X | X | X | X | X | X | X | X | X | | X | X | | X |
| Cautious Decision-Making | X | X | X | X | X | X | X | X | X | X | | | X | | |
| Risk Aversion | X | X | X | X | | X | X | | X | X | | | X | X | |
| Family Control Continuity | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Past Performance | X | X | X | X | X | X | X | | X | X | X | X | | | |
| Exploration Avoidance | | X | | X | X | X | X | X | X | | | X | | | X |
| Dept Avoidance | X | X | X | X | X | X | X | | | X | X | | X | X | |
| Cash accumulation | X | X | X | X | X | X | X | | | X | X | | | X | |

## Discussion

The strategic posture of family businesses is influenced by their conservatism. Several studies describe the defensive nature of conservative strategies. Some of our cases explain this through the contradiction between economic objectives and those of a social nature within their businesses. The results also show that strategic conservatism is reflected in inflexibility towards change, a long-term orientation, a focus on exploitation, and a search for financial security.

### Flexibility

Firstly, inflexibility towards change in conservative businesses is manifested through a culture of anomie, the mismatch between their strategy and the environment, and resistance to organizational change. Therefore, we sought to assess the perception and behavior of leaders towards the overall or partial transformation of their organizational models. Indeed, the results indicate that leaders feel demoralized in situations of rapid change: "[…] truly, change is a nightmare for us!" (7th Case); "Changes are harder in family firms […] and change always follows fear or discontentment regarding the business […]" (5th Case). The results also suggest that, as argued in the theory of punctuated equilibrium, conservative family businesses do not easily adapt to the environment; they take their time to observe changes and choose those that succeed: "[…] If it's imposed initially, it frustrates me, and to adapt, I adapt, albeit reluctantly. So, over time, I become less impulsive and take the time to absorb the change, whether it's decisional or strategic. […] Adaptation takes a lot of time for me" (2nd Case). They are more focused on internal alignment, diverting attention from the need to maintain alignment with the external environment. Consequently, the organization is slow to adapt to environmental changes. According

to Lewin (1947), conservatism maintains a state of stable and quasi-stationary equilibrium until the misalignment reaches a point where major changes are triggered. An explanation that we observed in some cases is the pressure to achieve short-term results. This pressure directs the attention of conservative leaders towards improving internal alignment to increase operational efficiency and diverts their attention from external alignment. Finally, the last aspect of inflexibility is resistance to organizational change: "Frankly, we step back, we resist […]" (6th Case). Despite this, we chose to adopt these three propositions after studying anomie (leaders' culture), willingness to change (organizational mode), and the adaptive capacity that the firm can express (strategic behavior). The results of our survey of family businesses indicate that those with a conservative approach may be less willing to modify their organization and strategy to meet new internal and external needs.

Proposition 1: Conservative businesses that operate in the tourism sector in the Atlas Mountains exhibit inflexibility through cultural anomie, slow adaptation to environmental changes, and resistance to organizational change.

### Long-term Orientation

Moreover, a significant portion of the existing literature on the subject states that family businesses have a strong risk aversion and are more conservative in strategic decision-making (Carney, 2005; Schulze, Lubatkin, & Dino, 2003). Family businesses are often believed to be risk-averse because their founders invest their human and financial capital in the business. However, contrary to the literature, some of our cases are not risk-averse; instead, they prioritize improving their businesses' values and thus adopt risky business strategies. The interviewed leaders mention the notion of risk controllability: "I will choose less risky projects if the most profitable ones have uncontrolled risk" (1st Case); and this depends greatly on cash flow: "It depends on my savings, can I bear the risk or not? If this risk affects my employees or the business, in any case, I won't take the risk […]" (6th Case); "It's a sector with a lot of risk […] Frankly, we take financial risks a lot, but it's because we have a project that is dear to us. It's no longer about the financial aspect; it's about the success of the project" (8th Case). Gómez-Mejía et al. (2007) propose that some families in family businesses value control rights for socioemotional reasons and take risks to maintain this control, even if it means foregoing financial gains.

We also found that the spirit of challenge is lacking in conservative family businesses. In fact, 11 out of 15 participants prefer a cautious approach over one involving greater risk-taking, reflecting the long-term orientation of family businesses. Thus, in the case of choosing between two projects, one profitable but low-risk and the other more profitable but riskier, most cases express that they opt for the low-risk project. However, 4 out of 15 participants do not confirm this proposition, which can be explained by the managerial culture of the leaders of these businesses. Risk aversion is observed not only in the business owner but also throughout the family. These decision makers are often referred to as conservative entrepreneurs, emphasizing heritage preservation rather than growth. Based on recent literature and our findings, we can therefore conclude that risk-taking in conservative family businesses varies, and this variation seems to be linked to differences in inherited family values, experience, and financial controllability.

The final aspect of long-term orientation is the continuity of family control over the business. Our results show that all participants have an intention to pass the business on to future generations. In conservative businesses, this need for preservation is reflected in the desire to maintain the business and cultural heritage within the family. According to Harris et al. (1994), conservative family businesses exhibit certain rigidities when it comes to paradigm shifts because they prioritize internal succession.

Proposition 2: The long-term orientation of conservative family businesses that operate in the tourism sector in the Atlas Mountains is characterized by risk aversion in strategic decision-making, a preference for low-risk projects, and a strong emphasis on preserving the business and cultural heritage for future generations.

### Exploitation

Regarding strategy modification, only the leader of Case 8 states that they have no hesitation in modifying their strategies when changes occur in the needs of their businesses and their environments: "[…] It is more than essential to surpass our performance … we want to exceed last year's goals, it is a personal objective, and to profit from the investment we made as soon as possible and reinvest and develop the project, so it is absolutely essential, even in other projects […], the goal is always to do better." For Cases 13, 14, and 15, they are obliged to change their strategy as they operate internationally and must therefore explore and follow international market trends. On the other hand, the rest of the leaders refuse to change their strategies. This maintenance of strategy is explained by the success of their strategies in the past: "[…] We don't change a winning strategy."

(Case 2). Indeed, they turn to history. However, it is not history in general, but their own histories, which are theirs because they are reservoirs of formative influences on how they operate today and how they construct their visions of the future. Yet, their attitude is not one of unexamined prejudice in favor of collective patterns that have become traditional in their family. They certainly aim to preserve certain traditional collective dispositions, but only those that reflection shows to be successful.

This vision of success also influences the firm's exploratory capability. Our results show that the more conservative the family, the less the firm will engage in exploration. In fact, organizations that adopt this posture "will likely lock themselves into a suboptimal steady state" (March, 1991, p. 1). If these firms do not focus on exploration and to avoid financial and psychological costs, they instead adopt strategies that have succeeded in other firms in the industry: "[…] We see if it works for others, and then we replicate it if it's guaranteed […]" (Case 2).

Proposition 3: Conservative family businesses that operate in the tourism sector in the Atlas Mountains prioritize preservation of successful strategies, leading to limited exploration and reliance on proven industry practices for long-term orientation.

### Financial Safety

The final aspect of the strategic dimension of organizational conservatism is that of a financial policy oriented towards the safety and financial independence of the firm. Analysis of the obtained responses shows that safety is a crucial element in decision-making, both in terms of finances, investments, and more generally, for all decisions with significant repercussions. Regarding dividend payments, the reported evidence seems to indicate that family firms that pay dividends are cash-rich with little debt, confirming findings from other studies (Bigelli & Sánchez-Vidal, 2012; Strebulaev & Yang, 2013).

"Whenever our company realizes a profit, our priority is to replenish our reserve funds before distributing profit shares or dividends" (Case 2). This proposition was confirmed by over 75% of the cases, with only 25% denying it. Thus, we note that 10 out of 15 firms confirm that they prioritize self-financing over other types of financing: "Purely self-financed. We don't take on debt. My father doesn't like Riba […]" (Case 7); "Although self-financing remains a preferred option personally. Borrowing from credit institutions is the second choice. In general, we prefer not to rely on external individuals to finance our projects in order to keep decision-making internal […]" (Case 11); "We avoid turning to banks as much as possible" (Case 14). It is also observed that owner-managers of family firms have a preference for internal accumulation of financial resources to avoid turning to banks to finance the growth of their firms. To guarantee autonomous financing for their firm, decision makers would be inclined to favor hoarding: "The basic idea is self-financing because the core business has allowed for significant value creation. And it enables us to have a well-endowed treasury […]" (Case 2). Thus, it is observed that in all cases, the family in charge of the firm, particularly the manager, is willing to provide financial support to the firm by drawing from their own resources to meet its needs. In order to preserve the firm's independence and avoid relying on external financing, the family would favor financing the firm by making withdrawals from its own wealth: "When I wanted to start my business, I did approach several banks, but with the guarantees they asked for, I changed my plan and turned to family and friends instead" (Case 15). Along the same lines, all surveyed family firms do not support the participation of non-family employees in the capital of their firms. No firm fully accepts the participation of non-family employees and executives in the capital.

In the literature, Weitzman (2014) confirms that conservative financial policy is one of the predictors of firm longevity. It argues that financial conservatism enables organizations to withstand shocks caused by a constantly changing environment; therefore, researchers have claimed that less leveraged firms are more resilient (Abdel-Khalik, 1993; Balcaen & Ooghe, 2006; Musso & Schiavo, 2008). Basly (2007) argues that the main dimensions of financial conservatism in family SMEs are self-financing and avoidance of external financing. Lozano (2015) maintains that there is a link between conservatism and cash holdings in family firms. Two statements will be proposed to translate conservative financial policy: debt avoidance and cash accumulation. Financial debt should be considered net of cash to take into account both aspects of financial conservatism (low debt and high cash) as practitioners generally do (Bigelli et al., 2014).

Proposition 4: Conservative family businesses that operate in the tourism sector in the Atlas Mountains prioritize financial safety through self-financing and cash accumulation.

## Conclusion

The study sheds light on the phenomenon of family firm strategic conservatism, exploring its various dimensions and implications. The literature

review highlighted the preference for incremental changes and aversion to radical shifts in strategy, driven by the focus on preserving socioemotional wealth and family legacy. The resistance to change, flexibility, risk aversion, family control continuity, and exploration avoidance emerged as key characteristics of strategic conservatism in family firms.

Through a qualitative analysis, we examined 15 diverse family businesses, analyzing their strategic behaviors, long-term orientation, exploitation tendencies, and financial policies. The findings revealed that conservative family firms tend to resist organizational change, prioritize internal alignment, and exhibit risk-controllable decision-making. While some firms display risk aversion, others embrace risk to maintain control and uphold family values. Moreover, the study elucidated the challenge of balancing tradition with innovation, allowing some family firms to change strategically to remain true to their core values. Financially, these conservative family businesses prioritize self-financing, debt avoidance, and cash accumulation, ensuring financial stability and independence. This cautious financial approach contributes to their resilience and longevity, in line with previous research.

The study highlights the complexities of strategic conservatism, where family dynamics, values, and experiences influence decision-making and adaptation. The study identifies strategic rigidity as a potential challenge, but also illustrates how some firms effectively navigate conservatism to embrace selective change and internationalization. The findings carry practical implications for family business leaders, advising them to strike a balance between tradition and innovation for long-term success.

This study puts forward four key propositions, indicating that future research would benefit from adopting quantitative methods to assess the developed model. Moreover, broadening the scope of investigation to involve other stakeholders could offer valuable insights. In family businesses, the concept of a strategic actor goes far beyond the organizational boundaries (Mastroberardino & Calabrese, 2019). Lastly, to draw meaningful comparisons, replicating the study in different economic, political, and cultural contexts is recommended.

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# Qlobal istiləşmə və Azərbaycana qlobal istiləşmənin təsiri

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**Xülasə**

Bu gün planetimizin üzləşdiyi ən böyük problemlərdən biri qlobal iqlim dəyişmələri nəticəsində baş verən qlobal istiləşmə və onun yaratdığı böyük fəsadlardır. Bəs, buna nə səbəb olur?

Son bir neçə yüzillikdə baş vermiş sənaye inqilabı nəticəsində insanlar təbii mineral yanacaqlarından daha çox istifadə etməli oldular. Beləliklə, insanlar Yer üzərindəki canlılar arasında Günəş enerjisi ilə kifayətlənməyən yeganə varlıq oldular. Zaman keçdikcə insanlar daha çox mineral yanacaqlardan da istifadə etməyə başladılar. Hazırda Yer kürəsində hər il 900 milyard tona yaxın mineral xammal çıxarılır. Bu, planetimizdəki bütün çayların il ərzində daşıdıqları çöküntülərin miqdarı ilə müqayisə oluna bilər. Çıxarılan faydalı qazıntıların böyük bir hissəsi təbii mineral yanacaqlardan ibarətdir.

Qlobal istiləşmə Yer kürəsində təbii fəlakətləri artırır, təbii resurslara, insanların həyat tərzinə mənfi təsir edir. Son 100 illik kosmik müşahidələr göstərir ki, tufan və çovğunların həm intensivliyi, həm də tezliyi artıb. İsti külək, qasırğa, yağıntılar güclənib, eyni zamanda, sel, daşqın hadisələrinin sayı artıb. Bütün bu təbii fəlakətlərin artımında əsas amil iqlim dəyişmələridir.

**Açar sözlər:** qlobal, iqlim, istilik, cop, alternativ enerji,

## Giriş

Hal- hazırda bəşər övladının Kainatda yeganə “kosmik evi” hesab olunan Yer kürəsində iqlim dayanıqlığının kəskin dəyişməsi ciddi problemlərin baş verməsinə şərait yaratmışdır. Nəticədə, təbii fəlakətlərin (quru səthini su basması, qasırğaların baş verməsi, orta illik hərarətin artması, anormal təbiət hadisələrinin çoxalması, kənd təsərüfatında məhsuldarlığın aşağı düşməsi və s.) sayının artması insanlar arasında ciddi narahatlığın yaranmasına səbəb olmuşdur. Belə ki, iqlimşunas alimlər qlobal istiləşmənin baş verməsini vaxtında etiraf etməsələr də, sonda XX əsrin II yarısından başlayaraq qlobal istiləşmənin başlandığını bildirdilər. Onlar bunun təsirinin çox ciddi olacağını açıqlamışdılar. Həmin sahə ilə məşğul olan alimlər haqlı olaraq bir araya gələrək, həyacan təbili çalmağa başladılar. 2004-cü ilin sentyabr-oktyabr aylarında Rusiyanın paytaxtı Moskva şəhərində Ümumdünya konfransında problemin çox ciddi olmasını nəzərə alan tədqiqatçılar qarşısında həlli vacib olan konkret məsələlər qoyuldu.

Qlobal istiləşmə - Yer atmosferinin və Dünya okeanının orta illik hərarətinin tədricən artması prosesidir. Bu problem artıq bəşər övladını narahat edən ən ciddi və həlli vacib olan məsələdir. Son bir neçə ildə qlobal istiləşmənin yaratdığı nəticələr daha açıq şəkildə hiss olunmağa başlamışdır. Qeyd etmək lazımdır ki, qlobal istiləşmə hər yerdə və həmişə hərarətin artmasına səbəb olmur. Belə istiləşməni bütün coğrafi enliklər üzrə orta illik hərarəti hesablasaq hiss etmək mümkündür.

Dünya iqlim sistemində dəyişikliklərə səbəb olan qlobal istiləşmənin təsirləri ən yüksək zirvələrdən, okean dərinliklərinə, ekvatordan qütblərə qədər dünyanın hər yerində hiss edilir. Qütblərdəki buzlaqlar əriyir, dəniz suyu səviyyəsi yüksəlir və sahil seqmentlərdə torpaq itkinləri artır. Məsələn, 1960-cı illərin sonlarından bu yana Şimal Yarımkürədə qar örtüyündə 10/100 azalma olub. XX ci əsr boyunca dəniz səviyyələrində də 10-25 sm arasında bir artım olduğu müəyyən olunub. Qlobal istiləşməylə bağlı olaraq dünyanın bəzi bölgələrində qasırğalar, sellər və daşqınların şiddəti və sıxlığı artarkən, bəzi bölgələrində isə uzun, davamlı, şiddətli quraqlıqlar və səhralaşmalar baş verir.

Bəs qlobal istiləşmə nədir? Qlobal istiləşmə

yerin orta səthi temperaturunun zərərli qazlar səbəbindən yüksəlməsidir. Belə ki, karbon dioksid, metan qazları istiliyi çəkərək özündə saxlayır və hər hansı bir yolla torpaqdan çıxmasına imkan vermir.

Ətraf Mühitin Mühafizəsi Agentliyi ötən əsr ərzində yerdə temperaturun 0,8 dərəcə yüksəldiyini açıqlayıb. Temperatur artımı əsasən əsrin son 25 ilinin payına düşüb. Bu, onu göstərir ki, temperatur əvvəlki illərlə müqayisədə daha sürətlə yüksəlməkdədir. Sənayenin durmadan inkişafı, təbiətin çirkləndirilməsi, meşələrin qırılması qlobal istiləşmənin insan fəaliyyəti ilə bağlı olan səbəbləridir.

Aşağıda qlobal istiləşmə haqqında faktları təqdim edirik:

1. Qlobal istiləşməyə səbəb olan qazlar insanların həyat və fəaliyyəti üçün çox önəmlidir. Lakin bunu da bilmək lazımdır ki, həmin qazlar yalnız normadan artıq ətrafa buraxıldıqda mənfi nəticələrə səbəb olur.
2. 2007-ci ilin hesabatında bildirilir ki, qlobal istiləşmə nəticəsində əsrin sonuna qədər dənizlərin səviyyəsi 7-23 inç qalxacaq.
3. 1880-ci ildən bəri Yer üzərində temperaturun ümumilikdə 1,4 farenhayt dərəcə artdığı bildirilir.
4. İqlim araşdırmalarına əsasən, XX əsrin son iki onilliyi son 400 ilin ən isti illəri hesab edilir.
5. Qlobal istiləşmə ən çox Arktik ərazilərə öz təsirini göstərir. Arktikada buzlar çox sürətlə əriyir, 2040-cı ildə, hətta bəlkə daha tez orada yay aylarında buz olmayacaq.
6. 1910-cu ildə 150 buzlağa malik olan “Montana” milli buz parkında hazırda cəmi 25 buzlaq var.
7. Qlobal istiləşmə və ətraf mühitin çirklənməsi mərcan riflərinə də böyük zərbə vurur və onlar çox sürətlə məhv olmaqdadır.
8. Qlobal istiləşmə ekstremal hava dəyişikliklərinə səbəb olur. Nəticədə meşə yanğınları, quraqlıq, tropik qasırğalar dünyanı öz ağuşuna alıb.
9. Buzlaqların əriməsi dənizlərdə suyun səviyyəsinin artmasına səbəb olacaq. Qeyd edək ki, dünyada təxminən 100 milyon nəfər insan dəniz səviyyəsindən ən azı 3 fut aşağıda yaşayır.
10. 2011-ci ilin hesabatına görə, planetimizdə hər saniyədə ətraf mühitə 1000 ton karbon dioksid buraxılır.
11. Sənaye inqilabı nəticəsində ətrafa yayılan zərərli qazlar astma və digər tənəffüs yolu xəstəliklərinin artmasına şərait yaradır.
12. 2100-cü ildən orta temperatur göstəricilərinin 5,8 dərəcə yüksələcəyi proqnozlaşdırılır.
13. Qlobal istiləşmə kütləvi qida və su qıtlığına səbəb ola bilər.

Bu gün planetimizin qarşılaşdığı ən ciddi problemlərdən biri qlobal istiləşmə və qlobal istiləşmənin yaratdığı problemlərdir. Bəs qlobal istiləşmənin səbəbləri nələrdir?

Qlobal iqlim dəyişikliyinin əsas səbəbləri: Bu, əhalinin artımı və enerji istehlakı, torpaqdan istifadə, beynəlxalq ticarət və nəqliyyat kimi digər insan fəaliyyətinin artması ilə sənayenin inkişafıdır. İqlim dəyişikliyinin əsas səbəbi qlobal istiləşmədir. Buna səbəb atmosferdə “istixana qazlarının” artmasıdır.

Məlumdur ki, istixana qazları insan fəaliyyəti ilə artır. Karbon qazı ($CO_2$) ən vacib istixana qazıdır. Atmosferə avtomobillərin işlənmiş qazlarından, isitmə məqsədilə yandırılan yanacaqlardan və zavod bacalarından karbon və zəhərli qazlar buraxılır.

Qlobal istiləşmə dünyanın istisna olmadan bütün bölgələrinə təsir göstərir və bu regionlar arasında Azərbaycan da var. Ölkə alimləri Azərbaycanda əvvəlki illərə nisbətən havaların daha az yağmurlu keçdiyini, hava hərarətinin daha fərqli olduğunu qeyd edirlər. Onların məlumatına görə, bunun nəticəsində ölkədə səhralaşma prosesi sürətlənir və bu, artıq cari ildə kənd təsərrüfatında acı nəticələr verəcək. Bununla belə, bəzi ekspertlərin fikrincə, ölkədə həmin prosesin qarşısının alınması üçün ciddi işlər, o cümlədən əhalinin maarifləndirilməsi

aparılmalıdır. İqlim dəyişikliyi və qlobal istiləşmə Amerika və Avropa ölkələrində ciddi bir məsələyə çevrilib [1].

Elmi tədqiqatlar göstərir ki, iqlim və temperatur dəyişikliyi insanlara, qlobal iqtisadiyyata və dünyanın təbii sistemlərinə mənfi təsir göstərə bilər. Bu məsələ dünya problemlərini müzakirə etmək üçün Davosda toplaşan ən nüfuzlu dünya ölkələri rəhbərlərinin də diqqət mərkəzindədir.

Bəs görəsən bu məsələyə Azərbaycanın daxili gündəliyində hansı yer ayrılır? Qlobal istiləşmə Universitet və elmi qurumlarda kifayət qədər araşdırılırmı? Qeyri hökümət təşkilatları və ictimai qurumlar buna kifayət qədər diqqət yetirimi?

İnsanların çoxu baş verənlərin səbəblərini bilməsə və bundan çox da narahat olmasa da, iqlimdə müəyyən dəyişiklikləri sezirlər.Ekologiya üzrə ekspertlərin fikirlərinə əsasən, bu dəyişikliklər əhalinin fikirləşdiyindən də böyükdür.

Bakıda bunun səbəbi çoxalmış nəqliyyatdır, rayonlarda isə mal-qara. Onun tullantıları təmiz metan qazıdır ki, o da havaya gedir. Eləcə də məişət tullantılarımız metanın mənbəyidir. Cəmiyyətin bu sahədə fəaliyyət göstərməsi üçün ölkədə demək olar ki, maarifləndirmə işləri aparılmır. Onun fikrincə, qlobal istiləşmənin qarşısının alınması üçün ən yaxşı yollardan biri alternativ enerji mənbələrinin inkişafıdır.

Müasir sivilizasiyanın gələcəyini proqnozlaşdıran “World One” superkompüteri bizə bəşəriyyətin qaçılmaz sonunun 2050-ci il tarixində olacağını xəbər verir: “Təxminən 2040-cı ildən 2050-ci ilə qədər bu planetdə sivil həyat öz mövcudluğunu dayandıracaq”. Bu kompüter hesablamaları doğum nisbətini və ətraf mühitin çirklənmə səviyyəsini nəzərə alan mürəkkəb alqoritmə əsaslanır. Superkompüterin təbii ehtiyatların və həyati vacib mineralların əlçatanlılığının azalması ilə bağlı bir neçə proqnozları artıq özünü doğruldub. Proqnozlara əsasən, iqlim dəyişikliklərinin qarşısı alınmazsa, üç onillik ərzində sivilizasiyanın sonu gələcək. 2050-ci ilə qədər:

* dünya əhalisinin yarıdan çoxu ildə 20 gün ölümcül istilərlə üzləşəcək;
* məhsuldarlıq qlobal miqyasda beşdə bir azalacaq;
* Amazon meşələrinin ekosistemi dağılacaq;
* Arktikanın buzlaqları yayda tamamilə əriyəcək;
* İtaliya, ABŞ və Tanzaniyadakı bəzi buzlaqlar yox olacaq;
* Dəniz səviyyəsi yüksələcək və s.

Bəzi hesablamalara görə, bir milyard insan dəniz səviyyəsinin yüksəlməsi nəticəsində su basa biləcək ərazilərdə yaşayır, bu da bir milyard iqlim miqrantı deməkdir.

İqlim dəyişikliklərinin flora və faunada meydana gətirəcəyi acı nəticələrin aradan qaldırılması və əvvəlki vəziyyətinin bərpa edilməsi asan məsələ deyil. Bu halın bərpası üçün uzun illərə ehtiyac vardır. Alınması lazım olan tədbirlər müəyyəndir. Bu tədbirlər bir an əvvəl həyata keçirilməlidir. Sonraya saxlanılması yeni təhlükələrə səbəb olmaq gücündədir. Konkret tədbirlər görülmədiyi təqdirdə 2100 -cü ilədək qlobal istiliyin 1.4 - 5.8 dərəcəyə qədər artacağı təxmin edilir. Bu artım bəzilərimizə əhəmiyyətsiz görünə bilər. Ancaq 2°C-lik bir artım belə dünya əhalisinin təxminən yarısının susuz qalmasına səbəb ola biləcək qədər təhlükəlidir. Bu həm də təbii canlı növlərinin yox olması, kütləvi köçlər, susuzluq, iqtisadi fəlakət kimi təhdidləri özündə saxlayır.

Azərbaycanı qlobal istiləşmənin hansı fəsadları gözləyə bilər? Qlobal istiləşmə günəş radiasiyasının artmasına, ultrabənövşəyi aqressiv şüaların insana mənfi təsirinə, mutasiyalara, dəri xərçənginə səbəb ola bilir. Qlobal istiləşmə torpağın eroziyası münbit humus qatının itirilməsi prosesini də sürətləndirir. Qlobal istiləşmə nəticəsində 30-40 ildən sonra Azərbaycanın əkinə yararlı torpaqlarının səhralaşmasına səbəb ola bilər.

Qlobal istiləşmə ilə bağlı ən birinci sellər və çay daşqınları təhlükələsidir. Qlobal və regional miqyaslı buzlaqların əriməsi bol sulu çayların daşaraq əkin sahələrinin və yaşayış yerlərinin sıradan çıxmasına səbəb olursa kiçik sulu çayların və bulaqların qurumasına səbəb olur. Qlobal istiləşmə kimi buxarlanmanın artmasına səbəb olur. Onun nəticəsində qrunt sularının səviyyəsi aşağı düşür. Bunun nəticəsində isə bitki örtüyü və meşə sahələri məhv olur. Meşələrin məhv olması isə yağıntıların tutularaq il boyu çay və bulaqları təmin etmək funksiyasını itirməsinə gətirir. Yağan yağıntı münbit torpaqları yuyur, daşqınlar yaradır. İllik su norması bir-iki ay içərisində sərf olur, sonra quraqlıq yaranır.

## Azərbaycan və qlobal istiləşmə

Qlobal istiləşmə günəş radiasiyasının artmasına, ultrabənövşəyi qressiv şüaların nsana mənfi təsirinə, mutasiyalara, dəri xərçənginə səbəb ola bilir. Qlobal istiləşmə torpağın eroziyası münbit humus qatının itirilməsi prosesini də sürətləndirir. Qlobal istiləşmə nəticəsində 30-40 ildən sonra Azərbaycanın əkinə yararlı torpaqlarının səhralaşmasına səbəb ola bilər.

Aparılan çoxsaylı tədqiqatlara əsasən, qlobal istiləşməyə əsas səbəb insanın istehsal və təsərrüfat fəaliyyəti nəticəsində atmosferə atılan karbon qazı və digər parnik effekti yaradan qazlarının miqdarının durmadan artmasıdır. Sənayeləşmə dövründən başlayaraq yanacağa (neft, daş kömür, təbii qaz və s.) olan tələbatın durmadan yüksəlməsi ilə əlaqədar atmosferə atılan karbon qazının miqdarı kəskin artaraq son dövrlərdə təhlükəli həddə çatmışdır. Bunun nəticəsində Yerin şüalandırdığı uzundalğalı enerjinin getdikcə daha böyük hissəsi atmosferdəki karbon qazı və digər istilik effekti yaradan qazlardan geriyə əks olunur ki, bu da Yerin istilik balansını pozaraq qlobal istiləşməyə səbəb olur.

BMT-nin İqlim dəyişmələri üzrə hökumətlərarası ekspertlər qrupunun 2022-il avqustun 9-da Cenevrədə yaydığı sonuncu 6-cı hesabatına əsasən, 1850-1900-cu illər ilə müqayisədə Yer kürəsinin orta illik qlobal temperaturu 1,1-1,2 dərəcə artıb. Müasir iqlim ssenarilərinə əsasən yaxın onilliklərdə qlobal temperatur artımının 1,5, hətta 2,0 dərəcəyə çatacağı gözlənilir. Temperaturun artması ilə planetin bütün iqlim şəraiti də dəyişir – ekstremal təhlükəli hadisələrin təkrarlanması artır, təbii zonaların yerdəyişməsi baş verdiyindən bitki və heyvanlar məhv olur.

Azərbaycan ərazisində də qlobal istiləşmə öz təzahürlərini göstərməkdədir. İqlim norması 1961-1990-cı illərlə müqayisədə 1991-2020-ci illərdə havanın orta illik temperaturu orta hesabla 0,80 – 1,2 dərəcə artıb. Ən böyük artım isə avqust ayında müşahidə edilir ki, bu da bir çox hallarda davamlı və intensiv “isti hava dalğaları”, həmçinin ekstremal hava temperaturları ilə müşayiət olunur. Respublikanın əksər ərazilərində atmosfer yağıntıları iqlim normasına nisbətən azalsa da, ayrı-ayrı günlərdə müşahidə olunan anomal intensivli yağıntılar və onlarla əlaqədar olan təhlükəli hidrometeoroloji hadisələrin (leysan, ildırım, dolu, qasırğa küləyi, sel, daşqın və s.) təkrarlanması artıb. Bu, özünü cari ilin may və iyun aylarında daha qabarıq göstərməkdədir. Temperaturun artması və yağıntıların azalması səbəbindən suya olan tələbatın artması fonunda, ölkənin su ehtiyatlarının azalması müşahidə edilir. Yaxın onilliklərdə istiləşmənin daha da sürətlənəcəyi ilə əlaqədar olaraq Azərbaycanda da yuxarıda qeyd edilən neqativ təzahürlərin daha da kəskinləşəcəyi ehtimal olunur.

Bir çox digər dünya ölkələrində və bizim ölkəmizdə bütün bunların qarşısını almaq yolunda müəyyən işlər görülür: tullantıların azaldılması, enerjiyə qənaət, havanın çirkləndirilməsinin qarşısını almaq üçün müəyyən tədbirlər görülür. İqlim dəyişikliyinə qarşı mübarizəyə biz də qatılmalıyıq. Aşağıda sadalananlara əməl etməliyik ki, insanların yaşaması üçün əlverişli olan dünyamızı qoruya bilək:

- lazımsız su israfı edilməməlidir;
- enerjiyə maksimum dərəcədə qənaət edilməlidir;
- ətraf mühit çirkləndirilməməlidir;

- *plastik tullantılar azaldılmalı və hətta plastik vasitələrdən heç istifadə olunmamalıdır;
- şəxsi nəqliyyat vasitələri yerinə ictimai nəqliyyatlardan istifadəyə üstünlük verilməlidir;
- ağacların kəsilməsi ilə istehsal edilən heç bir vasitə israf edilməməlidir;
- kürklər üçün və ya zövq uğruna heyvanlar, xüsusilə də nəsli tükənməkdə olan canlılar ovlanmamalıdır;
- dənizlər, okeanlar, çaylar təmiz saxlanmalı və çirkləndirilməməlidir.

Ekspert ekoloq S.Səfərov bildirib ki, dünya ekspertlərinin ümumi rəyi bundan ibarətdir ki, ən yaxın gələcəkdə atmosferə atılan parnik və digər zərərli qazlarının miqdarını kəskin azaltmaqla, qlobal temperaturu stabilləşdirmək, iqlim dəyişmələrinin miqyasını məhdudlaşdırmaq mümkündür və bu da inkişaf etmiş dövlətlərin imkanları daxilindədir. Qlobal istiləşməni məhdudlaşdırmağın yeganə yolu dünyanın enerji balansında bərpa olunan enerjinin (külək, günəş və s. enerjiləri) xüsusi çəkisini kəskin artırmaqla, atmosferə atılan karbon qazı və digər parnik qazlarının miqdarının azaldılmasıdır.

İstiləşmənin ən əsas hərəkətverici qüvvəsi 90%-dən çoxu karbon qazı (CO2) və metandan ibarət olan istixana qazlarının emissiyasıdır. Antropogen amillər sırasında azot oksidi, azot-1 oksid və xlor-flor birləşmələri də yer alır. Bu emissiyaların əsas mənbəyi enerji istehlakı üçün təbii yanacaqların (kömür, neft və qaz) yandırılması olsa da, kənd təsərrüfatının, ağacların kəsilməsinin və sənaye proseslərinin də rolu var. Eyni zamanda məişət tullantıları, avtomobillərin hava buraxdıqları qazlar da atmosferi çirkləndirməklə istiləşməyə yol açır.

Son əsrdə, xüsusən də son 30-50 ildə müşahidə olunan qlobal istiləşmə onilliklər ərzində atmosferdə toplanan su buxarı, karbon dioksid, metan, azot oksidi xlorofloro karbonlar kimi günəş işığı ilə qızdırılan, Yer səthindən infraqırmızı istilik şüalarını udan qazlar tərəfindən əmələ gəlir. Başqa sözlə, Günəşdən gələn şüaların bir hissəsi ozon təbəqəsi və atmosferdəki qazlar tərəfindən sovrulur. Bir qismi litosferden, bir qismi isə buludlardan geriyə əks olunur. Yer üzünə çatan şüalar geriyə dönərkən atmosferdəki su buxarı və digər qazlar tərəfindən tutulur. Bu hadisə günəş şüalarıyla istilənən, amma içindəki istiliyi çölə buraxmayan istixanaları xatırladır. Nəticədə atmosfer istiləşir ki, bu da istixana effekti adlanır.

İqlim dəyişikliyinə səbəb olan digər amil kosmosun istismarıdır. Kosmosa buraxılan raketlər atmosferin yuxarı həddində ozon qatını zədələyir və atmosferdə istixana effekti yaranır. Ozon təbəqəsinin incəlməsi də qlobal istiləşməyə yol açan digər səbəbdir.

Bəşəriyyəti və Azərbaycanı təhdid edən təhlükələr

İqlim Dəyişmələri üzrə Hökumətlərarası Ekspertlər Qrupunun hesabatına görə, son 100 ildə Yer kürəsində orta temperatur 0,8 dərəcə artıb. BMT-nin hesabatında göstərilir ki, son 150 ildə dünyada temperatur 1 dərəcə yüksəlib. Ekspertlərin ehtimallarına görə, əgər Yer kürəsində temperatur bu sürətlə qalxmaqda davam etsə, 2050-ci ilə qədər hərarət 2-2,5 dərəcə, 2100-cü ilə qədər isə 6 dərəcəyə qədər yüksələ bilər.

Müəyyən olunub ki, temperaturun artması okeanda suyun 1000 metr dərinliyinə qədər hiss olunurdusa, indi bu rəqəm 2000 metrə enib. Bu da isti axınların daha da qızmasına səbəb olur. Bu ümumbəşəri problemi həll etmək üçün 1992-ci ildə Rio-de-Janeyroda BMT-nin Ətraf Mühit və İnkişaf üzrə Konfransında 154 dövlət tərəfindən “insanların iqlim sisteminə təhlükəli müdaxiləsi ilə mübarizə aparmaq üçün” “İqlim Dəyişmələri üzrə Çərçivə Konvensiyası” imzalandı. Çərçivə konvensiyasının əsas məqsədi “atmosferdə istixana qazlarının konsentrasiyalarının iqlim sisteminə təhlükəli antropogen müdaxiləsinin qarşısını alacaq səviyyədə stabilləşməsidir”.

1997-ci ildə Yaponiyada imzalanmış və 2005-2020-ci illəri əhatə edən Kioto protokolu tədbirlərin ilk icrası olub. Kioto protokolu 2016-cı ildə qüvvəyə minən Paris sazişi ilə əvəz olundu. 2022-ci ilə qədər tədbirin 198 tərəfdarı var idi. Onun ali qərar qəbuledici orqanı olan Tərəflər Konfransı (COP) iqlim dəyişikliyi ilə mübarizədə irəliləyişi qiymətləndirmək üçün hər il toplanır [3].

Sevindirici haldır ki, bəşəriyyət üçün vacib olan bu tədbir - hər il fərqli ölkənin ev sahibliyi etdiyi “Conference of the Parties”in (COP) 29-cu iclası, yəni Tərəflərin Konfransı noyabrın 11-dən 22-dək Bakıda keçiriləcək. COP29 iqlim dəyişikliyi məsələlərini müzakirə etmək və danışıqlar aparmaq üçün dünya liderlərini, hökumət rəsmilərini, alimləri, QHT-ləri və digər maraqlı tərəfləri bir araya gətirən böyük tədbir olacaq. İndiyə kimi belə ənənə formalaşıb ki, illik COP tədbiri keçirilməzdən əvvəl dünyanın fərqli ölkələrinin iqlim icmasından olan tanınmış şəxslər və nazirlər yığışaraq, bu tədbirin gündəliyini müəyyən edirlər. Burada nazirlər və diplomatlar növbəti COP tədbiri - əsas iqlim konfransı üçün prioritetləri müəyyənləşdirirlər.

COP konfransının məqsədi nədir? 2015-ci ilin dekabrında BMT-nin İqlim Dəyişmələri üzrə Çərçivə Konvensiyasına üzv ölkələrin 21-ci konfransında Paris Razılaşması qəbul olunub. Sənədi 171 ölkənin hökumətləri adından dövlət və hökumət rəhbərləri, xarici işlər, ətraf mühit nazirləri imzalayıblar. Bu sənədi 2016-cı ilin aprelində Nyu-Yorkda, Birləşmiş Millətlər Təşkilatının mənzil-qərargahında Azərbaycan Respublikası Hökuməti də imzalayıb. COP tədbirlərinin məqsədi Paris Sazişinin tələbi olaraq dünyada karbon qazının ($CO_2$) miqdarını sənayeləşmədən əvvəlki dövrdə olduğu kimi 1,5 dərəcə Selsi ilə məhdudlaşdırmaq üzrə irəliləyişə nail olmaqdır. Bundan başqa, inkişaf etmiş ölkələr inkişaf etməkdə olan ölkələrə iqlim dəyişikliyinin təsirini azaltmaq və uyğunlaşmaqda kömək etmək üçün maliyyə yardımı üçün fond toplayırlar.

İnkişaf etməkdə olan ölkələrin artıq üzləşdiyi iqlim dəyişikliyinin qaçılmaz təsirlərinə və bu təsirlərin aradan qaldırılması üçün maliyyə və digər dəstəyə ehtiyacı var. Bu dəstək olmadan inkişaf etməkdə olan ölkələr təmiz enerji mənbələrinə keçid edə, qlobal karbon qazı ifrazını azalda bilməzlər. COP29 konfransı, həm də iştirakçı ölkələr üçün yeni öhdəliklər götürmək və iqlim böhranını həll etmək üçün konkret addımlar atmaq üçün bir fürsətdir [4].

Dünya dövlətlərinin COP29-un Azərbaycanda keçirilməsini dəstəkləməsi təsadüfi deyil.

Bəs, Azərbaycanda qlobal iqlim dəyişiklikləri ilə bağlı vəziyyət necədir? Azərbaycanda da son illər temperatur 0,4-1,3 dərəcəyədək artıb. Temperatur artımı regionlardan asılı olaraq qeyri-bərabər paylanır. Belə ki, Böyük Qafqazın yüksək dağlıq ərazilərində temperaturun 1,1-1,3 dərəcə artması müşahidə olunur. Azərbaycanda aparılan tədqiqatlara əsasən, 1961-1990-cı illərlə müqayisədə 1991-2012-ci illərdə temperatur artımı 0,2-1,5°C intervalında dəyişib. Azərbaycan iqlim dəyişmələrinin təsirlərinə yüksək dərəcədə həssas olan ölkədir. İstilik effekti yaradan qazların milli tullantıları qlobal tullantıların yalnız 0.1%-ni təşkil edir.

Qlobal istiləşmə Yer kürəsində təbii fəlakətləri artırır, təbii resurslara, insanların həyat tərzinə mənfi təsir edir. Son 100 illik kosmik müşahidələr göstərir ki, tufan və çovğunların həm intensivliyi, həm də tezliyi artıb. İsti külək, qasırğa, yağıntılar güclənib, eyni zamanda, sel, daşqın hadisələrinin sayı artıb. Bütün bu təbii fəlakətlərin artımında əsas amil iqlim dəyişmələridir.


Dünya dövlətlərinin COP 29-un Azərbaycanda keçirilməsini dəstəkləməsi heç də təsadüfi deyil. Məlumdur ki, Azərbaycanın bərpaolunan enerji potensialı çox böyükdür və potensialın reallaşdırılması istiqamətində ciddi addımlar atılmaqdadır. Prezident İlham Əliyevin hələ 2004-cü ilin oktyabrın 21-də “Azərbaycan Respublikasında alternativ və bərpaolunan enerji mənbələrindən istifadə olunması üzrə Dövlət Proqramı” nın təsdiq edilməsi haqqında imzaladığı Sərəncam bu istiqamətdə Azərbaycan Respublikasının irimiqyaslı layihələr həyata keçirəcəyinin göstəricisidir. Sərəncamın icrası ilə əlaqədar artıq respublikamızda böyükhəcmli işlər həyata keçirilib. İşğaldan azad olunan torpaqlarımızın bərpaolunan enerji potensialını da nəzər alsaq, bu işlərin geniş miqyas alacağı birmənalıdır. Prezident İlham Əliyevin qətiyyəti,

sarsılmaz iradəsi, nəyi necə, nə vaxt etmək lazım olduğunu dəqiqliklə bilməsi Azərbaycan Respublikasının alternativ və bərpaolunan enerji mənbələrindən istifadə edilməsi istiqamətində də öz sözünü deyəcəyinə əminlik yaradır [4].

## Nəticə

Proqnozlara əsasən, iqlim dəyişikliklərinin qarşısı alınmazsa, üç onillik ərzində sivilizasiyanın sonu gələcək. 2050-ci ilə qədər:

- dünya əhalisinin yarıdan çoxu ildə 20 gün ölümcül istilərlə üzləşəcək;
- məhsuldarlıq qlobal miqyasda beşdə bir azalacaq;
- Amazon meşələrinin ekosistemi dağılacaq;
- Arktikanın buzlaqları yayda tamamilə əriyəcək;
- İtaliya, ABŞ və Tanzaniyadakı bəzi buzlaqlar yox olacaq;
- dəniz səviyyəsi yüksələcək və s.

Bəzi hesablamalara görə, bir milyard insan dəniz səviyyəsinin yüksəlməsi nəticəsində su basa biləcək ərazilərdə yaşayır, bu da bir milyard iqlim miqrantı deməkdir.

Bir çox digər dünya ölkələrində və bizim ölkəmizdə bütün bunların qarşısını almaq yolunda müəyyən işlər görülür: tullantıların azaldılması, enerjiyə qənaət, havanın çirkləndirilməsinin qarşısını almaq üçün müəyyən tədbirlər və s. İqlim dəyişikliyinə qarşı mübarizəyə biz də qatılmalıyıq. Aşağıda sadalananlara əməl etməliyik ki, insanların yaşaması üçün əlverişli olan dünyamızı qoruya biləkk:

- lazımsız su israfı edilməməlidir;
- enerjiyə maksimum dərəcədə qənaət edilməlidir;
- ətraf mühit çirkləndirilməməlidir;
- plastik tullantılar azaldılmalı və hətta plastik vasitələrdən heç istifadə olunmamalıdır;
- şəxsi nəqliyyat vasitələri yerinə ictimai nəqliyyatlardan istifadəyə üstünlük verilməlidir;
- ağacların kəsilməsi ilə istehsal edilən heç bir vasitə israf edilməməlidir;
- kürklər üçün və ya zövq uğruna heyvanlar, xüsusilə də nəsli tükənməkdə olan canlılar ovlanmamalıdır;
- dənizlər, okeanlar, çaylar təmiz saxlanmalı və çirkləndirilməməlidir.

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## Резюме

### Глобальное потепление и влияние глобального потепления на Азербайджан”

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Глобальное потепление, произошедшее в последние столетия, негативно отразилось на образе жизни людей, что привело к увеличению стихийных бедствий среди живой и неживой природы. Чтобы ликвидировать последствия глобального потепления, ученые мира принимают решения на международных конференциях, в которых они принимают непосредственное участие.

**Ключевые слова**: глобальный, климат, тепло, КС, альтернативная энергетика,

## Abstract

### Global warming and the impact of global warming on Azerbaijan

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Global warming that has occurred in recent centuries has negatively affected the way of life of people, which has increased natural disasters among living and non-living nature.

In order to eliminate the consequences of global warming, world scientists make decisions at international conferences in which they directly participate.

**Keywords**: global, climate, heat, cop, alternative energy

# Measures to combat desertification in the Absheron Peninsula.

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**Abstract**

Due to the influence of global climate changes and anthropogenic factors, the process of desertification in Absheron Peninsula lands has taken a sharper shape today. Thus, 70% of industrial production and more than 60% of onshore oil production falls on Absheron Peninsula. In addition, the improper use of land as a result of the agricultural activities of people on the peninsula with an increasing population indicates that the desertification process on the Absheron Peninsula is accelerating and there is a need for urgent restoration of these lands. As the temperature rises, the habitats of many plant species are subject to changes. The destruction of species, unable to keep up with the rapidly changing conditions, disrupts the balance of the ecosystem. Degraded dead zones that have lost their ability to live are increasing, and the process of desertification is accelerating.

Thus, one of the main environmental problems of the Republic of Azerbaijan

- Degradation of fertile lands (erosion, salinization, desertification);
- the issue of biodiversity depletion is one of the most pressing issues that are waiting to be resolved today.

**Keywords**: Global climate changes, anthropogenic factors, environmental problems, xerophytes, soil degradation, desertification, phytomelioration.

## Introduction

The problem of climate change remains one of the global problems of the world today. Climatic changes that occur as a result of the interference of man's economic activities with nature for centuries, today have a great impact not only on all areas of human life, but also on nature, ecosystems, and the ecological situation. As temperatures rise, the habitats of many plant species undergo changes. The extinction of species, unable to keep up with rapidly changing conditions, disturbs the balance of the ecosystem. Degraded dead zones that have lost their ability to live are increasing, and the process of desertification is accelerating.

Thus, one of the main environmental problems of the Republic of Azerbaijan.

- Degradation of fertile lands (erosion, salinization, desertification);
- thinning of biodiversity issues are among the most urgent issues that are waiting to be resolved today.[2].

The article examines the characteristics and causes of the desertification process on the Absheron peninsula, and shows the measures that must be taken to prevent this process and restore the fertility of the land. Thus, as a result of the impact of climate changes and anthropogenic factors on the Absheron peninsula, opposite processes are taking place on the peninsula. On the one hand, due to the influence of global warming and anthropogenic factors, the desertification process is expanding here. On the other hand, the introduced plants brought to the peninsula for the purpose of combating desertification and cultivated here suppress and eliminate local plant species, causing their destruction. Therefore, it is recommended to use more local plants than introduced plants in the phytomelioration measures carried out on the Absheron Peninsula.[1].

Today, the process of desertification in Azerbaijan is going more sharply mainly in 3 regions. It includes Nakhchivan Autonomous Republic, Kur-Araz lowland and Absheron peninsula. We have written this article based on the results of our research on the process of desertification on the Absheron Peninsula.[3].

The Absheron Peninsula is the largest peninsula in the Republic of Azerbaijan, located on the western shores of the Caspian Sea, and is located in the southeastern corner of the Greater Caucasus. The total area of the peninsula is 2220 km2. Absheron peninsula, bordering Gobustan from the west, is 60-80 km long and 30 km wide at its widest point. The terrain of the Absheron Peninsula is mainly hilly plains and mountains. The surface of the territory consists of wide plains, ridges, plateaus

and hills separated from each other by valleys and depressions. The western part of the Absheron Peninsula is relatively high. The coastal part is 28m below sea level. The maximum height is the 390 m mountain of Kerkas in the north-west.[4].

Climate. The climate of Absheron is included in the dry subtropical climate zone with dry and very hot summers, warm and mild autumns, and short winters. I.V. Figurovsky (1926) included the Absheron Peninsula in the Central dry subtropical zone and divided it into two climatic zones:

1. Temperate coastal zone covering 3 parts of the peninsula.
2. South-western coastal part, warm, dry subtropical zone near Baku.

Land. One of the main problems of the Absheron peninsula is related to soil pollution. The total area of waste lands of the Absheron peninsula, which has a total area of 222 thousand hectares, is 33 thousand ha, including the area of oil-contaminated land - 10.6 thousand ha.

The land cover of the Absheron peninsula has been subjected to extensive anthropogenic influences during the last 100 years and has almost lost its fertility parameters. The main reasons for the degradation of land resources in this area are:

-Salinization and swamping as a result of the rise in the level of the Caspian Sea, ponds created by ballast water from oil wells, excessive irrigation of gardens and other areas;

-Deflation and erosion of surface waters caused by sand blasts caused by northeast winds, salty, clay sediments brought by torrential rains and floodwaters, and water erosion;

-Dry bioclimatic conditions and weakening of biological activity as a result of lack of natural moisture and moisture in degraded saline-saline gray-brown soils in summer months;


**Picture 1**- Vegetation map of the Absheron Peninsula based on Landsat 8 satellite imagery (section 3, 4. Optical channel range: red, infrared 550,800 nm)

Vegetation. Since the climate of Absheron is dry subtropical, the plants that grow naturally here are drought- and heat-resistant and not demanding on the soil.

Absheron Peninsula, which at first glance appears to be unfavorable and extreme conditions for vegetation, actually has a very rich floristic biodiversity. According to experts, 22% of the plant diversity of Azerbaijan's flora belongs to the Absheron peninsula. In April and May, these places do not lag behind the alpine meadows with their fascinating views. In some areas of this area, there are 10-12 plant species per 1m2.

Since the soil of the Caspian coastal areas of the Absheron Peninsula is salty and alkaline, the plants naturally distributed in those areas are salinity-resistant species and reflect its historical vegetation.

A large number of ephemerals are naturally distributed on the Absheron peninsula. The abundance of ephemeris here is related to the climate regime. Thus, the presence of certain correspondences between temperature and relative humidity creates normal conditions for these ephemerals. The ephemeral grasses characteristic of the peninsula dry up and burn in the summer, but here small bushes: wormwood, blackberry, davitika and other perennial grasses continue their dynamic development even in the heat of the summer and bloom and give seeds in the fall. Vegetation is rare on rocky and gravelly slopes. Shrubs grow in the armpits of large stones.

Table 1-Analysis of the systematic structure of the flora of the peninsula

| № | Plant groups | Systematic category | | | | | |
|---|---|---|---|---|---|---|---|
| | | Familia | | Sexes | | Species | |
| | | Total number | In % by number | Total number | In % by number | Total number | In % by number |
| I | Primitive plants | | | | | | |
| 1 | Algae | 1 | 1.4 | 1 | 0.3 | 1 | 0.2 |
| 2 | Lichenes | 3 | 4.3 | 3 | 1.1 | 3 | 0.5 |
| II | Vascular plant | | | | | | |
| 3 | Fern-like | 2 | 3.0 | 2 | 0.7 | 2 | 0.4 |
| 4 | Moss | 1 | 1.4 | 1 | 0.3 | 1 | 0.2 |
| III | Gymnosperms | 2 | 3.0 | 2 | 0.7 | 4 | 0.8 |
| IV | Angiosperms | 69 | 84.1 | 29.1 | 96.3 | 499 | 97.7 |
| 5 | Monocotyledon plants | 15 | 21.8 | 68 | 22.6 | 114 | 22.4 |
| 6 | Dicots plants | 54 | 78.2 | 233 | 77.4 | 315 | 75.3 |

As can be seen from the table, the flora of the region consists of 69 families, 301 genera and 511 species. Of this, 0.9% are primitive plants, 0/6% are higher spores, 0.8% are gymnosperms, and 97.7% are angiosperms (monocotyledons 22.4%, dicotyledons 75.3%). The species composition of the vegetation recorded here is mainly angiosperms. In the area, 24 types of ecomorphic plants included in 8 chapters and 19 classes were found to be edifying or indicative.

**Table 2**- Composition of the flora of the peninsula by ecological groups

| № | Environmental groups | Species | |
|---|---|---|---|
| | | Number | In % of the total numbe |
| 1 | Xerophytes | 214 | 41.9 |
| 2 | Mesoxerophytes | 92 | 18.0 |
| 3 | Psammophytes | 68 | 13.3 |
| 4 | Halophytes | 51 | 10.0 |
| 5 | Mesophytes | 44 | 8.6 |
| 6 | Hydrophytes | 42 | 8.2 |
| | Total | 511 | 100.0 |

In the flora of the peninsula, ephemeris and ephemeroids belong to the group of xerophytes. Ephemerals are one-year plants, have a weak root system, germinate in early spring and complete their vegetation within 1-2 months. Ephemeroids are perennial plants, bulbous grasses with rhizomes and tubers. Ephemeroids and ephemeroids form groups together with wormwood and sorrange in desert and semi-desert vegetation.[5].

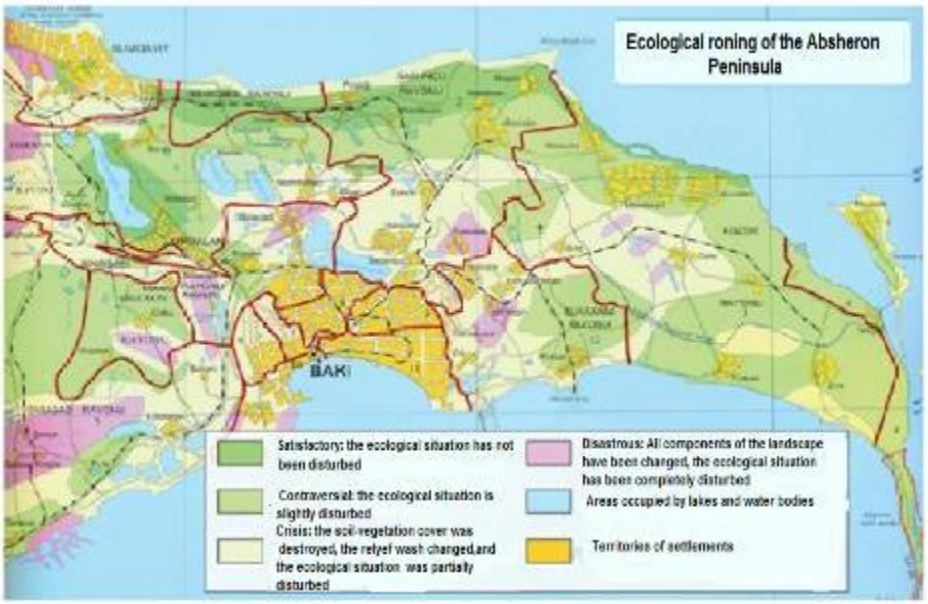
The concept of desertification was developed during the formation of the concept of desertification as a global ecological and socio-economic problem at the end of the 20th century. At that time, anthropogenic influence was announced as the main cause and mechanism of desertification. Such an understanding has directed researchers to solve a number of problems, but the problems that deviate from this order have escaped their attention. One such problem is that desertification is a reversible process caused by climate change.

One of the main features of the modern climate is the intensification of global warming since the second half of the 1970s. Global warming causes loss of soil moisture, aridification, desertification, etc. has led to unfavorable results. Undoubtedly, arid lands and deserts existed in previous climatic periods, but the global warming that has begun has been reflected in the ecosystems in the form of aridification and desertification intensification.

Today, the amount of degraded land in the world is considered equal to 2 billion hectares. Every year, this figure increases by 12 million ha of productive land. According to the Global Desertification Atlas, four-thirds of the earth's surface is degraded, and by 2050 this figure may increase to 90%.


**Picture 3- Desertification processes occurring in the world**

According to the scale of industrial production, Absheron is the largest economic district of the republic. More than 70% of industrial production, more than 60% of onshore oil production, all oil refining and petrochemicals, more than 80% of mechanical engineering and metallurgy, 30% of electricity production, more than 75% of wood processing, 40% of food production, It accounts for 50% of light industry and 70% of construction materials. All this shows that the process of aridification in the Absheron peninsula is going on fast and there is a need for urgent restoration of these lands.




According to the degree of damage to arid landscapes, the ecological condition of the peninsula can be divided into 4 groups:

- -Satisfactory condition-soil-vegetation not damaged (about 6% of the area)
- Moderate degree of damage - soil-vegetation cover is slightly damaged (about 40% of the area)
- -Critical situation-soil-vegetation is damaged, relief has changed (28% of the area)
- Catastrophic situation - all elements of the landscape, inter-landscape relations are broken (7% of the territory).

**Changes in the lands of the Absheron Peninsula.**

Gray-brown and gray soils are common in the Absheron peninsula. These soils are young soils, formed on proluvial and alluvial sediments. Soil profiles are less variable and horizons are poorly differentiated. A light color means that there is less organic matter in the soil. The amount of humus varies between 1.5-0.9%. According to their mechanical composition, the soils are sandy, granular and heavy clay. The disadvantage of these soils is that their profiles are intact and dry. They

can only be improved through phytomelioration. Salt flats are found in the central part of Absheron, in the low places of the relief and around the salt lakes. The surface part of the soil is characterized by an extreme amount of slightly soluble salts. The amount of salts is more than 3% and is chlorine, sulfate and chlorinated-sulfate. Saline soils are located in a complex in some places. According to its mechanical composition, it is clayey and loamy. Saline soils can be rehabilitated through reclamation and washing.

Until recent times, most of the Absheron Peninsula lands were used for agricultural purposes - horticulture, viticulture, animal husbandry. As a result of land reforms, changes in property relations, population migration from other regions of Azerbaijan to Absheron, radical changes in the structure of land use have occurred. Thus, except for the state-owned industrial lands, the remaining lands are owned by private owners, local municipalities and the Baku City Executive Authority. In Absheron, 30,000 hectares of land under oil fields are in use. All of these soils are contaminated to varying degrees. For many years, fuel oil lakes were created due to the relentless production of oil from mines without taking into account environmental protection, and 10,000 hectares of land were contaminated with oil. Therefore, it can be said that the most acute situation in the problem of land degradation is in Absheron.[6].

As a result of the rise of the level of the Caspian Sea from 1977 to 2.5 m from 1977 to 1995, the lowest abrasion-accumulative terrace of the Bosphorus plain, Absheron-Gobustan coasts was flooded and caused the creation of salt marshes and hydromorphic landscapes.

The progressive development of salt marshes and lakes of man-made origin plays an important role in the degradation of both natural and anthropogenic landscapes, stressing geo-ecological conditions and desertification.

Since the 50s of the last century, the development of coastal zones has reached its peak. Coastal lands are used for agricultural production, urban planning and port construction. The scale and quantity of extraction in coastal areas is greater than inland and poses significant risks to the environment. As a result of Caspian Sea level fluctuations and anthropogenic influence, a modified soil structure was created. The role of sea level fluctuations in the degradation of vegetation cover is known. Thus, the regulation of water-salt exchange in the development of the root system of plants by irrigation and other experimental methods leads to a decrease in the speed of the degradation process in the soil. The replacement of hydromorphic conditions with arid conditions along the coast from north to south accelerated the degradation process, including the loss of humus. The negative changes in soil and vegetation were related to these extreme conditions.[7].

Taking into account all this, phytomelioration, land reclamation measures, as well as measures to combat desertification, are being implemented in Absheron recently, and very strong greening works are being carried out. Phytomelioration is one of the systems of melioration measures that have a positive effect on changing a number of physico-chemical properties of soils, returning unusable land areas to farm circulation, preventing erosion, increasing productivity, and providing people with food products. Phytomelioration is considered one of the important measures against drought, surface erosion and similar natural phenomena. Taking into account its importance, phytomelioration is conventionally divided into two groups. 1. Forest reclamation. 2. Reclamation with the help of grass plants. Forest strips are important against drought and wind erosion. According to their use, forests are divided into protective and anti-erosion forests, forests in soils, sandy soils and grasslands. Field-protecting forests reduce evaporation, weaken the wind, prevent re-salination, improve the microclimate, and cause an even distribution of snow cover. Forests and alleys planted on the sides of the roads prevent the roads from being covered with snow and the soil being deprived of the fertile layer due to wind erosion. Considering all this, forest reclamation measures are widely used in the Absheron peninsula .

Today, 11.5 thousand hectares of the Absheron peninsula, i.e. 2.1% of the total area, have been planted with forest plantations. This indicator is increasing year by year. Forest plantations are planted in the new areas of Absheron.[8].

A large number of introduced plants are planted and cultivated in Absheron territory. The development of new plant species brought from other countries, specific for different geographic latitudes, has begun in the peninsula. In fact, plants with low water requirements prevail here. But new artificial irrigation systems are used to adapt new types of plants that require a lot of water to the climate of the peninsula. Extensive use of irrigation systems for plant care leads to increased evaporation in the atmosphere. This, in turn, leads to an increase in the amount of moisture in the air. Therefore, there is a transition from the continental climate type to the temperate climate type in the area. As a result of the research conducted by the Institute of Dendrology of the Azerbaijan National Academy of Sciences, it was observed that the Absheron peninsula changed its climate type, and

as a result, changes in the composition of the peninsula's flora and a decrease in the number of some plants belonging to the local flora were observed. It was determined that the Absheron Peninsula has changed from a continental climate type to a temperate climate type.[9].

Substitution of well water with Jeyranbatan water, increased use of artificial irrigation system for adaptation of new types of plants to the climatic type of the area, change of soil composition, increase of relative humidity, annual temperature increase of 1-2 degrees led to creation of mild subtropical climate type in the areas. The number of trees and shrubs belonging to the local flora on the Absheron Peninsula is small. Baku juzgunu, artemisia, and tamarisk trees belonging to the local flora are already facing the threat of extinction.[10].

67% of the cultivated flora on the Absheron Peninsula belongs to the Mediterranean countries. Previously, this indicator was not higher than 40%. Some plants belonging to the Mediterranean countries have already fully adapted to the climate of the Absheron Peninsula. Examples of such plants are magnolia (Magnolia grandiflora), photonia (Photonia serrulata lindi), oleander (Nerium oleander), Japanese holly (Eriobotrya japonica), Japanese walnut (Ligustrum japonicum), immortelle bush (Pirocanta coccinea), cotomaster, boxwood. (buxus), oriental thuja (biota orientalis) and palm.[11].

## The result

As a result of the impact of climate changes and anthropogenic factors on the Absheron peninsula, opposite processes are taking place on the peninsula. On the one hand, due to the influence of global warming and anthropogenic factors, the desertification process is expanding here. On the other hand, introduced plants brought to the peninsula to fight desertification and cultivated here suppress and eliminate local plant species, causing their destruction. Therefore, it is recommended to use more local plants than introduced plants in the phytomelioration measures carried out on the Absheron Peninsula.

In general, it is important to implement the following measures to prevent desertification on the Absheron

**Peninsula**:

- -Inventory and mapping of desertified areas;
- To organize long-term environmental monitoring of desertification processes (this includes control of hydrometeorological, agrochemical, biological, hydrological stations, taking aerial photos of the area);
- Effective use of natural resources, control of the use of pastures;
- -Conducting amelioration works as well as phytomelioration works;
- Effective use of water resources and their expansion;
- Correct use of land in agriculture, compliance with agrotechnical rules
- -Phytomelioration of pastures, as well as planting of plants that strengthen sand dunes in desertified areas;
- Organization of biodiversity protection;
- -Conducting fundamental research on desertification, monitoring the dynamics of desertification, providing forecasts on desertification;
- -Using socio-economic mechanisms in the fight against desertification, ensuring state control of this fight;
- -Increasing the role of international cooperation in the fight against desertification.

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# Ailant tree genus: bioecological characteristics and economic importance in Absheron Peninsula

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**Abstarct**

Ailanthus altissima Mill is considered an invasive tree species due to its rapid growth and its ability to crowd out other tree species. It has the ability to produce a large amount of seeds. When these seeds fall to the ground, they quickly develop a strong root system in the soil, making it difficult to cut and destroy due to its strong growth from surface roots. The genus Ailanthus releases special allelopathic substances to the area where it spreads. These substances weaken the development of various tree species nearby, making their seeds useless. Ailanthus is mostly found in urban areas, roadsides, walls, which causes damage to buildings. The main aim of the research is to prevent its spread as an invasive tree species around Absheron, identifying the positive aspects of Ailanthus and making the most of it. In this study, it was determined that Ailanthus's low demand for water and land, its easy propagation and rapid growth in difficult conditions allow the establishment of its plantations.

**Key words:** distribution area, Ailanthon substance, reproduction of Ailanthus, being an invasive tree, water requirement, quick germenation of seeds, possible economical uses for Ailanthus

## Introduction

The origin of Ailanthus – (Ailanthus Altissima, Mill) Ailanthus is a tree native to northern and central China, distributed on all continents except Antarctica. Its rapid growth and the ability to grow in difficult conditions with little care made this tree relatively quickly a popular garden plant in the east. Ailanthus, which is grown from seeds for medicinal purposes, is most common in mountainous and foothill regions, and is also found in coastal plains. The Ailanthus tree has the capacity to produce several hundred thousand seeds per year, which are light and winged and can be spread by the wind over long distances. It forms dense, clonal ball-shaped pods that can crowd out trees and shrubs in the area by spreading vigorously. As Ailanthus is not sensitive to poor soils and atmospheric pollution, it manifests its general colonizing role in urban areas (Feret 1985, Mergen 1959) (Pic. 1). Roads ensure relatively rapid migration of this tree species.

Pic.1. Ailanthus in urban area

Pic. 2. Leaf structure of Ailanthus

## Bioecological characteristics of Ailanthus

Biology. Among the biological characteristics of the Ailanthus tree genus, the following can be noted:

• It is a small or medium-sized broad-leaved tree with a height of more than 25 m. In the conditions of Azerbaijan, the height of the Ailanthus is 12-15 m (rarely 20 m.), the diameter reaches 60 cm;

• Leaves are lanceolate (Pic. 2). Each leaf has 1 to 3 teeth on both sides. When the leaves are crushed, they produce an unpleasant smell;

• It had a smooth gray bark that cracked with age (Pic. 3);

• Blooms in July and August. The green-yellow flower has 5 sepals and 5 petals;

• Except for Verticillium wilt, no disease is a major problem;

Ailanthus's root system is mostly spread in the upper layers of the soil. The roots close to the trunk become thicker and ensure the stability of the tree (Pic. 4). Since most roots spread only in the upper 50 cm of the soil, the taproot is often not formed (Miller, 1990).

This feature allows Ailanthusa to be highly drought resistant. It is difficult for this breed to develop and spread in poorly drained soils. This is evidenced by the fact that Ailanthus does not spread in swamps and wetlands (Davies, 1943) (Pic. 4, 5]

Pic. 3. Ailanthus bark structure

Pic.4. Ailanthus root system structure

## Ecology

Ailanthus Altissima is a tree genus that grows up to 3-4.5 m during the year (Pic 4). Once the clone system is established, the young trees develop dense thickets and crowd out the native vegetation. It can dominate the areas colonized by migration for an indefinite period of time. In urban areas, Ailanthus's roots can damage sewer, water and electricity lines and structures.

Distribution in Azerbaijan: Since ancient times, it has been planted everywhere in Absheron, it is also found in Kura-Araz, Samur-Shabran, Lankaran, Alazan-Ayrichay lowlands, Kuratrafi, Nakhchivan, Ismailli and Caspian regions. The main distribution regions are: Baku, Shamakhi, Agsu, Kurdamir, Goychay, Agdash, Ganja, Yevlax, Mingachevir, Barda, Agdam, Salyan, Sabirabad, Beylagan, Nakhchivan.

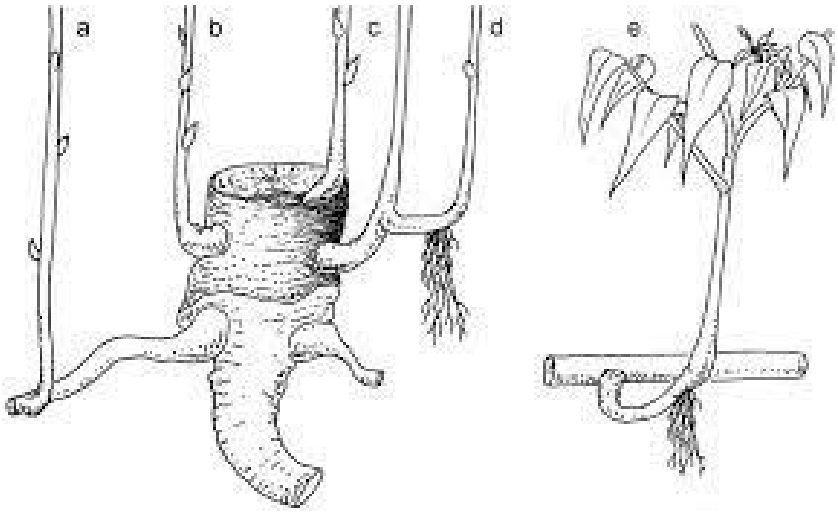
Although Ailanthus is more common in urban areas, it poses an ecological threat because it is invasive in cultivated fields and natural areas.

Ailanthus is a prolific seed producer; and its seeds can be dispersed by wind, water, birds, farm or road equipment. However, most new plants in an area usually originate from root shoots. If the top is opened or the stump is cut, new shoots can form from lateral roots at a distance of 15-27m from the mother tree (Pic. 6-7). Seedlings can establish deep roots within 3 months after germination, which allows the plant to grow quickly and outperform native species in terms of sunlight and space (Pic. 5). Grows in full sun but is also shade tolerant. In addition, this plant secretes an allelopathic chemical that prevents other plants from growing near it.

Reproductive characteristics of Ailanthus. Ailanthus is highly adaptable and can grow in limited or harsh conditions such as saline, nutrient deficient or highly compacted soils. It also thrives in areas affected by heat, drought or pollution. Allelopathic chemicals in the leaves, bark, roots and seeds can inhibit the growth and germination of surrounding plants.

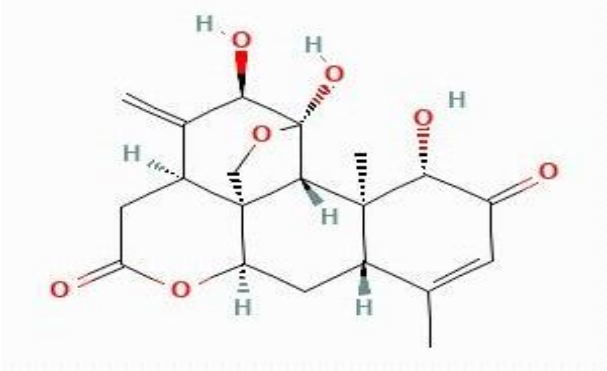
Pic. 5. Root system of Ailanthus

Pic. 6. Clonal propagation of Ailanthus




Pic. 7. Propogation of Ailanthus

Ailanthusın allopatik xüsusiyyətləri. One of the important factors of pollution is the release of compounds that have a negative effect on the surrounding vegetation. These allelopathic effects have been the subject of most experimental studies on Ailanthus. Among the allelopathic toxic substances released by Ailanthus, Ailonthon is considered the strongest. In the area where Ailonthon is, other plants develop slower. Ailonthon, which is released into the soil through the roots, changes the mineral substances in it. As a result, only Ailanthus uses those substances well. The trees around Ailanthus weakly absorb substances from the soil. The greatest damage caused by Ailonthon is to the seeds of foreign plants. Under such toxic conditions, the percentage of seed germination is very low.



**Pic. 8. Chemical structure of Ailanthus**

Phytotoxins in the roots and leaves of Ailanthus do not remain long in warm soil due to degradation by soil microbes. Toxicity decreases with high precipitation and moderate temperatures and increases with low precipitation and high temperatures (Heisey 1997, Lawrence et al. 1991). Studies show that the most poisonous part of Ailanthus is in the bark of its stem. Assumptions are made that this is why most fungal diseases cannot infect Ailanthus.

## Ways to use Ailanthus

Experience of using Ailanthus in Azerbaijan.There are many ways to use Ailanthus. Due to the rapid spread and growth of Ailanthus, its leaves are used as food for silkworms and to obtain bee honey. Honey is prepared quickly, but at the initial stage, the taste is sour. This honey however becomes sweet after being stored for a while. The quality of the silk produced by the silkworm that feeds on the leaves of Ailanthus is not high but since invasive plants such as Ailanthus are eaten, it is considered appropriate to use them in silk production. Ailanthus has a lot of leaves and its cultivation in plantations requires little financial cost.

In India, Ailanthus is used as a firewood material and also in the form of sawn materials. Ailanthus is also widely used in plantation forests in difficult conditions - saline and arid areas. Ailanthus has a strong ability to adapt to the area where he lives. It can grow and develop in almost all difficult conditions. Due to the low demand for water, there is almost no need for human supervision and labor in the cultivation of this plant.

**Pic. 9. Ailanthus bark processing**

**Pic.10. Ailanthus bark processing**

Measures taken against the spread of Ailanthus. Ailanthus has been rapidly increasing in Absheron peninsula Control efforts should be focused primarily on preventing establishment in new areas. Then the seed available for germination should be reduced. Finally, tall trees should be removed or at least controlled. It should pay attention to treatments that stress the root system and cause a decrease in seed production. For example, a treatment regimen can be started in early summer when root stocks are at their lowest and repeated as needed to keep root stocks low. Since Ailanthus is relatively shade intolerant, establishment of desirable competitive trees and shrubs should be encouraged after control efforts. Ailanthusa will require full control, 1 to 5 years of continuous planning and integrated management.

Large female trees should be targeted to help reduce the spread of this plant by seed. Young seedlings can be pulled by hand when the soil is moist. Care should be taken to remove the entire plant as root pieces may regrow. Larger trees may be cut at ground level with power or manual saws. Cutting is most effective when trees have begun to flower (June-early July). A cut or injured tree-of-heaven may send up dozens of root sprouts. At least two cuttings per year may be necessary (one early in the growing season and one late in the growing season) to significantly weaken the plant. Although plants may not be killed after cutting, seed production will be inhibited and vigor will be reduced. Girdling of the tree trunk may also be an effective method to reduce vigor or kill large trees. A cut through the bark, approximately 6” above the ground, and cut completely around the trunk, will kill the top of the tree. However, re-sprouts are common, and may require follow-up treatments for several years. If the cutting process is repeated for many years, plants will be severely stressed and will likely eventually die.

For Ailanthus bushes, apply a solution of 4% glyphosate and 0.5% nonionic surfactant. The most successful chemical control is achieved with a solution of 1.0 oz metsulfuron/3789 L water and 0.5% nonionic surfactant. This solution will clear about 0.4 ha of land. It is advisable to apply a herbicide between summer and early fall when the plant is moving nutrients to the roots. One of the most effective methods is to pierce the stem and then inject a chemical substance into the pierced part (Pic. 10).

Tree-of-heaven tends to be more susceptible to triclopyr than to glyphosate, especially prior to late summer. Where permitted, foliar sprays are effective once the leaves are fully expanded. For larger trees, three approaches are possible: 1) Girdle the tree (see description above), and apply triclopyr in the cut around the trunk; 2) Cut down tree and apply triclopyr into the freshly cut surfaces of the stump; or 3) Cut down tree and spray re-sprouts before they get too tall to correctly spray the top surface.

Pic. 11. Hack and squirt method

Hack-and-squirt method is widespread in the fight against Ailanthus. This process is mainly carried out in summer (Pic. 11). Low angle cuts are made as close to the ground as possible to the tree trunk. A 50 percent triclopyr solution is immediately poured into the cuts so that the bottom of the cuts are covered, but the liquid does not run out. The incisions are placed so that there is approximately 2-5 cm of intact living tissue between them.

## Conclusion

Based on the conducted research, the following can be noted:

Although its homeland is China, this plant is widespread in the west. Ailanthus is known as an invasive plant in the west. Its height is more than 25m, its age is between 50-100. Ailanthus adapts to almost all conditions and is less demanding on soil fertility. It is often found in urban areas.

- In Azerbaijan, Ailanthus is spread from Absheron to Nakhchivan. Although it is found in mountainous areas, it is more widespread in big cities. The height of Ailanthus reaches 12-15 m in Azerbaijan.
- Ailanthus is an invasive plant, so it is necessary to take various control measures against it. Young specimens must be completely removed from the soil. The root must be completely separated from the soil, since the ability of the plant to grow through root growth is strong.
- Ailanthus has a strong adaptability and is less demanding on land, so it is considered more suitable for planting plantations. The fast growth of Ailanthus ensures its use as firewood. Ailanthus can also be used in beekeeping and sericulture.

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# Kənd təsərrüfat itrafı mühitə necə təsir edir?

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**Xülasə**

Qlobal istiləşmə bu gün bütün dünyanı narahat edən problemlərdəndir. Bu problemdən ən çox zərər görən sahə kənd təsərrefatı sahəsidir. Orta temperatur, yağıntı və ya karbon qazı və ozonun dəyişməsi kənd təsərrüfatına nəzərəçarpacaq dərəcədə təsir göstərir. Mənfi təsirlərə misal olaraq kənd təsərrüfatı zərərvericilərinin çeşidinin genişlənməsi, bəzi ərazilərdə quraqlığın mümkün intensivləşməsi və dəniz səviyyəsinin qalxması ilə torpağın şoranlaşması ola bilər. Müsbət təsirlərə misal olaraq vegetasiya dövrünün uzadılması və bununla əlaqədar risksiz kənd təsərrüfatı zonasının genişlənməsi, bəzi ərazilərdə yağıntıların artımı və atmosferdə karbon qazının səviyyəsinin artması ilə əlaqədar məhsuldarlığın artması daxildir. Kənd təsərrüfatı karbon dioksid səviyyəsini əhəmiyyətli dərəcədə artırır və onu onilliklər ərzində karbon qazı emissiyalarının əsas mənbələrindən birinə çevirir. Təsərrüfatlardan çıxan heyvan tullantılarında Cryptosporidium parvum və Giardia duodenalis kimi zərərli patogenlər var ki, onların hər ikisi xəstəlik və infeksiyaya səbəb olurlar, torpağa və su sistemlərinə daxil olduqda ziyan vurur və insanların sağlamlığına təhlükə yaradırlar. Bu problemlər həm bilavasitə, həm də birbaşa olaraq sağlamlıq risklərinə səbəb olur. Gübrələr də bir sıra fəsadlar yaradır. Onların tərkibində azot və fosfatlar kimi zərərli elementlər var ki, hər ikisi hava və suyun keyfiyyətinə mənfi təsir göstərir. Onun istifadəsi ammonyakın sərbəst buraxılmasına, azotun axmasına və evtrofikasiyaya səbəb olur ki, bunların hamısı ətraf mühitə mənfi təsir göstərir.

**Açar sözlər:** iqlim dəyişkənliyi, kənd təsərrüfatı, ətraf mühit, torpaq, pestisidlər, istixana qazları.

Kənd təsərrüfatının çirklənməsinin nə olduğunu, səbəblərini, növlərini, qarşısının alınması üsullarını və təsirlərini ətraflı şəkildə anlayaq. Əhalinin artması ilə mütənasib olaraq qidaya tələbat artdıqdan sonra kənd təsərrüfatı üsulları ilə çirklənmə gündəmə gəlmişdir. Fermerlər təsərrüfatların və tarlaların məhsuldarlığını artırmaq üçün əlavə kimyəvi gübrələrə, pestisidlərə, alaq dərmanlarına, heyvanlar üçün hormonal müalicələrə, qida maddələri ilə zəngin yemlərə və ənənəvi olaraq əkinçilik üsulunu dəyişdirən bir çox bu kimi təcrübələrə əsaslandılar.

Kənd təsərrüfatının çirklənməsi təbii və kimyəvi məhsulların əkinçilik üçün istifadəsi nəticəsində ətraf mühitin və əlaqədar ətrafın çirklənməsidir. Kənd təsərrüfatında ətraf mühitin çirklənməsinə səbəb olan iki mühüm amil-əhalinin sürətli artımı və istehlak balansının pozulmasıdır. Bu iki problem kənd təsərrüfatının üzərinə istehsalın artırılması vəzifəsini qoyur. Bu, əkilmiş bitkilərin və qidalanan heyvanların təbii istehsal qabiliyyətləri gərginləşdikdə və daha çox məhsul verdikdə baş verir. Buna nail olmaq üçün bitkiçilik və heyvandarlıq yolu ilə yüksək istehsal gücünə malik canlılar seçilir. Bu vəziyyətdə ətraf mühiti çirkləndirə biləcək gübrələmə, balanssız qidalanma kimi bəzi əkinçilik üsullarının tətbiqi zəruri hesab olunur. Hazırda dünyada torpaqların yalnız 40%-i kənd təsərrüfatı torpaqları kimi istifadə olunur (ABŞvə Avropa ölkələri). Tətbiq olunan sistemlərlə otlaqlar və meşələr məhv olur, hər il 1 milyon hektara yaxın kənd təsərrüfatı sahəsi torpaqlardan düzgün və məqsədsiz istifadə nəticəsində itirilir.

Kənd təsərrüfatı təcrübəsi yüz illərdir mövcuddur və dünyanın əksər ölkələri üçün əsas həyat tərzinə çevrilmişdir. Araşdırmalar nəticəsində məlum oldu ki, illər ərzində kənd təsərrüfatının inkişafı, sahələrdə aparılan tədqiqatlar və yeni texnologiyalardan istifadə ətraf mühitin çirklənməsində rol oynayır. 1920-ci illərə qədər kənd təsərrüfatı karbon qazı ilə ətraf mühitin çirklənməsinin əsas səbəbi olmuşdur. Mövcud kənd təsərrüfatı təcrübələri cəmiyyət üçün vacib olsa da, həm yerli, həm də qlobal miqyasda ətraf mühitimizə zərərli təsirlərə səbəb olur. Kənd təsərrüfatı istixana qazlarının səviyyəsinin havada da artmasında rol oynayır. Bu çirklənmə əslində becərilməsi zamanı qidadan asılı olan bütün canlı orqanizmlər üçün zərərlidir. Əkinçilik və kommersiya qidası, istər kartof və qarğıdalı kimi bitkilər, istərsə də heyvanlar olsun, hamısı ətraf mühitə zərər verir. Əhalinin sayı artdıqca, yaşaması üçün daha çox əlavə resurslara ehtiyac duyuldu.

Bu sahə dünyada ən geniş yayılmış sahələrdən biridir. Demək olar ki, hər bir ölkədə təmsil olunur və inkişaf edir. Torpaq kənd təsərrüfatının əsas

istehsal vasitəsidir. Bu həqiqəti nəzərə alsaq, insanların ehtiyacları artarkən, onların ehtiyatlarını düşünmədən israf etmələri təəccüblüdür. Dünya əhalisi durmadan artdığı üçün daha çox qida tələb olunur və bu da əkin sahələrinin çoxalmasına gətirib çıxarır. Əgər əvvəllər ətraf mühitin çirklənməsinin əsas səbəblərinin fabriklər, nəqliyyat vasitələrinin tullantıları, elektrik enerjisi istehsalı və s. olduğu hesab edilirdisə, indi bütün bu amillərlə yanaşı, kənd təsərrüfatı da gündəmə gəlmişdir. Bu sahədə insan fəaliyyətinin təbiətə xeyli ziyan vurması 40 ildən çox əvvəl baş vermişdir. 1980-ci ildən bəri BMT kənd təsərrüfatının vurduğu ziyanı ən təhlükəli dördlükdən biri kimi müəyyənləşdirib. Havanın çirklənməsi ilə əlaqəli əsas kənd təsərrüfatı çirkləndiriciləri CO2, metan (CH4) və azot oksididir (N2O). Bu çirkləndiricilərin hər biri kənd təsərrüfatında müxtəlif proseslər nəticəsində yaranır. CO2 ilk növbədə iki kənd təsərrüfatı: torpaqdan istifadənin dəyişdirilməsi və becərilməsi üsullarından yaranır. Kənd təsərrüfatı sahələrinin genişləndirilməsi nəticəsində meşələrin məhv olması da karbon qazının artmasında mühüm rol oynayır. Bu qazın yayılması kənd təsərrüfatı sahələrinin yandırılması zamanı da baş verir.

Zərərverici, xəstəlik və alaq otlarına qarşı əkin sahələrinə kimyəvi preparatlar tətbiq edilir. Tətbiq olunan kimyəvi maddələr torpaq örtüyündən və bitkilərdən yuyulan zaman su hövzələrində toplanır. Catherina Lindell və başqaları apardıqları təcrübələr və müşahidələrlə təsdiq edirlər ki, kənd təsərrüfatı və digər mədəni, yabanı bitkilərin çiçəklənməsi dövrü pestisidlərin tətbiqi həmin bitkilərin tozlanmasında iştirak edən arıların kütləvi məhv olmasına səbəb olur. Amerika Birləşmiş Ştatlarının Balıq Təsərrüfatının və vəhşi təbiət xidmətinin məlumatlarına əsasən pestisidlərin tətbiqi ilə əlaqədar hər il Amerikada 72 milyon quş ölür. Pestisidlərin tətbiqi,davamlı üzvi çirkləndiricilər ekoloji mühit üçün ciddi problemlər yaradır, belə maddələr uzun müddət deqrodasiyaya uğramırlar, su mənbələrində, torpaqda saxlanılaraq torpağın profilinə doğru miqrasiya edirlər. Buna misal olaraq olaraq DDT, alderin, tedion, dilor, mezoks və s. misal göstərmək olar.

1961-2018-ci illər arasında əkin sahəsinə hər hektara azot gübrəsinin istehlakı təxminən doqquz dəfə artmışdır (FAO 2018). Bu inkişafın mənfi tərəfi intensiv əkinçilik təcrübələrinin torpağın deqradasiyası, suyun çirklənməsi və biomüxtəlifliyin itməsi kimi ciddi ekoloji problemlərə səbəb olmasıdır.

Kənd təsərrüfatında məhsuldarlığın artırılmasında kimyəvi gübrələrdən də istifadə olunur, lakin çox vaxt həddindən artıq tətbiq olunur. Azot və fosfor gübrələri axar su ilə torpaqdan yuyula və aşağı axına çökə bilər. Su hövzələrində toplanmış azot və fosfor gübrələri yosunların çoxalmasına səbəb olur. Nəticədə suyun oksigeni tükənir, balıqlar və sudakı digər canlı orqanizmlərin məhvinə səbəb olur. Onu da qeyd edək ki, yosun çiçəkləri insanlar üçün zəhərli olan maddələr buraxa bilirlər. Qeyd etdiyimiz maddələr ( pestisidlər, gübrələr) qısamüddətli dövr üçün yüksək məhsul istehsalını təmin etsə də, torpağın münbitliyini azaldır, torpağı keyfiyyətini pisləşdirir, biomüxtəlifliyin itirilməsinə səbəb olur və su obyektlərini çirkləndirir [1].

Kənd təsərrüfatının ətraf mühitə bir sıra mənfi təsirləri arasında sənaye və kənd təsərrüfatı tullantıları ekosistem və insanlar üçün ən təhlükəli hesab olunur. Bitki qalıqları, heyvan atqıları, quş peyini və s kənd təsərrüfatı tullantıları hesab edilir. Bu tullantıların yandırırlaraq məhv edilməsi havada yüksək CO2 səviyyələrinin istehsalı ilə nəticələnən, insanlarda və heyvanlarda ciddi tənəffüs problemlərinə səbəb olur. Küləşin yandırılması ilə torpağın səthindəki mikroorqanizmlər məhv olur, torpağın yuxarı hissəsinin bioloji keyfiyyəti pisləşir, rütubəti qorunub saxlanıla bilmir, kənd təsərrüfatının biomüxtəlifliyi korlanır, torpaqda üzvi karbon və azot itkisinə səbəb olur. Bundan əlavə, küləş yanğınları havanın çirklənməsinə və meşə yanğınlarına da gətirib çıxarır.[2] Gübrə sənayesi də havanı və suyu çirkləndirir, bu da ölkənin ekoloji sisteminə mənfi təsir göstərir. Bu parçalanmayan tullantılar bitki və heyvanlarda, xüsusilə suda yaşayan canlılarda toksiklik yaradır, həmçinin torpağın qida maddələrinin balansını pozur.

Bir çox ölkələrdə kənd təsərrüfatı çirklənmənin əsas mənbəyi hesab olunur. Pestisidlər, gübrələr və digər zəhərli təsərrüfat kimyəvi maddələri şirin suyu, dəniz ekosistemlərini, havanı və torpağı zəhərləyir. Onlar həmçinin nəsillər boyu ətraf mühitdə qala bilirlər. Məhsuldarlığı artırmaq üçün bütün dünyada kimyəvi gübrələrdən intensiv istifadə olunur. Bununla belə, onlar öz zərərli təsirlərini torpağa və ətraf mühitə yerləşdirməyə başlayırlar ki, bu da torpağın keyfiyyətinin aşağı düşməsinə və ətraf mühitin deqradasiyasına səbəb olur (Rodriguez et al., 2004). Bu gün kənd təsərrüfatı resurslarının idarə edilməsində ekoloji problemlər artmaqdadır. Kənd təsərrüfatının ətraf mühitə mənfi təsiri daima gündəmdə olan problemlərdən biridir və hətta ekspertlər eko-səmərəliliyi artırmaq üçün innovativ vasitələr hazırlasalar da, bu günə qədər problem öz həllini tapmamışdır.[3] Son zamanlar mal-qara tullantılarının ətraf mühiti çirkləndirməsi ilə bağlı narahatlıqlar davam edir.[4] Qlobal istiləşmə çox vaxt istixana qazları emissiyaları, eləcə də kənd təsərrüfatına aid olmayan torpaqların becərilməsi,

məsələn, kənd təsərrüfatı torpaqları üçün meşələrin təmizlənməsi ilə əlaqədardır. Yer kürəsində metan və azot oksidinin artmasının əsas səbəbi kənd təsərrüfatıdır. Alimlər hesab edirlər ki, istixana qazları planetdə qlobal istiləşmə və iqlim dəyişikliyinin səbəbidir. Onların bir çoxu təbiətdə olur, lakin insan təsiri onların atmosferdə konsentrasiyasının artmasına səbəb olur. Karbon qazı Yerin istiləşməsinə ən böyük töhfə verir - onun atmosferdəki konsentrasiyası 2020-ci ilə qədər sənayedən əvvəlki səviyyədən demək olar ki, yarıya qədər artmışdır. Bunun səbəbi insanlar tərəfindən meşələrin qırılması, flüorlu qazların və azot tərkibli gübrələrin istifadəsi və s-dir. Heyvandarlığın inkişafı da istixana qazlarının artmasına səbəb olur, heyvanlar qidanı həzm edərkən çoxlu miqdarda metan istehsal edirlər. Kənd təsərrüfatının ətraf mühitə təsiri müxtəlif amillərə təsirləri əhatə edir: torpaq, su, hava, heyvan və torpaq müxtəlifliyi, insanlar, bitkilər və qidanın özünə. Kənd təsərrüfatı ətraf mühitin deqradasiyasına səbəb olan bir sıra daha böyük ekoloji problemlərə öz töhfəsini verir: iqlim dəyişikliyi, meşələrin qırılması, biomüxtəlifliyin itirilməsi,[5] ölü zonalar, gen mühəndisliyi, suvarma problemləri, çirkləndiricilər, torpağın deqradasiyası və tullantılar.[6]

Torpaqdan yuyulmuş kimyəvi elementləri doldurmaq üçün hər il sahələrə mineral gübrələr verilir. Gübrələr bitkilərdə metabolik prosesləri tənzimləyir, zülalların, yağların, karbohidratların və vitaminlərin yığılmasına kömək edir. Tətbiq olunan kiçik dozada gübrələr məhsuldarlığını artırmağa kömək edir. Ancaq çox vaxt gübrələrin tətbiqi qaydaları pozur. Gübrələrin yüksək dozalarda sistemli şəkildə verilməsi, düzgün saxlanılmaması, daşınma zamanı itkilər ətraf mühitin, xüsusilə su hövzələrinin çirklənməsinə səbəb olur və nəticədə insan sağlamlığına təsir göstərir. Pestisidlərin gözlənilməz nəticələri müasir sənaye kənd təsərrüfatının ətraf mühitə mənfi təsirinin əsas amillərindən biridir. Bu preparatlar zərərli orqanizmləri məhv etmək üçün nəzərdə tutulmuş zəhərli kimyəvi maddələr olduğundan, bitkilər, heyvanlar və insanlar kimi hədəf olmayan canlılara da təsir göstərə bilər. İstifadə olunan insektisidlərin 98%-dən çoxu və herbisidlərin 95%-i hədəf növlərindən başqa bütün ətraf mühitə yayılır.[7] Pestisidlərin tətbiqi onları uzaq su mühitlərinə və ya digər sahələrə, otlaq sahələrinə, insan məskənlərinə və inkişaf etməmiş ərazilərə qədər daşıya bilir. Digər problemlər istehsal, nəqliyyat, saxlama və utilizasiyanın keyfiyyətsiz olması ilə əlaqədardır.[8] İnteqrasiya edilmiş zərərvericilərlə mübarizə kimi pestisidlərin ağır istifadəsinə alternativlər və polikultura kimi davamlı kənd təsərrüfatı texnikaları zərərli zəhərli kimyəvi tətbiq etmədən bu nəticələri azaldır. Ətraf mühitin modelləşdirilməsi göstərir ki, qlobal əkinçilik ərazilərinin 60%-dən çoxu “birdən çox aktiv maddə ilə pestisidlərlə çirklənmə riski altındadır” və 30%-dən çoxu “yüksək risk” altındadır, bunun üçdə biri yüksək biomüxtəlifliyə malikdir. Bu cür arzuolunmaz təsirlər bir çox pestisidlərin qadağan edilməsinə gətirib çıxardı, qaydalar isə digərlərinin istifadəsini məhdudlaşdırdı .

Heyvandarlığın təsiri altında geniş ərazilərdə təbii bitki örtüyünün məhv edilməsi və otlaqların həddən artıq yüklənməsi nəticəsində səhralaşma da baş verir. Otlaqlarda təbii bitki örtüyünün deqradasiyası, nəqliyyat yollarında və s. bitki örtüyünün və torpaq eroziyasının məhv edilməsi, kəsim məntəqələrinin və emal müəssisələrinin yaxınlığında, mal-qaranın saxlanması zamanı səth sularının heyvandarlıq tullantıları ilə çirklənir. Kənd təsərrüfatı sənayesində müxtəlif meliorativ sistemlərdən və torpaq drenajlarından istifadə edildiyi üçün yaxınlıqdakı bütün su obyektlərinin rejimi pozulur. Bir çox canlı orqanizmlərin yaşayış yerləri də məhv olur və bütövlükdə ekosistem dəyişir. Beləliklə, kənd təsərrüfatı ətraf mühitə əhəmiyyətli dəyişikliklər gətirir. Bu, bitki örtüyünün növ müxtəlifliyindən tutmuş təbiətdəki su dövrünə qədər ekosistemlərin bütün komponentlərinə aiddir, ona görə də bütün resurslardan səmərəli istifadə etmək və ətraf mühitin mühafizəsi tədbirlərini həyata keçirmək lazımdır.

Heyvandarlıq və quşçuluq peyin, zibil, istixana qazları və digər tullantılarla ətraf mühiti getdikcə daha çox çirkləndirir. Bu çirkləndiricilər torpağın münbitliyini və məhsuldarlığını azaldır, suyun və havanın keyfiyyətini pisləşdirir. Heyvandarlığın ətraf mühitə təsiri bütün dünyada tətbiq olunan kənd təsərrüfatı təcrübələrinin geniş çeşidinə görə dəyişir. Buna baxmayaraq, bütün kənd təsərrüfatı təcrübələrinin müəyyən dərəcədə ətraf mühitə müxtəlif təsirləri olduğu aşkar edilmişdir. Heyvandarlıq, xüsusilə də ət istehsalı çirklənməyə, istixana qazları emissiyasına, biomüxtəlifliyin itməsinə, xəstəliklərə və torpaq, qida və suyun əhəmiyyətli istehlakına səbəb ola bilər. Ət müxtəlif üsullarla, o cümlədən üzvi əkinçilik, intensiv heyvandarlıq istehsalı və təbii kənd təsərrüfatı ilə əldə edilir. Heyvandarlıq sahəsinə həmçinin yun, yumurta və süd istehsalı, əkin üçün istifadə olunan heyvandarlıq və balıqçılıq daxildir. Kənd təsərrüfatının bu sahəsi istixana qazı emissiyalarına əhəmiyyətli töhfə verir. İnəklər, qoyunlar və digər gevişən heyvanlar qidalarını bağırsaq fermentasiyası yolu ilə həzm edirlər və bu heyvanlar torpaqdan istifadənin dəyişməsi və meşə təsərrüfatı nəticəsində metan emissiyalarının əsas mənbəyidir. Ət istehlakının əhəmiyyətli dərəcədə azaldılması iqlim dəyişikliyini yumşaltmaq üçün

vacibdir.[9] Çoxsaylı tədqiqatlar göstərmişdir ki, ət istehlakındakı artımlar hazırda əhalinin artımı və ÜDM-in artması ilə əlaqələndirilir və buna görə də, cari davranışlar dəyişməyincə ət istehsalı və istehlakının ətraf mühitə təsiri artacaq.[10

Quşçuluq və heyvandarlıq müəssisələri tərəfindən ətraf mühitin çirklənməsi ən çox istifadə olunan texnologiya və texniki vasitələrin mükəmməl olmaması, müəyyən edilmiş ekoloji tələblərə əməl edilməməsi nəticəsində baş verir. Təbiətə mənfi təsirləri azaltmağın ən asan yolu texnoloji avadanlıqların müasirləşdirilməsi, təsərrüfat fəaliyyətinin təşkilində müasir ekoloji standartlara uyğun dəyişikliklərin tətbiq edilməsidir. İnsan fəaliyyəti nəticəsində ətrafda çoxlu miqdarda tullantı qalır ki, onların da əksəriyyəti təkrar emal üçün yararlı olan qiymətli xammaldır. Kənd təsərrüfatı tullantılarının təkrar emalı istehsalçılara böyük fayda verə bilər. Kənd təsərrüfatı tullantıları kənd təsərrüfatı xammalının istehsalı və ilkin emalı zamanı əmələ gələn əlavə məhsullardır. Müəssisələr onlardan təyinatı üzrə istifadə edə bilmirlər. Üzvi tullantıların, qaz və toz emissiyalarının həcmini, su sərfini və tullantı sularının axıdılmasını azaltmaqla ətraf mühitə mənfi təsirləri azaltmaq mümkündür. Kənd təsərrüfatı tullantıları təbii mühitə ciddi təsir göstərir, bu tullantılar bitki mənşəli kənd təsərrüfatı tullantıları və heyvandarlıq tullantılarına bölünür. Kənd təsərrüfatının bitki tullantıları məhsul yığıldıqdan və sənaye emalından sonra, kənd təsərrüfatı məhsulunun lazımi hissəsinin çıxarılmasından sonra qalan bitki örtüyünün qalıqlarıdır. Heyvandarlığın kənd təsərrüfatı tullantıları üzvi mənşəli tullantılardır, əsasən mal-qaranın, donuzların və toyuq tullantılarının peyin və peyin axınıdır.

Heyvandarlığın təbiətə təsirinin daha qabarıq olduğu sahələri nəzərdən keçirək. Yer üzündə inəklərin sayı ildən-ilə artır, bəşəriyyətin qidaya olan tələbatı da çoxalır. Ət sənayesinin bir neçə lideri taxıl bitkilərinin yetişdirilməsinin dünya əhalisi üçün açdığı imkanları etiraf etməyə hazırdır. Eyni zamanda, kənd təsərrüfatı sənayesinə qoyulan xərc, ilk növbədə gəlirli bir iş olan ət istehsalından daha çox sayda insanın ərzaq ehtiyaclarını ödəməyə imkan verir. Bununla yanaşı, hər bir inəyin istehsal etdiyi metanın miqdarı ötən əsrdə bir dəfə artmışdır. Bunun səbəbi inəklərin qida rasionunda süni məhsulların payının artması və oturaq həyat tərzidir.

İnsanların otlaq üçün istifadə etdiyi torpaqların miqdarı orta hesabla 1/3, bəzi bölgələrdə isə mövcud torpaqların ümumi sahəsinin hətta 1/2-ni təşkil edir. Bu vaxt, çox sayda heyvanın olması torpağın vəziyyətinə yaxşı təsir göstərmir: torpağın deqradasiyası baş verir, bu, torpağın sıxılması və eroziyası ilə ifadə edilir, fermada mal-qara saxlamaq və yem yetişdirmək üçün istifadə olunan kimyəvi maddələrlə çirklənir. Yem bitkilərinin becərilməsi üçün zəruri olan otlaqların və sahələrin genişləndirilməsi çox vaxt yaxınlıqdakı meşələrin məhv olmasına səbəb olur. Tullantılar - daha dəqiq desək, onların utilizasiyası - istənilən ölkədə kənd təsərrüfatı üçün böyük problem yaradır. ABŞ Hökumətinin Hesabatlılıq İdarəsinin 1999-cu il statistikasına görə, heyvandarlıq müəssisələri tərəfindən istehsal olunan tullantıların miqdarı ölkənin bütün sakinlərinin məişət tullantılarının ümumi həcmindən 130 dəfə çoxdur. Çaylara və göllərə atılan tonlarla heyvan tullantıları onları peyin çuxurlarına çevirir, yaxınlıqdakı torpaqları və atmosferi zəhərləyir. Tullantıların tərkibində metan, ammonyak, hidrogen sulfid, karbonmonoksit və ağır metallar kimi təhlükəli maddələr var.

Kənd təsərrüfatı torpaqlarının çox hissəsi əsasən otlaq kimi istifadə olunur. ABŞ-ın qərbində bu məqsədlə yüz milyonlarla hektar ərazi ayrılıb - bu, digər ölkələrlə nisbətdə daha çoxdur. Mal-qaranın otarılması kənd təsərrüfatının ətraf mühitə əsas mənfi təsirlərindən biridir. Bundan əlavə, həddindən artıq otlaq da davamlı ətraf mühit üçün ciddi problemdir. Həmçinin hesab edilir ki, mal-qara və digər heyvanlar tərəfindən torpağı tapdalamaq torpağın üst qatını məhv edir və onu su və külək eroziyasına məruz qoyur.

Tədqiqatlar sübut etmişdir ki, kənd təsərrüfatı torpaqlarının suvarılması yağışların nəinki suvarılan ərazilərdə, hətta minlərlə kilometr uzaqda paylanmasına təsir göstərə bilər. Kənd təsərrüfatı dünya üzrə ümumi şirin suyun 70%-ni təşkil edir. Ekspertlərin proqnozlarına görə, artan əhalini qidalandırmaq üçün 2050-ci ilə qədər suya olan ehtiyac daha 15% və ya daha çox artacaq. Digər tərəfdən, sulu təbəqələrin, çayların və yeraltı su anbarlarının tükənməsi əlavə olaraq qlobal su itkilərinə səbəb olur. Bir çox kənd təsərrüfatı mütəxəssisləri hesab edirlər ki, suvarma kənd təsərrüfatının ətraf mühitə bir çox mənfi təsirlərinin əsasını təşkil edir. Suyun tükənməsindən başqa bir sıra digər mənfi təsirlər də suvarma ilə əlaqədardır, məsələn, duzluluq, bataqlıq, anaerob parçalanmanın artması, bitki köklərinin zəhərlənməsi və bitki məhsuldarlığının azalması. Həddindən artıq suvarma həm atmosfer istiliyinə, həm də təzyiqə təsir edən buxarlanmanın artmasına səbəb olur. Yeni Zelandiyada 1970-ci illərdən bəri iki dəfə artmışdır. hər 12 ildən bir ümumi suvarılan kənd təsərrüfatı torpaqları

Kənd təsərrüfatı ətraf mühiti ən çox çirkləndirən sahədir. Bu gün dünyada təxminən 60 müxtəlif növ bioqaz texnologiyası istehsal olunur və istehlak olunur. Bioqazı anaerob fermentasiya yolu ilə emal etdikdən sonra tərkibində çoxlu miqdarda üzvi maddə olan qalıq alınır. Sonra gübrə kimi istifadə olunur. Xüsusilə aqrar-sənaye müəssisələrində

bioqazın istehsalı səmərəli və iqtisadi cəhətdən əsaslandırılmışdır. Bu texnologiyaya heyvandarlıq və bitki tullantılarının emalı üçün üstünlük verilir. Prosesin təşkili və idarə olunması böyük xərc tələb etmir, emal üçün xammal isə pulsuzdur.

Kənd təsərrüfatı sənayesində çalışan hər kəs sənayedə yaranan tullantıların düzgün şəkildə utilizasiyası ilə tanış olmalıdır. Hər bir ölkədə təsərrüfatlar, kəsimxanalar və digər kənd təsərrüfatı əməliyyatları nəticəsində yaranan tullantıların utilizasiyası ilə bağlı ciddi qaydalar mövcuddur. Bununla belə, başa düşmək lazımdır ki, bu, sadəcə olaraq, qanunun hərfinə əməl etmək məsələsi deyil. Düzgün olmayan utilizasiya təkcə ətraf mühitə deyil, həm də biznesə də zərər verə bilər. Digər tərəfdən, düzgün təlimatlara əməl edilsə, yalnız zərərdən qaçmaq deyil, həm də müəyyən faydalar əldə etmək mümkündür. Müasir kənd təsərrüfatı tullantılarının utilizasiya üsulları heyvanların əlavə məhsullarını təkrar emal etmək və xəstəliyin yayılmasının qarşısını almaq üçün istifadə edilə bilər.

Kənd təsərrüfatı tullantılarının böyük hissəsi mal-qaranın yemi üçün və ya qiymətli kimyəvi maddələrin, qida və yem əlavələrinin, vitaminlərin, antibiotiklərin və digər bioloji aktiv dərmanların alınması üçün sonrakı emal üçün istifadə olunan qiymətli xammaldır. Kənd təsərrüfatı istehsalı ildə 250 milyon ton tullantı istehsal edir ki, bunun da 150 milyon tonu heyvandarlıq və quşçuluqdan, 100 milyon tonu bitkiçilikdən əldə edilir.

Kənd təsərrüfatında ətraf mühitin mühafizəsi probleminin aktuallığı müasir şəraitdə kənd təsərrüfatı istehsalında istifadə olunan təbii ehtiyatların sənaye, tikinti və digər qeyri-kənd təsərrüfatı müəssisələri tərəfindən çirkləndirilməsi prosesləri ilə əlaqədar olaraq artır. Bu çirkləndiricilər torpağın münbitliyinin və məhsuldarlığının azalmasına, suyun və atmosferin keyfiyyətinin pisləşməsinə gətirib çıxarır, bitkiçilik və heyvandarlığa ziyan vurur, bu da kənd təsərrüfatı məhsullarının qıtlığına və keyfiyyətinin pisləşməsinə səbəb olur. Kənd təsərrüfatının çirklənməsi təbii və kimyəvi məhsulların əkinçilik üçün istifadəsi nəticəsində ətraf mühitin çirklənməsidir. Bu çirklənmə əslində becərilməsi zamanı qidadan asılı olan bütün canlı orqanizmlər üçün zərərlidir.

Tələbin artması təklifin artması deməkdir, lakin kənd təsərrüfatı istehsalının artması suda və havada geniş şəkildə kənd təsərrüfatı çirklənməsinə səbəb olur və nəticədə hər dəqiqə daha çox ehtiyac duyan əhaliyə zərər verir. Kənd təsərrüfatının çirklənməsinin əsas səbəbləri fermerlərin də qeyd etdiyi kimi məhsuldarlığı aşağı salan zərərli orqanizmlərə qarşı, həmçinin daha bol məhsul əldə etmək məqsədi ilə məhsullarının böyüməsi üçün istifadə etdikləri pestisidlər və gübrələrdir. Onu da qeyd edək ki, pestisidlərdə olan kimyəvi maddələr təbiətdə yoxdur, hətta məhsullardan yuyulduqdan sonra belə təbiətdən tamamilə yox olmur, qalan kimyəvi maddələr suya sızaraq yeraltı su sistemlərinə daxil olur və hətta su hövzələrinə axıb axınların çirklənməsinə səbəb olur.

## Nəticə

Ekoloji problemlər bu gün ən vacib və qlobal problemlərdən biridir. Belə nəticəyə gəlmək olar ki, kənd təsərrüfatının hər bir sahəsi ətraf mühitə fərqli təsir göstərir. Fəaliyyətinin mənfi nəticələrini nəzərə alaraq, bütün növ kənd təsərrüfatı məhsullarının saflığını təmin etmək üçün meşə-çəmən-otlaq balansının yaradılması, torpağın sağlamlığının yaxşılaşdırılması, biogeokimyəvi dövrlərin bərpası, aqroekosistemlərin dayanıqlığının artırılması istiqamətində işlər aparılmalıdır.

Ən səmərəli üsullardan biri kimyəvi maddələrdən imtina edərək təbii gübrələrdən istifadə hesab olunur. Bu, kimyəvi tərkiblərin istifadəsi ilə müqayisədə məhsulun miqdarına mənfi təsir göstərsə də, istehsal itki verməyəcək. Pestisidlərin istifadəsindən yayınan zərərvericilərlə mübarizə üçün yeni üsullardan da istifadə olunması ətraf mühitin çirklənməsinin qarşısını müəyyən qədər almış olur. Belə üsullardan biri də parazitləri və həşəratları dəf etmək üçün ultrasəsdən istifadə etməkdir.

Tullantıların idarə edilməsi sisteminin dəyişdirilməsi - heyvandarlıq təsərrüfatlarının tullantı sularının süzülməsi və dezinfeksiya edilməsi, torpaqların təmizlənməsi, meşələrin təbii filtr kimi qorunması müsbət təsir göstərə bilər. Ətraf mühiti zərərli maddələrlə zəhərlənmədən qorumağın yeganə yolu kimyəvi maddələrin istifadəsini azaltmaq və onları təhlükəsiz analoqlarla əvəz etməkdir. Zibildən bioyanacaq, qida əlavələri, gübrələr (və bir çox başqa faydalı maddələr) əldə etmək üçün kənd təsərrüfatı istehsalçıları müasir biotexnologiyalardan istifadəyə üstünlük verilməlidir.

Torpağın və suyun vəziyyətini yaxşılaşdırmaq üçün bir sıra tədbirlərdən istifadə edilə bilər, bunlara daxildir: dəqiq əkinçilik, üzvi əkinçilik, kənd təsərrüfatının kimyəviləşdirilməsi, əkin dövriyyəsinə uyğunluq, əkin sahələrinin azalması, suvarma sahələri üçün avadanlıq, çay məcralarının təmizlənməsi və dərinləşdirilməsi.

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## Abstract

# How does agriculture affect the environment?

Global warming is one of the problems that concern the whole world today. The area most affected by this problem is agriculture. Changes in average temperature, precipitation, or carbon dioxide and ozone have significant effects on agriculture. Examples of negative impacts include the expansion of the range of agricultural pests, possible intensification of drought in some areas, and soil salinization due to sea level rise. Examples of positive effects include the extension of the growing season and the associated expansion of the risk-free agricultural zone, increased precipitation in some areas, and increased productivity due to increased levels of carbon dioxide in the atmosphere. Agriculture significantly increases carbon dioxide levels, making it one of the main sources of carbon dioxide emissions for decades. Animal waste from farms contains harmful pathogens such as Cryptosporidium parvum and Giardia duodenalis, both of which cause disease and infection, damage soil and water systems, and pose a threat to human health. These problems cause health risks both directly and indirectly. Fertilizers also cause a number of complications. They contain harmful elements such as nitrogen and phosphates, both of which adversely affect air and water quality. Its use causes ammonia release, nitrogen leaching, and eutrophication, all of which have a negative impact on the environment.

**Keywords**: climate change, agriculture, environment, soil, pesticides, greenhouse gases

# Detonation approach to ecological recycling of used lubricant

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## Abstract
Waste lubricants are one of the hazardous chemical compounds polluting the environment. Their volumes are increasing annually all over the world due to the increasing use of the oil and transport industries in everyday life. The article provides an overview of the problem of waste lubricants disposal, describes the main existing technologies for the disposal and recycling of waste oils. A new method for converting organic waste using detonation technologies is presented in detail, including creating conditions for the transition of combustion of a mixture of oxidizer and fuel to an explosion in a metal pipe with a combustion chamber; creating a shock wave propagating along the pipe at a speed of about 2 km / sec; obtaining ultra-superheated water vapor with a temperature of over 2000 degrees 0C, which is then capable of instantly (less than one second) gasifying the above materials and converting most of them into synthetic combustible gas (CO + H2). This work also highlights the features of this innovation and the prospects for implementing the installation in Azerbaijan. The possibilities of creating a mobile mini-plant for processing not only lubricants, but also any organic waste, regardless of their phase state, were analyzed.

**Keywords**: used lubricants; detonation waste converter; shock wave; burning; environmental pollution; synthesis gas.

## Introduction
The history of human development shows that most of our lives are covered by inventions, installations, power equipment complexes with internal combustion engines with various mechanisms of action and use, in which lubricants are used. This process will only continue to grow irreversibly and has long covered almost all industries, including mining, energy and transport.

Motor oils are divided mainly into synthetic and mineral types. The most toxic of them is synthetic oil, this is due to the presence of esters and their polyhydric alcohols, carboxylic acids, as well as silicone, sulfur-containing and chlorine-containing additives, fluorine compounds [1, 2].

In the process of production and operation of lubricants, problems of pollution of the natural environment (soil, water resources and the atmosphere) arise. Accumulating in the environment, they can appear in food products. The main causes of these pollutions are illegal discharges of used motor oils, their losses due to improper collection, storage, disposal, emergency incidents during operation of vehicles - this applies not only to motor wheeled vehicles, but also to watercraft, aircraft, and rail transport. According to early reports from environmentalists, used lubricants account for about 50% of total oil pollution [3]. Used oil is classified as hazardous waste of the second or third class (highly hazardous or moderately hazardous), and is controlled in accordance with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

Environmentally friendly disposal of used motor oils is a complex, technologically expensive process that requires finding more effective approaches and cost-effective processing methods. At present, such waste is mainly burned and partly regenerated - cleaned of impurities for reuse. The most effective solution to the problem is thermal action, which is based on direct combustion, pyrolysis and gasification. In all these processes, the temperature does not exceed 1200 0C, which leads to the formation of many harmful gaseous substances, including polyaromatic hydrocarbons, dioxins, furans, toxic fly ash, slag, mono and carbon dioxide ($CO_2$), NOx, SOx, HCl and others that pollute the environment. It is possible to avoid their formation if the temperature exceeds the above value [4]. One of the promising technologies is the possibility of using ultra-superheated (USH) water vapor with a temperature above 2000 0C, obtained by burning a hydrogen-oxygen mixture or

synthetic gas (H2 + CO) with oxygen diluted with water vapor [5, 6].

## Experimental procedure

In [7-10], an innovative method for the economic production of USH with subsequent gasification of liquid and solid organic waste in a reactor using a pulse-detonation gun, as well as various modifications of the installation, is presented. The essence of the detonation method of waste disposal is that the impact on the waste is carried out in a complex - a shock wave (having a crushing effect) and the resulting ultra-superheated steam with a temperature above 2000 $^0$C due to the detonation of a triple mixture. Under such conditions, with an increase in temperature at atmospheric pressure, the depth of carbon conversion in organic waste and the gas yield increase, and the yield of harmful substances decreases [4, 7].

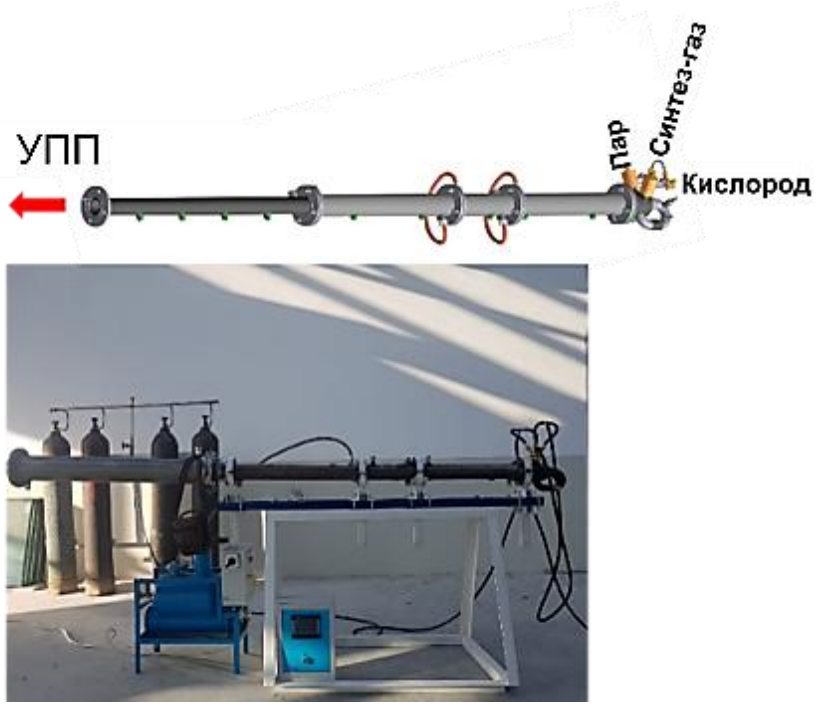


**Fig. 1. Three-dimensional model and photograph of a detonation gun [7].**

The pulse detonation gun [8] is a metal tube 2.7 m long with an internal diameter of 50 mm and a combustion chamber attached to it, in which a mixture of automobile spark plugs with an ignition energy of about 100 mJ is ignited through special fuel, oxygen and water vapor injection systems (Fig. 1). With the help of known devices [11], the flame from the combustion of the ternary mixture is turbulized and its accelerated transition to detonation is carried out with the formation of a shock wave propagating along the tube at a speed of over 2 km/sec. Methane was chosen as the fuel; in the stoichiometric ratio of the ternary mixture, the expansion temperature of their detonation products exceeded 2200 0C [7]. In this experimental setup, the content of ultra-superheated steam in the expanded detonation products reached 75% (vol.), and the rest was mainly CO2. In Fig. 2 shows a diagram of a setup for high-temperature steam gasification of waste motor oil, in which the feedstock was fed through nozzles in a pipe at the entrance to the reactor channel with a liquid waste feed rate of up to 15 g/sec [9], with the detonation gun installed in the lower part of the reactor and oriented tangentially to create a vortex due to the supersonic flow of the UPP jet with waste (see section A-A). To enhance the gasification of the feedstock and increase the processing volume, the setup at the end of the pipe was converted to a Y-shape with a connection to the reactor at two points. In this setup, the detonation wave splits into “sleeves” and synchronously enters the flow reactor (see Fig. 3), colliding inside, creating high-speed vortices, twisting and grinding the gasified materials with the formation of mainly synthesis gas (H2 + CO) and a small amount of CO2, CH4, O2, N2, depending on the experimental conditions. For waste engine oil after gasification in a unit with a 40-liter flow reactor, the H2/CO and CO2/CO ratios in the synthesis gas were 0.9 and 0.2 [10].

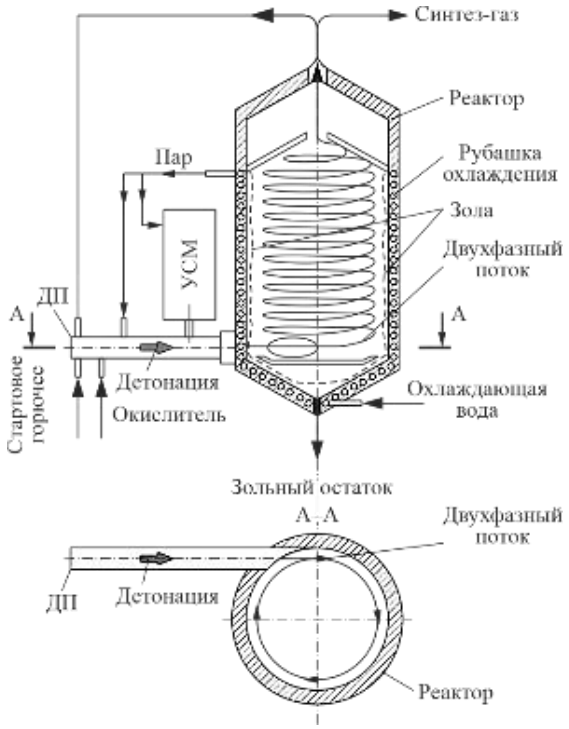


**Fig. 2. Schematic diagram of the installation for high-temperature steam gasification of waste motor oil [7].**

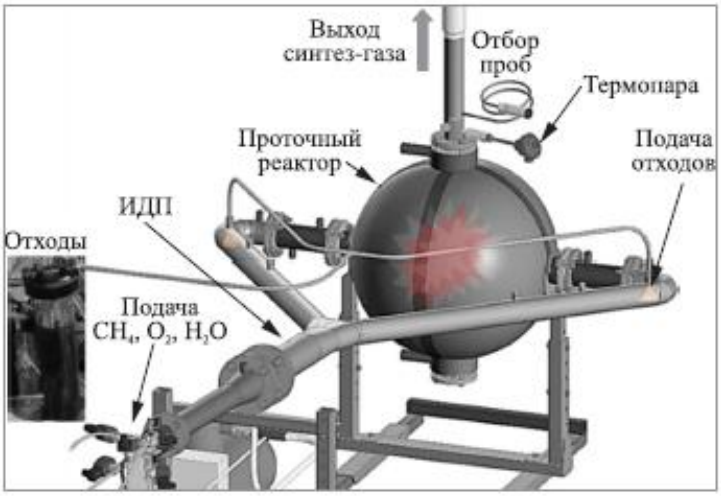


**Fig. 3. Schematic diagram of the installation for high-temperature steam gasification of waste motor oil using counter-currents [9].**

In the case of sawdust gasification experiments, the synthesis gas contained up to 40-45% (vol.) of hydrogen and carbon monoxide in a 1:1 ratio, with a small amount of carbon dioxide and methane [7].

## Results and discussion

Thus, through a detonation waste converter, complete gasification is possible with the production of high-quality combustible synthesis gas, which can be used to produce hydrogen, methanol, ammonia and other purposes. In this case, sulfur, chlorine and nitrogen contained in the waste will be converted into useful products - sulfides, chlorides and nitrides of hydrogen, while solid inorganic materials will be converted into molten slag consisting of simple oxides and salts, which are an excellent and safe building material. In fact, such technologies allow for the complete restoration of energy and material resources contained in waste without any harmful effect on the environment. In addition, the use of CO2 as a gasifying agent will reduce greenhouse gas emissions, for example, flue gases from thermal power plants can be used to process waste, thereby reducing the carbon footprint, which is very important in anticipation of the 29th International Conference of the Parties to the UN Framework Convention on Climate Change (COP29) in Baku. Despite the fact that the convention has existed since 1992, many of its key member countries still

do not fully fulfill their obligations and the amount of greenhouse emissions continues to grow from year to year. Due to its mobility (the unit fits into a 20-foot sea container (Fig. 4)) it can be moved to different regions as accumulated organic waste is disposed of, including any plastic, used motor oils, waste from oil refining, agricultural and food industries, sawdust, waste paper, medical waste, etc. The resulting synthesis gas can be used to improve the heat supply of the local population, feeding it directly to boiler plants of settlements, farms, and various structures instead of natural gas.

**Fig. 4. Photograph of a mobile organic waste converter in a 20-foot sea container [7].**

Another positive feature of the plant is that it is self-sufficient in fuel - for full operation, it is necessary to select up to 15% of the resulting synthesis gas and feed it into the system instead of methane, and wastewater can be used for water vapor obtained by steam generators.

It is worth noting that there are high-temperature allothermic technologies, such as plasma gasification using steam plasma guns, where the process occurs due to the heating of water vapor and raw materials by plasma of an electric arc charge with a temperature above 10000 $^0$C. But such technology requires huge costs for electricity, as well as special structural materials and refractory linings for the walls of gasifier reactors, including expensive maintenance and service with spare parts [7].

All of the above shows the environmental and economic advantages of detonation processing of organic waste.

When drawing up a business plan, it is imperative to take into account the energy characteristics of the resulting synthesis gas. In these parameters, it is 2.8 times inferior to natural gas (Table 1).

**Table 1.** Energy characteristics of substances

| **Fuel type** | **Unit of measurement** | **Specific heat of combustion** | | |
|---|---|---|---|---|
| | | **kCal** | **kW** | **MJ** |
| Liquefied gas | 1 kq | 10800 | 12,5 | 45,2 |
| Synthesis gas | 1 kq | 3344-4300 | 3,9-5,0 | 14 - 18 |

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## Conclusions

The prospects for the implementation and bringing the prototype of the installation to a commercial version with the possibility of its expansion and use in the form of franchises for business Azerbaijan will open up opportunities for the development of business and services in this area, reduce unemployment, and most importantly - will improve the state of the environment, reducing the harm caused by pollution by waste lubricants, reducing greenhouse gas emissions into the atmosphere. All of the above is very relevant not only for Azerbaijan, but also for all countries of the planet.

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# Use of alternative energy sources in solving environmental problems

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**Abstract**. The Republic of Azerbaijan is a country with rich natural resources and developed industries. However, the environmental problems of our Republic have been excessively polluted because the ecological problems that have been accumulated for many years have not been solved in time. At present, there are a number of environmental problems in our republic that urgently need to be solved: pollution of water bodies, including the Caspian Sea, with domestic and industrial water waste, damages caused by changes in the level of the Caspian Sea, the release of harmful gases into the atmosphere in excess of the permissible norm, the reduction of biodiversity, soil erosion and salinization, disposal of industrial and household waste, etc.

The sustainability of the growth of achievements in the social and economic spheres has been accepted as the main priority by the country. The environmental strategy of the country is aimed at the protection of natural resources at the national, international and regional levels by strengthening the coordination of activities in the field of environmental protection, the application of science-based development principles, and the sustainability of the use of economic and human resources of the country, which provides the interests of current and future generations.

**Key words :** alternative energy , climate change , energy security, environmental policy, global

## Introduction

After the Republic of Azerbaijan gained independence and chose the path of market economy, the environmental policy in the field of environmental protection in our country took a new dimension and began to be formed. This is also explained by the perception of environmental issues as a universal problem.

The "Ecological Concept of the Republic of Azerbaijan" based on the principles of "Sustainable development" can be mentioned as the first document on environmental policy in our republic in this period. In this concept, the main principles for solving the problems of environmental protection for our republic were reflected.

The main goal of the environmental policy implemented in the Republic of Azerbaijan is to ensure sustainable development with the protection of existing ecological systems, economic potential, and efficient use of natural resources in order to meet the needs of current and future generations. In order to realize this, ways of using natural resources should be developed and economic development should be carried out based on the principles of sustainability. [4]

In order to ensure sustainable development from an ecological point of view, it is necessary to eliminate serious environmental problems that arise during economic activity, and to minimize their negative impact on the environment.

Taking into account the current ecological situation and socio-economic situation, the following three main directions of the environmental policy of our republic can be defined:

Applying progressive methods according to the principles of sustainable development in order to minimize environmental pollution and regulate protection based on the provision of environmental safety;

efficient use of natural resources to meet the needs of current and future generations, use of inexhaustible energy sources through alternative, non-traditional methods, and achieving energy efficiency;

assessment of needs at the national level for global environmental problems, determination of solutions, expansion of relations with international organizations, as well as ensuring implementation

using national potential opportunities.

In recent times, the countries of the world are trying to attract new sources to their fuel-energy balance. Non-traditional sources of energy such as wind, sun, wave, swell-pull, hydrological energy of small rivers occupy a special place in the implementation of this trend. The potential possibilities of this type of alternative (renewable) energy sources are endless. No one doubts their ecological purity.

On the one hand, the inclusion of these energy sources in the economic cycle reduces the use of organic (oil - gas, peat, coal, wood, etc.) fuel resources, saves energy, and improves environmental conditions.

On the other hand, one of the questions that worries the world community in modern times - "how to meet the ever-increasing energy demand of humanity" - is answered optimistically. However, even if the modern "production-consumption" crisis is resolved soon, sooner or later the world will face this problem - the problem of depletion of non-renewable energy sources, oil, gas, coal. The more actively these resources are used, the more their reserves decrease and their price increases.[2]

Alternative energy is not only important for environmental protection. It reduces the dependence of countries, territories, economic systems on oil and its price. Depending on regional characteristics, one or another source dominates the structure of alternative energy use. It is advisable to use wind farms in plain areas, and solar batteries in tropical and subtropical latitudes . Special combustion technology of biomass (sawdust, sawdust) is widely used in countries with rich forest resources. [ 6,7 ]

As it can be seen, the use of non-traditional energy sources is based on two important conditions: a) recovery of the fuel source;

b) presence in the given area.

It refers to non-traditional (alternative) renewable energy sources:

- Biomass energy;
- Wind energy;
- Solar energy;
- Hydroelectric power;
- Geothermal energy;
- Wave energy;
- Nuclear fission energy;
- Thermonuclear fusion energy;
- Hydrogen fuel energy;
- Swelling – pulling energy;
- Thermal energy of the world ocean.

The possibilities of using these natural energy carriers, which have been widely used in recent decades in different regions of Europe, are already in the center of attention in Azerbaijan. The use of alternative energy sources will reduce the amount of emissions (harmful waste) released into the environment by saving fuel burned in thermal power plants in our country, bring additional income to the population and add a serious positive vector to the quality factor in living conditions. [5,7]

Modern solar cells are made of silicon, not selenium, which many sources attribute to Daryl Chapin, Calvin Fuller, and Gerald Pearson at Bell Labs in 1954 as the original invention of solar panels. They acknowledge that solar cells originated with their silicon photovoltaic (PV) creation. The first silicon solar cell achieved a solar conversion efficiency of four percent, which was less than a quarter of the efficiency achieved by modern solar cells. Improvement was required. Some of the earliest applications of solar technology were in space, where it was used to power satellites. In 1958, the Vanguard I satellite used a small watt panel to power its radios. In the same year, PV technology was also used on Vanguard II, Explorer III and Sputnik-3 satellites. In 1964, NASA launched the first Nimbus spacecraft powered entirely by a 470-watt solar array. In 1966, NASA launched the world's first Orbiting Astronomy Observatory. In 1981, Paul MacCready built the Solar Challenger, the first solar-powered aircraft, and successfully flew it across the English Channel from France to Great Britain. NASA surpassed this record in 2001 with its unrocket aircraft reaching an altitude of 96,000 feet. In 2016, Bertrand Piccard completed the world's first zero-emission flight with Solar Impulse 2, the largest and most powerful solar-powered aircraft to date. [12]

Today, energy security, global climate changes and environmental pollution are among the main problems that concern humanity and its progressive region, Europe. Various directions are proposed for their solution, the most important of which is the use of alternative and renewable energy sources [1,3].

Despite the fact that Azerbaijan is a producer of important energy carriers - oil and gas, the prospects of constantly increasing the possibilities of using alternative and renewable energy sources in all areas of the economy and social life are being investigated, and it is carrying out purposeful activities for the application of renewable energy types in areas that require little energy. In addition, the possibilities of replacing the energy-intensive devices used in oil and gas production and processing areas with more efficient devices are being investigated. [8,14]

From an environmental perspective, alternative energy sources offer significant benefits. They produce low greenhouse gas emissions during

operation, which helps mitigate climate change and reduce air pollution. By reducing dependence on fossil fuels, they also contribute to improved air and water quality, as well as habitat destruction associated with resource extraction. In addition, alternative energy sources have a minimal impact on ecosystems, protect biodiversity and support ecological balance. [10]

In modern times, energy saving is becoming more and more important due to a number of factors:

- With technological progress, there is a continuous increase in energy demand, which leads to higher demand for fossil fuels. This increased consumption of fossil fuels contributes to environmental pollution.

- Irresponsible energy usage and unnecessary wastage of electricity at commercial, industrial and residential levels results in inflated utility bills.

− Equipment inefficiencies such as motor overload, oversized cables and motors, outdated lighting systems, and less efficient machinery cause avoidable energy losses.

Therefore, it has become important to prioritize energy saving measures in order to reduce pollution, minimize losses and reduce electricity costs.

An energy policy consists of a set of rules or guidelines that outline strategies and measures to promote energy conservation. Various standards serve as benchmarks for developing energy policies.

For example, the energy management standard ISO 50001 covers the following key components:

- Formulation of energy policy to promote efficient use of energy.

- Determining goals and objectives according to the energy policy.

− Reviewing data to increase understanding and inform decision-making about energy use.

− Measuring results to assess the effectiveness of energy management efforts.

- Regularly review the energy policy to ensure its relevance and effectiveness.

- Continuous improvement of energy policy based on assessment and feedback.

In summary, energy policies are designed based on established standards such as ISO 50001, with a focus on efficient energy management and continuous improvement.

Alternative energy sources produce little or no greenhouse gas emissions during operation. Solar, wind, hydro and geothermal energy production does not emit carbon dioxide or other pollutants that cause climate change. By replacing fossil fuel-based energy production, these sources help reduce greenhouse gas emissions and mitigate the effects of climate change. From an environmental perspective, alternative energy sources offer significant benefits. They produce low greenhouse gas emissions during operation, which helps mitigate climate change and reduce air pollution. By reducing dependence on fossil fuels, they also contribute to improved air and water quality, as well as habitat destruction associated with resource extraction. In addition, alternative energy sources have a minimal impact on ecosystems, protect biodiversity and support ecological balance. [10]

The Decree of the President of the Republic of Azerbaijan on the "State Program for the use of alternative and renewable energy sources in the Republic of Azerbaijan" proves that Azerbaijan is in solidarity with the idea of a "clean world" with the progressive world community and the European Union. [10,13]

"Ecological Park" project has been successfully implemented in the area of 9.3 ha specially allocated in the area of Khazar region of Absheron for large-scale greening works, planting of tree and shrub plants in massifs and ecological education of the young generation in the important production activity zones of Azerbaijan, recultivated areas. [2,11,12]

## Discussion

One of the main points is that the regional body has the potential to play an important role in world politics and to influence the positive solution of global issues. Although each of the member states of Europe approaches these issues from its own perspective and interests, the Council of Heads of State and Government and the Council of Ministers of the European Union play an important role in the formation of a common strategy in the field of solving common security policy, including a set of issues related to nature protection.

## Results

In order to develop the non-oil industry, the involvement of the country's natural and economic resources in the economic cycle will be expanded and the efficiency of their use will be increased.

In order to accelerate the use of alternative (renewable) energy sources during the period covered by the concept, it is planned to implement stimulating measures, develop the institutional environment, strengthen the scientific and technical potential, continue specialist training and educate energy consumers. In addition to the projects implemented by the state in this area, close participation of the private sector in this process will be encouraged, flexible regulation of alternative energy tariffs will be ensured.

A production, social and market infrastructure network that serves the development of the non-oil sector and meets modern requirements will be

created, and the use of progressive forms of farming and management will be expanded.

Renewable energy technologies have witnessed rapid advances in recent decades, making them increasingly cost-effective and efficient. For example, solar energy has become more accessible with the widespread adoption of photovoltaic panels and solar thermal systems. Wind energy has also experienced significant growth with the development of large-scale wind farms that use the kinetic energy of the wind to generate electricity. In addition, hydropower, geothermal and biomass energy systems have proven to be reliable sources of clean energy, further diversifying the global energy mix.

The use of alternative energy sources is increasingly widespread throughout the world due to the need to solve environmental problems, strengthen energy security and promote economic development. In recent years, the Republic of Azerbaijan has achieved sufficient achievements in the fields of social and economic development, which is reflected in national and international documents. Azerbaijan, like many other countries, is actively exploring the potential of alternative energy to diversify its energy portfolio and reduce dependence on traditional fossil fuels.

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# Ekoloji mühitin qorunması və təhlükəsizliyinin araşdırılması

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**Xülasə**

Elmi texniki tərəqqinin ətraf mühitin müdafiəsini aktual problemə çevirdi. Məqalədə ətraf mühitin ümumi müdafiəsi nəticəsində təmiz hava probleminin əhəmiyyəti barədə danışılır. Atmosfer çirklənməsi insan həyatı üçün təhlükə yaradır. İnsan fəaliyyəti nəticəsində yaranmış atmosfer çirklənməsinin analizi mürəkkəb problemlərdən biridir.

Mütəşəkkil tullantılar atmosferə tüstü borularından daxil olur və hündürlüklərə yayılması ilə yüksək konsentrasiya və çirkləndirici maddələrin böyük miqdarı ilə seçilirlər.

Xüsusi halda, havanın yer qatında çirkləndiricilərin yayılmasının hesablamaları üçün müxtəlif meteoroloji şərtlər zamanı havanın yer qatında küləyin şaquli profili haqqında məlumatlara malik olmaq lazımdır. Orta çirklənməyin hesablamaları üçün tədqiq edilən ərazidə küləyin gücünə və istiqaməti haqqında statistik məlumatın yığılması çox vacibdir.

Su anbarlarının tikilməsi ətraf mühitin ekologiyasına çox böyük təsir göstərir. Təbii mühitin dəyişməsi, zəlzələlərin, vulkan püskürmələrinin baş verməsi, yanğınların olması, daşqın və sellər çox böyük sahənin su altında qalması, torpaq və bitki örtüyündə dəyişikliklər baş verir. Təbii fəlakətlərin baş verməsi zamanı normal həyat tərzi pozulur, əhalinin həlak olması faktları, maddi və təbii sərvətlərin məhv olmasına gətitib çıxarır. Yanğın zamanı, meşə yanğınları səbəbi ilə müxtəlif növ heyvanların nəsli kəsilib. Suyun çirklənməsi isə dənizdə balıqların, xüsusən də nərə balığının nəslinin kəsiləsinə götürüb çıxarır. Ətraf mühitin çirklənməsi prosesinin nisbətən qarşısını almaq üçün müəyyən tədbirlər həyata keçirilməlidir.

Müasir texnologiyalardan istifadə etməklə, torpaq kanallarının dəmir-beton, kanal və ya boru xətləri ilə əvəz edilməsi, yeni enerjiyə qənaət edən nasos stansiyalarının quraşdırılması, boru kəmərlərinin dəyişdirilməsi zəruridir. Yeni, hündür mərtəbəli binaların tikilməsində xüsusi qaydalarına fikir vermək lazımdır ki, zəlzələdən qorunsun. Sellərin, daşqınların qarşısını almaq üçün isə bəndlər tikilir, körpülər salınır. Ətraf mühitin qorunması insanlardan da asılıdır. Ərazilərdə ekoloji təhlükəsizliyin təmin edilməsi, tullantıların səmərəli, o cümlədən yerli və beynəlxalq standartların tələblərinə uyğun idarə olunmasının təşkili, emalı, qiymətli resursların təkrar istifadəyə qaytarılmasıdır.

**Açar sözlər:** tulantı sular, çirkləndirici maddələr, çirklənmə mənbələri, təbii fəlakətlər, atmosfer çirklənməsi

## Əsas hissə

5 iyun Dünya Ətraf Mühitin Mühafizəsi Günüdür. XIX əsrin sonlarından başlayan elmi-texniki tərəqqi, sənayenin sürətli inkişafı nəticəsində ətraf mühitə edilən təsiri XX əsrin ortalarında öz mənfi nəticələrini biruzə verməyə başladı.

Dünya Ətraf Mühitin Mühafizəsi Günü hər il geniş tədbirlərlə qeyd edildiyi Azərbaycanda da ətraf mühitin mühafizəsi və ekoloji problemlər daim diqqət mərkəzindədir.

## Giriş

Azərbaycan Respublikasının Prezidenti hörmətli cənab İlham Əliyevin rəhbərliyi ilə ölkəmizdə bütün sahələrdə olduğu kimi, ekoloji problemin həlli, ətraf mühitin mühafizəsi, ekoloji tarazlığın bərpa edilməsi istiqamətində də mühüm işlər görülür. Meşələrin bərpa edilməsi və artırılmasına dair milli proqramlar Azerbaycanda hidrometeorologiyanın inkişafına dair Dövlət Proqramı uğurla yerinə yetirilir. Təbiətdən, yeraltı sulardan, mineral xammal ehtiyatlarından və yerüstü sərvətlərdən səmərəli istifadə edilməsi, onların bərpası və mühafizəsi, bioloji müxtəlifliyi qorunub saxlanılması məqsədi ilə müxtəlif tədbirlər həyata keçirilir.

Ekoloji təhlükəsizliyin təmin olunması üçün çirklənmənin minimuma endirilməsi və mühafizəsini təkmilləşdirilməsi, indiki və gələcək nəsillərin tələbatını ödəmək məqsədilə təbii sərvətlərdən səmərəli istifadə Azərbaycan dövlətinin ekoloji siyasətinin əsas istiqamətlərindəndir.

Aparılan tədqiqatlar onu göstərir ki, hazırda ölkədə əsas ekoloji problemlər, su ehtiyatlarının çirklənməsi, yəni Xəzər dənizinin sənaye və məişət tullantı suları ilə çirkləndirilməsi, su obyektləri ilə transsərhəd çayların çirkləndirilməsi, tullantı

suların idarə olunması, təmizləyici qurğuların gücünün formalaşan tullantı sulardan az olması, tullantı sularının təmizlənmədən su hövzələrinə axıdılması daxildir. Atmosfer havasının stasionar mənbələrdən çirklənmələr torpaqların deqradasiyaya uğraması, yəni erroziya və şoranlaşma prosesləri, torpaqların tullantılarla çirkləndirilməsi, torpaq örtüyünün həddindən artıq otarılması da əsas ekoloji problemlərdən sayılır. Bərk məişət və sənaye, həm-çinin təhlükəli tullantıların tələb olunan səviyyədə utilizasiya olunmaması tullantıların tam səviyyədə idarə edilməsi, biomüxtəlifliyin azal-ması əsas ekoloji problemdir. [1]

Elmi-texniki yüksəlişin artması ilə ətraf mühitin mühafizəsi aktual problemə çevrildi. Ətraf mühitin ümumi mühafizəsi nəticəsində təmiz hava problemi ayrıca əhəmiyyətə malikdir ki, atmosferin çirklənməsi insan həyatı üçün təhlükə yaradır. Həyat üçün zəruri təmiz hava və torpağın flora və faunasının təmizliyidir. İnsan 5 həftə yeməksiz yaşaya bilər, 5 gün susuz qaia bilər, 5 dəqiqə isə havasız qala bilməz. Bu da havanın təmiz olmasına XVIII əsrdə fransız alimi Antuan Soran Savuzye havanın müxtəlif qazların mexaniki qarışığından ibarət olmasını kəşf etmişdir. [1]

Müəyyən ərazilərdə fövqəladə ekoloji halları təbii fəlakətlər, yəni təhlükəli təbii hadisələr yaradır. Bu zaman normal həyat tərzi pozulur, əhalinin həlak olması faktları, maddi və təbii sərvətlərin məhv olması baş verir. Zəlzələlər, vulkan püskürmələri, daşqınlar, sunamilər, tropik siklonlar, qasırğalar, sellər və dolu, qar uçqunları, aramsız leysan yağışları, intensiv buzlaşmalar buna misaldir.

**Zəlzələ** - Yerin təkində baş verən fiziki-kimyəvi proseslər nəticəsində Yer kürəsinin hər hansı bir yerində güclü gərginlik yaranmasıdır. Bu gərginlik, yer qabığını təşkil edən maddələrin möhkəmliyindən artıq olarsa, onda Yerin böyük kütləsinin parçalanması və yerdəyişməsi baş verir, bu zaman qüvvətli titrəyişlər qeydə alınır, 12 balla ölçülür.

**Sunami** – Zəlzələnin seysmik mərkəzi dənizin dərinliyində olarsa, dənizdə həddindən artıq hündür dalğalar – sunamilər yaranır. Bu dalğaların dağıdıcı qüvvəsi zəlzələdən güclü olur. 1960-cı ilin may ayının 22-də Çində baş vermiş zəlzələ nəticəsində yaranmış dalğanın hündürlüyü 10 m-dən artıq olmuşdur. Əraziləri su basmış dalğa gəmiləri sahilə atmış, tikililəri su yuyub apararaq okean sularına qarışdırmışdır.

**Vulkan püskürməsi** – Dağlarda od püskürmüəsi vulkan, qədim Romanın od və dəmirçilik sənətinin tanrısı Vulkanın şərəfinə adlanır. Püskürmələr zamanı həddindən artıq qızmış daşlar, ərimiş dag süxurları, maye və buxar qazlarının axını müşahidə olunur. Sakit okean sahilində, Kamçatkada qeydə alınıb.

**Sellər** – “Seyl” ərəb sözü olub, “güclü axın” deməkdir. Sellər, aramsız yağan güclü leysan yağışların yağması, dağ qarının, buzlaqların intensiv əriməsi zamanı magistral və dəmir yolları, kommunikasiya xətləri, elektrik dirəkləri məhv olur. Sel suları kanalizasiya və içməli su xətlərini sıradan çıxarır, yaşayış evlərini, məişət və digər tikililəri uçurur, əkin bitki örtüyünü yuyur., yük maşınlarını belə aparır. Daşqınlar, çayların adi səviyyədən artıq daşması nəticəsində ərazinin müvəqqəti olaraq, su altında qalmasıdır. Bu təbiət hadisəsi insanların həyat fəaliyyəti üçün çox təhlükəli olmaqla yanaşı, ətraf ərazilərin ekologiyasına da mənfi təsir etmiş olur. Daşqınlar zamanı bəndlər və qurğular dağılır, məhsuldarlıq aşağı düşür, torpaq şoranlaşmaya məruz qalır. Bu səbəbdən epidemiya və xəstəliklər yaranır.

**Qar uçqunu**. Təbiətdə qarın böyük əhəmiyyəti vardır. Qar az istilik keçirmə qabiliyyətinə malik olduğundan torpağın dərin qatlarının donmaya məruz qalmasına və bitkilərin soyuqda məhv olmasının qarşısı alınır. Qar bəzi ərazilərdə 4-5 ay, 8-9 ay qalır. Dağdan qopan üçü aşağı iri qar kütləsi uçqun formasında sürüşür. Bu uçqunlar kökündən yüzillik ağacları qoparır, evləri, yolları, körpüləri, hər şeyi dağıdır. Uçqun zamanı sürüşən qar kütləsinin ağırlığı 200-300 min, bəzən isə 500 min ton ola bilər.

**Qasırğalar**. Adətən, soyuq atmosfer kütləsindən əvvəl müşahidə olunur. Qasırğa küləyinin sürəti saniyədə 50-60 metrə davametmə müddəti isə bir neçə dəqiqədən bir neçə saata qədər olur. Qəflətən baş verməsinə görə qasırğa çox təhlükəli təbiət hadisəsi hesab olunur.

Güclü küləklər. Saniyədə 30 metr və daha artıq sürətlə əsən küləklər güclü küləklər kateqoriyasına aiddir. Güclü küləklərə düzənlik ərazilərdə rast gəlmək olar.

**Leysanlar**. Leysan yağışları zamanı 1 saat ərzində 30 mm və ya artıq yağış yağır. Qısamüddətli yağan leysan yağışı fəlakət yarada bilər. Dağlarda daha təhlükəlidir. Sellər və subasmalar yaranır. Tropik və subtropik iqlim üçün xarakterik olan leysanlar mülayim iqlim şəraitində də yağır.

Dolu. İqlim isti mövsümlərində yağıntı iri və ya xırda buz dənələrunə bənzər – dolu şəkildə də yağa bilər. Dolu dənələrinin ölçüləri böyük olduğundan kənd təsərrüfatına ziyan dəyir.

Yanğınlar – Yanğın fəlakət olub, alovun dağıdıcı qüvvədə ətrafa yayılması deməkdir. Yanğınların yaranma səbəbləri (təbii, texnogen, antropogen mənşəli) müxtəlif olur. Meşə yanğınları çox təhlükəlidir. Ağaclar, kolluqlar, meşə məhsulları, meşə canlıları yanaraq ekoloji fəsadlara səbəb olur, geniş ərazidə ekoloji sistemə məhvedici

təsir göstərir. Nəticədə meşənin flora və faunası məhv olur. 2010-cu ilin iyul-avqust aylarında Rusiya Federasiyasında baş vermiş meşə yanğınları, minlərlə hektar sahəni əhatə etmiş və bir neçə yaşayış məskəninin məhv olmasına səbəb olmuşdur. Azərbaycanda 2010, 2011-ci illərdə Şamaxı, İsmayıllı, Lənkəran rayonları ərazilərində meşə yanğınları olub. Meşə yanğınları səbəbilə müxtəlif növ heyvanların nəsli kəsilib. [2]

Şəkil 1.Suyun çirklənməsi

Hal-hazırda 200 milyon ton karbon qazı və 50 milyon tondan çox azot-oksidi havaya buraxılır. Hər il yanacaq istehsalı nəticəsində yeddi yüz milyon tondan çox karbon qazı, kükürd-oksidi, azotoksidi , karbohidrogenlər 200-300 milyon ton aerozol və atmosferə atılan sənaye şəhərləri ən çox kükürddioksid ilə zəhərlənir. Kükürddioksidin çirklənməsi baxımından birinci yeri istilik elektrik stansiyaları ( İES ) tutur. [3]

Dünyada və Azərbaycanda ətraf mühitin çirklənməsinin aktual problemlerindən biri sənaye və məişət tullantılarının sürətlə artması-dır. Bu problem xüsusilə xammal və ehtiyat emalı sənayesi yüksək olan bölgələrdə aktualdır. Müasir texnikanın və qabaqcıl texnologiya-ların sənayedə tətbiq olunmasına baxmayaraq, xammalın xeyli hissəsi tullantılara gedir. Sənaye tullantılarının idarə edilməsi sahəsində fəaliyyəti ekoloji cəhətdən ən əhəmiyyətli və təhlükəlidir. Yüksək bioloji aktivliyə malik ağır metallar, kadmium, qurğuşun, xrom, nikel və s. çox sayda təbii və süni polimer kağız və tekstil, tullantı kauçuklar metal, plastik məmulatlar. Onlar parçalanır, əmələ gələn maddələr yeyinti və yeraltı sulara nüfuz edir, bitkilərdə toplanır, insan sağlamlığına təhlükə yaradır. Sənaye tullantılarının atılması üçün bütün zərərli maddələrin zərərli təsirlərini minimuma endirən xüsusi metod və texnologiyadan istifadə olunur. [4]

Təbii ərazilərdə getdikcə artan ekoloji təzyiqlər, həm yerli, həm də dünya miqyasında ekoloji problemlər yaradır. Yerli ekoloji idarəetmənin optimallaşdırılması problemləri elm və texnologiyanın inkişafının əsas sahələrindən biridir. İstehsal və istehlakın tullantıların idarə olunması sahəsində, ərazi daxilində idarəetmə metodlarının işlənib hazırlanmasına və təkmilləşməsinə ehtiyac var. Müəssisə səviyyəsində Azərbaycanın yanacağı enerji balansında aparıcı rol oynayan neft-qaz kompleksinin indiki inkişaf tempi ətraf mühit obyektlərə yüklərin kəskin artmasına səbəb olur, nəticədə hava, su, torpaq ( litosfer ) və yeraltı ərazilərdə də antropogen ərazinin formalaşmasına səbəb olur. Neft və qaz-kondensatı yataqlarının işlənməsi zamanı xüsusilə vacibdir.

Azərbaycanın yanacaq- enerji balansında aparıcı rol oynayan neft-qaz kompleksinin indiki inkişaf tempi ətraf mühit obyektlərin yüklərin kəskin artmasına səbəb olur.[5]

**Şəkil 2.Atmosferin çirklənməsi**

Tullantıların atılması zamanı onların ətraf mühitə mənfi təsiri litosferin ayrı-ayrı elemetlərinin dəyişməsi ilə landşaftların dəyişməsi ilə müşayiət olunur. Bundan əlavə tullantıların təsnifatı onların idarə olunmasının səmərəli texnologiyalarının inkişafı üçün də vacibdir. Hazırda neft-qaz və qaz-kondensat yataqları üçün ciddi problem, çirkab yataqları üçün ciddi problem çirkab suların təmizlənməsi, avadanlıqların təmiri, karbohidrogen xammalının hazırlanması və emalı, neft saxlama anbarlarının təmizlənməsi, istehsalatda yaranan digər növ tullantıların hərəkəti ətraf mühitin təhlükəsizliyinə əhəmiyyətli dərəcədə təsir göstərir. Sənaye istehsalı gündən-günə artır, bu da metallurgiya, kimya, neft, qaz və kömür sənayesində tullantıların artmasına səbəb olur. Böyük şəhərlərdə havanın yüksək çirklənməsi qeydə alınıb. Ümumi atmosfer çirkliliyi bütövlükdə qlobal istiləşmə, buzlaşma iqlim dəyişikliyinə səbəb ola bilər.

Çirkləndiricilər arasında dörd əsas növü ayırmaq olar: kükürdtərkibli yanacağın yanma məhsulları, nəqliyyatdan buraxılan tüstü qazlar sənaye müəssisələrinin tullantıları, radioaktiv ayırmalar. Tullantılar adətən 3 əsas qrupa bölünür: mütəşəkkil, qeyri-mütəşəkkil və paylanmış.

Mütəşəkkil tullantılar - atmosferə tüstü borularından daxil olur və hündürlüklərə yayılması ilə yüksək konsentrasiya və çirkləndirici maddələrin miqdarı ilə seçilir.

Qeyri- mütəşəkil - tullantılar atmosferə istehsalat binalarından daxil olur.

Paylanmış tullantılar - kənd təsərrüfatında hava nəqliyatından istifadə nəticəsində kimyəvi məhsullardan istifadənin nəticəsidir.

Çirkləndiricilərin arasında kimyəvi üzvi və qeyri üzvi məhsullar var. Onlar qaz, maye və bərk hissəciklər formasındadır. Müasir dövrdə şəhərlərin atmosferində zərərli qatışıqların konsentrasiyasının təyini kimyəvi analiz metodu ilə həyata keçirilir. [6]

## Nəticə

Ölkəmizin iqtisadi inkişaf tempinə uyğun olaraq, ekoloji siyasətin həyata keçirilməsi istiqamətində ətraf mühitin hər hansı komponentinin bərpa olunmayan dərəcədə pozulmasına səbəb olan fəaliyyətinin qarşısının alınması, aztullantılı texnologiyanın tətbiq edilməsi, beynəlxalq təşkilatlar və inkişaf etmiş ölkələrə ətraf mühitin mühafizəsi sahəsində əlaqələrin genişləndirilməsi, əhali arasında ekoloji təbliğatın və maarifləndirmənin gücləndirilməsi prinsiplərini tətbiq edir.

Ətraf mühitə təsiri olan faktorlardan biri də atmosfer havasının oksigenlə zənginlik səviyyəsidir. Bu gün yaşıllaşdırma kütləvi və davamlı prosesə, vətandaş vərdişinə çevrilib. Son illərdə Abşeronda, ölkəmizdə milyonlarla ağac əkilib və bu işlər bu gün də davam etdirilir.

Atmosfer havasının çirkləndirilməsinin qarşısının alınması ilə bağlı mütəmadi olaraq, tədbirlər görülür. Atmosfer havasına atılan tullantıların zərərsizləşdirilməsi məqsədilə ölkənin şəhərlərində 500-ə yaxın iri ictimai-iaşə obyeklərində təmizləyici qurğular quraşdırılıb.

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Научно-технический прогресс превратил охрану окружающей среды в актуальную проблему. В статье говорится о важности проблемы чистого воздуха как результата общей защиты окружающей среды. Загрязнение атмосферы представляет угрозу для жизни человека. Анализ загрязнения атмосферы, вызванного деятельностью человека, является одной из сложных проблем. Организованные отходы попадают в атмосферу через дымовые трубы и отличаются высокой концентрацией и большим количеством загрязняющих веществ при распространении на высоту. В частности, для расчетов рассеяния загрязняющих веществ в приземном слое воздуха необходимо иметь информацию о вертикальном профиле ветра в приземном слое в различных метеорологических условиях. Для расчетов среднего уровня загрязнения очень важен сбор статистической информации о силе и направлении ветра на исследуемой территории.

Строительство водоемов оказывает большое влияние на экологию окружающей среды. Происходят изменения природной среды, землетрясения, извержения вулканов, пожары, наводнения и затопления больших территорий, изменения почвы и растительности. Во время возникновения стихийных бедствий нарушается нормальный образ жизни, факты гибели населения приводят к уничтожению материальных и природных ресурсов. Во время пожара из-за лесных пожаров погибли различные виды животных. Загрязнение воды приводит к гибели морской рыбы, особенно осетровых. Необходимо принять определенные меры для относительного предотвращения процесса загрязнения окружающей среды.

Используя современные технологии, необходимо заменить земляные каналы железобетонными, каналами или трубопроводами, установить новые энергосберегающие насосные станции, заменить трубопроводы. При строительстве новых высотных зданий необходимо обращать внимание на особые правила по защите их от землетрясений. Для предотвращения наводнений строятся плотины и мосты. Защита окружающей среды также зависит от людей. Обеспечение экологической безопасности на территориях, организация обращения с отходами в соответствии с требованиями местных и международных стандартов, переработки, вторичной переработки ценных ресурсов.

**Ключевые слова:** сточные воды, загрязняющие вещества, источники загрязнения, стихийные бедствия, загрязнение атмосферы.

## Abstract

## Environmental protection and safety research

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Scientific and technical progress has turned environmental protection into an urgent problem. The article talks about the importance of the clean air problem as a result of the general protection of the environment. Atmospheric pollution poses a threat to human life. Analysis of atmospheric pollution caused by human activity is one of the complex problems. Organized waste enters the atmosphere through smoke pipes and is distinguished by its high concentration and large amount of pollutants as it spreads to heights.

In particular, it is necessary to have information about the vertical profile of the wind in the ground layer during different meteorological conditions for the calculations of the dispersion of pollutants in the ground layer of the air. It is very important to collect statistical information about wind strength and direction in the studied area for the calculations of average pollution.

The construction of reservoirs has a great impact on the ecology of the environment. Changes in the natural environment, earthquakes, volcanic eruptions, fires, flooding and flooding of large areas, and changes in soil and vegetation occur. During the occurrence of natural disasters, the normal way of life is disrupted, the facts of the death of the population lead to the destruction of material and natural resources. During the fire, various types of animals were killed due to forest fires. Water pollution kills fish in the sea, especially sturgeon. Certain measures should be implemented to relatively prevent the process of environmental pollution.

Using modern technologies, it is necessary to replace earthen channels with reinforced concrete, channels or pipelines, install new energy-saving pumping stations, and replace pipelines. In the construction of new, high-rise buildings, it is necessary to pay attention to the special rules in order to protect them from earthquakes. Dams and bridges are built to prevent floods. Protecting the environment also depends on people. Ensuring environmental safety in the areas, organization of waste management in accordance with the requirements of local and international standards, processing, recycling of valuable resources.

Keywords: waste water, pollutants, sources of pollution, natural disasters, atmospheric pollution

# Prospects for using solar energy in conditions of negative global and regional climate change

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**Abstract**
With the development of science and technology, intensive development of industry and agriculture, as well as a sharp increase in the population of the Earth, the human impact on nature has increased. The problem of climate change has worsened. This paper reflects the results of solving two problems: the first is a study of the theory of calculating solar water heating systems, taking into account the change in the main parameters depending on the type of climate for use in mountainous areas; the second is increasing the productivity of solar systems by creating a new design for orientation and setting the angle of inclination of the SC (panel). The proposed improvement of the theory of the design of solar water heating systems allows increasing the efficiency of their use taking into account climate change. In the article, these issues are considered for the conditions of global and regional (Azerbaijan) climate change. Therefore, at the beginning, a brief overview of this problem is given.
**Keywords:** climate, solar collector, energy, environment, tilt angle, ecology.

## Introduction

As a result of changes in the energy balance of the Earth, there is a modern change in the global and regional climate. Since the 60s of the 20th century, experts consider the ecological state as catastrophic. In this regard, ecology has become an area of international cooperation. Throughout the history of the Earth, its climate has repeatedly changed. But climate changes occurred in a long historical time. They are now happening only in a short time, at high speed. Human production and economic activity has a great influence on the change. It is a source of abundance. In the life of mankind, climatic conditions open up wide opportunities for the development of various sectors of the economy. With improper organization of production, this leads to air pollution. The main source of climate change is energy based on hydrocarbons [1]. According to the territory covered, the ecological crisis can be global, regional and local.

Global environmental crisis. Before the emergence of life on the planet, there was a biogenic factor consisting of inanimate nature, and with the advent of man, an anthropogenic factor emerged, exerting the most significant influence on the environment. High rates of population growth and the modern scientific and technological revolution have exacerbated the environmental problem. It has been proven that in the first half of the 20th century, the annual accelerated movement of the Earth created conditions for warming in the summer months, and in the second half of the century, conditions were created for warming in winter. All this occurs mainly due to changes in the heat balance associated with changes in the composition of the atmosphere. The main gases that create the greenhouse effect are carbon dioxide ($CO_2$), methane ($CH_4$), and nitrogen oxide ($N_2O$). For this reason, the temperature of the lower layer of the atmosphere increases [2]. Over the past 100 years, the global temperature has increased by 0.8 ºC. This change occurs differently on a global and regional scale. The main component of climate change in each area, depending on the average

weather temperature from the season, is the warming of this area of the earth's surface by the sun's rays, lighting conditions. During the year, the illumination of the globe at a given latitude changes. For the climate, the most important thing is how much energy comes to a unit of surface area in general per day. During the summer, the sun's rays warm only the uppermost layer of the surface - about 100 meters of water in the oceans and seas and only 1-2 meters of soil. Since the density of the warm surface water is less than the density of unheated water from below, their mixing in spring and summer occurs very slowly. Another thing - in autumn and winter.

Today, the invasion of the ecological balance of nature has acquired dangerous proportions for humanity. The environment is so polluted that nature is unable to fully restore itself. Currently, an example of a global ecological crisis can be acid rain, the greenhouse effect, climate change, ozone holes, changes in the speed of rotation of the Earth, etc. Problems caused by technology and technology can be solved again with the help of alternative technology and technology using new renewable energy sources. The future of humanity largely depends on the expansion of the scale of use of renewable alternative energy sources.

Climate change (regional crisis) in Azerbaijan and the problems to be solved. The territory of Azerbaijan is located in the subtropical and temperate climate zones. The formation of the climate of our country is greatly influenced by the relief, geographical latitude, various air masses penetrating the territory, which are the cause of climate diversity. Under the influence of these facts, several types of climate have formed. In order to maintain the formed type of climate, it is necessary to maintain the energy balance. There is a close relationship between the altitude and the type of climate [3]. On the territory of Azerbaijan, 9 sub-types of climate are distinguished and all of them are combined into 4 types. The types of climate change from the plains to the highlands. The 1st combined type is a semi-desert and dry steppe climate from the Caspian Sea to altitudes of 600-800 m. The 2nd combined type is a moderately warm climate covers territories up to an altitude of 1000 m. The 3rd combined type is a cold climate between altitudes of 1000 m-2700 m. The 4th combined climate type is mountain tundra areas located at an altitude of over 2700 m. When designing solar systems, this factor must be taken into account. Unfortunately, this factor is not taken into account in existing methods. The active development of the Azerbaijani economy has sharply increased the demand for energy raw materials. Currently, the country is reorienting itself to expanding the use of alternative energy sources. In these conditions, fundamentally new scientific and technical developments are needed. Research work on reducing the harmful effects of traditional energy sources on the environment is also being carried out in our country. It has been established that all useful and waste energy is converted into thermal energy. This thermal energy is dissipated into the atmosphere and accumulates there. This accumulation process is the main cause of the critical increase in temperature. Of particular scientific and practical interest is the work published in the article [4]. In this work, using the theory of prof. Lutfizade, a model for managing the mode of thermal energy consumption is described using qualitative methods with linguistic variables. Unlike the known economic models of providing buildings with thermal energy, the developed system and new methodology make it possible to take into account all factors of the mode of thermal energy consumption under various influences in centralized heat supply with favorable economic indicators. The purpose of the report is to submit for discussion by conference participants a number of developments on climate change, reflecting the scientific, methodological and design foundations of safe and efficient provision of engineering and communication systems with energy that is harmless to humans and the environment. To achieve this goal, we will consider the following scientific and technical tasks:

1. For a more accurate calculation of solar water heaters, determine the relationship between parameters that simultaneously change with the altitude of the area. This is the density $\boldsymbol{\rho}$, pressure P, and temperature T.

2. Increasing the performance of solar systems (solar receiver) by creating a new design for orientation and setting the tilt angle of the solar panel.

1. Solution of the first scientific and technical problem. Some aspects of this problem were considered by us in the previously published article [5]. At the conference, consideration of a number of issues given in this article, related to temperature changes, we consider it appropriate. Considering the vertical structure of the Earth's atmosphere, we can see that, with height, three parameters simultaneously change density $\rho$, pressure P, and temperature T of air. Basically, these parameters are used to calculate solar water heaters. Currently, a lot of work is being done to apply the latest technologies in the Karabakh and East Zangezur economic regions of Azerbaijan. Considering that most of the settlements here are located in mountainous areas, a new method for calculating solar water heaters has been developed, taking into

account the conditions of their operation in highlands. The new method for calculating solar water heaters, taking into account the conditions of their operation in highlands, has been developed. is an urgent task for designing this system. At the beginning of the calculation, it is necessary to obtain equations that determine the altitude dependence of pressure and density. This dependence can be obtained from the equation of an ideal gas with a molecular mass of μ = 29, which corresponds to the average nitrogen-oxygen molecular mass of the atmosphere of our planet. After such reasoning, you can write a mathematical expression for this equation

$$P=\frac{\rho \cdot N_A kT}{\mu}, \quad (1)$$

For a more in-depth calculation, one should use the well-known hydrostatic equation [6] showing how the pressure in a liquid changes with height z. Considering that the density of the atmosphere, unlike the density of an incompressible liquid, changes variably, therefore the hydrostatic equation should be written in differential form, for changing the pressure dp when the height increases by dz:

$$dp = -\rho g dz, \quad (2)$$

In this formula, the minus sign shows that pressure decreases with altitude. If we transform these two equations, excluding density, we can obtain a differential equation for the dependence of pressure on altitude.

$$\frac{1}{\rho} dp = -\frac{g \cdot \mu}{N_A \cdot kT} dz, \quad (3)$$

It is not difficult to notice that on the right side of the equation there is a ratio of the increment of the potential energy of the molecule mgdz=$\mu g dz / N_A$ to the characteristic kinetic energy of molecules κT. As you rise to a height within the troposphere, the air temperature begins to decrease. Therefore, when calculating heating devices, it should be taken into account that the density also changes with height $\rho$, and pressure P, and temperature T of air. To ensure normal provision of country houses or individual houses with hot water, it is necessary to determine the amount of heat consumed. The daily consumption of the calculated heat required for mansions can be obtained by the formula

$$Q= k \frac{mgc(t_r - t_x)}{24} \quad (4)$$

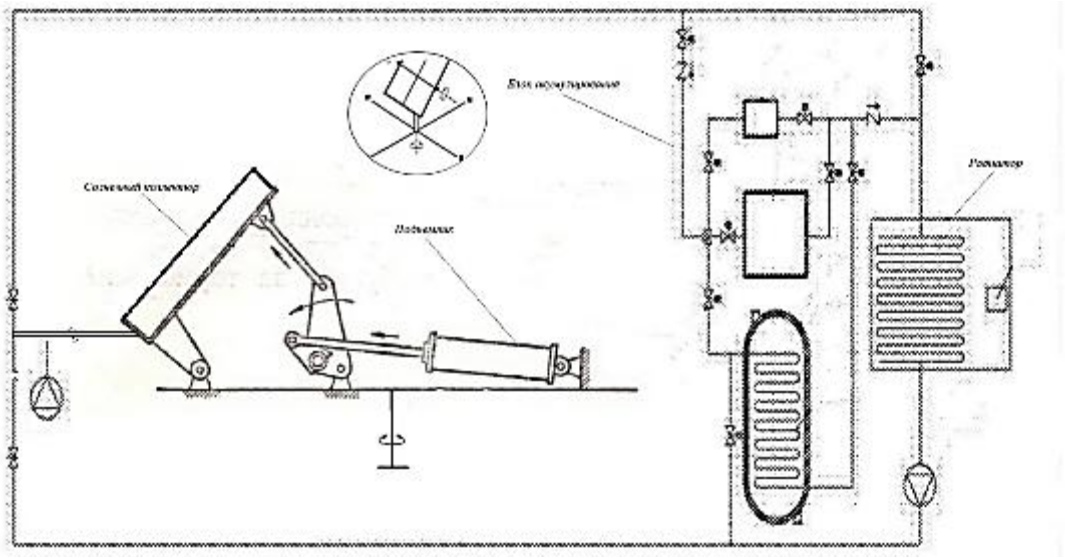

**Fig. 1. Scheme of the proposed device**

Where: k- is the coefficient of daily unevenness of the required hot water (taken from regulatory sources); m- is the number of hot water points received; g -is the standard of consumed water; $t_x -$ is the temperature of cold water; $t_r -$ is the calculated temperature of hot water; c - is the heat capacity of hot water. Since the main intensity of solar radiation under terrestrial conditions is in the spectral range of 0.4-1.8 μm, ordinary glass is used as a transparent top layer. The transmittance of glass in this sectorial range reaches 95%. In active systems, sunrays enter a solar receiver - a solar collector, where their energy is converted into heat with the calculated parameters [7, 8].

## Solution of the second scientific and technical problem

To absorb the maximum amount of solar energy, it is necessary to install the SC (panels) at a right angle to the direction of the sun's rays. The collector facing the sun heats the coolant or water, which is then sent to the consumer or goes into the storage system. The sun shines on the Earth's surface at different angles depending on the time of day and season of the year. Therefore, for the optimal installation of the SC (panels), it is

necessary to take into account the rotation of the Earth around the Sun and around its axis, the main angular parameters [9]. There are many schemes of solar water heating systems, arranged mainly on the same (close in content) operating principle. In the vast majority of them, the general installation angle of the SC (panels) is fixed for the entire period of operation and the usual heating process is relatively slow. But there are solar water heaters, the design of which allows you to change the position of the collector depending on the direct solar angle of each season, twice a year relative to the geographic latitude. Such a solar water heater was invented in 2017 in China [10]. The invention discloses a solar water heater with rapid heating of steam, consisting of a collector, a heat accumulation unit, a controller and a radiator, an adjustable bracket for adjusting the tilt angle of the solar water heater. The tilt angle of the solar collector is changed manually, spring-summer and autumn-winter period of the year, which should correspond to the geographical latitude of the area ±15 degrees. Taking this device as a basic one, a fundamentally new design has been developed that allows for automatic change of orientation and tilt angles of solar collectors (see Fig. 1).

A large amount of solar energy comes to the surface of the earth every day, which can be converted into hot water or steam. In order for the performance of the solar system to be high, the solar collector is installed in such a way that it follows the Sun and constantly maintains a position perpendicular to the incident rays. The device of such a solar collector with a sun tracking system has a number of advantages over the known ones.

The lifting-lowering mechanism (panel) is (see Fig. 2). a hydraulic cylinder 1, the body of which is hingedly connected to the frame of the SC (panel), and the piston rod is connected by a lever mechanism 5 to the body of the SC (panel). The cylinder is connected by pipelines to a gear oil pump 3, driven by an electric motor receiving a signal from a sensor monitoring the location of the Sun. Depending on which cavity of the cylinder the oil is pumped into, the SC (panel) rises, stays in a certain position or falls.

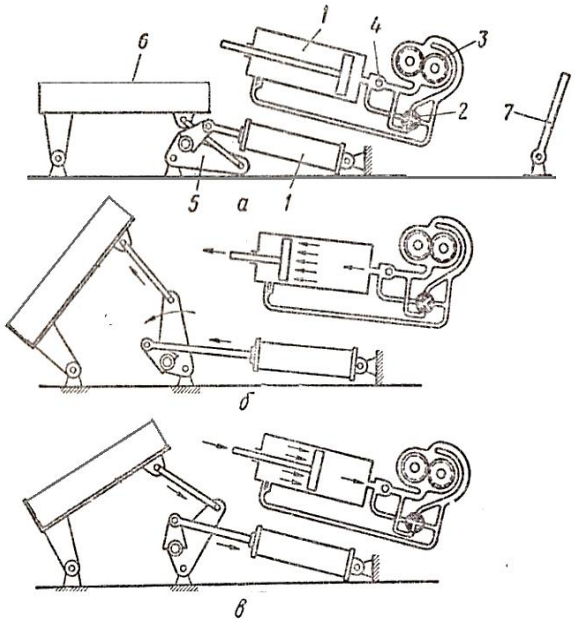


**Fig.2. Schematic diagram of the device and operation of the lifting mechanism of the solar collector a-horizontal position; b-lifting; c-lowering.**

1-hydraulic cylinder; 2-control valve from the sensor; 3-oil pump; 4-valve; 5-lever mechanism; 6-solar collector; 7-sensor and tracking system for the Sun.

Controls the lifting-lowering mechanism of the SC (panel) by a signal from the sensor monitoring the location of the Sun 7 [11], turning on or off the electric motor and turning the valve 2. Along with the process of lifting and lowering the collector, it turns the water heater (collector) together with the lifting mechanism (see Fig. 1.) by the signal from the sensor. Thus, the device, turning the SC (panels) towards the direction of the sun's rays, ensures its lifting, delay and lowering. It is also taken into account that the Sun gradually moves, and its height above the horizon changes depending on the season.

This proposed device, given in this article, is

intended to illustrate it and it should be considered that it is not limited to the above embodiment and can be implemented in various modifications of solar water heaters of the corresponding nature. In this case, the basic solar systems are subject to significant changes to obtain effective modifications of solar collectors (panels).

## Conclusion

1. Climate change is associated with the emission of toxic gases and other waste into the atmosphere by industrial enterprises and other areas of production using traditional fuel. The most important measure aimed at protecting the atmosphere is the widespread use of alternative fuel sources.

2. The existing technical documentation of solar water heating systems for their design and operation does not sufficiently take into account the influence of natural and climatic factors on their operation. The proposed recommendation for improving the theory and development of solar systems is the most suitable for operation in various conditions, taking into account the climatic characteristics of the operating locations.

3. To increase the productivity of solar systems, the orientation and angle of inclination of the solar collector are extremely important. Therefore, the design we have developed allows the solar collector to follow the Sun and constantly maintain a position perpendicular to the incident rays.

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# Globalization and mountain tourism: the impact of international tourist flows on the economy

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**Abstract**

Globalization has significantly changed the tourism industry, including mountain tourism, which has a significant impact on the economies of countries with mountainous regions. This process is characterized by the cross-border movement of people, capital and cultural assets, which leads to an increase in tourist flows to mountainous areas and stimulates economic development at the local and national levels. International tourist flows contribute to the growth of tourism revenues, job creation and the development of local infrastructure, including hotels, restaurants, transport and entertainment services. In particular, mountainous regions are becoming attractive for tourists interested in ecological and active recreation, which expands the market of tourist services. At the same time, mountain tourism faces challenges related to environmental sustainability. An increase in the number of tourists can lead to the destruction of natural landscapes, environmental pollution and loss of biodiversity. Without proper regulation and implementation of the principles of sustainable tourism, these factors can cause long-term damage to mountainous regions. From an economic point of view, globalization opens up opportunities to attract international investment in tourism infrastructure and create global partnerships. However, it also creates the risk of cultural commercialization and the dependence of local economies on external factors such as global crises or changes in tourist preferences. Thus, globalization and international tourist flows play a key role in the development of mountain tourism, while simultaneously providing opportunities for economic growth and creating challenges for sustainable development.

## Introduction

Globalization is a process that actively affects the economy, culture and social life of many countries, affecting various industries, including tourism. One of the fastest growing sectors in this context is mountain tourism. The mountainous regions, with their unique natural landscapes, cultural heritage and opportunities for outdoor activities, attract more and more international tourists. This process is accompanied by significant economic changes at the local and national levels, which is associated with an increase in tourist flows, infrastructure development and an increase in tourism revenues. The impact of international tourism on the economy of mountain regions is expressed through several key aspects. Firstly, the increase in the number of tourists contributes to the creation of new jobs and stimulates the development of related industries such as hospitality, catering and transport. Secondly, tourism revenues become an important source of finance for local communities and contribute to improving the quality of life of the population. However, along with the positive economic effects, globalization and the growth of tourist flows bring with them a number of challenges. Environmental problems such as the destruction of natural landscapes and environmental pollution are becoming an acute problem in mountainous regions. In addition, dependence on international tourism can lead to instability of the local economy in the event of a change in global trends.

## Results and Discussion

Globalization has a significant impact on mountain tourism and the economy of the regions where it is developing.

### Key aspects:

1. Economic growth: International tourist flows contribute to economic growth by creating jobs and stimulating infrastructure development.

Tourism is increasingly recognized as an important source of income for local communities around the world. As more and more people travel to new destinations, they open up opportunities for economic growth, especially in regions where traditional industries may be underdeveloped or in decline.

### Employment opportunities

Tourism directly creates jobs in various sectors such as hospitality, transportation and entertainment. Local hotels, restaurants, tour operators and cultural attractions rely on local workers, from guides and drivers to hotel staff and artisans. In remote or rural areas where employment opportunities may be limited, tourism is a sustainable way to provide jobs and income.

### Support for local businesses

Tourism increases the demand for goods and services produced by local enterprises. Visitors often buy locally produced products, crafts and souvenirs, which helps to increase the income of small producers. In addition, tourists spend money in local restaurants, markets and shops, which stimulates the growth of local businesses and encourages entrepreneurship.

### Infrastructure development

The influx of tourists usually leads to improvements in infrastructure, including improvements in the quality of roads, airports and communication networks. While these improvements are necessary to accommodate tourists, they also benefit local communities by improving transportation, access to services, and overall quality of life. In many cases, local governments and businesses work together to create a tourism-friendly infrastructure that serves both visitors and local residents.

### Preservation of cultural heritage

Tourism can serve as a mechanism for preserving and popularizing local culture and traditions. As tourists seek authentic cultural experiences, local communities have an incentive to preserve their customs, festivals and historical sites. This not only strengthens local pride, but also generates income through cultural tourism such as performances, tours of cultural heritage sites and seminars.

### Diversification of income sources

For communities that depend on agriculture, fishing, or other seasonal industries, tourism provides a valuable opportunity to diversify income sources. The demand for year-round types of tourism, such as ecotourism, adventure tourism and cultural tours, provides a more stable income stream, reducing the economic vulnerability of the local population.

### Environmental protection

The practice of sustainable tourism encourages the protection and conservation of natural resources, which are often key attractions for tourists. By generating income from ecotourism or environmental tourism, local communities receive an incentive to preserve their natural environment, rather than to exploit it irrationally. This not only preserves ecosystems, but also provides long-term economic benefits from tourism.

### Empowering the community

Tourism can empower local communities by involving them directly in tourism planning and management. Community-based tourism models allow local residents to take responsibility for tourism development, ensuring that the economic benefits remain within the community. This helps foster a sense of ownership and control over the tourism industry, ensuring a more equitable distribution of profits.

### Environmental challenges

An increase in the number of tourists can lead to environmental problems such as pollution and destruction of natural landscapes.

An increase in the number of tourists can lead to serious environmental problems, as popular tourist destinations try to balance the economic benefits of tourism with the need to protect natural ecosystems. These problems include environmental pollution, destruction of natural landscapes and depletion of natural resources, which can have long-term consequences for both the environment and communities dependent on tourism.

The development of tourist infrastructure — hotels, resorts, roads and recreation areas — often leads to the destruction of the natural habitat. Forests, wetlands and coastal areas can be cleared or modified to accommodate tourist sites, which damages ecosystems and reduces biodiversity. Overpopulation of protected areas such as national parks or beaches can lead to soil erosion, trampling of vegetation and disturbance of wildlife habitat. Popular attractions such as coral reefs or mountainous areas can be affected by over-tourism when huge numbers of visitors put pressure on a fragile environment. Activities such as diving, hiking and off-road riding can cause direct physical damage to natural areas, further threatening these landscapes.

### Depletion of natural resources

Tourism increases the demand for natural resources such as water, energy and food, which puts a strain on local resources. In regions with limited resources, the influx of tourists can lead to shortages for the local population, as hotels, resorts and recreation areas require large amounts of water and electricity. In coastal areas, there is often

excessive water abstraction to meet the needs of tourists, which leads to problems such as groundwater depletion and saltwater infiltration. In addition, the construction of golf courses, swimming pools and water parks requires significant water consumption, which can lead to the depletion of local resources and negatively affect agriculture and local communities.

### Climate change

Tourism contributes significantly to climate change due to carbon dioxide emissions produced by transport, especially air transport. Long-haul flights and the growing demand for tourist destinations around the world contribute to greenhouse gas emissions, exacerbating climate change. In addition, energy-intensive tourism infrastructure such as resorts and cruise ships increases the industry's carbon footprint. Climate change also threatens many popular tourist destinations such as coastal areas, islands and ski resorts, as rising sea levels, changing weather conditions and shrinking glaciers alter or destroy these natural conditions. This creates a feedback loop in which tourism damages the environment, and the resulting climate impacts, in turn, threaten the sustainability of tourism itself.

### Overpopulation and the burden on infrastructure

Excessive tourism can lead to the depletion of local infrastructure and environmental resources, which will lead to the degradation of both the natural and urban environment. Roads, water treatment plants, and waste disposal systems may struggle to cope with the needs of a large number of visitors. In places with limited infrastructure, such as rural areas or small islands, this stress can lead to environmental damage as natural resources are overexploited.

The impact of international tourist flows on the economy International tourism has become one of the most significant and fastest growing sectors of the global economy. It stimulates economic growth by generating income, creating employment opportunities and contributing to infrastructure development. The impact of international tourist flows is multifaceted and has an impact on the economy at various levels — local, regional and national. The impact of international tourism on the economy and the specific factors that form this relationship are discussed below.

1. Income generation - One of the most immediate and measurable results of international tourism is the income generated from travel expenses. For many countries, especially those with limited industrial or agricultural production, tourism can be the main source of foreign currency.

2. Job creation - International tourism plays a key role in job creation, especially in labor-intensive industries. Tourism stimulates demand for services, which leads to job creation in sectors such as hospitality (hotels, restaurants), transportation (airlines, taxis, buses) and entertainment (tours, excursions). This employment is not limited to large cities or tourist centers, but extends to rural and coastal areas, helping to reduce regional economic differences. According to the World Travel and Tourism Council (WTTC), the tourism sector accounts for 10.4% of global employment.

3. Infrastructure development - The influx of foreign tourists encourages governments and private enterprises to invest in infrastructure. The improvement of transport (airports, roads and railways), accommodation facilities and communication networks is often driven by the needs of the tourism industry. These changes benefit not only tourists, but also local residents, which leads to a long-term improvement in living standards. In countries with a well-developed tourism sector, rapid modernization of urban and rural infrastructure is often carried out, stimulated by tourism.

4. Foreign direct investment - Another important economic effect is tourism-related FDI. International hotel chains, restaurant franchises and transportation companies often invest in countries with growing tourism markets, attracting capital, experience and jobs. These investments also facilitate the transfer of technology and knowledge, helping local businesses improve their standards and quality of service.

5. Economic diversification - In some countries, tourism serves as a means of diversifying the economic base. For countries dependent on natural resources or countries with a weak industrial sector, international tourism can become an alternative source of income that helps reduce dependence on traditional industries such as oil, agriculture or manufacturing. Countries such as the United Arab Emirates have made significant strides in using tourism to reduce dependence on oil revenues by developing luxury tourism centers.

6. Seasonality and related problems - Despite the many advantages, international tourism also faces economic problems, especially those related to seasonality. In many tourist destinations, there are fluctuations in the number of visitors, and peak seasons bring the bulk of annual income. This can lead to underemployment or unemployment during off-peak months, as well as insufficient use of infrastructure. Managing the economic risks associated with seasonality requires the development of alternative forms of tourism, such

as ecotourism or business travel, which can generate more stable income throughout the year.

7. Cultural and environmental costs - Although international tourism can promote cultural exchange and mutual understanding, it can also lead to the transformation of local culture and the environment into a commodity. Tourist destinations often face problems related to excessive tourism, which can lead to the degradation of local ecosystems and cultural heritage sites. From an economic point of view, these problems can lead to long-term costs, as environmental degradation and excessive commercialization of culture can scare away future visitors, which will negatively affect the local economy.

8. Inflation and income inequality - Increased demand from foreign tourists can lead to higher prices for goods and services, which will lead to inflation in the local economy. Such price inflation can disproportionately affect local residents, especially in areas with high tourist traffic. In addition, the income generated from tourism can be unevenly distributed, which leads to income inequality. Large international companies often shoulder a significant portion of tourists' expenses, while local businesses may find it difficult to compete.

9. Stimulating trade and investment - Tourism often serves as a gateway for expanding trade and investment relations between countries. The attractiveness of a country as a tourist destination can improve its image and increase the interest of foreigners in its goods and services.Имеется положительные и отрицательные факторы влияния глобализации на горный туризм:

## The positive impact of globalization on mountain tourism

1. Expanding access to mountain regions - Globalization simplifies access to remote mountain regions through improved transport infrastructure and the development of international tourism. Air travel, the construction of new roads and the creation of tourist routes make it easier to travel to previously inaccessible areas. This expands the opportunities for visiting mountain places and contributes to an increase in the number of tourists.

2. Development of tourism infrastructure - The growing interest in mountain tourism leads to the development and modernization of tourism infrastructure. Global investments in the construction of hotels, ski resorts, tourist centers and outdoor recreation areas contribute to improving travel conditions. Innovative technologies and global service standards are being implemented in mountainous regions, which improves the quality of the tourist experience.

3. Cultural exchange and interaction - Globalization promotes cultural exchange when tourists from different parts of the world come to mountain regions and get acquainted with local culture and traditions. It also creates opportunities for locals to share their knowledge, traditions and crafts with visitors. Such an exchange contributes to the enrichment of the cultural experience of both sides and contributes to the development of cultural tourism.

4. Economic growth - Mountain tourism brings significant economic benefits. Global tourism flows contribute to job creation, local business growth and increased tourism revenues. Local businesses such as hotels, restaurants, travel agencies and craft shops receive additional income due to the flow of tourists.

## The negative impact of globalization on mountain tourism

1. Environmental problems - An increase in the number of tourists in mountainous areas can lead to environmental problems such as pollution, destruction of natural landscapes and loss of biodiversity. Building infrastructure for tourism, such as road networks and hotels, can disrupt ecosystems and lead to environmental degradation. Without proper monitoring and sustainable management, the consequences can be devastating.

2. Cultural commercialization - Globalization can lead to the commercialization of local culture and traditions. In the pursuit of tourist profits, traditional customs and art can be transformed into tourist attractions, which can lead to the loss of their authenticity. Local cultural practices can only become elements of a tourist product, which reduces their value to local residents.

3. Infrastructure overload - The rapid development of tourism infrastructure can lead to an overload of existing systems and resources. Hotels, roads and other facilities can experience significant pressure due to the large flow of tourists, which can lead to problems with water supply, waste disposal and traffic congestion.

4. Economic dependence - Dependence on tourism revenues can make local economies vulnerable to external factors such as economic crises, changes in tourism preferences, or global events (e.g. pandemics). This can lead to instability and economic difficulties for communities dependent on tourism.

In the context of globalization, tourism is one of the key factors of economic development, and Azerbaijan is no exception. Special attention is paid

to mountain tourism, which, thanks to its unique natural landscapes and cultural heritage, attracts a significant number of foreign tourists. The influence of tourist flows on the economy of Azerbaijan in the context of globalization is manifested in the creation of jobs, infrastructure development, growth of export revenues and the promotion of the country in the international arena.

### The growth of the number of tourists and the development of mountain tourism

The mountainous regions of Azerbaijan, such as the Caucasus Range and the vicinity of Gabala, are becoming increasingly attractive to foreign tourists. Regions such as Gusar and Guba offer a variety of routes for climbers and trekking enthusiasts. For example, Shahdag Mountain in the Gusar district, with a height of 4243 meters, is a popular climbing site To maintain and develop this area, the State Tourism Agency and the Azerbaijan Tourism Bureau are actively working to create and improve mountain hiking routes, which helps attract tourists and develop local infrastructure. Globalization makes it easier for people from different countries to find and choose new destinations for outdoor activities and eco-tourism. The introduction of simplified visa procedures and access to information through digital platforms facilitates the flow of tourists into the country. Foreign tourists visiting the mountainous regions of Azerbaijan are interested in hiking, mountaineering, ski resorts and getting to know the local culture. This influx of tourists stimulates demand for local goods and services, which in turn leads to the growth of small and medium-sized enterprises, especially in rural and remote areas.

### Economic benefits for local communities

Tourist flows to mountainous regions create new economic opportunities for local residents. The development of mountain tourism contributes to the creation of jobs in the field of hospitality, transport, catering and sightseeing support. For local communities, this means new sources of income and the opportunity to diversify the economy, especially in rural areas where traditional activities such as agriculture may be limited. Tourism also supports handicrafts and agro-industrial production, as tourists often purchase local souvenirs, folk art and food.

### Infrastructure development

With the growing interest in mountain tourism in Azerbaijan, there is a need to improve infrastructure. Investing in the construction of roads, hotels, restaurants, cable cars and tourist centers contributes not only to the development of tourism, but also to improving the lives of local residents. Improving the transport accessibility of mountain regions also opens up new business and trade opportunities. The development of infrastructure makes the mountainous regions of Azerbaijan more attractive to international investors, which contributes to additional capital and technology inflows.

### Environmental challenges and sustainable tourism

Despite the economic benefits, mountain tourism also brings environmental challenges. An increase in the number of tourists in vulnerable natural areas can lead to landscape degradation, environmental pollution and loss of biodiversity. It is important to develop sustainable tourism practices that minimize the impact on nature. Azerbaijan is already taking steps towards eco-tourism, including the creation of nature protection zones and the application of practices aimed at preserving natural resources.

### The impact of globalization on cultural exchange

Globalization contributes to the fact that tourists not only come to Azerbaijan, but also get acquainted with its culture, traditions and history. Local residents, in turn, get the opportunity to communicate with people from different countries and cultures, which contributes to the exchange of knowledge and mutual understanding. This cultural exchange helps to increase the attractiveness of Azerbaijan as a unique tourist destination, which in the long term contributes to the growth of tourist flows.

### Conclusion

Globalization and the growth of international tourist flows have a significant impact on the development of mountain tourism and the economies of countries with mountainous regions. On the one hand, the tourism industry provides huge opportunities for economic growth, infrastructure development and improving the well-being of the local population. Mountainous regions are becoming attractive destinations for international tourists, which leads to increased income, job creation and investment attraction. On the other hand, the intensive development of tourism carries environmental and social risks. An increase in the number of tourists can lead to the destruction of fragile natural ecosystems, environmental pollution and depletion of natural resources. Without the introduction of sustainable approaches to tourism management, these problems can negatively affect the economy of mountain

regions in the long term.

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# Digital technologies and artificial intelligence in environmental protection

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**Abstract**: This study explores the integration of Artificial Intelligence (AI) into environmental conservation efforts, aiming to assess AI's transformative potential in enhancing sustainability practices. Employing a systematic literature review and content analysis, the research scrutinizes peer-reviewed articles, reports, and case studies from 2014 to 2024, focusing on the application of AI in biodiversity preservation, climate change mitigation, and sustainable resource management. The methodology hinges on a comprehensive search strategy, adhering to strict inclusion and exclusion criteria to ensure the relevance and quality of the literature analyzed. Key findings reveal that AI significantly contributes to environmental conservation by optimizing resource management, improving predictive analytics for biodiversity conservation, and facilitating advanced monitoring and analysis to mitigate environmental impacts. However, the deployment of AI technologies also presents ethical and cybersecurity challenges, necessitating robust frameworks for responsible use. The study underscores the importance of interdisciplinary collaboration, stakeholder engagement, and the development of ethical AI solutions to address these challenges effectively. Finally, AI holds immense promise for advancing environmental sustainability efforts. Strategic recommendations include fostering partnerships across disciplines, prioritizing ethical considerations in AI development, and enhancing AI literacy among conservationists. Future research directions emphasize the need for innovative AI applications in conservation and addressing the socio-technical complexities of integrating AI into environmental strategies. This study contributes valuable insights into leveraging AI for a sustainable and resilient future, highlighting the critical balance between technological advancements and ethical considerations.

**Keywords:** Artificial Intelligence (AI), Environmental Conservation, Sustainability, Cyber Risks.

## Introduction:

One of the world's global problems is the protection of ecology and the environment. This problem has reached a crisis point on our planet. At the same time, the development of digital technologies and artificial intelligence allows a new approach to problem solving. In modern times, it is possible to protect the environment by applying innovative technologies. Today, digital technologies and artificial intelligence play an important role in ecology and environmental protection. It is possible to use them in various fields in order to solve the problem. Let's pay attention to some of those directions.

The Intersection of Artificial Intelligence and Environmental Conservation: An Overview The intersection of Artificial Intelligence (AI) and environmental conservation represents a burgeoning field of study, driven by the escalating urgency of climate change and biodiversity loss. This convergence aims to leverage AI's computational prowess to address and mitigate environmental challenges, fostering sustainable practices across various domains. The integration of AI into environmental conservation efforts is not merely a technological advancement but a necessary evolution to enhance the efficacy of sustainability initiatives.

Data analysis. Environmental monitoring is carried out through databases. Artificial intelligence can monitor and analyze environmental changes by analyzing this data. Prediction. Artificial intelligence can be used to predict environmental events. For example, by predicting weather conditions, measures can be taken to prevent harmful effects. Resource management. Digital technologies and artificial intelligence can ensure efficient use of water, energy and other natural resources. This helps to protect the environment and ensure sustainable development. Environmental monitoring. Drones, satellites, etc. it is possible to observe environmental problems through Artificial intelligence can analyze this data to identify contamination and other damage and suggest solutions.

**Ecological studies.** Artificial intelligence can help study natural ecosystems and monitor changes. Sustainable development. Digital technologies and

artificial intelligence provide effective tools to achieve sustainable development goals. These tools are very important for environmental protection and important for promoting sustainable development.

It is also possible to apply artificial intelligence technologies in the optimization of the transport sector, in waste management, and in the protection of biodiversity.

Digital technologies are being developed in the field of ecology in Azerbaijan. The Great Leader Heydar Aliyev once said: "I want you all to be nature protectors." Today, the application of digital solutions is considered an important factor in protecting the environment in our republic. At the same time, forest strips and green areas are being increased in our country, and tree planting campaigns are being carried out. Modernization of industry and transport sector reduces environmental pollution. Important projects are being implemented for the protection and efficient use of water resources. Legislative regulations on environmental protection are updated and strengthened. Azerbaijan has joined international agreements to combat climate change.

The first issue is that energy efficiency can be regulated with the help of technology and artificial intelligence. That is, artificial intelligence can optimize the use of energy in the field of transport production and other areas of industry. The more we save energy, the more we protect the environment.

The second issue is related to renewable energy, which directly relates to technologies. That is, by developing technologies and using artificial intelligence, we increase renewable energy sources. For example, artificial intelligence can predict which renewable energy sources can be used. Technology helps protect renewable energy sources. Of course, renewable energy sources such as the Sun and wind are currently being used. This is directly thanks to the technologies we have.

The third issue is about forecasting. Artificial intelligence allows us to simulate the planet's climate change in the coming years based on the data we have. Artificial intelligence will allow us to determine what changes in the climate will happen in 10-15 years, what awaits us, by including the database we have. That is, one of the main advantages of applying artificial intelligence is related to prediction. If we have normal forecasts, we will start taking steps on it sooner. Artificial intelligence solutions now allow us to create certain simulations by performing a wide range of predictions based on the data we have.

The fourth issue is the support given to us by satellite technologies. At present, satellite technologies help us to monitor climate changes and capture the processes taking place in the world. For example, through these technologies, we can monitor deforestation, we have the opportunity to see how the flora and fauna in nature change, we can make comparisons and analyzes according to years. Different countries send satellites just for this purpose. The functions of these satellites are to monitor nature and record the changes that occur there. China is an example here. China had a project that was related to this process. It could observe flora and fauna as well as the state of the oceans thanks to artificial intelligence.

The fifth issue is related to the reduction of carbon emissions. Here, the main task of artificial intelligence is to determine the most effective methods of reducing carbon emissions and monitoring strategies based on the available data. Of course, if we talk about preventing climate change and protecting nature, the number one issue is reducing carbon emissions. This is where artificial intelligence can offer us solutions. For example, what we change will reduce carbon emissions in nature, what recycling technologies

should be used, etc.

The sixth issue is the production of hydrogen and electric cars with the development of technology. In order to prevent natural climate changes and release less harmful substances into nature, very serious changes are taking place in the automobile industry. Everything is leading us towards electric cars, hydrogen powered cars. At present, it is clear that even electricity does not exactly harm nature, it also harms nature in the purchase of electricity in a certain sense. Therefore, the big car brands, which are the future of technology, see hydrogen engines as harmless. They are engines that are currently less harmful to nature, no matter how difficult and expensive the manufacturing process is. It is no coincidence that a number of countries have announced that they will abandon cars with other engines after certain years. This means that we are trying to protect nature with the help of technology. We see that thanks to digital technologies and artificial intelligence, there are better opportunities for ecology and environmental protection.

Generative artificial intelligence significantly changes the way people work and perform tasks. But giant computer systems powered by artificial intelligence consume huge amounts of water and emit tons of carbon dioxide. Although large companies are implementing various projects dedicated to improving the environment, the effects of artificial intelligence are still expected to increase.

As the use of technology increases, environmentalists say, more significant impacts will occur.

The information and communication technology industry uses up to 10% of the world's electricity and emits 2-5% of global carbon emissions worldwide. According to research, this amount is expected to increase to 14% of global emissions by 2040.

Researchers at the University of Massachusetts have calculated that the amount of energy used to develop large artificial intelligence models is equivalent to about 626,000 pounds of carbon dioxide.

Artificial intelligence is being hailed as a solution to climate change, with the UN's 2023 Intergovernmental Panel on Climate Change claiming the technology will "enhance energy efficiency" and "promote the adoption" of renewable energy. But people do not fully understand the damage that current technology is causing to the environment.

ChatGPT, one of the technology's biggest innovations, said its carbon footprint would be limited to the power consumption of the computers and servers used to run it and process requests.On the other hand, some big tech companies have launched green initiatives to combat their environmental impact. For example, Google's goal to fill 120% of the water it consumes and Microsoft's goal to be carbon neutral by 2030, etc. But even these projects are not perfect enough to fight climate and environmental problems.

As the global community grapples with the growing threat of climate change, the integration of Artificial Intelligence (AI) is emerging as a key strategy to reduce environmental degradation and increase sustainability. Against this backdrop, Azerbaijan's hosting of the upcoming COP29 represents an important opportunity to highlight the transformative potential of artificial intelligence in climate action.

.Artificial Intelligence for Climate Monitoring and Forecasting: AI-powered climate monitoring systems use advanced algorithms to analyze vast data sets from satellites, sensors and environmental sensors, providing real-time understanding of weather patterns, natural disasters and ecosystem changes. By enhancing our understanding of climate dynamics, AI enables more accurate prediction of extreme weather events such as floods, droughts and wildfires, proactive risk management and disaster preparedness. As Azerbaijan prepares to host COP29, using artificial intelligence for climate monitoring can strengthen the country's resilience to environmental hazards and inform evidence-based policymaking for climate adaptation and mitigation.

AI-driven climate modeling and simulation: AI algorithms play an important role in climate modeling and simulation, allowing scientists to simulate complex climate scenarios, assess the impacts of greenhouse gas emissions, and assess the effectiveness of climate mitigation strategies. By using artificial intelligence for high-resolution modeling, Azerbaijan can gain valuable insights into regional climate trends, vulnerabilities and adaptation pathways. In addition, AI-based climate models facilitate scenario analysis and decision-making, empowering policymakers to identify cost-effective interventions and prioritize climate resilience investments.

Artificial Intelligence for Sustainable Energy Solutions: Artificial intelligence technologies hold great promise for optimizing energy efficiency, accelerating the transition to renewable energy sources, and reducing greenhouse gas emissions. In Azerbaijan, where energy security and sustainability are paramount, AI-based solutions can strengthen the integration of renewable energy into the national grid, optimize energy consumption in industries, and promote energy-saving practices

in buildings and transportation. By using artificial intelligence for sustainable energy solutions, Azerbaijan can achieve its climate goals, reduce dependence on fossil fuels and contribute to global efforts to combat climate change.

AI-enabled Climate Resilience and Adaptation: AI innovations such as predictive analytics, risk mapping and early warning systems enable communities to build climate resilience and adapt to changing environmental conditions. In Azerbaijan, where climate change poses significant challenges for agriculture, water resources and infrastructure, AI-driven solutions can strengthen adaptive capacity and improve disaster response mechanisms. Azerbaijan can protect livelihoods, ecosystems and support sustainable development in the face of climate uncertainty by integrating IS into climate resilience planning and implementation.

Technology plays a pivotal role in addressing environmental challenges and achieving sustainable solutions. In this article, we will explore the various ways in which technology is advancing environmental protection efforts and contributing to a greener and more sustainable future.

1. Monitoring and Data Collection

Technology has revolutionized our ability to monitor and collect data on environmental conditions. Advanced sensors, satellites, and drones enable scientists and researchers to gather real-time information on air quality, water quality, deforestation, and more. This data is invaluable for making informed decisions and taking timely actions to mitigate environmental threats.

2. Renewable Energy

The development and deployment of renewable energy technologies have been instrumental in reducing our reliance on fossil fuels. Solar panels, wind turbines, and hydropower systems harness clean and sustainable energy sources, significantly reducing greenhouse gas emissions and air pollution. The shift towards renewable energy is not only crucial for reducing our carbon footprint but also for ensuring a reliable and sustainable energy supply for the future.

3. Energy Efficiency

Smart technologies and energy-efficient appliances help individuals and businesses reduce their energy consumption. These technologies optimize heating, cooling, and lighting systems, leading to lower energy bills and reduced environmental impact. For instance, smart thermostats can learn user preferences and adjust heating and cooling systems accordingly, thereby reducing energy wastage.

4. Waste Management

Technology has improved waste management practices in numerous ways. Waste-to-energy facilities can convert trash into electricity, reducing landfill usage and methane emissions, a potent greenhouse gas. Additionally, recycling facilities benefit from automated sorting systems that enhance the efficiency of recycling processes. Moreover, advances in waste reduction technology have led to the development of compostable and biodegradable materials, further reducing the environmental impact of waste.

5. Environmental Modeling and Predictive Analytics

Complex environmental models and simulations enable scientists to predict the consequences of various scenarios and policies. This helps policymakers and businesses make informed decisions about land use, resource management, and climate change mitigation. With the aid of powerful computing technology, researchers can simulate the impacts of climate change on ecosystems, forecast weather patterns more accurately, and assess the long-term effects of various interventions.

6. Conservation and Wildlife Protection

Technology aids in conservation efforts by tracking and monitoring wildlife populations. GPS collars and camera traps help researchers gather valuable data about animal behavior and habitat use. Additionally, drones are used to monitor and protect endangered species and their habitats. These technologies enable conservationists to better understand and protect wildlife, contributing to the preservation of biodiversity.

7. Sustainable Agriculture

Precision agriculture technologies, such as GPS-guided tractors and data analytics, allow farmers to optimize their crop yields while minimizing the use of pesticides and fertilizers. This approach promotes sustainable farming practices that are less harmful to the environment. By precisely targeting inputs like water and fertilizers, farmers can reduce waste and environmental impacts while improving the efficiency of food production.

8. Environmental Education and Awareness

Technology has expanded the reach of environmental education and awareness campaigns. Social media, online courses, and virtual reality experiences engage a broader audience in environmental issues and promote eco-conscious behaviors. These platforms provide accessible and interactive ways to learn about environmental challenges and solutions, fostering a more informed and environmentally aware society.

Challenges and Considerations

While technology offers promising solutions, it also presents challenges and considerations for environmental protection:

E-Waste: The rapid pace of technological

advancement contributes to the growing problem of electronic waste (e-waste). Proper disposal and recycling of electronic devices are essential to mitigate this issue. Recycling programs and regulations are essential to address this concern effectively.

· Energy Consumption: The production and use of technology can have a significant carbon footprint. Manufacturers and consumers must prioritize energy-efficient designs and practices. This includes using sustainable materials in manufacturing and reducing energy consumption during device use.

Privacy and Data Security: Environmental monitoring technologies raise questions about data privacy and security. Balancing the benefits of data collection with individual rights is a critical concern. It’s essential to establish robust data protection regulations and ensure that sensitive environmental data is handled responsibly and securely.

A Global Population Is Facing Current Environmental Sustainability Issues.

At heart, sustainability is a problem of matching production to consumption. Consume more than the planet can produce over the lifetime of the species, and sooner or later you've got trouble.

In many ways, sooner is now. Either directly or indirectly, humanity:

Burns more fossil fuels than it can without cooking ourselves off the planet

Creates and throws out more plastic than ecosystems can absorb

Wastes enormous amounts of food while people starve

Mines and uses more rare earths than reserves can handle

Manufactures and pollutes sensitive ecosystems with more toxic chemicals than they can fend off

There's little sign these trends are slowing down or reversing. Even as the bill comes due for our excesses, the economy is throttled up on building more, encroaching farther, and consuming more than ever.

Hazardous substances in the environment are those that pose a threat to human health, plant, and animal life, or the environment. These substances include heavy metals, pesticides, herbicides, and persistent organic pollutants (POPs) that have been introduced into the environment through various means (Young et al., 2004). Sources of hazardous substances in soil include industrial activities, improper disposal of hazardous waste, agricultural practices, and natural processes such as erosion and weathering. These substances can persist in the environment for long periods and can have a negative impact on soil quality, plant growth, and human health (Bachmann, 2006; Baran et al., 2011; Bolan et al., 2021; Rani et al., 2021). The effects of hazardous substances in the environment can vary depending on the type and concentration of the substance, as well as the duration of exposure. Some hazardous substances can cause acute health effects, such as respiratory problems, skin irritation, poisoning, nausea, and vomiting, while others can lead to chronic health problems, including cancer, reproductive disorders, and developmental abnormalities.

Effective management of hazardous substances in the environment requires monitoring, remediation, and prevention strategies. Monitoring involves regular testing of soil for the presence of hazardous substances, which allows for early detection and appropriate management strategies to be implemented. Remediation involves the removal or treatment of contaminated sites. Prevention strategies include reducing the use of hazardous materials (i.e., source control) and implementing best practices for waste disposal and land use. Effective management is essential for ensuring the long-term health and sustainability of soil and its ecosystems

Real-time monitoring of hazardous materials in soil and plants is an important task that can help to ensure the safety of food crops, protect the environment, and prevent human exposure to harmful substances. The use of artificial intelligence (AI) powered sensors and devices can greatly enhance the accuracy and efficiency of this monitoring process. AI-powered sensors and devices can be used to detect and quantify the presence of various hazardous materials in soil and plants (Wilson, 2012; Yang et al., 2021). These sensors and devices can be designed to measure parameters such as pH, temperature, moisture, conductivity, and various chemical properties of the soil and plant tissue. Machine learning algorithms can be used to analyze the data collected by these sensors and devices, enabling the identification of specific hazardous materials in real-time (Wilson, 2012; Yang et al., 2021). These algorithms can also be used to predict the potential impact of these materials on human health and the environment. For example, E-nose (olfactory) algorithms are used to analyze data generated by sensors and identify the presence of hazardous chemicals based on their unique chemical signature (Jeong and Choi, 2022). These algorithms can use a variety of techniques, such as pattern recognition, artificial neural networks, and fuzzy logic. One of the key advantages of E-nose technologies is their ability to detect hazardous chemicals in real-time, allowing for immediate response to potential threats. E-nose technologies can be used for a variety of applications, such as monitoring air quality in urban

areas, detecting leaks from industrial processes, and detecting explosives and other hazardous materials

The use of AI-powered sensors and devices for real-time monitoring of hazardous materials in soil and plants has several benefits (Singh and Kaur, 2022). Firstly, it allows for more accurate and reliable detection of these materials compared to traditional laboratory-based methods. Secondly, it provides real-time data, allowing for quick responses to any potential contamination events. Finally, it reduces the need for manual data collection and analysis, reducing the workload and increasing the efficiency of the monitoring process (Jeong and Choi, 2022). The use of AI-powered sensors and devices for real-time monitoring of hazardous materials in soil and plants is a promising approach that can help to ensure the safety of food crops, protect the environment, and prevent human exposure to harmful substances. Various approaches can be used for AI-based toxicity prediction, including machine learning methods, deep learning methods, and hybrid approaches that combine both methods. Integrating various sources of data, such as chemical structures, toxicological and physiological data, and environmental factors, to improve the accuracy and reliability of toxicity predictions, is important

One of the recent advances is the combination of AI and Internet of Things (IoT) technologies, for particulate matter (PM) monitoring, which uses low-cost sensors that can be easily deployed in various environments (Bhagat et al., 2020). These sensors can collect data on PM levels and send it to a centralized platform for analysis. AI algorithms can then process these data to provide real-time information on PM levels and predict future trends. Heavy metals can also be monitored using AI. Numerous studies have been conducted over the last 10 years to forecast the effectiveness of heavy metal removal from soil using machine learning (Zafar et al., 2017; Zhu et al., 2019). AI models for the optimization and prediction of heavy metal removal include black box, fuzzy logic, kernel, evolutionary, and hybrid models.

With the rapid changes that the environment is experiencing, data sharing and reuse with the help on AI algorithms and instruments (Shen, 2018), plays an important role in supporting researchers to safeguard the continuous threatened environment and ensure the implementation of sustainable environmental management practices (Aggestam and Mangalagiu, 2020). Scientists can make use of online data sharing tools and platforms that comprise vast and intricate Earth and environmental science data like climatic and atmospheric data, pedology, hidrology, ecology, and biodiversity data (Crystal-Ornelas et al., 2022; Basel et al., 2023) for testing, analyzing, interpretation of theories, prediction models and experimental data (Kostal et al., 2022) that lead to better undestanding environmental issues

In this comprehensive review, we will examine the application of artificial intelligence (AI) in monitoring hazardous materials across different environments, namely, soil, air, and water. We will explore the latest breakthroughs and progress made in this field, which integrates machine learning algorithms with sensor technologies. We will also consider the benefits and drawbacks associated with AI-powered monitoring systems. This new field has revolutionized soil, air, and water monitoring, enhancing accuracy, efficiency, and timeliness in detecting and analyzing hazardous substances.

A literature search was conducted in Web of Science Core Collections with the following search terms (TS stands for Topic Searches): TS=("artificial intelligence" or "AI" or "machine learning" or "deep learning" or "Internet of Things" or "IoT" or "computer vision" or "robotics" or "natural language process" or "real-time monitoring" or "e-nose") AND TS=("hazardous substance" or "hazardous chemical" or "hazardous material" or "pollutant" or "contamination" or "toxin" or "heavy metal" or "pesticide" or "herbicide" or "persistent organic pollutants" or "POPs" or "microplastic") AND TS=("environment" or "soil" or "terrestrial" or "aquatic" or "aqueous" or "freshwater" or "lake" or "river" or "sediment" or "marine" or "ocean" or "air" or "atmosphere"). A total of 2828 results were retrieved. The results were visualized using the VOS (visualization of similarities) viewer software (version 1.6.19). Figure 1 presents the systematic literature search results covering the number of publications and the keyword co-occurrence map on the topic of the review (AI-Driven Technologies for Hazardous Substance Monitoring

AI solutions for hazardous substance monitoring in different environments

In recent years, there has been an increase in interest for using AI to anticipate and predict environmental pollution. We can split AI solutions into three steps or phases that include inputs (data), models (AI algorithms), and outputs (monitoring or decision support) (Figure 2). Data forms the basis of any AI solution. These models work best when they have a high number of data points, especially the ones that are coming from environments that are continually being monitored and expending solutions for probable actions. Data sources today can be a variety of sensors, ranging from imaging to non-imaging types or remote to in-contact sensors that provide large volumes of data. Then

there are the historic or legacy data. AI algorithms can analyse massive amounts of sensor readings, historical data, and other important information from monitoring systems. AI can detect hazardous material levels and contamination events by identifying patterns, trends, and anomalies in data using machine learning and data mining. Image analysis can detect hazardous material spills via satellite photos or drone images. Computer vision algorithms can recognise chemicals, vegetation changes, and pollution sources

Figure 2


**FIGURE 2**. AI solutions: making use of Data and AI algorithms for hazardous substance monitoring and containment.

AI algorithms can be trained on past data to predict hazardous material releases and environmental pollution. AI solutions for environmental monitoring, thus, would include early warning systems for hazardous material release, autonomous pollution monitoring systems as well as decision support systems. These models can help authorities and organisations prepare for and respond to emergencies. These models have proved useful for multiple environmental conditions, be it soil, air, or water. AI modellers, however, should offer sufficient details to explain and support the selection of model parameters, as well as their creation and assessment.

## Conclusion

As Azerbaijan prepares to host COP29 and assume a leadership role in global climate action, the integration of artificial intelligence is emerging as a strategic imperative to accelerate progress towards a sustainable and resilient future. By using artificial intelligence for climate monitoring, modeling, sustainable energy and resilience-building initiatives, Azerbaijan can open new opportunities for innovation, collaboration and transformative change. As stakeholders gather at COP29 to find collective solutions to the climate crisis, let's inspire positive change and harness the power of artificial intelligence to ensure a thriving planet for generations to come. The AI projects described help to maintain infrastructures, improve coordination and assess situations faster and with different data sources. They show that there is not one big artificial intelligence that can do everything. Rather, there are many different small applications that do not necessarily have to contain AI technology in order to work.None of the projects presented describe AI as the solution, but always as one part of a possible solution. It is not a question of hyping artificial intelligence as a technology that will “solve” the climate crisis. Rather, it is about developing useful applications where they are needed. It should be remembered that AI applications in themselves are not sustainable. However, they can be used for sustainable purposes if they are embedded in many other structures. Nevertheless, this must not negate the responsibility to phase out fossil fuels and stand up for social justice.

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# Agroecological Characteristics of Soils Distributed in the Territory of Karabagh Economic Region (Aghdam District)

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**Abstract**
In our Republic, fundamental reforms have been implemented in many areas of the national economy. Especially the development of the agricultural sector in the territories liberated from occupation is one of the main goals of today.
Carrying out of research work in the direction of soil survey in Aghdam region is of great interest. Aghdam region is a large agricultural region in our republic. The occupied part of the Lesser Caucasus with favorable valleys and foothill plains, with good humidity is one of the areas with wide opportunities for the development of agriculture and animal husbandry.
According to the laws and decisions adopted in the liberated territories of Aghdam region, it is of great importance to reorganize the agricultural area, to use the land efficiently, to arrange the soil structure in agriculture in a modern way.

**Keywords**: Mil-Karabakh; Agdam district; nitrogen; phosphorus; potassium; grass grey soils; cadaster, fertility.

## Introduction

Mil-Karabakh Plain of our republic has a rich soil wealth. Therefore, it is fundamentally different from other regions of our republic. The soil cover in this region was formed in the historical process.

One of the main factors that play a role in the cultivation of agricultural plants and obtaining high yields from them is the natural fertility of the soil.[1] In this respect, this region stands out. In the formation of natural fertility indicators of soils, the interaction of soil-forming factors occurring in the ecological environment is of great importance. This is also important for agro ecological evaluation [2] .As it is known, in the development of the soils spreading in the Mil-Karabagh plain, both in the meridian and latitudinal directions, soil-working rocks are used for physico-chemical, reclamation, etc. In terms of complexity and predominance of mosaic in the plasticity of the relief surface, they have clearly manifested themselves as negative features and signs as well as positive signs and characteristics in fertility. Revealing these signs and features, analyzing them, investigating the causes of their negative impact on the productivity of cultivated plants in the agro-ecological environment and their scientific justification are very important tasks for the development of agriculture [2]

The agrarian reforms carried out in the Republic in recent years are aimed at increasing the production of agricultural products and improving the material well-being of the population.

The socio-economic development of the modern era has brought current and important problems to the fore. One of the main factors of ensuring agriculture in the current period is the preservation of soil reserves. Strict control of land use, comprehensive implementation of measures to increase fertility preservation are required. [5]

From this point of view, it is one of the urgent issues to investigate the fertility characteristics of the soils spread over the Mil-Karabagh plain.

## Aim and methodology of the research

The research was carried out on grey-grass soils with irrigated agriculture within the borders of Mahrızlı village of Aghdam district. The climate of the region corresponds to temperate hot semi-desert and dry desert climate with dry summers.

Soil samples were taken from 0-20, 20-40, 40-60, 60-80, 80-100 cm layers using the envelope method in order to examine the pesticide properties of the experimental area and the total and

assimilated forms of nutrients were determined.

Total nitrogen (Keldal method), easily hydrolyzed nitrogen (I.B. Tyurin and M.M. Kononova method), water soluble ammonia (colorimetric method using Nesler reagent), absorbed ammonia (D.P. Konev method) were determined in the collected soil samples. Nitrate (by the method of Grandval Lyaju), total phosphorus (by the method of A.M. Mesheryakov), water-soluble phosphorus (by the method of Denije in modification of A. Malyugin and E. Khrenova), reactive phosphorus (method of B.P. Machkin). Total potassium (according to Smith), water-soluble potassium (by the method of V.G. Aleksandrov), exchangeable potassium (by the method of P.B. Protasov, looking at a flame photometer with 1% ammonium carbonate weight), the pH of the water suspension in a potentiometer was determined.

## Analysis and discussion

The rapid development of the economy and agriculture of Azerbaijan has brought to the forefront the efficient and intensive use of land resources. In a land-scarce country like Azerbaijan, various forms of land ownership and farming, efficient use of land resources, proper distribution of land among different sectors of the economy, specialization, use of intensive methods in agriculture. The use of land, which is an important component of nature and production relations, and at the same time its protection, restoration and increase of productivity require comprehensive measures (organizational-territorial, economic, social, legal, etc.) at the national level. In the implementation of these measures, measures related to the management of land resources act as a valuable and indispensable tool of the state. The management of land resources plays an important role in regulating land-ownership relations and establishing the principle of social justice in the land market as a whole.

The processes occurring in the environment and the living world, which are part of it, as a result of natural processes or under the influence of the human factor, have always sought their own scientific solution, such as land structure problems. soil science and ecology. Preserving the ecological balance in nature, protecting the environment, preventing pollution, solving the problems related to nature as a whole are among the main problems of today.

As we know, as a result of the 44-day war of our people against the Armenian invaders, the occupied Karabakh region of the Republic, including the Aghdam region, was liberated.

Agdam region is a large agricultural region. The occupied part of the Lesser Caucasus, with its favorable valleys and foothill plains and good humidity, created ample opportunities for the development of agriculture, crop and livestock breeding. Agriculture was dominated by grain growing, fodder production, viticulture, tobacco growing, potato growing, cotton growing, meat and dairy farming and especially sheep breeding.

As a result of Armenia's aggression, many agricultural enterprises operating in the region stopped their activities.

**Image 1. General view of the liberated city of Agdam.**

The mountainous part of Karabakh is in close economic relations with lowland Karabakh. The roads along the river valleys have closely connected these two regions economically. Contrary to all these historical and geographical facts, the occupation of Nagorno-Karabakh by Armenians and its forcible separation from Karabakh created serious problems for the population and economy of the region.

Environmental problems in the occupied territories - The movement of heavy military equipment, numerous shells, buried mines in the occupied mountainous areas caused serious damage to the soil cover and vegetation of these areas.

During the occupation, forests were ruthlessly cut down and used for furniture production. Realizing their temporary presence in these regions, Armenians ruthlessly exploited the natural resources and mineral deposits. Easy-to-use mineral waters, various technical materials, resources and more were adopted. The Armenians who left the region started fires in those areas. This fire caused serious ecological damage in those areas.

Since Nagorno-Karabakh, as an illegal entity, has no responsibility to international organisations for the protection of environmental conditions in the occupied territories, the ecological environment in these territories has become increasingly difficult.

In the occupied territories, hydraulic installations, pumping stations, irrigation systems, header devices of the irrigation system, inter-field irrigation canals, in-field systems were disabled, and quality irrigated lands were eroded.

As a result of land degradation in the arid Caucasus region, millions of people have been deprived of their main source of livelihood.

During the occupation, agricultural enterprises, including organised viticulture and winemaking, carts, cultivating and trailer tractors, hydraulic equipment, water pumps and irrigation units, irrigation canals between farms, farmland, plantations and young fruit-bearing grape fields were destroyed.

Heavy military equipment, a large number of shells, buried mines, moving in the occupied mountainous areas caused serious damage to the soil cover and vegetation of these areas. During the occupation, forests were ruthlessly cut down and used for furniture production.Roads and dirt roads, bridges, power lines, transformers, water pipelines, gas pipelines, sewerage lines, water reservoirs, gas distribution facilities, telephone exchanges, Baku-Agdam railway lines, etc. were destroyed throughout the region.

Dozens of industrial and construction facilities were completely destroyed in the occupied territory.In this context, within the framework of the Concept developed for the reconstruction of the economy of these regions and the Aghdam region, in addition to state investments, it is also planned to reconstruct the economic and social infrastructure in the regions liberated from occupation, attracting local and foreign investments and the implementation of work to ensure the employment of the population are among the priority issues.

The construction of social, economic and social infrastructure in the liberated territories, the construction of housing and houses in the liberated administrative district centers and villages, these are among the priority directions of the policy of restoration and provision of occupation-free territories. Ensuring the sustainable balanced development of the regions in our country and ensuring the settlement of the population with the aim of its implementation in a short time, the creation of production, service and trade areas in these areas, providing employment for the population, etc. is one of the topical problems of our time.

Today, the socio-economic development observed in our Republic has spread to every region, city, district and even to remote mountain villages.

The reason for this development is, of course, the special share and weight of successfully implemented state programmers.

As we know, the Mil-Karabakh cadastral region covers part of the Nagorno-Karabakh economic zone. It should be noted that the Nagorno-Karabakh economic region includes Agdam, Terter, Khojavend, Khojaly, Shusha, Jabrail, Fuzuli, Askeran districts and the city of Khankendi. The territories of Khojavend, Khojaly, Shusha, Jabrail districts of the economic region and the city of Khankendi, Aghdam (most of the territory of the region, including the administrative centre of the region, Aghdam city) remained under Armenian occupation for some time. For a long time, only 10 villages of the Aghdam region were under Azerbaijani control, state programmers were successfully implemented in the non-occupied areas, and the socio-economic development of the population in these areas, including the city of Khankendi, has noticeably increased. Aghjabadi, Aghdam, Aghdere, Berde, Fuzuli, Khojaly, Khojavend, Shusha and Tatar regions (8).

Its total area is 7330 km2, which corresponds to 8.94 per cent of the territory of Azerbaijan. Population 900,3 thousand.

Of this area, 271.8 thousand hectares are crops, 21.4 thousand hectares are perennial crops and 217.4 thousand hectares are pasture.

In total, 515,6 thousand hectares of land are suitable for agricultural needs. The cultivated land is 49,1 thousand hectares in Berde and 53,7 thousand hectares in Aghjabadi. The least arable land is in Tarter district. This area covers the plains and foothills of Karabakh and Mil plain. According to the degree of humidity, the region belongs to semi-arid (Md=0.10-0.15 throughout the year) region. The amount of precipitation is 250-450 mm. The region is sufficiently heated. Temperatures above 10°C are only 4700-3800°. The vegetation period is 226-211 days. Residual temperatures are 300-1900 degrees 0C. Semi-desert dry steppe landscape types dominate here.

Dark grey-brown, light grey-brown, grass-gray, grassy grey, light grey, primeval grey, flooded meadow-forest, meadow-fallow and marsh-meadow

soils are spread in the area. Grey-brown, cultivated grass-grey and grey soils are widely used in agriculture.[4,6]

Grassy-gray soils are common in the semi-desert region of the Mil plain where irrigated agriculture is practiced and they are formed mostly on alluvial and proluvial rocks where surface moisture is high. The upper layer of these soils is rich in organic matter. Humus content is 1,3-3,19 per cent. And there is a decrease in the length of the profile. The provision of total nitrogen and phosphorus varies according to humus.[6.7]

Irrigated cultivated grassy-grey soils are carbonate soils with high absorption capacity. Mechanical composition changed under the influence of irrigation.[3,8]

When we pay attention to the credit ratings of grey-grassy soils based on fertility indicators, we see that the main factors limiting the fertility of the soil are the amount of rainfall, climate aridity and the amount of carbonates, granulometric composition and the amount of dry residues in the soil.From this point of view, the credit rating of steppe lands was 77 points. .[8]

Let us take a look at the above-mentioned in the case of the grassy-gray land cultivated in Mahrızlı village of Aghdam region.


**Image 2. Map diagram of Mahrizli village of Aghdam district.**

According to the results of the analysis of the grassy-grey soils in the Aghdam region, the pH is 7,5 in the 0,20 cm layer and it becomes alkaline and reaches 8,2 in the 80-100 cm layer. Total nitrogen is 0.10% in a layer of 0.20 cm and 0.04% in a layer of 80-100 cm. Total phosphorus ranges from 0.12% to 0.06% and total potassium from 2.28% to 1.31%. Similarly, for the above-mentioned layers, water-soluble ammonia is 6.07-1.51 mg/kg, absorbed ammonia nitrogen 16.3-5.4 mg/kg, nitrates 7.71-3.12 mg/kg, water-soluble phosphorus 3.84-0.67 mg/kg, active phosphorus 17.5-5.2 mg/kg and exchangeable potassium fluctuates between 153.0-85.35 mg/kg.

**Table 1.** Agrochemical characterization of cultivated grass-grey soils irrigated in the field

| Depth cm | Nitrogen | | | | P2O5 | | | K2O | | pH |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total % | N/NH3 | | N/NO3 mg/kg | Total % | Soluble in alkali mg/kg | Water soluble mg/kg | Total % | Exchange mg/kg | |
| | | Soluble in water | absorbed | | | | | | | |
| 0-20 | 0.10 | 6.07 | 16.3 | 7.71 | 0.12 | 17.5 | 3.84 | 2.28 | 153.0 | 7.5 |
| 20-40 | 0.10 | 5.05 | 15.1 | 6.60 | 0.11 | 15.0 | 2.81 | 1.96 | 204.85 | 7.7 |
| 40-60 | 0.08 | 3.43 | 13.3 | 5.89 | 0.10 | 13.4 | 1.70 | 1.68 | 141.98 | 7.94 |
| 60-80 | 0.07 | 2.41 | 10.0 | 4.41 | 0.08 | 9.5 | 1.0 | 1.59 | 108.45 | 8.1 |
| 80-10 | 0.04 | 1.51 | 5.4 | 3.12 | 0.06 | 5.2 | 0.67 | 1.31 | 85.35 | 8.2 |

It should be noted that the high total amount of essential nutrients cannot indicate the degree of nutrition of these soils with nutrients assimilated by plants. These soils are poorly supplied with the forms of nitrogen, phosphorus and potassium available to plants.

The results of the research show that in order to utilise these lands with maximum efficiency, modern agricultural systems should be used and appropriate rules should be applied.

## Solution

Land use of unoccupied lands of Aghdam district was analyzed on the example of Mahrizli village. The agrochemical properties of the grassy-gray soils in the region were analyzed, and it was found that the soil was undernourished in terms of nitrogen, phosphorus and potassium elements in general and modified forms in the 0-100 cm layer. During the agrochemical studies, it was determined that the grassy-grey soil rating adopted for the republic is mostly nutrient deficient.

The results of the researches show that in order to make maximum efficient use of these lands, it is necessary to apply the relevant rules, to use modern agricultural systems where organic and mineral fertilizers are applied together, and to carry out modern land development projects. area should be prepared.

The current state of the liberated territories, ecological assessment, instructions for the organization of land construction works, protection of land and other resources were examined and analyzed.

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# Global Environmental Problems

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**Abstract**

The emergence of global, all-planetary environmental problems is a new problem that entered human life in the 20th century. Human being constantly in the opposite relationship with the environment - digs, demolishes, burns and destroys the resources of the planet, changes the structure of water and air, impoverishes by reducing the fertility of the soil, and this uncontrollable process is called the development of mankind. Until now, there has never been such a dangerous form of disturbance to the environment in providing natural resources to the rapidly growing population of the Earth. Never before has man had such a powerful impact on the environment. In contrast to anthropogenic environmental disasters, the current era of human impact on the biota (the totality of all living organisms of the biosphere) takes on a global character, not being limited to one or a few ecosystems, but covering the entire planet.

**Keywords:** environmentalist, atmosphere, ocean, tsunami, magnetuda, COP29, green life, "smart" projects

The impact of the scientific and technical revolution leads to a large-scale modification of the biosphere, leaving deep traces and causing ecological manifestations. Because of all these, ecological problems have become the most important global problems of the modern world and are of political importance. The modern era, which is full of large-scale events in the evolution of the earth, is characterized by interacting, intensively developing socio-historical and natural-historical factors. Never before have there been problems so dangerous to the whole of humanity itself. These problems include peace and disarmament, demographics, food problems, modern desertification, space problems, volcanic eruptions, earthquakes, tsunamis, storms, tornadoes, etc. including economic, social, national, and global ecological problems. This is a situation that people did not meet in previous millennia. Man played the role of creator and destroyer at the same time, his imagination showed its negative side. At the turn of two millennia, man had to face the problem of depletion of the biosphere (oil, gas, coal, iron, copper, mineral fertilizers, etc.) and modern creative systems that provide our life (soil, water, atmosphere, forest, biological diversity, etc.). The nature of these processes is predicted by scientists as a rapid process in history, and once this process begins, they show that it will stop the entire biosphere, reduce its unavoidable activity, and cause it to fall into a primitive state. In this case, the area of regions suitable for human habitation will decrease, their quality will deteriorate, and the demographic capacity of the Earth will decrease.

According to the unanimous opinion of ecologists, there is very little time left before such a catastrophic phase begins and changes. There are several hypotheses of global problems at the present time. Two of them are the main ones:

According to the pessimistic hypothesis, global food, resource and environmental problems may occur in the middle of the XXI century.

According to the optimistic hypothesis, in the conditions of peace and scientific and technical progress of the human society, excess population density and pollution of the environment, etc. cannot cause the destruction of people.

Global problems are truly global in nature and touch the lives of all people on Earth. Social sciences themselves are under the strong influence of universal, planetary processes. The ancient idea of unity in this case receives a new powerful impulse. Global problems, if they are not solved, are very frightening to humanity, and may even lead to the destruction of life and civilization.

Scientific and technical progress has created problems for humanity that are difficult to solve. The main place among them is the relationship between man and the environment. In the 20th century, the population increased by 4 times and the volume of production by 18 times, created serious problems in the nature of the Earth. Since anthropogenic impact on the environment covers all countries of the world, it has been called a global

environmental problem. The cause of global environmental problems, i.e. environmental pollution, is the return to nature of waste generated during production and consumption.

**Fig. 1. Environmental pollution**

Water basins are polluted as a result of industrial, agricultural and domestic water. Every year, up to 20% of the water volume of our planet is discharged into water bodies. In order to reduce the effect of pollutants in these waters, 10 times their volume of pure water should be mixed with them. Because this is not possible, the problem of drinking water on Earth is becoming more and more acute. As a result, the pollution of some rivers and lakes has reached the level of disaster. Sitarum (Indonesia), Yamuna (India), Ganges, Yansizı, Nile rivers have become the most polluted rivers in the world. The world's oceans are also rapidly becoming polluted. Middle, Northern, Azov, Kara, etc. seas, Mexico, Iran, Bay of Biscay are among the most polluted water basins of the World Ocean. In the central parts of the ocean, in its deep depressions, the amount of radioactive substances (waste from nuclear power plants, waste from nuclear weapons tests) is increasing. The share of oil and oil products in ocean pollution is greater. From 3 million to 10 million tons of oil are discharged into the ocean per year. During a tanker accident, thousands of tons of oil flow into the ocean in a short period of time. Currently, environmental problems have become acute in all regions of the world.

Scientists have identified 3 centers where the ecological situation is the worst:

1. Central regions of Europe.
2. Eastern, southern and southeastern parts of Asia.
3. The center of North America.

Only 5-10% of natural ecological systems are left in these areas. Medical geography, a branch of geography and healthcare, studies the influence of the natural environment on human health and the spread of diseases on Earth. The main goal of medical geography is to achieve the improvement of natural conditions, thereby improving the level of health of people. At present, cardiovascular diseases, malignant tumors, AIDS, bird flu, swine flu and a number of diseases have spread around the world due to environmental problems.

3 main ways of solving environmental problems have been identified.

- The first way is the production of various treatment facilities, transition to alternative energy sources, waste processing and disposal, land reclamation, etc. consists of measures.
- The second way involves the transition to low-waste and zero-waste technologies. Although this solution requires a large amount of funds, it is considered the most efficient.
- The third way involves a more optimal placement of dirty farms. Such fields include chemistry and petrochemical, metallurgy, pulp and paper industry, heat energy, production of building materials.

Environmental policy is implemented in order to solve environmental problems in the countries of the world. Various international organizations have been established for the protection of nature; they include UNEP (within the UN), "Greenpeace" (an independent organization), etc. includes Ecological monitoring and expertise are carried out to determine the ecological condition of the territories. States determine appropriate norms for the protection of nature, check the degree of change in the state of the environment. The comprehensive study of the compliance of the results of these inspections with existing norms is called environmental audit. The fact that ecological systems are in a state of equilibrium within a certain area is called an ecological norm.

The reasons for the exacerbation of the global ecological problem are as follows:

- Failure to destroy household waste on time;
- Release of toxic gases into the atmosphere;
- Inadequate treatment of sewage and sewage;
- Industrial enterprises and radiological stations;
- Shipwrecks in the ocean and seas;
- Forest fires, storms and floods, flora and

fauna diseases;

- Intensification of erosion processes, acceleration of desertification;
- Wars, testing of weapons of mass destruction;
- Global warming;
- Poaching;

In my opinion, the global ecological problem that we should pay attention to is the global ecologıcal problems of the world's ocean. Our main focus here is on the disasters caused by tsunamis and measures to protect against them.People have experienced many natural cataclysms in their lives. One of them - the most dangerous, widespread, resulting in numerous human casualties and causing numerous material losses - are tsunami waves.

Tsunami. Tsunami (Greek word, translated as "big wave") - these are long waves caused by turbulence of water in the ocean and other water bodies. Most tsunamis are caused by strong underwater earthquakes. More than 80% of tsunamis occur on both coasts of the Pacific Ocean, as well as in the Indian Ocean. In the open ocean, tsunami waves propagate with a speed g · H, where g is the acceleration of free fall and H is the depth of the ocean (when the length of the wave is much longer than its depth, less water approaches the shore). If the average depth of the ocean is 4000 m, the speed of the waves is 200 m/s or 720 km/h. In the open sea, the height of the waves in most cases does not exceed a meter, and the length of the wave (the distance between the waves) reaches 500-1000 km, and therefore it is not dangerous for shipping. When the waves are shallow, approaching the coast, close to the coastline, their speed decreases and their height increases. When reaching the coast, the height of tsunamis can reach several tens of meters. Higher waves, i.e. 30-40 m high, occur on hard coasts, bays and anywhere that can be seen. . Closed bays in coastal regions are considered less dangerous places (Figure 2 , 3.).

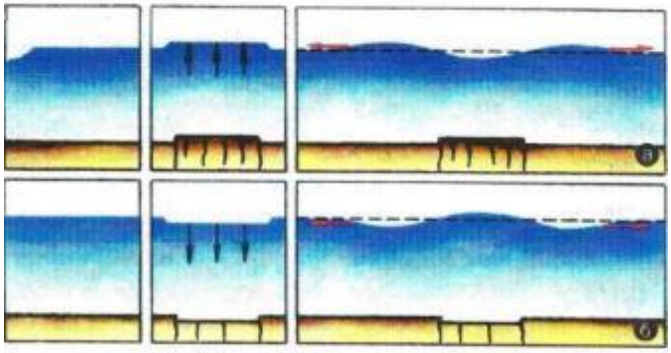

**Fig. 2. The formation of tsunamis is shown schematically in two cases: a) the bottom of the ocean rises up, b) the bottom of the ocean changes its position down.**

In the first case, the tsunami propagates forward with the entrainment wave. In the second case, a short-term withdrawal of the sea from the coast is observed. This happens just before the peak of the tsunami waves approaches the coast.


**Fig. 3. An initial state of the sequential propagation of the Chilean tsunami of May 22, 1962, obtained with the help of ENM, is given.**

Apparently, after 14 hours, the waves reached Hawaii and New Zealand, after 19 hours, they reached the shores of Australia, and after 22 hours, they reached the shores of Japan.


Fig. 4. The profile of the last-stage change of tsunami waves is shown in general.

Here 0 is the level of the calm sea, 1-7 is the successive profile of the waves crashing on the shore and throwing a huge mass of water there.

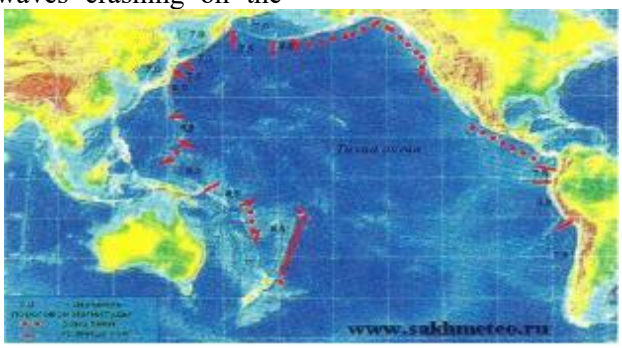


**Fig. 5. An alarm will be announced on the coast of Russia's Pacific Ocean about tsunamis above the permissible limits - map-scheme**

Fig. 6.. Consequences of the Tsunami on the island of Sumatra (Indonesia). 26.12. 2004 (E. Khalilov)

**Fig. 7. The arrival of tsunami waves**

If we talk about environmental problems in our country, Azerbaijan, we can mention the following:

We know that oil and oil products are considered indispensable in people's social life, and today the number of products made from oil is quite large. People use petroleum products in many areas in their daily life. From our household to transportation, we are witnessing the use of petroleum products almost everywhere. In modern times, the use of oil and oil products and fuel is inevitable in order to benefit from technical means and transportation. During the use of these products,

the generation of waste is inevitable. However, human society should try to minimize those wastes, and even achieve it. Otherwise, the human society itself will pollute the environment, it will not be possible to achieve the protection and restoration of nature, fauna and flora, and this will lead to a violation of the ecological balance. Violation of the ecological style means the formation of global problems and more dire consequences. So, first of all, protection of the ecological balance should be taken into account, and for this, the most important point, the most important condition is not to approach the mentioned issues that can lead to serious and terrible consequences.

Azerbaijan is an oil-producing and exporting country, and if efficiency is not taken into account during oil production, it can lead to an increase in the amount of waste, pollution of the environment, and disruption of the ecological balance. Of course, all this is taken into account, and the main goal of the environmental policy implemented in Azerbaijan is to ensure the prevention of ecological balance. Our goal is to achieve the preservation of ecosystems and biodiversity that can support life, and the prevention of serious environmental problems that may arise. That is why the emerging environmental problems were analyzed, national and state programs aimed at their comprehensive solution and based on the principles of sustainable development were approved, and measures were taken to implement them over the years. Expansion of the territory of nature reserves and sanctuaries, creation of national parks are among the measures taken in our country, and all of these are, without a doubt, evaluated as steps taken in the direction of strengthening the protection of the environment.

After the re-establishment of our independence, the ecological policy in the field of environmental protection in Azerbaijan has entered a new stage and is being carried out more perfectly. The "Ecological Concept of the Republic of Azerbaijan" based on the principles of "Sustainable Development" is considered the first document on the environmental policy carried out in our republic. The main principles for solving the problems that are of utmost importance for the country in terms of environmental protection are reflected in that Concept.

As it can be seen, environmental protection is one of the priorities of the state policy in Azerbaijan, and this issue is the focus of special attention of the head of the country, Mr. President Ilham Aliyev.

The Ministry of Ecology and Natural Resources implements various measures to protect ecology and the environment. In addition to the protection of ecology, environment, nature, there is also a special attention to restoration. In our country, practical measures are being taken in the direction of planting green spaces and increasing their areas. In addition to administrative measures to prevent the destruction of greenery, public condemnation also plays an important role. In general, educational measures in the direction of protecting nature, environment, and ecology are particularly effective. People understand that they have to protect, protect, and prevent anything that can cause environmental problems. They understand that otherwise, the whole human society will have to face its negative effects and they will have to face very serious consequences as a result of the disturbance of the ecological balance at the global level.

2024 has been declared the "Year of Solidarity for the Green World" in Azerbaijan. On December 25, the President of the Republic of Azerbaijan, Ilham Aliyev, signed the Decree on declaring 2024 as the "Year of Solidarity for the Green World" in our country. The decree states that the Republic of Azerbaijan, as a reliable and responsible member of the international community, has contributed to the fight against the consequences of climate change. It is reported that one of the five national priorities for socio-economic development of Azerbaijan until 2030 is defined as "Country of clean environment and green growth". In accordance with that priority, work is being done to improve the environment, restore and increase greenery, and ensure efficient use of water resources and sustainable energy sources.

Compared to the base year (1990), Azerbaijan has set a goal of reducing greenhouse gas emissions by 35 percent by 2030, and by 40 percent by 2050. Freed from occupation, Karabakh and East Zangezur, as well as the Nakhchivan Autonomous Republic, have been declared green energy zones. Environmental protection is a priority in the large-scale restoration and reconstruction process in liberated areas. In those areas, innovative approaches such as "smart city" and "smart village" are applied, and the ecosystem is restored. Creation of green energy types and transportation of green energy to world markets is the priority of Azerbaijan's energy policy. Azerbaijan aims to increase the share of renewable energy sources in the installed capacity of electricity production to 30 percent by 2030. We can mention them for the upcoming COP29. COP 29, within the framework of international cooperation and discussion of strategies for solving global problems, it is possible to develop a number of solutions for improving the environmental situation in the world. One of the main directions of action can be the transition to sustainable use of natural resources. This includes the ratification and observance of international

environmental agreements, the development of alternative energy sources, the improvement of energy efficiency and the reduction of the emission of harmful substances into the atmosphere.

Another important solution can be the strengthening of international cooperation and exchange of experience in the field of nature protection. Within the framework of COP 29, it is possible to create a platform for the exchange of advanced technologies and methods for the regulation of environmental processes between countries, as well as to develop joint projects for solving specific problems at the global level. In addition, it is important to pay attention to educating and informing the population about environmental problems.

Educating and informing the population about environmental problems plays a key role in solving global environmental problems. Increasing the environmental awareness of society helps to form an understanding of the importance of protecting nature, paying attention to environmental problems, and adopting responsible behavior in relation to the environment.

## Conclusion

Environmental protection problems are currently being solved mainly at 3 main levels: country, regional and global level.

The global level is more important due to its mundane nature, the wealth of natural resources (atmosphere, world ocean), because these resources are universal resources. 12 environmental protection problems, especially at the global level, require the joint effort of all the countries of the world. The main way of its successful solution is that the production and non-production activities of people should be organized in the next decades in such a way that the interaction between society and nature is optimal. The fact that the countries of the world, regardless of their social structure, are exposed to the modern environmental crisis shows that now all countries should unite without national and class discrimination and make a joint effort to protect the environment. Nature conservation problems are multifaceted and have general planetary, universal and at the same time local importance.

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# Ecological assessment of the use of pesdicides used in palm, olive and elm plants in Azerbaijan

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**Summary**

Agricultural products are considered indispensable raw materials for the steadily growing world population. The production of agricultural products in high quality and in the required quantity is considered one of the global problems at the present time. For this reason, farmers and many entrepreneurs take a number of measures to combat the normal development of agricultural products during their cultivation. One of such measures of struggle is based on the use of chemical preparations, namely pesticides. In the last century, pesticides used by farmers in agriculture came to the fore after a while with their negative impact on the environment. In the course of research, the fact that pesticides become a source of danger to the environment and living organisms has been proven on the basis of facts. The main purpose of the article is to investigate the negative effects of pesticide use on the environment, which is considered a global environmental problem in the world. In addition, the article includes the results of methods of combating plant pests and diseases based on research by minimizing the use of pesticides in the fight against them.

**Keywords**: pesticides; biopesticides; imidacloprid; chlorpyrifos; insecticides

## Introduction

In the last century, pesticides used have been applied against pests in agriculture, in addition to diseases that cause epidemics around the world. However, by the end of the century, claims that overused chemical preparations were dangerous to the environment began to be investigated. After that, the introduction of restrictions on the use of some types of pesticides was not a solution to the problem. Because on the other side, it was becoming more difficult to fight pests and diseases in agriculture. For this reason, countries around the world have begun to explore effective solutions that carry a minimum risk of danger to the environment and living organisms. After some time, the IPM strategy was developed. Although these strategies were successful, they could not be effective in solitude. Finally, new pesticides were created for environmentally friendly struggle.

This group of pesticides called biopesticides without posing any threat to the environment, harmful organisms, pathogenic diseases also showed effective results in the fight against weeds [1,2].

Currently, the use of pesticides in agriculture is increasing. However, pesticides that are not used properly are considered one of the sources of danger to the environment. Knowing the rules for using pesticides and then using them in proper form is considered an urgent problem today. Therefore, checking the awareness levels of farmers and taking the necessary measures should be one of the important conditions for each country. The use of pesticides to protect agricultural crops from pests and increase yields was inevitable. Pesticides used to protect plants from harmful Hashar and a number of diseases have a certain degree of negative effects on the environment.

As we know, pesticides are chemicals. Most of them have the ability to evaporate. The movement of pesticides in the atmosphere through the air flow away from the place of use to another is called dirft. In this case, during their use, along with the target organisms, certain effects on the environment are shown. Thus, due to its ability to evaporate, pesticide particles spread over kilometers of long distances and settle on living organisms in that area or on soil, water. Based on the studies carried out, we can note that organic chlorine pesticides, polychlorinated biphenyls, polybrominated diphenyl ethers, polycyclic aromatic hydrocarbons, dioxins and furans, which are among a number of resistant compounds, are the most exposed to long-distance atmospheric transport [3].

Methods of using pesticides also play a role in atmospheric pollution. Thus, the spraying of

pesticides by airplanes mainly leads to pollution of the atmosphere. Up to 30-50% of the sprayed pesticides settle off-site or remain suspended in the atmosphere [4]. It has also been established that the use of pesticides indoors is more efficient than in open areas and gives high results. Pesticides used in open fields tend to be more volatile and can quickly mix into the atmosphere [5].

Samples were taken from the atmosphere of areas from the western part of the Pacific Ocean to the southern part. In studies on these samples, 24 of the organic pollutants were found. This was 50% of the samples taken. Pesticides discharged into ocean waters are considered as the main source of pesticide residues in the ocean atmosphere [6].

As one of the data of recent years, it can be noted that in 2022, global pesticide use in agriculture reached 2.7 million tons. Asia and America have accounted for about 80% of total global pesticide use in recent years [7].

The rapid growth of the population in recent years has led to an increase in demand for agricultural products. In order to make up for the food shortages that have arisen, farmers are trying to get the maximum harvest on their farm plots. In this case, the use of plant protection means becomes mandatory. So, to protect agricultural crops from pests and diseases, chemical synthetic means - that is, pesticides-have been used since the last century. Although these tools are considered successful in achieving the desired result, as we have mentioned, they are considered a source of danger to the environment. The massive use of DDT, which was used in the last century both in the field of medicine to combat diseases that caused epidemics, and was later considered effective against plant pests, has led to the fact that even today these compounds still remain in a residual form in the soil layer. Although one of the causes of contamination of the soil with pesticide residues in general is considered to be pesticides used in agriculture, we can also include the abandonment of production plants after restrictions on the use of DDT and the fact that those areas are areas of serious environmental risk. We can mention the atmosphere as another polluting factor. As is known, most pesticides have volatile properties. Some of the pesticides that spread through the wind in the atmosphere eventually settle on the soil. As a result, these substances can be found in the soil layer even in areas where pesticides are not used.

Pesticides used in agriculture are applied directly to the leaf, root of the plant or to the soil in the fight against weeds. The method of introducing pesticides into the soil for high results is becoming more widely used. In this case, excessive use of chemicals negatively affects living beings that are in the soil. It leads to the destruction of microorganisms necessary for the plant. As a result, the plant does not develop normally or its yield is low. Unfortunately, pesticides currently used in agriculture are not used in accordance with the necessary rules and dosage. This also leads to pollution of agricultural land. As we mentioned, the re-Return of soils rich in pollutants to agriculture requires high labor and financial costs. Therefore, during the use of pesticides, it is important to pay attention to the correct selection of the amount, that is, the overdose, the use of substances that decompose relatively quickly in the environment and are minimally effective for living beings, and the organization of regular monitoring of the soil.

Although pesticides are used in agriculture to protect crops, they are considered a source of danger to the environment. During anthropogenic activity, pesticides can mix into the water system. This also lowers the vital activity of the aquatic ecosystem. It also negatively affects human health. But the global use of pesticides continues to grow every day. Countries such as China, the United States and Argentina are registered as the countries that use pesticides the most. Currently, due to industrial waste, floods, pesticides are being detected in underground, surface and wastewater. Rain also plays a role in the transfer of pesticides to groundwater. Pesticides used in agriculture can be washed out of the soil along with rain and mix with groundwater [8].

It is pesticides that are one of the main factors that negatively affect the aquatic ecosystem [9]. In 2016, pesticide consumption worldwide amounted to 4.1 million tons. But year after year, pesticide consumption is increasing even more. Residual pesticides accumulate in the environment, limiting or completely destroying the activity of living organisms. Pesticides can enter bodies of water in different ways. So, pesticides used in agriculture pass into the water system through underground drainage. In addition, pesticide residues are present in soils washed due to rain. Also, pesticide residues in the atmosphere can be transported over long distances by wind and deposited on water bodies.

According to research, in many countries of the world, the second factor that harms fish farming is the mixing of pesticides into the water system as a result of improper use. After the rainy season, pesticides on the soil surface are washed away and mixed with water bodies, causing the death of most of the living world there. We can also note that pesticides are still used at present, which interfere with the water system and cause the death of living organisms there [10].

Pesticides used against pests or weeds directly or indirectly affect entire groups of animals. As we

mentioned, microorganisms that live in the soil are exposed to the negative effects of pesticides. As a result, the microfauna of the soil is disturbed and its quality decreases. Thus, a decrease in yield is observed. Most of the pesticides used become resistant and can remain in the soil for many years. This also poses a threat to microorganisms in that soil. As we know, microorganisms play an important role in soil fertility and providing plants with nutrients. In pesticide-contaminated soils, this activity of microorganisms becomes impossible.

Currently, many scientific centers are investigating the effect of pesticides on bee colonies. In recent years, there has been a mass death of bee colonies in most countries. The reason for this is considered to be the use of neonicotinoid insecticides. A great danger to bees is the use of insecticides mixed with herbicides or fungicides [11]. A number of behavioral disturbances as a result of observation have been noted in bees exposed to the action of insecticides. As a result of the direct impact on the nervous system in these bees, signs such as memory impairment, forgetfulness, loss of the way back to the nest, forgetting nutritious areas were recorded [12]. Also, loss of sense of smell has been observed in bees that are regularly exposed to pesticides. In the course of recent global studies, the content of neonicotinoids in samples taken from honey reservoirs of bees is noted at 75% [13]. This is a pretty high figure.

During observations in animals living in areas contaminated with pesticides, it has been proven that deformation occurs in reproduction processes, as well as in various organs. Thus, the mixing of pesticides into the water system by washing in water bodies located in areas close to agriculture affects the living beings living in that area. Such a fact has been recorded in several lakes located in Canada. Deformation of jaws, limbs, skull was observed in turtles living in those areas. Also, cases such as dwarfism, eye regeneration and underdevelopment of embryos in eggs were recorded [6].

Pesticides are highly toxic to target organisms as well as the environment and the human body. Pesticides to humans come into contact in different ways. Thus, it can be transmitted to the human body in the form of residues during production and spraying activities in agriculture, when applied to gardens and, most importantly, in food. As a result, acute pesticide poisoning occurs. Diseases and even deaths caused by pesticides are currently being recorded all over the world. According to research, the estimated annual morbidity rate of agricultural workers in developed countries is 100,000 per 18.2 workers. During exposure to pesticides, various diseases occur, the most dangerous of which are considered to be leukemia, lymphomas, soft tissue sarcomas, cancer of the brain, bones, stomach. Also pesticides are able to provoke the development of Parkinson's disease [14].

The use of pesticides has been recognized as an important component of pest control in modern agriculture. But their inefficient and unprotected use threatens our ecosystem, health and environment. Excessive use of pesticides has already resulted in severe environmental deterioration, such as pollution in aquatic ecosystems and groundwater. In addition, pesticide residues in agricultural products can threaten human health through the food web.

The risk group most exposed to pesticides is farmers. Manual spraying of pesticides, especially in developing countries, puts the human body at direct risk due to the lack of awareness of the long-term sustainability effect. In case of non-observance of sanitary rules of personal hygiene during activities with pesticides in agriculture, a chemical preparation in high doses comes into contact with the human body. Pesticides taken during inhalation through the oral air droplet cause a number of serious diseases for the respiratory system [15].

The use of plant protection products in agriculture in the countries of the world began from different periods. The high level of pesticide application for our country dates back to the last century. Part of the cotton-growing regions of the USSR was located in the territory of Azerbaijan. In the 1980s, the use of DDT on cotton farms was organized in tons. In 1958-1989, 480549 tons of DDT and 10000 tons of other groups of pesticides were produced at factories throughout the country to protect farms from pests [16]. This has also had a negative impact on the workers and the environment in these areas. Pesticides used in high doses in those areas are still present in the soil in residual forms and have not lost their influence on the living world.

Along with chemical pesticides, biopesticides are used on the territory of the country. Microbes, some plant extratines, pyrethrins, and microbial extratines that have been identified under local conditions have been registered. Examples of such biopesticides are the insecticide Bacillus thuringiensis and the fungicide containing Bacillus subtilis. These biopesticides can be obtained from local biological laboratories in the country, as well as from foreign companies [16].

Pesticides produced in the Republic of Azerbaijan or chemical preparations imported from foreign countries are transported, stored and applied on the basis of specially prepared rules. According

to the law, chemical hazardous preparations should be stored in special warehouses in accordance with special sanitary and hygienic requirements. Warehouses should be provided with fire-fighting equipment and a forced ventilation system should be installed. In warehouses with pesticides, it is forbidden to store other products food, fertilizer products. Toxic products should be released from factories in special containers, and on it the composition is written. Chemicals must be transported by special machines.

Biopesticides are pesticides produced from materials obtained from nature. They mainly make up plants, microorganisms or plant-based substances. Sometimes these substances are effective in controlling pests and help to avoid harm to human health, environment and other living things with minimal impact. Biopesticides are mostly produced from softened water, oil, vegetable or other substances of nature. These do not feel the need to have a higher treatment effect, unlike chemicals, so that the use of these substances can be safer. Many of the biopesticides can act against different species, and chemical pest we can note that it is known that it was precisely plant extrasens and oils that were used as the first pesticides. However, later, the more effective and sustainable mechanism of action of chemical pesticides reduced the use of biopesticides. Over time, the increase in residual forms of chemical pesticides in the environment and their danger to all living organisms again increased the appeal to biopesticides.

## Methods

Scientific methods such as Empric, collection and selection of facts, establishing a relationship between them, observation, comparison, description, experiment, analysis and synthesis were used in the preparation of the article.

During the study, the bioecological characteristics of the harmful organism were studied and the development cycle was observed in the garden area. Later, the experiences of foreign countries were studied. During the research process, various methods of struggle were applied. Pesticides containing imidacloprid (Hekvidor) and chlorpyrifos (Priban) were used in the chemical fight against harmful organisms. Imidacloprid is an insecticide of red color, with a specific odor, in liquid form, and chlorpyrifos is in powder form. Chemical preparations were mixed with water and applied using a hand sprayer, and the amount of the working solution was taken 10 L/wood. The biological efficiency of pesticides used during the experiment was 92-95% [17].

## Discussions

Pesticides are used in research works in various enterprises in the territory of the Republic. The head of the executive power of Baku City, located in Mardakan settlement of Khazar district, uses a number of pesticide groups in the research of the “dendrology Garden” public legal entity “Department for plant protection and development” in the garden area. Thus, the regional phytosanitary specialist group of the Food Safety Agency of the Republic of Azerbaijan was invited by” dendrology Garden". Together with the employees of the Department for plant protection and development, samples of plants in the garden were taken and sent to the Central phytosanitary Laboratory of the Azerbaijan Food Safety Institute (AFSI). It was noted in the test protocol sent by AFSI that a group of pests and diseases were detected in various plants in the garden area.

According to the results, the Department of protection and development of plants carried out research work on pests and diseases found in plants in the garden area. The Red Palm Beetle (Rhynchophorus ferrugineus Oliver 1790) was found in the Phoenician palm plant, which existed in the “Garden of dendrology”, as noted in the test protocol.

According to the test protocol sent by AFSI, the pest black false shield yastica (Parasaissetia Nigra Nietner 1861), which was detected on Maclura plant existing in the “dendrology Garden”, was observed for the first time in the Republic of Azerbaijan and is considered an external quarantine object. The employees of the Department for plant protection and development have studied the bioecological characteristics of the pest and followed the development cycle. Then, pest control measures were carried out. The presence of a waxy surface of the pest complicates the fight process. In this direction, natural enemies of the harmful organism and a number of chemical preparations, namely insecticides, were used. The use of insecticides such as Diazinon, demethoate, formothion, malathion and nicotine gave positive results [17].

Various varieties of the olive tree are found on the territory of the ”Dendrology Garden". The presence of various species has led to the presence of a number of pests in the garden area. According to the test protocol, from the samples taken from olive trees, pests such as olive sapling Caterpillar (Palpita vitrealis (Rossi, 1794)) and Olive Honeysuckle (Euphyllura olivina Costa, 1839) were found [18]. Employees of the Department for plant protection and development monitored the life cycle of harmful organisms and carried out a number of experiments. First of all, agrotechnical

care works were carried out in the garden area, plants infected with pests were pruned and the soil around the trunk was softened. After agrotechnical care, a significant decrease in the number of pests has been observed. According to the literature, we can note that if there is a high level of infection with pests in plants, then pheromone traps and a number of insecticides should be used. In the chemical fight with pests, Beta sypermetrin 40g/l+Dimethhoate 300g/l (0.25 l/ha), Deltamethrin 250g/kg (0.3 kg/ha), Thiamethoxam 250g/kg (0.12 kg/ha), thiacloprid 480g/L (0.3 l/ha), Indoxarb 150g/l (0.4 l / ha), etc. one of the drugs that can be used [19]. Elm leaf-eater (Pyrrhalta luteola Müller, 1766) was discovered and samples were taken on the Elm (Ulmus L) plant located in the ”Dendrology Garden". The life cycle of pest insects has been monitored and various methods of struggle have been tested. Elm leaf-eating insects feed in the adult and larval stages. If they are massively infected on the plant, they cause 90-95% damage to the leaves of plants.

Before using chemical preparations in the fight against elm leaf-eater, agrotechnical measures should be carried out in order to prevent mass infestation. First of all, the dried branches and leaves around the trees should be cleaned, the trunk should be softened, (belted or plowed) a special protective belt should be attached to the trunk. Because, it is through the withered plant remains that the development of insects begins. Mass infections are reduced if preventive measures are taken there is no need to use chemical preparations. So, neonicotinoid insecticides are mainly used if there is a need to fight pest insects.

Various support programs are being implemented by the state for the development of agricultural sectors in our republic. Subsidies are allocated to local farmers within the framework of state programs for the development of private farms. Thus, within the framework of the” state program on the development of citrus fruit growing in the Republic of Azerbaijan for 2018-2025", a successful step has been taken in the cultivation of citrus crops in the southern regions of the country-Lankaran-Astara. During the study, observations were carried out on 14.04.2023 in “Lenk Fruit”, “Gilan Orchards LLC”, “Gilan agro-citrus” farms located in Lankaran region. It has been studied that pests are more likely to occur during the spring-summer planting of plants. During observations in farms, traces of citrus whiteflies and aphids were found on plants. In the chemical fight against pests in orange, tangerine and kinkan Gardens, acaricides and insecticides are used, which are allowed for use on the territory of the country. It has been observed that goldplan 20sp, Awacant, Kratos-24% SC, mass plant forte SP insecticides, Spider 20 WP, Moonmite acaricides are used in household plots.

## Conclusion

Currently, pesticides used in our country are imported from foreign countries and produced in chemical laboratories existing throughout the country. Chemical preparations authorized for use are inspected, tested and formalized by a special commission established by the Ministry of Agriculture.

Pesticides that are allowed to be used on the territory of the country, as stated in the law on pesticides and agrochemicals, are tested by the Ministry of Agriculture. Individuals who want to engage in trade and use of products produced in foreign countries and brought to the territory of the Republic should apply to the Ministry of Agriculture. Pesticides submitted upon application must meet a number of requirements. Thus, it must comply with state standards, hygiene and sanitary requirements, not be hazardous to the environment and the human body, and also have a high impact for its intended purpose. Pesticides that meet these requirements are sent to the Ministry of Health and the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan. Based on the positive opinion of these organizations, a state test is carried out by research institutions. State testing of pesticides and agrochemicals is carried out in three stages: laboratory testing, field testing, production testing. Laboratory testing is the development of a regulation for the introduction of a new product in field conditions. During field testing, the bilogical efficiency of the new preparation is checked and the application regulation is developed. Production testing is carried out in order to clarify economic efficiency, hygiene-sanitary and environmental standards in different zones of the country, as well as to determine the amount of residues in the environment. Then the research institutions where the test was carried out submit a report on the results to the Ministry of Agriculture. With the participation of specialists from the Ministry of Agriculture, the Ministry of Health and the Ministry of Ecology and Natural Resources, an individual and other interested entities, a decision is made on the registration of an agrochemical or pesticide based on the results. The decision is formalized by the Ministry of Agriculture and certified by the state agency for Standardization, Metrology and Patents of the Republic of Azerbaijan.

The first stage of the first pesticide production plant of “Agrochemistry Azerbaijan” Limited Liability Company, which is part of “Gilan Industrial Group” in Sumgayit Chemical Industrial

Park in the territory of the Republic, was put into operation by the head of state in 2017. The first plant protection equipment in the country based on modern technologies, i.e. plant for the production of pesticides, is to meet the demand for these products in the agricultural sector, as well as to support the development of the state economy by implementing export processes in the future. The plant produces 145 types of pesticides, and quality analyzes of these pesticides will be carried out in specially designed laboratories that meet international standards. The technologies established at the plant belong to leading companies in countries such as Turkey and Italy. In the preparation of products, preference is given to the use of local raw materials.

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# Eco-geographical problems of forest ecosystems on the southeastern slope of the Greater Caucasus

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**Abstract**

Relevance and feasibility of the research problem

Starting from the mids of the 20th century the industrial revolution and scientific-technical progress intensified the use of natural resources in developed countries. Inefficient utilization of natural resources has led to a complete change in the original visage of the environment. These changes have been most evident in forest ecosystems. The area of forest ecosystems began to decrease in the course of being intensively exploited in our Republic as well. The present article is dedicated to the extent of transformation of forest ecosystems which is another global problem of modern times.

## Purpose of the article

The middle and high mountainous zone of the southeastern slope of the Greater Caucasus under study is completely covered with forests. However, the low steepness of the slopes has led to their cutting and use as agricultural land. Our goal is to identify eco-geographical problems of existing forest ecosystems and prevent them.

## Leading method for investigating the problem

Satellite images taken in different ranges, base and topographic maps were used and analyzed in geographic information systems (GIS) in order to study the eco-geographical problems of forest ecosystems.

## Author's results

In the course of the research it was found out that 90% of the changes in forest ecosystems occurred due to the influence of anthropogenic factors. For this reason, we consider it expedient to enlarge the area of existing National Parks.

## Practical and theoretical significance of the obtained results

The results we have obtained will help municipal authorities, representatives of local executive bodies and forest management departments to contribute to the protection and expansion of forest ecosystems in the future.

## Introduction

Nationwide and worldwide growth of anthropogenic interventions in the nature has led to radical change of natural ecosystems. These changes have mainly affected forest ecosystems. So, as a result of natural and anthropogenic influences the forest ecosystems of our country of 1213.7 thousand hectares were reduced to 1021 thousand hectares. Currently 49% of forest ecosystems occupying 11.8% of the territory of the Republic are located on Greater Caucasus 18% of which is widespread on a southeast slope of Greater Caucasus and constitues our research territory.

The forest ecosystems extended to territories under research are one of the main components of the environment and belong to the first group that has crucial value in mitigation of climate change, expansions of processes of desertification, reduction of biological diversity, violation of gas balance in the atmosphere which are considered as global environmental problems. They also play an important role in social and economic, cultural, defensive development of our Republic.

Southeast part of Greater Caucasus borders with Atachay in the Greater Caucasus Range in the north, Girdimanchay in the west and the horizon of 200 meters in the south and the southeast. The total area of the studied territory is 5976 sq.km considerably extending to the east of Girdimanchay. So, in the Shamakha-Gobustan lowland (from Girdimanchay to Meraza) wide plateaus (Georgian, Shamakha, Meraza plateaus) and low ridges (Meysari ridge) replace each other.

## Literature review

Along with a number of traditional methods, contemporary ones are also applied in studying the reduction of forest ecosystem areas in the world. In recent years, remote sensing and geographic information systems have been preferred. Arshad A., Azhar A., Gajendiran K., Parashar A., and others have proposed several new methods for studying forest ecosystems. With the methodology they mentioned it is possible to quickly determine the species composition of forest ecosystems, forest substrate, fires and other problems.

It is worth to note that Aliyev H.A., Khalilov M.Y., Mammadov G.S. and other scientists played a significant role in studying forest ecosystems in our Republic. However, preference was given to observation, monitoring, field, historical-statistical and other methods in the conducted research at that time. The study of forest ecosystems using modern methods has not yet been fully feasible. In the presented article, the modern problems of forest ecosystems on the southeastern slope of the Greater Caucasus were investigated using geographic information systems and remote sensing methods.

## Research scope and methodology

These are various grades of intensive exploitation of forest ecosystems of the southeastern slope of the Greater Caucasus. The dynamics of exploiting forests since 1950 were studied within the framework of the research. To this end, the dynamics of the state of reforestation in 1950, 1980, 2001, 2023 were analyzed and appropriate scientific recommendations prepared to eliminate negative situations that may arise here in the future. Topographic map compiled in different years (1950), aerospace images as well as geographical information systems were used for this purpose. Route-field, comparative, observational, historical-statistical and other methods have also been applied in the course of the study.

## Results

In the study area, forest ecosystems are mainly distributed in the middle and high mountainous areas and belong to the Forest Fund Group I. These forests combine important factors such as water retention, water regulation, soil protection, climate regulation, sanitary-hygienic and recreation. These components we mentioned indicate the importance of producing a thorough strategy for protecting and using forests in our study area.

The forest ecosystems spread in the southeastern part of the Greater Caucasus were subjected to intensive exploitaiton and completely lost their initial state. Thus, in the Pirsaatchay basin, the upper forest cover was completely eliminated and the middle mountain-forest belt remains only on the right bank slope. In the Gozluchay basin the forest coverage is below 5%. Here, small forest areas with severe disturbance are found at absolute heights of 1400-1800 meters. In the eastern areas from Gozluchay, the Chikilchay and Chebotarchay basins consist only of secondary type shrubs.

Beech-hornbeam forest ecosystems spread in the middle mountains cover altitudes of 1200-1600 meters and 900-1000 meters in the research area. According to research data, areas near the watershed in Shamakhi district were once completely covered with forests (currently agricultural lands). It connected the south-eastern slope of the Greater Caucasus with the north-eastern slope. Presently, forest ecosystems remain in the form of islands. Pirgulu Reserve was created to protect these forests.

Oak and oak-hornbeam forests spread in the low mountains are distributed on isolated river valley slopes from 500-550 meter to 800-900 meter altitude in the south-eastern part of the Greater Caucasus. The relief of these areas is moderately fragmented. River valleys moderately fragmented the relief. River valleys consist of relatively predisposing terraced slopes. Mountain slopes are covered with thick deluvial sediments.

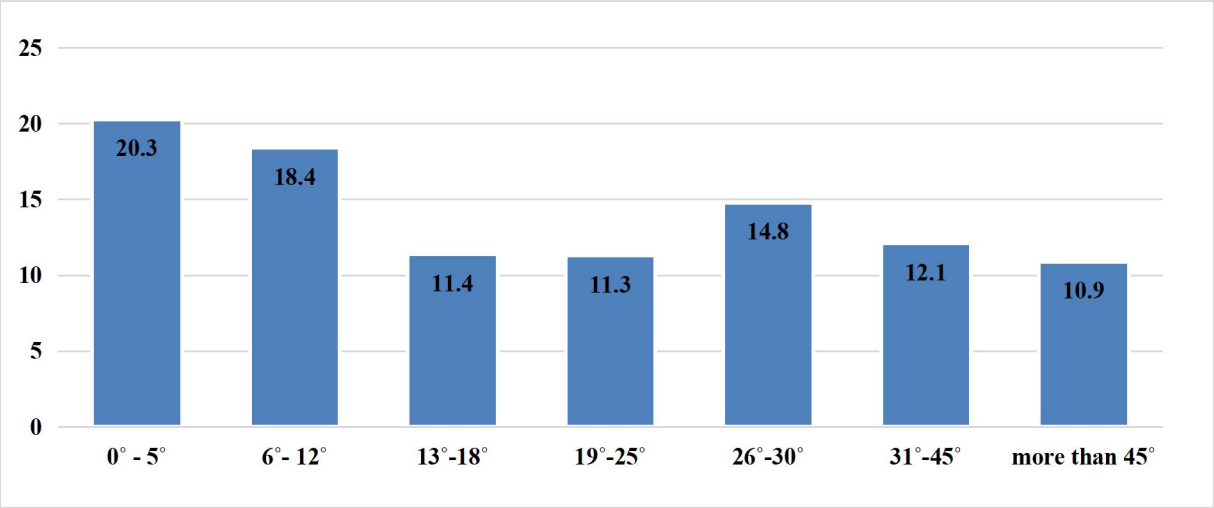
The forest landscape of the low mountains was severely disrupted as a result of human economic activity. Deforested areas were replaced by either cultivated fields or settlements. The relatively dry climate zone of the low mountains is characterized by sparse oak-hornbeam, oak forests, and mainly oak, hornbeam, cornelian cherry, elm and other shrubs. Low mountain forests were unsystematically cut down in the studied area and the forest regeneration process is not occurring due to uncontrolled grazing. As a result, water resources in the area have been depleted and soil erosion intensified. Therefore, there is a great need to regulate unsystematic deforestation and uncontrolled grazing in the area.

Based on our research, we have determined that the forest belt on the southeastern slope of the Greater Caucasus is subject to degradation at its upper and lower boundaries. Both natural and anthropogenic factors contribute to forest degradation. These factors include: slope steepness (natural), population density (village density), agriculture, intensive cattle grazing, tourism development, deforestation, fires etc.

## The Discussion section should include

The gentle, low-slope terrain in the study area facilitates intensified exploitation. According to our research, 0.03% (23 ha) of the forests on the

southeastern slope of the Greater Caucasus are located on slopes steeper than 30° while the remaining 99.96% (76,200 ha) are on slopes less than 30° (Graph 1).




Graph 1. Steepness of slopes in the southeastern part of the Greater Caucasus (%).

The low steepness at the lower boundary slopes of the forests, their proximity to settlements and district centers created conditions for the local population to use them as fuel. This led to a decrease in forest density and area. The local population uses the forest not only for fuel but also break trees to make apple, pear, peach and other fruit orchards on these slopes. At the upper forest boundary where the slope is relatively steeper, parts of the forest close to settlements are used as hayfields and pastures. Currently, these areas are experiencing negative processes such as intensive soil erosion, ravine formation, drying up of springs etc. For this reason, the upper forest boundary does not rise above 1400-1800 meters. In very steep, inaccessible areas of the slopes, small "islands" of forest remain at altitudes of 2000-2100 meters above the sea level.

Thus, the intensification of exploitation year-by-year in various economic sectors of the research area, the cutting of forests – are our source of oxygen – for various purposes during 1950-2023 and their intensive exploitation brought about to a significant reduction in their area. According to our research, the forest cover of the north-eastern slope of the Greater Caucasus decreased by 9.9% in 2023 compared to 1950, reaching 76 thousand hectares. Consequently, the intensive exploitation of the area in various economic sectors over a long historical period caused certain changes in the degree of vegetation cover. In order to calculate the current degree of vegetation cover, it is vital to determine the NDVI (Normalized Difference Vegetation Index) coefficient which is widely used in international practice in recent years through the ArcGIS program. Usually NDVI referred to as the vegetation index in literature and applied to determine the quantitative indicators of vegetation cover. The following formula is used in this case:

**NDVI=(NIR-RED)/(NIR+RED)**

NIR here stands for near-infrared wavelength of the light spectrum (0.68-0.78μm), RED is the red range wavelength (0.61-0.68 μm) and NDVI is the vegetation index.

It becomes obvious from the presented formula that as the amount of red radiation at a certain point approaches zero, the value of the vegetation index at that point approaches +1. As the amount of infrared radiation at a certain point approaches zero, the vegetation index at that point approaches -1. The "Normalized Difference Vegetation Index" (NDVI) processes infrared images. For each pixel, the red count value for that pixel is subtracted from the infrared count value for the same pixel. This difference varies depending on the density of vegetation cover. In areas with dense vegetation cover this number is large while in areas with sparse vegetation it is smaller.

A value in the range (-1, +1) is obtained by adding these two numbers whose differences are taken and dividing the difference by the sum. To create a new 8-bit image, this range needs to be equalized to 0.255 which is called normalization. In the created NDVI image pixels have high values in areas where vegetation is dense and low ones where it is not. Based on this, it becomes easy to identify areas with dense, medium and sparse vegetation cover.

We used multi-spectral satellite images to determine the degree of vegetation cover in the

studied area. Based on these images we defined that as a result of exploitation, compared to 1987, in 2023 areas with sparse vegetation cover increased by 19.3%, areas with medium vegetation cover increased by 13.8% while areas with dense vegetation cover decreased by 29.4% (Table 1). If the exploitation of the area continues at this pace, then this indicator will increase further and as a result the process of plant degradation will intensify. The degradation of vegetation cover will also bring to the activation of landslides, floods and other processes in the studied area. For this reason, it is crucial to adhere to the establishment of new forest belts, protection of existing forests, agrotechnical care of plants, including the cleaning of wild, harmful and poisonous plants.

**Table 1.Extent of vegetation coverage in 1987-2023 (in hectares)**

| Extent of vegetation coverage | 1987 | 2023 |
|---|---|---|
| Areas with sparse vegetation cover | 2694 | 3341 |
| Areas with moderate vegetation cover | 2043 | 1761 |
| Areas with dense vegetation cover | 1239 | 874 |

It should also be emphasized that the forest cover has suffered more from the intensive exploitation of the research area. So, at present, the area under study is 184.7 hectares. However, this figure decreased by 3% compared to 1980. In light of this, national parks (Pirgulu, Altiagach) have been created on the territory to protect forests. Oak, beech and hornbeam trees predominate here. Out of endemic plants, juniper, blackberry, khary bulbul (Caucasian ophrys, chestnut oak and more than 500 plant species have also been preserved (Fig. 1, 2).

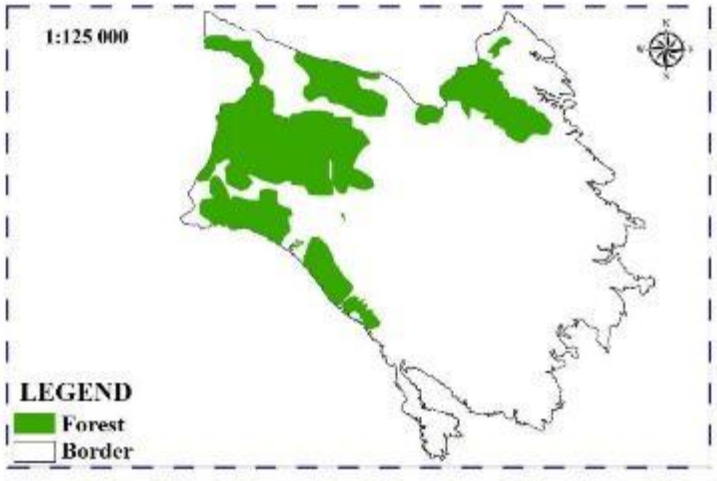



Fig. 1. Forest cover of the southeastern slope of the Greater Caucasus (1980)

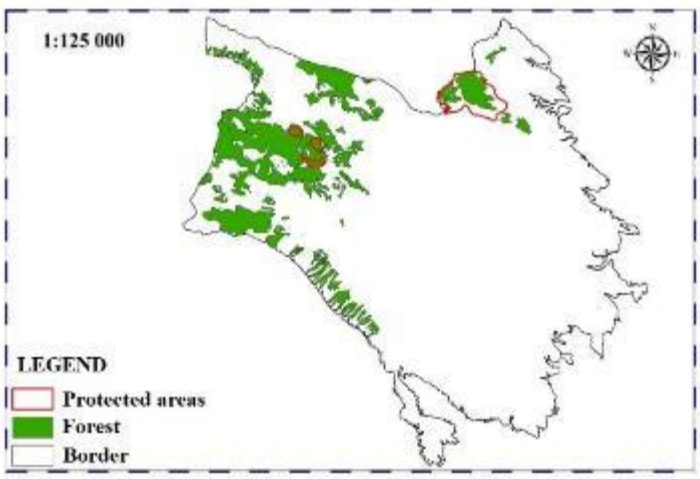



Fig. 2. Forest cover of the southeastern slope of the Greater Caucasus (2023)

Certainn measures were taken in Khizi and Gobustan districts to promote the natural regeneration in natural forests in the region for example oak seeds were sown in the area by sowing method and pine and other trees were planted. Especially with a view to protect roadside areas and

atmospheric air, as well as to reduce noise from traffic, 70 hectares of dried trees along the Baku-Guba highway in Khizi district were replaced with new ones, including forest strips along the Baku-Shamakhi-Yevlakh highway where relief and climate conditions are favorable (Figure 3).

**Fig. 3. Artificial forests along the Baku-Shamakhi-Yevlakh highway**

If declining trend of forests continues at this rate, the area of forests will be 54 thousand hectares in the next 50 years. This decrease will lead to changes in climate, soil, vegetation and hydrographic network in the research area and an increase in natural disasters such as landslides, avalanches and floods.

Forest fires are one of the other environmental problems of forests common to mountain geosystems of the northeastern slope of the Greater Caucasus. It was found out through Geographic Information Systems that over past 22 years (2001-2023) forest ecosystems which make up 22% of the studied area have decreased by 696 hectares. This figure is 0.61% less than in 2000 (Chart 2).

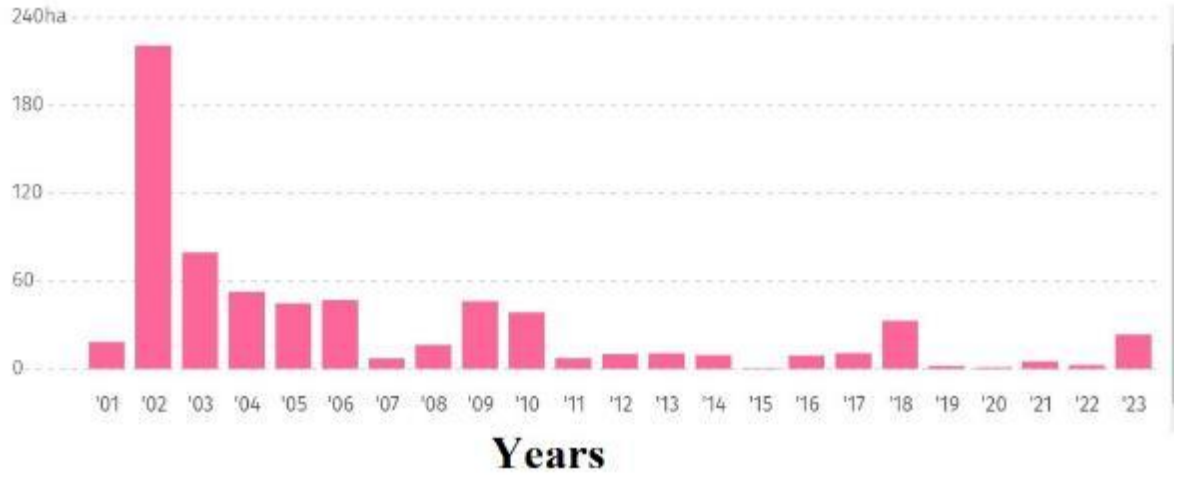



**Chart 2. Dynamics of decline in forest ecosystems of mountain geosystems of the northeastern slope of the Greater Caucasus (2001-2023)**

The largest decrease in forest ecosystems in the study area was recorded in Ismayilli district. Here, forest ecosystems decreased by 583 ha which is more than the average (174 ha).

The forest fire season in the region usually starts in early September and lasts about 4 weeks. From 2001 to 2023, 87 ha of forest were lost due to fires in the study area while 609 hectares were lost due to all intensive use (diagram 3). During this period, the greatest loss due to fires was recorded in 2023. At that time, 12 ha of forest area was completely burned.

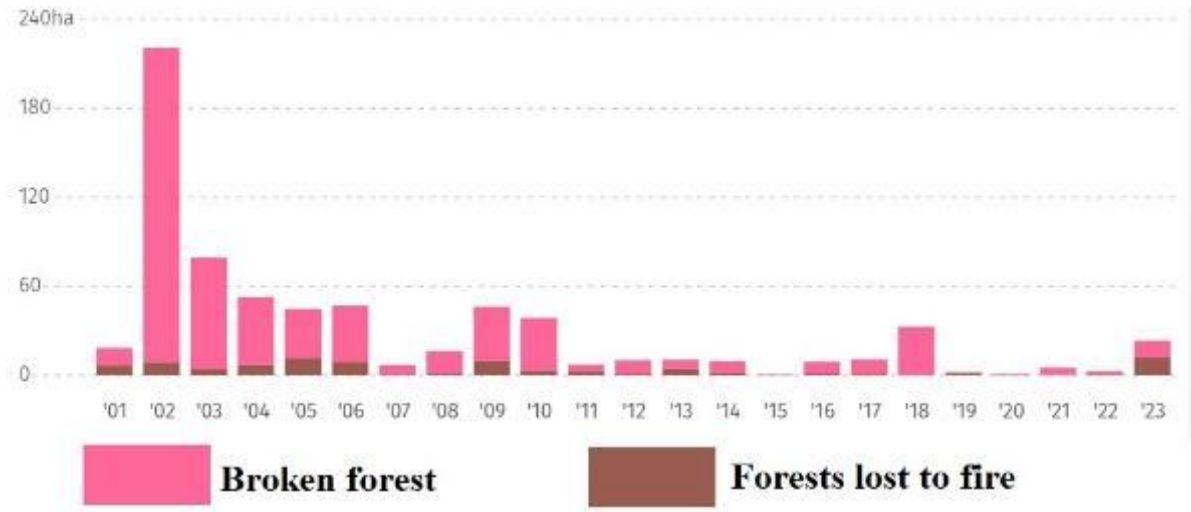



**Chart 3. Forest loss in mountain geosystems of the north-eastern slope of the Greater Caucasus (2001-2023)**

## Conclusion

Based on our research, we can conclude that human economic activity primarily led to a decrease in forest density, reduction of area, soil erosion, drying up of springs and other negative effects. To eliminate these negative effects it is recommended to create a civilized monitoring system in accordance with the internal ecology of the Republic. Also, in order to prevent soil erosion and return them back to agricultural use, forests should be replanted on moderately and severely eroded slopes. Only forest cover plays an important role in soil regeneration, fertility, and protection.

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# Impact of temperature changes on urban heat island: Baku

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**Abstract**

The Urban Heat Island (UHI) effect is a critical environmental issue, where urban areas experience higher temperatures compared to their rural counterparts, driven by factors such as dense infrastructure, reduced vegetation, and increased human activities. This study focuses on Baku, Azerbaijan's capital, to examine the relationship between temperature changes and the UHI effect. Over the past few decades, Baku's rapid urbanization has led to significant land-use changes, contributing to the intensification of the Urban Heat Island effect. The key contributors to this phenomenon include heat-absorbing surfaces, reduced vegetation, and increased energy consumption. Impacts of the UHI effect in Baku include worsening air quality, health risks, stress on local ecosystems, and increased energy demand. To quantify and analyze the Urban Heat Island effect, mathematical models such as the Surface Energy Balance (SEB) model and statistical regression analysis were used. These models highlight significant temperature increases, especially in densely populated and industrial areas of Baku. The research suggests possible solutions to lessen the Urban Heat Island effect in Baku, such as creating more green areas, adopting environmentally friendly city planning, and using energy more efficiently. By implementing these strategies, Baku can mitigate the Urban Heat Island effect, reduce its environmental impact, and enhance the quality of life for its residents.

**Keywords**:Urban Heat Island (UHI); temperature changes; heat-absorbing surfaces; sustainable urban planning; mitigation strategies; public health; green infrastructure.

## Introduction

The Urban Heat Island (UHI) effect has emerged as one of the most pressing environmental issues facing cities worldwide. This phenomenon occurs when urban areas exhibit significantly higher temperatures than their rural counterparts, primarily due to the replacement of natural landscapes with buildings, roads, and other infrastructure. As cities grow, the concentration of heat-absorbing materials like concrete and asphalt, combined with reduced vegetation and increased human activities, intensifies the retention of heat within urban environments. The implications of this temperature disparity extend beyond mere discomfort; they pose significant threats to urban sustainability, public health, and environmental quality.

In recent years, Azerbaijan, particularly its capital city Baku, has experienced rapid urbanization, leading to a pronounced UHI effect. As the country continues to modernize and expand its urban infrastructure, the natural cooling mechanisms provided by vegetation have diminished, further exacerbating the issue. Baku, a coastal city with a unique geographical and climatic profile, faces heightened challenges as its dense infrastructure and high energy consumption contribute to soaring temperatures, especially during the summer months. This increase in urban heat not only affects the comfort and well-being of its residents but also places immense pressure on the city's energy resources, increases air pollution, and intensifies public health risks such as heat-related illnesses [5].

The UHI effect in Baku is influenced by several factors. The extensive use of heat-absorbing surfaces like asphalt and concrete, coupled with the significant reduction of green spaces due to urban expansion, has amplified the city's heat retention capacity. Furthermore, increased energy consumption, particularly for cooling systems during hot periods, contributes additional heat to the environment. As Baku's population grows, these factors intensify the UHI effect, creating a feedback loop where rising temperatures lead to greater energy consumption, which in turn exacerbates urban heating [16].

The impacts of the UHI effect in Baku are far-reaching. On a broader environmental scale, higher temperatures contribute to the formation of ground-

level ozone, which worsens air quality and poses health risks, particularly for vulnerable populations such as children, the elderly, and those with pre-existing health conditions [6]. Additionally, the elevated temperatures can negatively affect local water bodies, as warmer air leads to increased water temperatures, impacting aquatic ecosystems and water quality. Biodiversity in urban areas is also under threat, as rising temperatures and altered ecosystems reduce the survival of native flora and fauna. Beyond the environmental and ecological consequences, the UHI effect leads to higher energy costs for both residents and businesses, straining the city’s energy infrastructure and reducing overall quality of life by making outdoor activities less enjoyable during heatwaves [9, 19, 20].

Given these challenges, understanding the causes and consequences of the UHI effect is critical for Baku's future urban development. The city’s rapid urbanization, geographical location, and climatic conditions make it a prime case study for examining the UHI effect in Azerbaijan. Analyzing temperature variations, urban infrastructure, and land-use changes in Baku provides valuable insights into the complex dynamics of urban heating.

This article aims to explore the relationship between temperature changes and the UHI effect in Baku, shedding light on the primary causes and the various impacts on the environment, public health, and energy systems. In addition, the article presents potential mitigation strategies to address the UHI effect in Baku. By adopting sustainable urban planning practices, incorporating green infrastructure, and promoting energy-efficient technologies, the city can alleviate the UHI effect, ultimately improving the quality of life for its residents and contributing to a more resilient urban environment [2].

In conclusion, as urbanization continues to shape the future of cities like Baku, addressing the UHI effect becomes a critical priority. Mitigating the impacts of rising urban temperatures requires a comprehensive approach that balances economic development with environmental sustainability. By understanding the underlying causes and implementing effective strategies, Baku can not only reduce the adverse effects of the UHI phenomenon but also create a healthier and more sustainable urban ecosystem for future generations [14, 15, 18].

## Material and Method

Understanding the Urban Heat Island Effect

The UHI effect occurs when natural landscapes are replaced with buildings, roads, and other infrastructure that absorb and retain heat. This leads to higher temperatures in urban areas compared to their rural counterparts. Key contributors to the UHI effect include:

Heat-Absorbing Surfaces: Materials like asphalt and concrete store heat during the day and release it slowly at night, maintaining higher temperatures.

Reduced Vegetation: The loss of trees and green spaces diminishes the natural cooling effects provided by shade and evapotranspiration [1, 7 ].

Human Activities: Industrial processes, transportation, and energy use generate additional heat, exacerbating the UHI effect.

Baku, Azerbaijan's capital and largest city, exemplifies the challenges associated with the UHI effect [13]. Over the past few decades, Baku has undergone rapid urbanization, leading to significant changes in land use and infrastructure. Historical temperature data reveals a clear upward trend in both daytime and nighttime temperatures, particularly during the summer months. This trend correlates with increased urbanization and the intensification of the UHI effect.

## Causes of the UHI Effect in Baku

Urban Infrastructure: Baku's dense infrastructure, including high-rise buildings, roads, and industrial facilities, contributes significantly to the UHI effect. These structures absorb and retain heat, leading to higher temperatures.

Reduction in Vegetation: Rapid urban development has led to the conversion of green areas into commercial and residential zones. The reduction in vegetation has diminished the natural cooling effects, exacerbating the UHI effect [7, 10].

Increased Energy Consumption: The high demand for air conditioning and other cooling systems during the hot months leads to increased energy consumption, further contributing to urban heat.

Impacts of the UHI Effect in Baku are: Higher temperatures contribute to the formation of ground-level ozone, worsening air quality and posing health risks, increased temperatures can elevate water temperatures in local water bodies, impacting aquatic ecosystems and water quality and the stress on local flora and fauna due to elevated temperatures can lead to reduced biodiversity and altered ecosystems. Also, higher urban temperatures increase the incidence of heat-related illnesses, such as heat exhaustion and heatstroke, particularly affecting vulnerable populations, increased demand for cooling leads to higher energy costs for residents and businesses, putting additional strain on the energy infrastructure and the UHI effect reduces the overall quality of life by making outdoor activities less enjoyable and increasing discomfort during heatwaves.

Baku serves as a critical case study for understanding the UHI effect in Azerbaijan. The city's rapid urbanization, combined with its geographical location and climatic conditions, makes it particularly susceptible to the UHI phenomenon [17].

### Mathematical Model for UHI Analysis

To quantify the UHI effect in Baku, we utilize several mathematical models, including the Surface Energy Balance (SEB) model, statistical regression analysis, and Geographic Information System (GIS) modeling. Surface Energy Balance (SEB) Model

The SEB model calculates the net radiation at the surface, which is a critical factor in understanding the UHI effect.

The balance equation is given by:

$$Q^* = H + LE + G \quad (1)$$

where:

$Q^*$ is the net radiation.

$H$ is the sensible heat flux.

$LE$ is the latent heat flux.

$G$ is the ground heat flux.

In urban areas, $H$ and $G$ are typically higher due to heat retention by buildings and roads, while $LE$ is lower due to reduced vegetation.


**Fig. 1. Variation of UHI Effect by area**

### Statistical Regression Analysis

Regression models help identify the relationship between urbanization factors and temperature variations. A multiple regression model can be used to analyze the impact of various factors on the UHI effect:

$$T = \beta_0 + \beta_1 U + \beta_2 V + \beta_3 H + \epsilon \quad (2)$$

where:

- $T$ is the temperature.
- $U$ represents urban infrastructure variables (e.g., building density).
- $V$ represents vegetation cover.
- $H$ represents human activities (e.g., energy consumption).
- $\beta_0, \beta_1, \beta_2, \beta_3$ are regression coefficients.
- $\epsilon$ is the error term.

Analysis of historical temperature data for Baku indicates a significant increase in both average daytime and nighttime temperatures over the past few decades. The difference between urban and rural temperatures is more pronounced during the summer, highlighting the intensity of the UHI effect.

**Hotspot Identification**: Satellite imagery and GIS analysis reveal that certain areas in Baku, such as densely populated districts and industrial zones, are particularly prone to higher temperatures. These hotspots lack sufficient vegetation and are characterized by extensive heat-absorbing surfaces.

Impact on Residents: Surveys indicate that residents of Baku face increased energy costs and discomfort during the summer months. Public health records show a correlation between high temperatures and increased incidences of heat-related illnesses, particularly among vulnerable populations [20].

### Mitigation Strategies

Addressing the UHI effect in Baku requires a multi-faceted approach involving urban planning, green infrastructure, and public engagement.

Increasing green spaces, such as parks, green roofs, and urban forests, can significantly mitigate the UHI effect. These areas provide natural cooling through shade and evapotranspiration, helping to lower surface and air temperatures [4].

Initiatives to plant more trees and create urban gardens can enhance biodiversity, improve air quality, and provide recreational spaces for residents.

Incorporating sustainable design principles in urban planning can reduce the UHI effect. This includes using reflective materials for buildings and pavements, optimizing building layouts to enhance airflow, and integrating water features like fountains and ponds.

Zoning regulations that prioritize the preservation and expansion of green spaces can help balance urban development with environmental conservation [8].

Promoting energy-efficient buildings and appliances can reduce the heat generated by human activities. Incentives for adopting renewable energy sources, such as solar panels, can also decrease reliance on fossil fuels and reduce urban heat.

Implementing smart city technologies, such as energy-efficient street lighting and temperature monitoring systems, can help manage energy consumption and mitigate the UHI effect [12].

Raising awareness about the UHI effect and its impacts can encourage residents to adopt practices

that help mitigate urban heat. This includes using energy-efficient cooling methods, participating in tree-planting initiatives, and supporting policies aimed at reducing urban heat [3, 11].

## Conclusion

The Urban Heat Island (UHI) effect represents a significant challenge for cities like Baku, where rapid urbanization, dense infrastructure, and the reduction of green spaces have led to higher urban temperatures compared to surrounding rural areas. As Baku continues to develop, the effects of this phenomenon have become increasingly pronounced, with serious implications for the city’s environment, public health, and energy consumption. Rising temperatures exacerbate air pollution, contribute to heat-related illnesses, and put additional strain on energy infrastructure, particularly during the summer months.

This article has examined the key factors driving the UHI effect in Baku, including heat-absorbing surfaces, reduced vegetation, and increased energy use. It has also highlighted the negative impacts of this temperature disparity on the environment, such as worsening air and water quality, and on the city's residents, who face increased energy costs and heightened health risks during heatwaves. Understanding the relationship between temperature changes and the UHI effect is essential for developing effective mitigation strategies that balance urban growth with environmental sustainability.

To address these challenges, Baku must adopt a multi-faceted approach that integrates urban planning with environmental conservation. Increasing green spaces, such as parks and urban forests, can help cool the city through natural processes like shade and evapotranspiration. Incorporating sustainable design principles, such as reflective building materials and better air flow in urban layouts, can further mitigate the UHI effect. Additionally, promoting energy-efficient technologies and renewable energy sources will reduce the heat generated by human activities, easing the demand on the city’s energy resources.

By implementing these strategies, Baku has the potential to reduce the intensity of its UHI effect, improve the quality of life for its residents, and enhance its resilience to climate change. The lessons learned from Baku’s experience can also serve as a model for other rapidly developing cities facing similar challenges. Ultimately, addressing the UHI effect is not just an environmental necessity, but a crucial step toward creating a more sustainable, livable, and healthy urban future for Azerbaijan.

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# Study of soil erosion in Zagatala region

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## Annotation

Our environment faces a number of problems, many of which are deteriorating over time, leading us to a real ecological crisis. In this regard, the main goal has become to be able to observe the degradation of various components of the ecosystem and explore ways to prevent it. The article discusses the process of soil erosion and its consequences as a result of natural and anthropogenic impact on the southern slope of the Greater Caucasus within Azerbaijan.

**Keywords**: slope, soil, forest vegetation, relief, erosion, climate

## Introduction

The territory of Zagatala district is located in the northwestern part of the southern slope of the Greater Caucasus (with in Azerbaijan). The territory is represented by complex geological and geomorphological conditions, which enhances the erosive activity of surface waters. The main rocks are clay shales, sandstones, limestones, which have weak anti-erosion resistance.

Here, low-mountain, mid-mountain and high-mountain zones are distinguished. The high-mountain zone is characterized by a highly dissected erosional relief. Here, large areas are occupied by placers, which in turn are the centers of origin of mudflows. Watersheds have a ridge-shaped and stepped-ridge-shaped form. The mid-mountain zone is characterized by a complex geological structure and erosional relief. In this zone, due to the presence of forest vegetation, erosion processes are weak. The low-mountain zone is composed of tertiary and quaternary deposits [1].

In the region, slopes with a steepness of >50, at which erosion processes cause significant damage, occupy 93.5% of the entire territory [2].

In terms of climate, the mountainous part of the Zagatala region belongs to the moderately warm and cold climate. In the lower mountain zone, the average annual air temperature is +13.1 $^0$C, the amount of precipitation is 900-940 mm, in the mid-mountain zone (altitude 1750m) the amount of precipitation during the year is no more than 1210 mm. As the altitude increases, the amount of precipitation and the intensity of their fall increase. In particular, about 70-80% of precipitation falls in April-October. As a rule, heavy rainfall is observed here after a dry period, which causes intense erosion and the formation of destructive mudflows. The intensity of precipitation reaches up to 1-2 mm/min, and rarely up to 10 mm/min.

In the mountain-meadow zone of the region, there is stable snowfall and the soil freezes [3]. The mountain-forest zone covers an altitude of 500-2000m above sea level, and the mountain-meadow zone from 1800 to 3000m.

Both the climatic factor and the vegetation cover of the southern slope change depending on the altitude of the area. Here the vegetation cover is very diverse, which is due to the presence of high ridges with a highly dissected relief, formed by geological and geomorphological conditions, human economic activity, intensive development of erosion, etc.

In the forest region of the Greater Caucasus there are about 172 species of trees and shrubs, the role of which in terms of erosion control is high [4].

## Research method

The research used both ground-based measurement data and digital maps created by decoding space images.

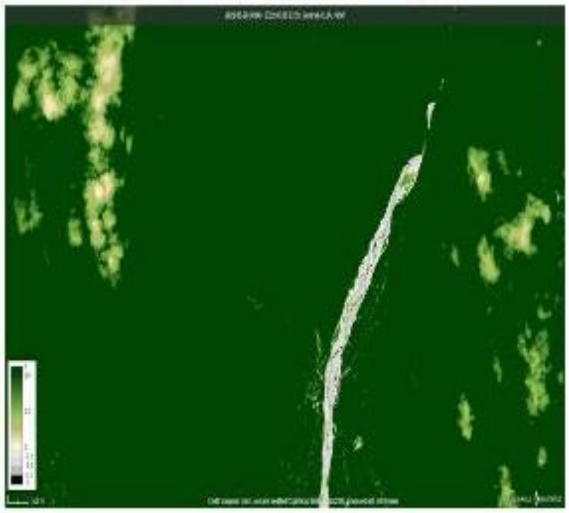
Analysis of results: In the territory of Zagatala district, depending on the altitude, there are 2 main vegetation zones: mountain meadow and mountain

forest.

In the mountain meadow zone (1800-3400 m), the soils of summer pastures are heavily eroded, rocky areas, scree, and scattering are found. On the southern slope of the Greater Caucasus, the subalpine belt occupies a large area and is characterized by a variety of grass species. In the subalpine belt, due to improper human activity, primary phytocenoses have undergone changes in many places. The vegetation of the lower and middle mountain belts is represented by broad-leaved forests. However, up to 60% of plantings here have a density of 0.5 and below,so they are not able to provide protection of steep slopes from erosion and, as a rule,the soils of such areas in most cases are heavily washed away[5]. In the upper boundary of the lower mountain belt, where the village pastures are located, oak-hornbeam forests predominate, which are subject to heavy logging and grazing. In this regard, the water-protective and soil-protective capacity of these forests has weakened. The plantations here have low density (0.2-0.3), as a result of which their productivity is very low, and they do not have seed renewal.

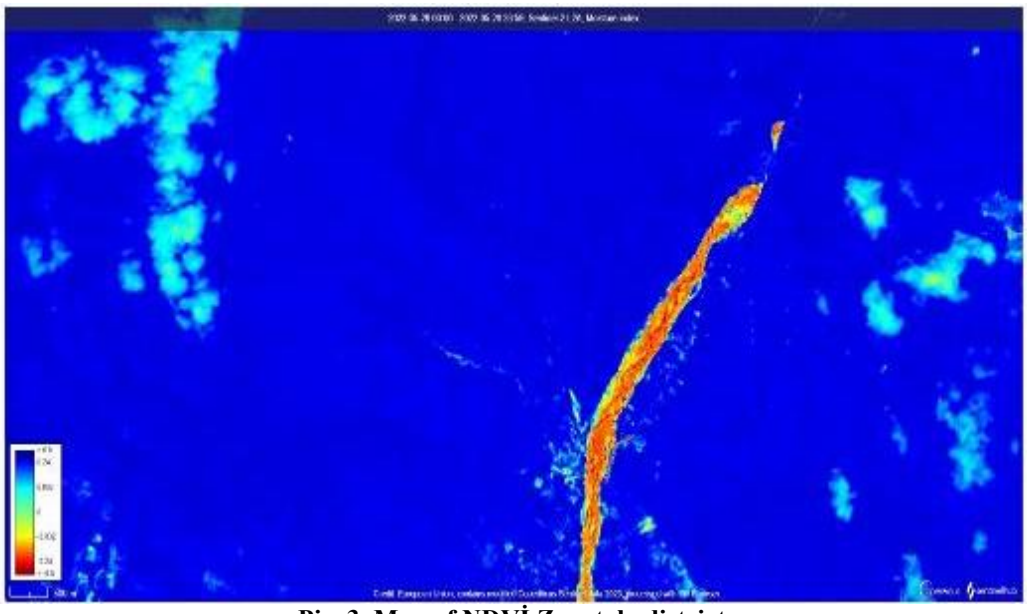
Due to erosion, forest growth conditions are unfavourable and in the area where the forest has been cleared, the direction of the soil formation process changes towards steppe formation (Picture 1) [6].

Pic. 1. Space image of Zagatala district



Pic. 2. NDVI map of Zagatala district

The peripheral zone bordering the mountain ranges is represented by the steppe type of soil formation. This zone includes dark gray-brown and light gray-brown (chestnut) soils. Desert-steppe soils develop in the drier lowland zone.



**Pic. 3. Map of NDVİ Zagatala district**

Taking into account erosion factors, the territory of the southern slope of the Greater Caucasus is divided into mountain-meadow, mountain-forest and sloping plain (Picture 4).


**Pic.4. Soil map of Zagatala region**

Mountain-forest brown steppe soils and sloping plain soils with the following characteristics are mainly widespread in the study sites. Mountain-forest brown steppe soils: Mountain-forest brown steppe soils in the region are widespread on the slopes of lands that were previously under forest vegetation. The structure of these soils is distinguished by a lumpy-granular structure, which is not typical for forest-type soils.

Mountain forest steppe soils have more powerful A horizons compared to mountain forest brown soils. The content of physical clay (<0.01 mm) in it in the unwashed variety is 72.5%, and <0.001mm particles - 26.5%, humus 5.62%, total nitrogen 0.30%, the sum of absorbed bases is 40.50m.eq. According to the degree of erosion, the above indicators decrease and are in the strongly eroded variety, respectively: <0.01mm - 68.10; <0.001mm - 18.8%, humus - 2.28%, total nitrogen 0.15%, the sum of absorbed bases is 29.25 m.eq (of which Ca - 24.75 and Mg - 4.50 m.eq.).

Soils of the sloping plain: within the sloping plain (Alazani-Avtaran valley) meadow-forest and their low-power and long-irrigated varieties,meadow-marsh, alluvial-meadow and other soils are widespread. It is believed that the formation of the above-mentioned soils is largely due to the removal and deposition of runoff and erosion products from the mountainous part of the southern slope of the Greater Caucasus. In the above-mentioned soil varieties,the parent rocks are alluvial deposits[7].

**Table 1. Water-physical properties of mountain-brown steppe soils of Zagatala region**

| Section | Genetic Horizon | Depth in sm. | Field moisture % | Bulk density g/sm3 | Specific gravity g/sm$^3$ | Total porosity % |
|---|---|---|---|---|---|---|
| 11 unwashed | A | 0-31 | 21,15 | 1,17 | 2,64 | 54,43 |
| | B | 31-52 | 20,44 | 1,19 | 2,66 | 53,62 |
| | C | 52-89 | 18,22 | 1,20 | 2,67 | 52,33 |
| 14 medium washed out | A | 0-16 | 19,67 | 1,19 | 2,65 | 52,97 |
| | B | 16-30 | 17,41 | 1,21 | 2,67 | 50,41 |
| | C | 30-64 | 15,16 | 1,22 | 2,68 | 49,25 |

**Table 2. Granulometric composition of mountain-brown soils of Zagatala region**

| Section | Genetic Horizon | Depth in sm. | Factions % | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1-0,25 | 0,25-0,05 | 0,05-0,01 | 0,01-0,005 | 0,005-0,001 | <0,001 | <0,01 |
| 11 unwashed | A | 0-31 | 1,32 | 14,51 | 31,63 | 16,75 | 19,84 | 42,75 | 61,54 |
| | B | 31-52 | 1,14 | 12,45 | 30,75 | 17,62 | 21,32 | 39,85 | 59,18 |
| | C | 52-89 | 4,12 | 17,34 | 26,42 | 21,18 | 19,55 | 38,17 | 60,31 |
| 14 medium washed out | A | 0-16 | 7,14 | 14,06 | 27,11 | 12,52 | 13,45 | 23,75 | 49,38 |
| | B | 16-30 | 6,25 | 12,366 | 25,46 | 14,36 | 16,52 | 20,11 | 53,45 |
| | C | 30-64 | 0,91 | 8,15 | 22,41 | 13,14 | 19,89 | 27,15 | 57,64 |

Sections №11 and №14 are located in the foothills of the Zagatala region on mountain-brown steppe soils.

Section №11 - unwashed

A 0-31 cm dark brown,intertwined with roots,granular,heavy loamy,moist, gradual transition,does not boil with HCl

B 31-52 dark brown,granular-nutty,heavy loamy,moist,clear,does not boil with HCl

C 52-89 light,dense,structure is not expressed rock fragments,boils with HCl

Section №14 - moderately washed

A 0-16 cm dark brown,roots,slightly moist,nutty,clayey,clear transition

B 16-30 cm it is brown,dense,clayey,the viscous transition is noticeable

C 30-64 cm it is light,there are many rock fragments,the structure is not expressed,it boils from HCl

Erosion processes are reflected in the mountain-brown steppe soils of the Zagatala region. From Table 1 it is evident that in the average washed away samples the volumetric specific gravity in the 0-16cm horizon is increased (1.19g/cm3) compared to unwashed soils, the total porosity decreases - 52.97%. According to the mechanical composition, these soils are heavy clay (<0.01-61.54%;49.38%-physical clay), (Table 2).

The study of the structural and aggregate composition showed that with dry sifting in unwashed soils 0-31cm horizon fractions of more than 1mm amounted to 61.78%, waterproof 42.97%, in the illuvial horizon 49.72%, waterproof 33.93% (Table 3).

In the average washed-out samples in the upper horizon, fractions larger than 1 mm constituted 35.20%, and water-resistant 18.90%.

The study of agrochemical indicators showed that the humus content in the upper horizon of unwashed soils constituted 4.9%, total nitrogen 0.329% with a tendency to decrease down the profile.

In unwashed soils, the sum of absorbed cations in the upper horizon was 33.48 m.eq. per 100g of soil.

In medium-washed analogues in the upper 0-16cm horizon, the humus content was 3.4%, total nitrogen 0.215%,the sum of exchangeable cations was 24.94m.eq. per 100g of soil with a tendency to decrease down the profile(Table 4).

**Table 3. Structural and aggregate composition of mountain-brown steppe soils of the Zagatala region**

| Section | Genetic Horizon | Depth in sm. | Fractionsm m | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | >7 | 7-5 | 5-3 | 3-1 | 1-0,5 | 0,5-0,25 | <0,25 | >1 |
| unwashed | A | 0-31 | 21,23<br>3,40 | 11,45<br>6,79 | 9,54<br>12,34 | 19,56<br>20,44 | 19,89<br>24,15 | 11,37<br>13,45 | 6,96<br>19,43 | 61,78<br>42,97 |
| | B | 31-52 | 15,29<br>5,61 | 12,45<br>10,92 | 14,13<br>12,91 | 7,85<br>4,49 | 9,35<br>29,71 | 21,94<br>15,64 | 18,79<br>20,72 | 49,72<br>33,93 |
| | C | 52-89 | 6,50<br>3,6 | 7,40<br>4,5 | 9,44<br>6,8 | 11,31<br>8,9 | 31,18<br>12,60 | 25,49<br>14,40 | 8,68<br>49,20 | 34,65<br>23,8 |
| medium washed out | A | 0-16 | 5,20<br>4,30 | 9,10<br>5,10 | 9,90<br>5,50 | 11,00<br>4,00 | 12,10<br>6,70 | 5,58<br>7,20 | 47,12<br>67,20 | 35,20<br>18,90 |
| | B | 16-30 | 3,18<br>2,90 | 4,20<br>5,30 | 17,60<br>4,40 | 4,09<br>5,00 | 7,66<br>9,19 | 8,29<br>10,00 | 54,98<br>63,21 | 29,07<br>17,60 |
| | C | 30-64 | 5,00<br>- | 3,30<br>4,90 | 3,80<br>5,00 | 4,40<br>4,11 | 5,80<br>9,80 | 10,59<br>16,59 | 67,11<br>59,60 | 16,50<br>14,01 |

Table 4. Some agrochemical indicators of mountain-brown steppe soils of Zagatala region

| Section | Genetic Horizon | Depth in sm. | Ca+Mgm/eq. 100g soil | | | Total nitrogen % | Humus, % | C:N |
|---|---|---|---|---|---|---|---|---|
| | | | Ca | Mg | Ca+Mg | | | |
| unwashed | A | 0-31 | 23,34 | 4,14 | 33,48 | 0,329 | 4,9 | 8.64 |
| | B | 31-52 | 24,51 | 3,28 | 24,79 | 0,312 | 3,2 | 5.95 |
| | C | 52-89 | 21,75 | 2,18 | 23,93 | 0,242 | 2,4 | 5.75 |
| medium washed out | A | 0-16 | 21,19 | 3,75 | 24,94 | 0,215 | 3,4 | 9.20 |
| | B | 16-30 | 18,15 | 2,95 | 21,1 | 0,196 | 2,2 | 6.51 |
| | C | 30-64 | 13,75 | 1,15 | 14,9 | 0,155 | 1,7 | 6.36 |

## Result

The reduction of the soil profile due to erosion and degradation also led to a decrease in absorbed cations and humus in the productive sowing layer. The gradation of transitions along the profile can be seen in the given example of a soil profile. In both given samples, we observe a differentiation of the shapes and sizes of morphological and type diagnostic indicators along the soil profile.

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**Xülasə**

**Zaqatala rayonu torpaqlarında eroziya prosesinin tədqiqi**

B.H.Əliyev,T.A.Hacıyev,A.V.Heydərova,R.R.Canməmmədovanın məqaləsinə xülasə

Məqalədə Böyük Qafqazın cənub yamacında yerləşən Zaqatala rayonunun torpaqlarının ekoloji vəziyyəti haqqında danışılır.



**Açar sözlər:** yamac,torpaq,meşə bitkisi,relyef,eroziya,iqlim



**Резюме**

**Исследование эрозии почв Закатальского района**

Б.Г.Алиева,Т.А.Гаджиева,А.В.Гейдарова,Р.Р.Джанмамедова

В статье говорится об экологическом состоянии земель Закатальского района, который расположен на южном склоне Большого Кавказа.



**Ключевые слова:** склон, почва, лесная растительност, рельеф, эрозия,климат

# Diagnostic indicators of eroded mountain gray-brown soils on the south-eastern slope of the Greater Caucasus

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**Abstract**

To restore and increase the fertility of the mountain gray-brown soils that we have studied and to use them effectively, and at the same time to obtain a high-quality and abundant harvest from the cultivated plants, the most effective soil protection agrotechnical measures are the cultivation of perennial legumes on the eroding slopes, planting siderates and giving them mineral fertilizers. The role of perennial leguminous grasses in improving the structural indicators, water-physical properties, agrochemical composition of eroded soils, enriching them with organic residues is very great. Perennial leguminous grasses improve the structure of the soil by keeping a lot of roots, stems, leaves and other organic residues, significantly weakening the erosion process. Widespread erosion causes many problems in land use. Therefore, in order to solve these problems during land use, it is important to classify them according to the diagnostic indicators of newly eroded gray-brown soils. According to observations and analysis of excavated sections, there are very few sharp differences between the indicators of residual sizes of horizons after the planting layer. In many cases, especially at a depth of 50-60 cm, this difference is noticeable almost by chance. Among the diagnostic indicators, the humus layer or the color of the upper horizon are considered more accessible. Because one of the first observed indicators during the research is the color of the upper horizon of the soil. The color of the AYva humus layer in the upper part of the uneroded gray-brown soil is mainly dark brown-brown, and the color of the AYca horizon located below it is yellowish gray-brown. And the color of the horizon is light brown.

**Key words:** erosion, gray-brown soils, structure, diagnostic indicators, horizon.

## Introduction

Agriculture has been developed in the mountainous regions of our republic, including the southeastern slope of the Greater Caucasus, since ancient times. Cultivation of the same plant in one place for a long time without paying attention to soil protection agrotechnical measures on the mountain slopes severely worsened the structure of the soil and reduced the amount of water-resistant aggregates, which caused the erosion process to cover large areas. In the south-eastern slope of the Greater Caucasus, the erosion rate of soils is very high.

Studies show that the organization of farming and grazing without taking into account the erosion process for many years has created fundamental changes in the morpho-genetic diagnosis of soils. It is especially important to consider modern climate changes. We witnessed this in the entire land area we studied. Erosion processes typical for mountain steppes, geological-geomorphological, as well as relief conditions, thinning of vegetation in many places, change in botanical composition have intensified erosion processes.

In Azerbaijan, the low mountains of the south-east of the Greater Caucasus and Gobustan are mainly used as pastures. But in the arid climate, the weakness of the vegetation, the short duration and intensity of the rains caused the erosion to be more intense. In particular, improper grazing gives further impetus to this process [4].

Improper establishment of the grazing system on inclined slopes, negative change in the grass cover promotes the development of erosion. The settlement process and the development of the transport-road network on the southeastern slope of the Greater Caucasus have also created conditions for the activation of soil erosion.

Currently, the main part of meeting the demand for food in our country is related to the development of animal husbandry. It is one of the areas in Gobustan region that differ in terms of animal husbandry development. In order to develop animal husbandry, protection of lands and increase of their fertility and productivity are urgent issues. The surface and internal structure of eroded pasture

soils have their own characteristics. Vegetation on the surface of these lands is weak and covers less than 50% of its surface. In unwashed soils, however, this can be 80-90% or more. The loss of the upper part in the washed soils is the formation of furrows of different sizes, the granulometric composition is distinguished by its relative lightness and skeleton. Such soils dry quickly after rainfall. This difference that we have mentioned is more pronounced as the degree of washing increases. Vertical cracks appear in the soil profile, the width of which can be from several mm to several cm. Compared to unwashed soils, the color of the upper horizon is grayish. The transition of the horizons is not sharp, and a relatively large number of small stones is visible in the upper and lower horizons [6].

Erosion-accumulation process, mass mixing occurs in the upper horizon of the soil in cultivated pastures. Accumulation process takes place at the bottom of the slope where the inclination is weakened. As a result of this process, three zones are selected within the pasture lands. But the border separating these zones is not clear and gradually replaces each other. Their parameter indicators change depending on the morphological structure of the slope and their morphometric indicators. From these features that we have shown, land areas with different properties and composition are formed within the slope. These land areas are quite unique due to their morphological structure, chemical composition, physical and water-physical properties.

## Methods:

The research works were carried out on the mountain gray-brown soils in the territory of the Gobustan region on the southeastern slope of the Greater Caucasus. The climate of the area is mostly dry and mild-hot in summer, and relatively humid in winter.

Geographical comparison, stationary and GIS methods were used during field research. Samples were taken from the genetic horizons for laboratory analysis [6].

In order to study the density of soils, soil samples were taken using small cylinders by the method of N. Kaczynski.

Soil samples were taken every 10 cm to a depth of 40 cm and agrophysical properties were studied [3]. Humus and total nitrogen were determined by the method of Tyurin, and phosphorus was determined by the Machigan method [2]. B. Dospehov's methods were used in field experiments [1].

## Main section

Hypsometric indicators of the area are very diverse. Of the total area, 274.8 hectares are below 200 meters, 151.4 hectares are at 200-300 meters, 17,175.0 hectares are at 300-400 meters, and 22,945.8 hectares are at 400-500 meters altitude (table 1). 68.1% or 93569.4 hectares of the district area varies between 500-800 meters. A small part of 1923.6 hectares or 1.4% is at an altitude of 800-1000 m. It is known from the table that the main part of the region, including the agricultural areas, is concentrated at 500-800 m altitude.

**Table 1. Hypsometric indicators of the area**

| № | Absolute height, m | Area | |
|---|---|---|---|
| | | hectares | % |
| 1 | Up to 200 | 274,8 | 0,2 |
| 2 | 200-300 | 1511,4 | 1,1 |
| 3 | 300-400 | 17175,0 | 12,5 |
| 4 | 400-500 | 22945,8 | 16,7 |
| 5 | 500-800 | 93569,4 | 68,1 |
| 6 | 800-1000 | 1923,6 | 1,4 |
| 7 | 1000 | | |
| Total | | 137 400 | 100,0 |

In weakly eroded soil, the color of the upper humus horizon is brown-brown. AYca, located below it, is yellowish gray-brown. The Bca horizon in this soil is gray-brown in color. The color of the upper horizon of the moderately eroded soil, that is, the AYa horizon, is brownish-light brown. Diagnostic indicators based on the degree of soil erosion are shown in table 2.

Table 2. Diagnostic indicators of eroded gray-brown soils

| Indicators | Not eroded | Weakly eroded | Moderately eroded | Severely eroded |
|---|---|---|---|---|
| Genetic layers and depth | AYvca 6-25<br>AYca 15-26<br>Bca 17-42<br>B/Cca15-56<br>Ccs 22-63 | AYa 18-22<br>AYca 13-24<br>Bca 16-40<br>B/Cca 15-55<br>Cca 21-64 | AYa 14-19<br>AYca 11-22<br>Bca<br>B/Cca<br>Cca | AYa 10-16<br>AYca 10-21<br>Bca<br>B/Cca<br>Cca |
| The color of the humus layer or upper horizon | AYvca - dark brown<br>AYca- yellowish/gray-brown<br><br>Bca light brown | AYa brown<br>AYca yellowish/gray-brown<br><br>Bca - gray-brown | AYa light brown<br><br>AYca grayish light brown | AYa gray-brown<br>AYca light gray brown |
| Structure | AYvca granule<br><br>AYca minor | AYa granule<br>AYca minor | AYa<br><br>AYca | AYa unstructured<br>AYca soft crumbly |
| Humus in % | 3,35 | 2,19 | 1,62 | 1,13 |
| Nitrogen in % | 0,25 | 0,20 | 0,19 | 0,10 |
| C:N | 7,16 | 6,10 | 5,00 | 5,40 |
| depth and shape of the carbonate layer | White spots on the upper surface | White spots on the upper surface | In the form of veins from the upper surface | In the form of veins from the upper surface |
| Sum of absorbed bases mg.eq. | 35,43 | 25,84 | 21,02 | 32,57 |
| pH | 7,6 | 7,3 | 7,8 | 8,0 |
| Physical clay < 0,01 mm, % | 52,25 | 50,20 | 49,56 | 44,02 |
| Sludge fraction (< 0,01mm), % | 19,42 | 11,68 | 12,44 | 1368 |
| Structural composition >0,25 mm | 92,4<br>31,9 | 88,0<br>24,5 | 88,1<br>20,4 | 97,1<br>18,9 |
| Structural factor | 0,95 | 1,26 | 0,85 | 0,86 |
| Density, g/cm3 | 1,24 | 1,28 | 1,32 | |

The color of the second horizon, that is, AYca, is grayish light brown. In severely eroded soil, the upper horizon is solid gray-brown. AYca can be considered light gray-brown in color.

The structure of the upper horizon of the uneroded soil of AYvca is granular and that of AYca is small ball-like.

In weakly eroded soils, the structure of the upper AYa layer is small-grained, and the AYca layer located below it has a small ball-like structure. If it is moderately eroded, the structural composition is more scattered and small granular and powdery. In severely eroded soils, the structure is completely destroyed. In the second layer, it appears to have a soft, fine-grained structure.

## Discussion

The conducted studies show that the thickness of the AYvca-horizon is 6-25 cm in the pasture in grey-brown soils that have not been subjected to erosion. But in cultivated lands, the thickness of this layer varies between 20-25 cm. In case of weak erosion, this indicator is not more than 18-22 cm, in moderate erosion, 14-19 cm, and in severe erosion, this indicator does not exceed 10-16 cm. However, it is important to note that the top part of the eroded soil used for cultivation is mixed with plowing, so its thickness cannot be accurately determined. Because it can participate in plowing in the second layer.

## Results

In eroded soils, it differs in that the color is relatively light in the upper layer. Soils that have been slightly eroded are used for cultivation. Therefore, the structure of the upper horizon is weak and quickly disintegrates compared to the non-eroded one. Because the soil has been plowed, it is not kip, and the subsequent layers differ little from the uneroded soil. This difference is felt more on the surface. Observations show that a relatively high slope of 2-30 allows for surface flow to occur. Traces of surface flow are visible in many places.

The changes in the morphological features in the

non-eroded soil area are only related to the evolution process, while in the eroded areas, they are related to the erosion-accumulation process. Therefore, erosion leads to a gradual reduction of the humus horizon of the soil and also to an elevation of the soil layer. The A horizon is completely destroyed in the soil area with severe erosion. But in cultivated and plowed lands, the soil mass is mixed up to the C horizon. As a result, the color in the upper part is slightly different from the lower layers. It is known that the development of erosion reduces the total soil layer along with the indicators of the soil, the traces of washing on the surface affect the hydrotechnical regime and change the direction of biochemical processes.

Planting along the profile is six layers high. It can also be seen from the morphological description of these sections. Although the reasons for this are different, it is enough to show two. The first is the compaction and hardening of the six layers of planting with plowing and cultivation, and the second is due to the washing away of the soft particles of the pomegranate as a result of erosion, and the soil quickly dries and hardens. Observations show that this is felt more clearly as the washing rate increases. As the rate of development of erosion increases, it increases especially on the surface and in the six layers of soil. As a result, the disaggregation process occurs in the soil in its profile, that is, the breakdown of soil aggregates intensifies. In particular, the amount of agronomically valuable particles decreases along the profile.

The rate of erosion reduces the amount of plant remains and roots along the profile. These features are visible in the morphological profile of almost all cuts. The main difference between the plants cultivated in the experimental area used for planting is the development of erosion, that is, the height of washing weakens the development of plants. This is one of the morphological characteristics of the profile of the ordinary gray-brown soils that we have studied.

The formation of cracks in the profile, their width and depth are essentially different from erosion, and in ordinary gray-brown soils subjected to moderate and severe erosion, ruts are very noticeable. Selection of horizons or alternating horizons is evident in the soil profile. In almost all cuts, moisture increases downward, boiling under the influence of 10% HCl. Carbonate crystals and white crystals are found in all layers.

Analysis of morphological profiles of eroded gray-brown soils shows that erosion creates an unfavorable environment in soils. In particular, the granulometric composition, water-physical properties, porosity, and aggregate composition are sufficiently transformed. Moisture indicators, density and many properties are changed. Therefore, measures to improve soil fertility are required.

We used NPK mineral fertilizer mixture in experiments to restore the fertility of eroded gray-brown soils. This method is a more radical direction in the restoration of eroded lands.

It should be considered practically and scientifically important to take into account the stated reasons and develop anti-erosion measures, as well as to determine the diagnostic indicators of gray-brown soils in order to effectively use the eroded soils.

It is clear from the results of the conducted research that most of the land here has been fragmented, scattered, and lost its vegetation due to the development of the ravine network. One of the main reasons for this is anthropogenic factors [10]. Because intensive movements of cattle on the slopes in irregular grazing lead to its hardening, a sharp weakening of the water absorption capacity, thinning of plants on the soil surface, rapid formation of surface streams of torrential rains, and intensive erosion [5 ] [9], [8].

Thus, the development of erosion creates conditions for the loss of the cover, the deterioration of the physical and water-physical properties of the soil, and the washing away of humus and biogenic elements along with the soil.

These areas, which we are conducting our research, are among the locations that differ in terms of the development of soil erosion. Here, along with surface washing, it manifests itself more in the development of linear erosion [12]. Due to these reasons, the arable land is very limited in the study area. The areas used for these crops are small, and the productivity of the soil is very low.

The development of erosion, especially gully erosion, affects the water regime and balance of the area. The soil's water holding capacity is weakening. This weakens the forage and even in such sparsely grazed areas, the supply of fodder drops sharply. In general, such negative conditions and increased leaching rates naturally reduce pasture productivity.

The erosion process affects the morphological structure of soils and their morphometric indicators. We have clearly defined them when laying the land sections. Studies show that the erosion-accumulation process in some cases disrupts the processes of soil penetration and elemental soil. Erosion of soils in pastures is affected by their resistance to erosion. For the region where we conducted our study, the fact that the soils are mainly composed of gravels increases their leaching and dispersal. But the formation of dense grass cover in such areas increases the adhesion and continuity between aggregates, which causes

erosion to weaken and stop completely [11], [7].

Carbonation of the soils distributed in the study area is high. Carbonates in the soil are of lithogenic origin. Therefore, as the parent rock improves, carbonation increases. These features have a major impact on the durability of pasture soils against erosion. It causes them to be intensively dispersed and washed away. Especially in the development of gully erosion, having this composition increases the security of its occurrence.

The surface and internal structure of eroded pasture soils have their own characteristics. Vegetation on the surface of these lands is weak and covers less than 50% of its surface. In unwashed soils, however, this can be 80-90% or more. The loss of the upper part in washing furnaces is characterized by the formation of furrows of different sizes, the relative lightness of the granulometric composition and the fact that it is skeletal. Such soils dry quickly after rainfall. This difference that we have mentioned is more pronounced as the degree of washing increases. Vertical cracks appear in the soil profile, the width of which can be from several mm to several cm. Compared to unwashed soils, the color of the upper horizon is grayish. The transition of the horizons is not sharp, and a relatively large number of small stones is visible in the upper and lower horizons.

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# Dynamics of Forest Development and Deforestation in Azerbaijan

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**Abstract**

Several forest areas were surveyed in 2023-2024. An analysis was carried out in the field of quantitative and qualitative characteristics, as well as the species composition, forest cover of the territory, and also the genesis of the development of our forests for 24 years. The reports of the international portal on global forest monitoring were also analyzed. The transformation of the forests of our republic occurred as a result of the destruction of beech forests and forest restoration work. The greatest losses of forest cover occurred in Lankaran, Sheki-Zagatala zone, as well as in the Ganja-Gazakh zone. In addition, as a result of the occupation of our lands, large forest areas of Karabakh were lost. Over the past decades, hornbeam, hornbeam-hornbeam-oak forests, as well as beech-hornbeam forests have formed in place of the cut down valuable beech forests. Thanks to the results of analytical studies, it will be possible to predict the further genesis of forests in our republic and also to draw up a development plan. It is necessary to conduct not only an inspection of forests, but also to assess the climatic and planted conditions of these territories.

**Keywords:** forest cover, genesis of forest development, global forest monitoring, transformation of forests, destruction of beech forests, forest restoration, Lankaran, Sheki-Zagatala zone, Ganja-Gazakh zone, Karabakh forest loss.

## Introduction

The development and loss of forests in Azerbaijan has emerged as a significant environmental concern, yet it remains under-researched in modern scientific literature. Very few studies focus on the detailed analysis of forest transformations in the region, resulting in a substantial gap in our knowledge of this critical issue. Moreover, discrepancies in data from various sources complicated the research process, requiring additional time to cross-reference and verify the available information. To address this, a comprehensive study was carried out over the course of a year, from 2023 to 2024, combining both satellite imagery and extensive on-the-ground surveys. This dual approach allowed for a more thorough analysis of multiple forested areas across the country.

The research focused on several key aspects, including the quantitative and qualitative characteristics of forests, species composition, forest cover, and the genesis of forest development over the last 24 years. International reports on global forest monitoring were also incorporated to provide a broader context.

Special attention was given to the Sheki-Zagatala zone, which has experienced the highest levels of deforestation across the entire republic, marking it as a hotspot for forest loss. Similarly, the Talysh zone, an area of immense ecological importance, was extensively surveyed due to its ongoing transformation and significant forest degradation. Other regions, were also assessed, with particular emphasis on Karabakh, where large forest areas were lost due to territorial occupation.

The study’s detailed findings are expected to contribute to a better understanding of the genesis of forest development in Azerbaijan. Furthermore, this knowledge will enable the government to accelerate the ongoing forest restoration efforts, ensuring that reforestation initiatives can be implemented more effectively and efficiently in the future.

The idea that the research will help the government expedite the forest restoration process that is already underway.

## Purpose

The purpose of this study is to conduct a comprehensive assessment of the extent of forest loss in Azerbaijan and to analyze the conditions under which the remaining forests are currently sustained. By quantifying the percentage of deforestation and understanding the environmental and climatic factors affecting the existing forest ecosystems, this research seeks to provide crucial insights into the current state of the country's forest resources. The results of this work are intended to

inform and guide the development of a long-term forest management and restoration plan. Such a plan is essential not only for the regeneration of the lost forest cover but also for the sustainable management of the remaining forests. Additionally, the study aims to support efforts to minimize future deforestation by identifying areas at high risk and proposing actionable strategies for preserving forested areas. Ultimately, this research will lay the groundwork for effective policy-making to ensure the sustainable development of Azerbaijan's forest landscapes for future generations.

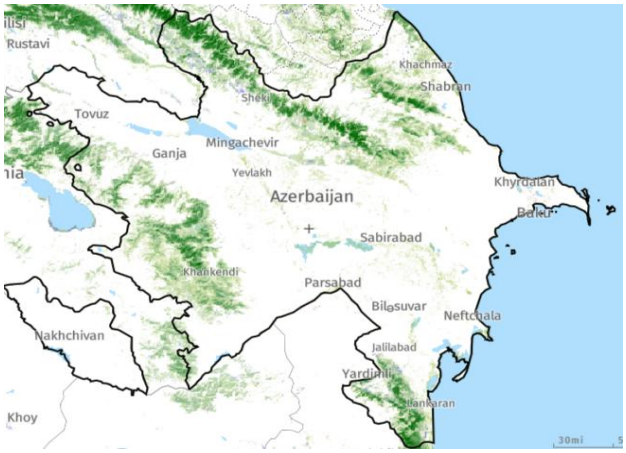
## Objectives of the Article

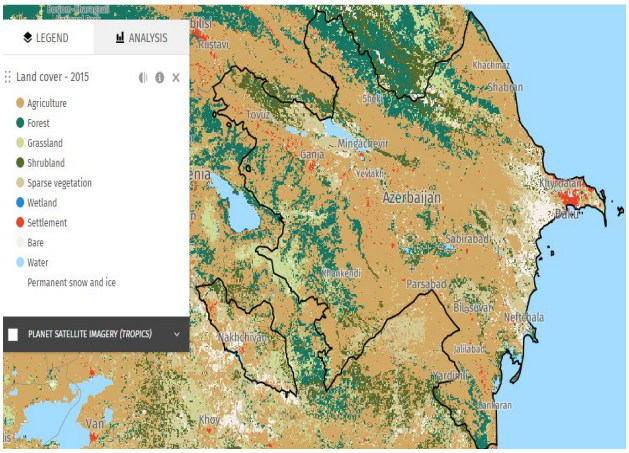
The primary objectives of this article are to assess the extent of deforestation in Azerbaijan and evaluate the current conditions of the country’s forest ecosystems, drawing on a variety of research tools and data sources. To accomplish this, a comprehensive review of research-oriented literature was conducted to provide a foundational understanding of forest development and loss. This literature included studies on forest management, biodiversity, and environmental sustainability, which offered essential context for the analysis.

One of the core data sources used in this study was the Global Forest Watch portal, which provided valuable insights into changes in forest cover, deforestation rates, and the health of forested areas over time. Additionally, a range of topographic maps were examined to track spatial changes in forest distribution across different regions of Azerbaijan, offering a visual and geographical perspective on deforestation trends. These maps, combined with satellite imagery, enabled a detailed evaluation of both historical and recent forest loss.

A significant part of the study involved analyzing 24 years of deforestation data, with a focus on identifying specific periods and areas where the highest rates of forest degradation occurred. This long-term analysis allowed for a deeper understanding of the factors contributing to forest loss and provided a basis for assessing the effectiveness of current conservation efforts.

In the final stage of the analysis, data from Global Forest Watch was revisited to create a comprehensive map of Azerbaijan, illustrating both the extent of forest loss and the areas where forest cover remains. This visual representation serves as a crucial tool for understanding the spatial distribution of forest resources and guiding future reforestation and conservation strategies.




## Objects and methods of research

The object of study of this article are Sheki-Zakatala zone and Kəlbəcər, Kalbajar-Lachin . To study and obtain data for further research and analysis, various methods are used. These methods may include the use of various types of topographic maps of regions. Also, to obtain data on these zones, Global Forest Watch is used, where they obtain data on their:tree cover loss,tree cover gain,tree cover by type.

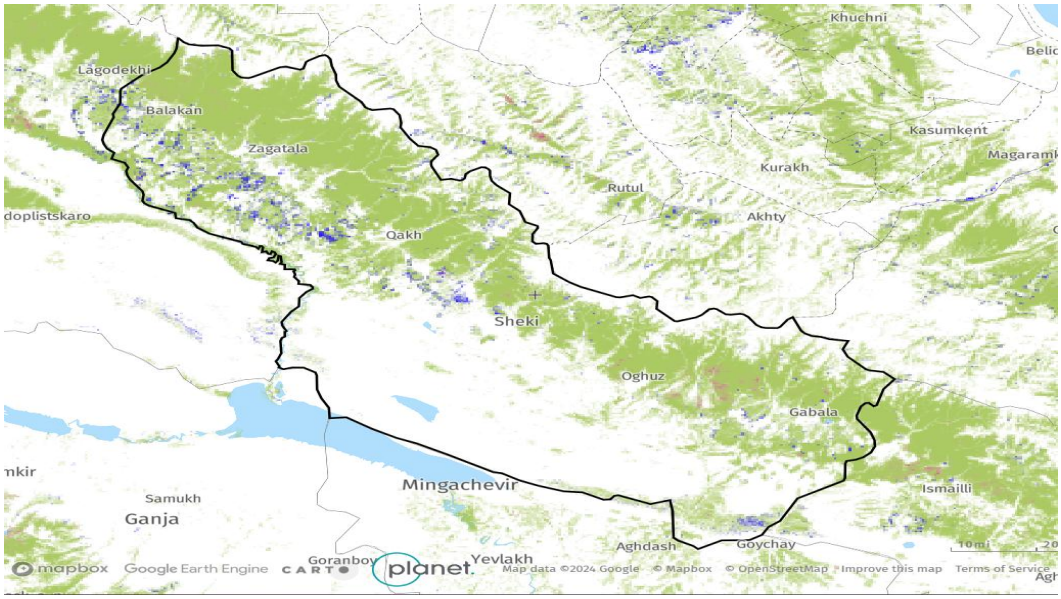
## Results

Analysis of forest cover in the Sheki-Zakatala zone:Sheki-Zagatala economic region is one of the economic regions of Azerbaijan. Includes Balaken, Gakh, Gabala, Oguz, Zagatala, Sheki administrative regions. The Sheki-Zagatala economic region borders Russia (Dagestan) in the north and Georgia in the west.

Climate in Sheki-Zagatala region:The number of days without precipitation ranges from 5 to 25 days in June-September. The frost-free period lasts for 150-250 days or more. Days with snow cover range from 20 to 120. At altitudes of 500-700 meters the climate is subtropical, while at higher altitudes it is mild and cool; The climate gets colder with increasing altitude. The region ranks second after the Lankaran-Astara zone for the range of

annual precipitation amounts.

In 2010, Sheki-Zakatala had 250 thousand hectares of natural forests, which was more than 30% of its territory. In 2023, it lost 51 hectares of natural forests. In the image taken from the source according to Global Forest Watch, you can see that as of 2000-2020, the territory of the Republic of Azerbaijan, or more precisely in the Sheki-Zakatala region, the increase in tree cover of 20 years, 30 meters is shown in blue.




32% of the territory of Sheki-Zagatala was covered by trees by more than 30%. Natural forest - 280 thousand hectares, Plantations - 15.4 thousand hectares, Other vegetation cover - 577 thousand hectares.


Loss of forest cover in Sheki-Zagatala, from 2001 to 2023, the area of forest cover in Sheki-Zagatala was 1.22 thousand hectares, which is equivalent to a decrease in forest cover by 0.41% in 2000.And the increase compared to other areas was from 2000 to 2020, the area of forest cover in Sheki-Zagatala was 9.24 thousand hectares, which is 31% of the total increase in forest cover in Azerbaijan.Increase in forest cover in forest cover in Sheki-Zagatala,Azerbaijan,compared with others ares.

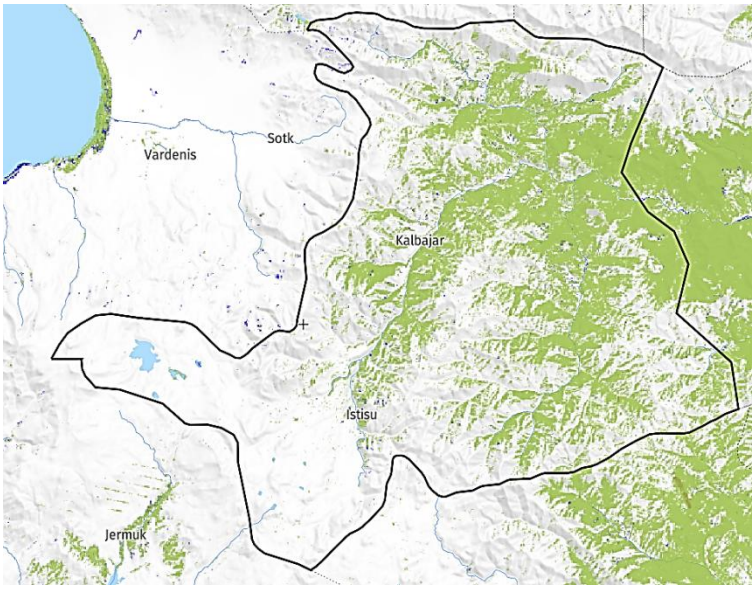
From 2000 to 2020, the area of forest cover in Sheki-Zagatala was 9.24 thousand hectares, which is 31% of the total increase in forest cover in cover in Azerbaijan.


**Analysis of forest cover in the Kalbajar-Lachin, Azerbaijan:**

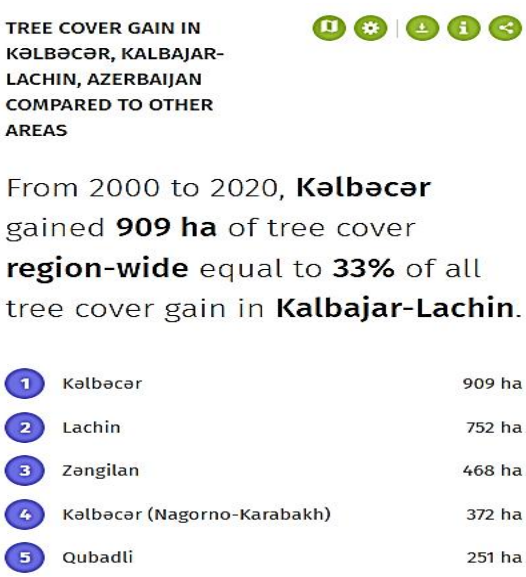
The territory of the Kelbajar region is located at an altitude of 1500-3800 meters above sea level in the valley of the Terter River within the Lesser Caucasus.The natural boundaries of the territory include the Mykhtokan (3411.4 m), Murovdag, and East Sevan ridges. The highest point of the area is Mount Gyamysh (peak of Murovdag) - 3724.6 m[3]. The second highest is Mount Delidag (3616 m). An area of 30,000 hectares is covered with forests.

Climate in Kalbajar region: Anthropogenic sediments are common on the plains and lower parts of river ravines. The average temperature in January on the plains and mountain slopes is 2-0.50C, in the highlands from -4 to -130C, in July -25-260C and 15-140C, respectively. Annual precipitation in the highlands exceeds 800-900 mm. The high peaks of the Murovdag massif are sometimes covered with snow all year round. The main rivers are the Kura, its tributaries are Terter, Khachin, Gargar and Araks with tributaries Kendelenchay, Guruchay, Gozluchay, etc.

In 2010, Kalbajar had 39.8 kha of tree cover, extending over 20% of its land area. In 2023, it lost 45 ha of tree cover.



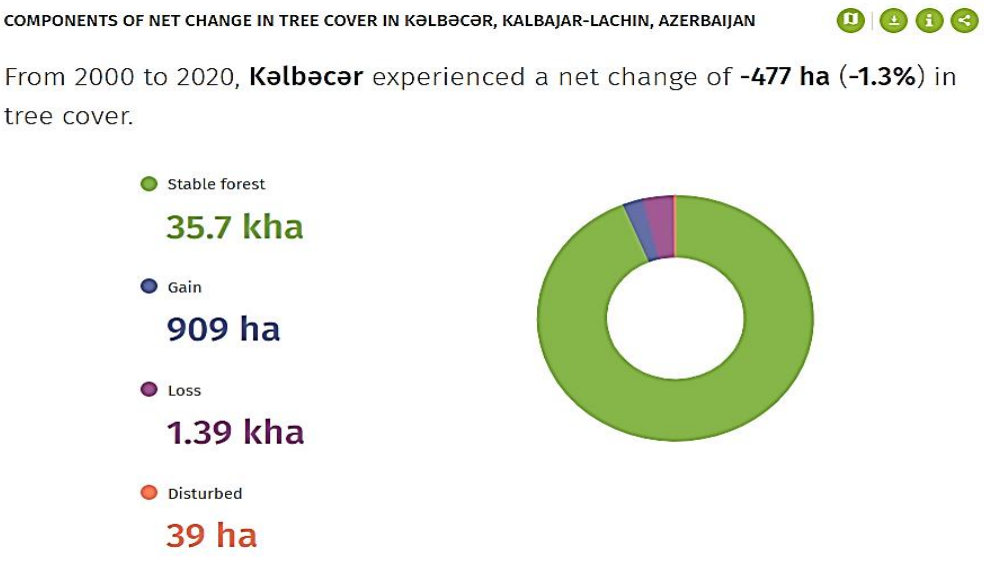

Tree cover loss in Kalbajar, Kalbajar-Lachin, Azerbaijan. From 2001 to 2023, Kalbajar lost 174 ha of tree cover, equivalent to a 0.33% decrease in tree cover since 2000.Tree cover gain in Kalbajar, Kalbajar-Lachin, Azerbaijan compared to other areas. From 2000 to 2020, Kəlbəcər gained 909 ha of tree cover region-wide equal to 33% of all tree cover gain in Kalbajar-Lachin. Tree cover by type Kalbajar, Kalbajar-Lachin, Azerbaijan .As of 2000, 26% of Kəlbəcər land cover was >30% tree cover.





In Kalbajar there have been 0 VIIRS fire alerts reported so far in 2024 considering high confidence alerts only. This total is normal compared to the total for previous years going back to 2012. The most fires recorded in a year was 2017, with 47.

Tree cover loss in Kalbajar, Kalbajar-Lachin,Azerbaijan. From 2001 to 2023, Kəlbəcər lost 174 ha of tree cover, equivalent to a 0.33% decrease in tree cover since 2000.

Conclusion on the analysis of forest cover in the economic regions of Sheki-Zagatala and Kelbajar.

Analysis of forest cover in the economic regions of Sheki-Zagatala and Kelbajar shows both positive and negative trends.

### Sheki-Zagatala:

General information: In 2010, forest cover was 250 thousand hectares (more than 30% of the territory). By 2023, a loss of 51 hectares of natural forests has been recorded.

Changes from 2000 to 2020: Increase in forest cover by 9.24 thousand hectares, which is 31% of the total forest growth in Azerbaijan.

Climatic Conditions: The region is characterized by a variety of climates, which influences biodiversity and forest conservation.

### Kalbajar

General information: In 2010, forest cover was 39.8 thousand hectares (20% of the territory). By 2023, the loss was 45 hectares.

Changes from 2000 to 2020: Gain at 909 hectares, which accounted for 33% of the total increase in the region.

Climatic Conditions: High mountains and difficult climatic conditions promote unique biodiversity, but also increase the risk of loss due to human influence.

### General trends

Both regions show a slight loss of forest cover in the last two decades, however Sheki-Zagatala shows a more significant increase.

- The climatic conditions of both zones affect the structure and condition of forests, which requires careful monitoring and management of forest resources.
- The need to protect and restore forest ecosystems remains an urgent task to ensure sustainable development and conservation of biodiversity.
- Recommendations:
- Sustainable management of forest resources.
- Programs to restore lost forests.
- Monitoring climate change and its impact on forest cover.

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# The impact of the erosion process on the soils of Oghuz region

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## Annotation

In modern times, there are many natural ecosystems that have been greatly degraded due to global climate change, among which soils formed in the vertical belt attract special attention. The article provides detailed information about the soils of the Oguz region and the differentiation of their typical diagnostic indicators as a result of the erosion process.

**Keywords:** ridge, climate, air temperature, soil erosion, genetic section, soil type

## Introduction

The Main Caucasian Range is a system of mountain folds that are never crossed by rivers, the Main Caucasian Range is characterized by high-mountain relief, its watershed part almost everywhere has the form of a narrow ridge, on which the highest peaks of the ridge are located - Tufan and Bazarduzi. The main properties of the relief of this geomorphological region are that the local mountain ranges and elevations belong to the anticlines, and the depressions to the synclines [1]. In the territory of the Oguz region, both at depth and in the areas of the outcrop of parent rocks, sedimentary materials consist of clays, limestones, loams and conglomerates. They are also unstable to the destructive action of water, so they play a large role in the development of gully erosion in the region. Climate is one of the active natural factors and plays a large role in the process of soil formation. Climate features largely predetermine the possibility of occurrence and development of erosion processes, as well as the intensity of their flow. To determine the role of climatic factors in the erosion process, we describe the climatic conditions of the region. The diversity of physical and geographical conditions of Azerbaijan in its individual natural zones has created various climatic types [2].

There are 8 climate types in Azerbaijan (from humid subtropical to mountain tundra). Of the 8 climate types, the following are typical for the Oguz region:

1. Moderately warm steppe climate with dry summers;
2. Moderately warm steppe climate with dry winters;
3. Moderately warm climate with dry winters.
4. The first two types cover the southern part, the third type-the central and northern parts of the region. The air temperature depends on the altitude of the area above sea level. Between the lowest point and the watershed, the temperature difference in winter is -20, in summer +30.

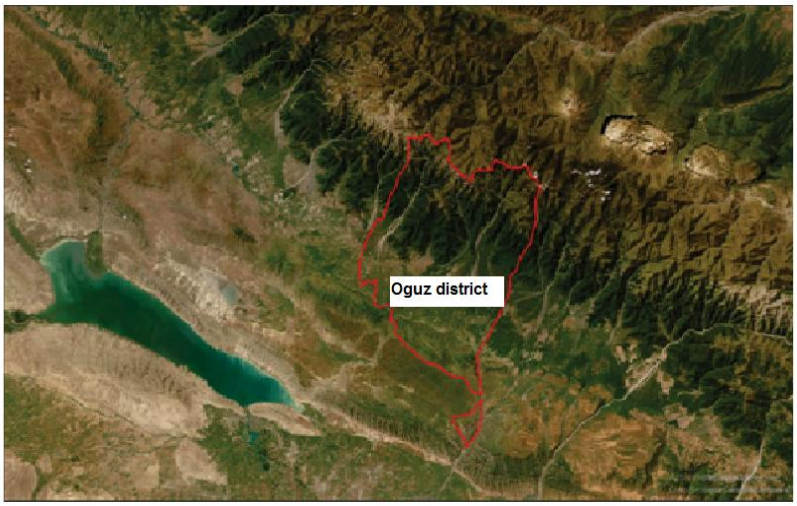
A sharp change in temperature both during the day and by season increases the destruction of the soil surface, and this weakens the development of vegetation, where soil erosion occurs with intense precipitation.

In winter, when the air temperature drops below 00C (especially in the elevated part of the region), the soil surface freezes in a short time. However, it should be noted that the average monthly soil temperature in the coldest months of winter is positive.

Research method: The research used both ground-based measurement data and digital maps created by decoding space images.

Analysis of results: In the Oguz district, 500 mm of precipitation falls annually, most of it in the spring and autumn months. The greatest soil erosion is observed in the spring, when the

maximum precipitation falls. The rapid development of the erosion process in the spring is associated with the intensity of precipitation, since they do not have time to be absorbed by the soil and create surface runoff, subjecting the soil to rapid erosion (Fig. 1) [3]. Little snow falls in winter, so soil erosion is observed in the winter months. Due to the moderate winter, there is no permanent snow cover, it is only observed when the air cools. The thickness of the snow cover is 8-14 cm, and lasts 15-60 days; the snow cover appears in late November or early December, and melts in March.

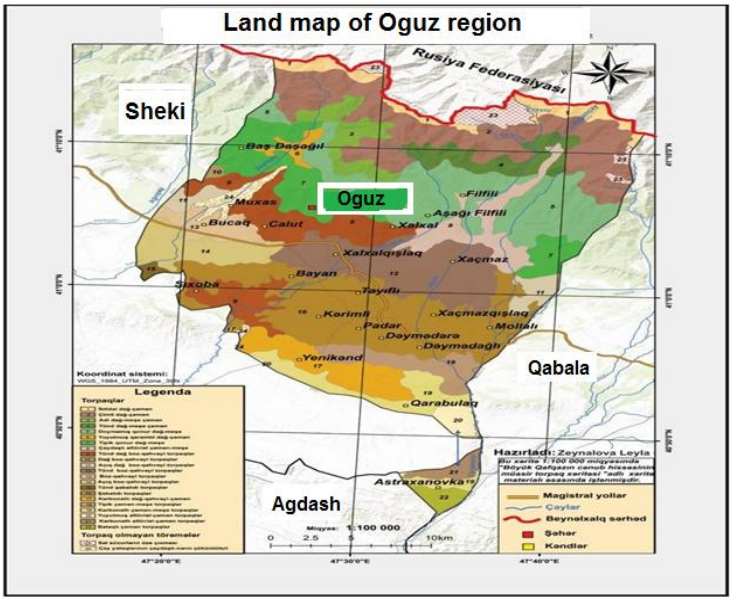



**Picture 1. Space image of the Oguz district**

The peripheral zone bordering the mountain ranges is represented by the steppe type of soil formation. This zone includes dark gray-brown and light gray-brown (chestnut) soils (Table 1, Pic.. 2) [4].

Table 1. Water-physical properties of steppe mountain-brown soils of the Oguz district.

| Section | Genetic horizon. | Depth in sm. | Field moisture % | Bulk density g/sm3 | Specific gravity g/sm3 | Total porosity % |
|---|---|---|---|---|---|---|
| 1 Unwashed | A | 0-36 | 19,85 | 1,06 | 2,45 | 55,61 |
| | B | 36-59 | 18,49 | 1,12 | 2,49 | 57,3 |
| | C | 59-88 | 16,19 | 1,14 | 2,52 | 57,9 |
| 2 medium washed out | A | 0-27 | 18,94 | 1,04 | 2,54 | 58,2 |
| | B | 27-44 | 18,35 | 1,09 | 2,54 | 58,7 |
| | C | 44-67 | 16,79 | 1,11 | 2,51 | 58,9 |




**Picture 2. Soil map of Oguz district**

Table 2. Particle size distribution of mountain brown soils of Oghuz district

| Section | Genetic horizon. | Depth in sm. | Factions % | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1-0,25 | 0,25-0,05 | 0,05-0,01 | 0,01-0,005 | 0,005-0,001 | <0,001 | <0,01 |
| 3 Unwashed | A | 0-25 | 6,95 | 0,92 | 20,56 | 9,84 | 18,00 | 42,00 | 69,84 |
| | B | 25-57 | 4,15 | 1,70 | 19,42 | 7,85 | 16,12 | 36,22 | 61,82 |
| | C | 57-86 | 5,35 | 11,20 | 21,42 | 7,33 | 19,10 | 33,45 | 64,52 |
| 4 medium washed out | A | 0-11 | 5,74 | 2,45 | 24,85 | 11,15 | 19,34 | 34,65 | 51,75 |
| | B | 11-39 | 2,35 | 10,55 | 13,14 | 8,09 | 17,55 | 29,15 | 47,65 |
| | C | 39-67 | 0,75 | 6,74 | 11,35 | 7,91 | 15,64 | 22,41 | 44,99 |

The research was conducted in the foothills of the Oguz district. Sections were laid in unwashed and moderately washed areas.

Section No. 1 unwashed

A 0-36 sm dark brown, granular-nutty structure, live roots, heavy loamy, wet, clear transition.

B 36-59 sm dark brown, roots, heavy loamy, wet, clear.

C 59-88sm light brown, structure is not clearly expressed, fragments of slightly weathered rocks are found, effervesces from HCl.

Section No. 2 moderately washed

A 0-27 sm brown, lumpy-granular structure, heavy loamy, wet, clear.

B 27-44 sm light brown, lumpy structure, heavy loamy, moderately wet, clear transition.

C 44-67 sm light clayey, structure is not expressed fragments of parent rock, dense, boils from HCl.

Water-physical properties of mountain-brown steppe soils of the Oguz region are given in table 5. Here the total porosity, specific and volumetric weight of unwashed soils in the upper horizon amounted to 55.6%; 2.45 and 1.06 g/sm3.

In moderately washed samples these indicators increased, which indicates the course of the erosion process. According to the mechanical composition, these soils are heavy loamy, physical clay 69.84%, however, in moderately washed samples, physical clay is noticeably lighter (Table 5). Judging by Table 6 of the structural-aggregate composition, the content of aggregates larger than 1 mm during dry sifting was 60.85% in unwashed samples, 33.80% in waterproof samples.

In moderately washed samples, these indicators in the upper 0-27 sm horizon were 52.68% and 21.20%. According to agrochemical indicators, mountain-brown steppe soils of the Oguz district contain total nitrogen in unwashed samples of 0.344%, humus 5.2%, the sum of exchangeable cations was 38.23 m.eq. per 100 g of soil.

In average washed analogues in the upper 0-27 sm horizon, total nitrogen is 0.279%, humus 3.1%, a downward trend is observed down the profile.

**Table 3.Structural and aggregate composition of mountain-brown steppe soils of the Oguz district.**

| Section | Genetic horizon. | Depth in sm. | Factions мм | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | >7 | 7-5 | 5-3 | 3-1 | 1-0,5 | 0,5-0,25 | <0,25 | >1 |
| 1 Unwashed | A | 0-36 | 35,42<br>8,80 | 6,31<br>7,00 | 9,42<br>11,60 | 9,70<br>16,40 | 1,01<br>14,60 | 0,94<br>6,40 | 2,14<br>27,00 | 60,85<br>33,80 |
| | B | 36-59 | 31,11<br>3,40 | 9,04<br>8,60 | 7,25<br>9,50 | 8,38<br>14,60 | 0,73<br>15,00 | 0,63<br>6,20 | 1,96<br>32,40 | 45,88<br>36,10 |
| | C | 59-88 | 20,44<br>- | 3,40<br>5,60 | 6,79<br>11,80 | 12,34<br>9,60 | 22,10<br>14,70 | 82,40<br>10,10 | 32,15<br>39,80 | 42,97<br>27,11 |
| 2 medium washed out | A | 0-27 | 25,67<br>- | 9,91<br>1,00 | 9,76<br>7,00 | 7,17<br>13,60 | 0,74<br>15,30 | 0,58<br>12,70 | 1,59<br>42,90 | 52,68<br>21,20 |
| | B | 27-44 | 15,65<br>- | 1,58<br>1,40 | 10,75<br>3,20 | 8,17<br>10,05 | 0,98<br>14,60 | 0,46<br>9,10 | 13,41<br>49,70 | 44,32<br>14,65 |
| | C | 44-67 | 11,31<br>0,91 | 7,32<br>2,51 | 5,68<br>5,49 | 4,14<br>3,75 | 15,77<br>24,75 | 28,95<br>32,84 | 26,83<br>29,75 | 28,45<br>12,66 |

**Table 4. Some agrochemical indicators of mountain-brown steppe soils of the Oguz district.**

| Section | Genetic horizon | Depth in sm. | Ca+Mg/eq. 100g. soil | | | Total Nitrogen% | humus, % | C:N |
|---|---|---|---|---|---|---|---|---|
| | | | Ca | Mg | Ca+Mg | | | |
| 1 Unwashed | A | 0-36 | 32,11 | 6,12 | 38,23 | 0,344 | 5,2 | 8.77 |
| | B | 36-59 | 30,52 | 5,8 | 36,32 | 0,336 | 4,8 | 8.28 |
| | C | 59-88 | 27,41 | 4,7 | 32,11 | 0,265 | 3,4 | 7.44 |
| 2 medium washed out | A | 0-27 | 23,15 | 4,31 | 27,46 | 0,279 | 3,1 | 6.44 |
| | B | 27-44 | 19,49 | 3,09 | 22,58 | 0,235 | 2,6 | 6.41 |
| | C | 44-67 | 14,19 | 2,8 | 16,99 | 0,174 | 1,9 | 6.30 |

## Result

In both given samples, we observe a differentiation of the shapes and sizes of morphological and type diagnostic indicators along the soil profile. The gradation of transitions along the profile can be seen in the given example of a soil profile. The reduction of the soil profile due to erosion and degradation also led to a decrease in absorbed cations and humus in the productive sowing layer.

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**Xülasə**

**Eroziya prosesinin Oğuz rayonunun torpaqlarına təsiri**

L.S.Zeynalova, T.A.Hacıyev, S.A.Hüseynovanın məqaləsinə

Məqalədə Böyük Qafqazın cənub yamacında yerləşən Oğuz rayonunun torpaqlarının ekoloji vəziyyəti haqqında danışılır.

**Açar sözlər**: silsilə, iqlim, havanın temperaturu, torpaq eroziyası, genetik kəsim, torpaq tipi

Резюме

Влияние эрозионного процесса на почвы Огузского района
Л.С.Зейналова, Т.А.Гаджиев, С.А.Гусейнова

В статье говорится об экологическом состоянии земель Огузского района, который расположен на южном склоне Большого Кавказа.

**Ключевые слова**: хребет, климат, температура воздуха, почвенная эрозия, генетический разрез, почвенный тип

**Abstract**

**The impact of the erosion process on the soils of Oguz region**

L.S.Zeynalova, T.A.Hajiyev, S.A.Huseynova

The article talks about the ecological condition of the lands of the Oguz region, which is located on the southern slope of the Greater Caucasus.

**Keywords**: ridge, climate, air temperature, soil erosion, genetic section, soil type

# Avtonəqiyyat vasitələrinin atmosfer havasına təsirinin ekoloji problemləri

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**Xülasə**

Quru nəqliyyatından, xüsusən də avtomobil nəqliyyatından emissiyalar atmosferə və iqlim dəyişikliyinə əhəmiyyətli təsir göstərir. Əhalinin intensiv artması ilə əlaqədar olaraq, avtomobillərdən istifadə günü-gündən artır. Avtomobillər, velosipedlər və yük maşınları kimi yolda hərəkət edən avtomobillər emissiyaların əsas mənbəyidir. Müxtəlif insan fəaliyyətləri nəticəsində atmosferə qarışan xloroflorokarbon kimi emissiyalar ozon təbəqəsinin deşilməsinə səbəb olaraq birbaşa və ya dolayı yolla iqlimə təsir edir. Bu artan emissiyalara görə qlobal ətraf mühit həm iqlimə, həm də insan sağlamlığına təsir edə biləcək ölçüyəgəlməz dəyişikliklərlə üzləşir. Havanın keyfiyyəti cəmiyyətimizin əsas problemlərindən biridir və havanın keyfiyyətinə təsir edən bir çox amillər var və bunlardan biri də nəqliyyat vasitələrinin tullantılarıdır. Bu məqalə, əsasən, müxtəlif ədəbiyyat sənədləri vasitəsilə aparılan bir araşdırmadan avtomobil emissiyalarının iqlim dəyişikliyinə necə töhfə verdiyinə diqqət yetirir. İnsan sağlamlığına, eləcə də ətraf mühitin dəyişməsinə təsir edən parametrlər və metodologiyalar ədəbiyyat tədqiqatından çıxarılıb və bu məqalədə müzakirə olunub. Havanın keyfiyyəti ilə iqlim dəyişikliyi arasındakı əlaqəyə də toxunulur, çünki istixana qazları havanın keyfiyyətinə təsir edir və ozon təbəqəsinin aşınmasına səbəb olur. Bu araşdırma sayəsində iqlim dəyişikliyinə səbəb olan və buna görə də insan sağlamlığına təsir edən avtomobil emissiyalarının səbəbləri müəyyən edilə bilər. Bu tədqiqatın əsas məqsədi mövcud ədəbiyyatın köməyi ilə nəqliyyat vasitələrinin çirklənməsinin, eləcə də onun müxtəlif səbəblərinin ətraf mühitə və iqlimə təsirlərinin strukturlaşdırılmış təhlilini təqdim etməkdir. Tədqiqatın nəticələrinə görə, nəqliyyat vasitələrinin çirklənməsinin azaldılması təkcə şəhərlər üçün müsbət deyil, həm də qlobal iqlim dəyişikliyinin yaxşılaşdırılması üçün vacibdir.

**Açar sözlər:** avtomobil nəqliyyatı; şəhər daxili;ekoloji; atmosfer; yanacaq; oksigen sərfi; alternativ.

## Giriş

Nəqliyyat vasitələrinin çirklənməsinin əsas təsirlərindən biri qlobal istiləşmədir. Avtomobillərin çirklənməsi atmosferə istixana qazlarının emissiyasını müəyyən edir, nəticədə ozon təbəqəsinin tükənməsi və atmosfer temperaturunun artması qlobal istiləşməyə səbəb olur. Nəticə etibarı ilə o, güclü yağışlar, daşqınlar və həyati əhəmiyyətin itirilməsi ilə bağlı həddindən artıq yüksək və ya soyuq temperatur kimi mənfi iqlimə, əmlakın məhvinə, torpağın zədələnməsindən və bəzən kənd təsərrüfatına da mənfi təsir göstərir.

1. Havanın çirklənməsi: Nəqliyyat vasitələrinin çirklənməsi havanı o qədər məhv edir ki, bəzi ölkələrdə insanlar inhalyasiya yolu ilə zərərli maddələrin sayını azaltmaq üçün üz maskalarından istifadə etməlidirlər. Xüsusilə ABŞ-da avtomobillər ölkənin atmosfer çirklənməsinin təxminən üçdə birini istehsal edir. Belə xoşagəlməz vətəndaşlarda yaşayır, bütün günü maska ilə gəzmək məcburiyyətində qalır və daha az sağlamlıq fəsadlarının inkişaf etdirilməsi üçün imkanlar var. Bu ərazilərin havası müxtəlif növ çirkləndiricilərlə doludur ki, bu da havanın keyfiyyət indeksini xeyli aşağı salır.

2. Görünüşün azaldılması: Nəqliyyat vasitələri çoxlu emissiyalar yaradır və bəzən görmə qabiliyyətini problem yarada bilər, xüsusən də köhnə avtomobil və ya yük maşını çoxlu yük daşıdıqda. Bu avtomobillər çoxlu tüstü çıxarır, bu da qarşısındakıları görə bilməyənlərin görmə qabiliyyətini çətinləşdirir. Bu o deməkdir ki, o, arxadan bir vasitə gətirsəydi, bir neçə saniyəlik də olsa, görünmə maraqlı olardı. Bu tüstü çıxaran bir çox nəqliyyat vasitəsi ilə güclü şəkildə çirklənmiş şəhərlərdə görünürlük böyük problemə çevrilir. Sual duman olduqda pisləşir, nəticədə duman əmələ gəlir (tüstü və dumanın qarışığı).

3. Sağlamlıq problemləri və ağırlaşmalar: Nəqliyyat vasitələrinin çirklənməsinin çirkləndiriciləri ağciyər infeksiyalarına,

ağırlaşmalara və hətta müxtəlif növ şişlərə səbəb ola bilər. Karbohidrogenlər insan sağlamlığı üçün yaxşı deyil və həmçinin ürək xəstəliklərinə səbəb ola bilər, mərkəzi sinir sisteminə zərər verə bilər, nəfəs almağa mane ola bilər, astmanı ağırlaşdıra bilər və nəzarət edilmədikdə, vaxtından əvvəl ölümə səbəb ola bilər. Hər il təxminən 5000 insan avtomobildən çıxan tüstünün səbəb olduğu ağciyər xərçəngi və infarkt səbəbiylə ölür. Bu xəstəliklərin müalicəsi də böyük vəsait tələb edir və xəstənin yaxınlarına böyük mənəvi ağrılar verir. Neftin xaric olması bitkilərə, heyvanlara və dəniz həyatına daha çox təsir edir. Hətta bir millətin sağlamlığı da risk altında ola bilər, xüsusən də insanların işləmək və gəlir əldə etmək qabiliyyəti təsirləndikdən sonra iqtisadiyyat dayanacaqsa.

4. Turşu yağışı: Nəqliyyat vasitələrinin yaratdığı qazlardan biri azot oksididir və oksidləşmiş avtomobilə və strukturların korroziyasına çevrilən yüksək dərəcədə aşındırıcı dumanın əmələ gəlməsinə kömək edir. Azot oksidi yağışda həll edildikdə, turşu yağışı baş verir ki, bu da birbaşa təmasda olduqda əhəng və mərmər binaların istifadə müddətini əhəmiyyətli dərəcədə azalda bilər. Bundan əlavə, bu cür yağışın hər hansı bir su yığılması insan və heyvan istehlakı üçün uyğun deyil və bitkilərdə atrofilləşmiş böyüməyə səbəb ola bilər.

Ötən əsrdə iqtisadi və sənaye artımı ilə əlaqədar hava çirkləndiricilərinin emissiyalarının kəskin artması havanın keyfiyyətini pisləşdirmişdir və bu, dünyanın üzləşdiyi ikinci ən əhəmiyyətli uğursuzluq kimi təsvir edilmişdir (İbrahim Aslan, 2014).

Nəqliyyat sektoru havanın çirklənməsinin mühüm səbəbidir, nəqliyyat vasitələrinin sayı artdıqca, nəqliyyat vasitələrindən atılan çirkləndiricilər də artacaq. Qalıq yanacaqların yandırılması nəticəsində əldə edilən $CO_2$ qazı avtomobillərdən atılan ən əhəmiyyətli çirkləndiricilərdən biri kimi göstərilmişdir. Avtomobillərdən istifadənin artması atmosferdə $CO_2$ səviyyəsini artırır, istixana effektinə və qlobal istiləşməyə səbəb olur (Peter Ndoke, 2006). Yer atmosferində yığılmış istixana qazlarının, xüsusən də $CO_2$ konsentrasiyaları artıq planeti qızdırıb, kəskin və temperatur dəyişkənliyinə, uzun müddətli istilik dalğalarına, görmə qabiliyyətinin azalmasına səbəb olur və insan sağlamlığına böyük təsir göstərə bilər, tənəffüs yolları xəstəliklərinə səbəb olur və həmçinin D vitamininə səbəb olur. kifayət qədər günəş işığının olmaması səbəbindən müxtəlif xəstəliklərə səbəb ola bilər (Lilian Lefol Nani Guarieiro, 2013). Qütb buzlaqları da iqlim dəyişikliyi səbəbindən əriyə bilər və okean səviyyələrində kütləvi artım ola bilər ki, bu da bütün ekosistemi pozaraq daşqınlara səbəb ola bilər (Peter Ndoke, 2006). Emissiyaların 86%-i Avstraliyadadır

Yol nəqliyyatı sektorundan gələn çirkləndiricilərin şokedici aspekti sürətlə genişlənir. Əhalinin intensiv artması ilə əlaqədar olaraq avtomobillərdən istifadə günü-gündən artır. Bir çox araşdırmalar göstərdi ki, avtomobil çirkləndiricilərinin pik səviyyələri havanın çirklənməsinə kömək edir. Avtomobillər, velosipedlər və yük maşınları kimi yol nəqliyyat vasitələri emissiyaların əsas mənbəyidir. Müxtəlif insan fəaliyyəti nəticəsində atmosferə daxil olan xloroflorokarbonlar kimi emissiyalar ozon təbəqəsinin tükənməsinə gətirib çıxarır ki, bu da birbaşa və ya dolayısı ilə iqlimə təsir edir. Bu artan emissiyalara görə qlobal ətraf mühit iqlimə və insan sağlamlığına təsir edə biləcək ölçüyəgəlməz dəyişikliklərlə üzləşir. Havanın keyfiyyətinə təsir edən bir çox amillər vardır ki, bunlardan biri də nəqliyyat vasitələrinin emissiyasıdır. Bu məqalə, əsasən, müxtəlif ədəbiyyat məqalələri vasitəsilə aparılan bir araşdırmadan avtomobil emissiyalarının iqlim dəyişikliyinə necə töhfə verdiyinə diqqət yetirir. Ətraf mühitin dəyişməsinə və insan sağlamlığına təsir edən parametrlər və metodologiyalar ədəbiyyat axtarışından çıxarılıb və bu məqalədə müzakirə olunub. Havanın keyfiyyəti ilə iqlim dəyişikliyi arasında əlaqə də qeyd edilmişdir, çünki istixana qazları havanın keyfiyyətinə təsir edir və ozon təbəqəsinin tükənməsinə səbəb olur. Bu araşdırma vasitəsilə iqlim dəyişikliyi üçün avtomobil emissiyalarının səbəbləri və buna görə də onların insan sağlamlığına necə təsir etdiyi müəyyən edilə bilər. Bu tədqiqatın əsas məqsədi mövcud ədəbiyyatın köməyi ilə nəqliyyat vasitələrinin çirklənməsinin ətraf mühitə və iqlimə müxtəlif səbəb və təsirlərinin strukturlaşdırılmış təhlilini təqdim etməkdir. Tədqiqatın nəticələrinə görə, nəqliyyat vasitələrinin çirklənməsinin azaldılması təkcə şəhərlər üçün müsbət deyil, həm də qlobal iqlim dəyişikliyini yaxşılaşdırmaq üçün vacibdir.

Məlum olduğu kimi atmosfer havasının çirklənməsinə səbəb olan amillər sırasında (metallurgiya sənayesi, AES, İstilik Elektrik stansiyaları, emal müssisələri və s.) nəqliyyat vasitələri, xüsusilə də avtonəqliyyat vasitələri mühüm yer tutur. Böyük şəhərlərdə onların ətraf mühitə ayırdığı qazlar havanı çirkləndirən qarışıqların 70-80%-ni təşkil edir. Avtomobillərin sayının az olduğu illərdə bu məsələyə o qədər də önəm verilmirdi. Lakin hazırda avtonəqliyyatın sayının sürətlə artması ciddi problemə çevrilmişdir.

Aşağıda qeyd edəcəyimiz statistik rəqəmlərdən problemin nə qədər böyük mahiyyət daşıması anlaşılır. Dünyada hər il avtomobil mühərriklərində iki milyard tondan çox neft mənşəli yanacaq

işlədilir. Bu qədər böyük kütləyə malik yanacağın ~24%-i faydalı işə çevrilsə də, onun 76%-ə qədəri ətraf mühitə müxtəlif zəhərli qazlar və su buxarı şəklində atılır.

100 km yol qət edən avtomobil insanın bir ildə tənəffüs zamanı qəbul etdiyi qədər oksigen istifadə edir[1]. Avtomobillər atmosfer havasını yalnız yanacaq məhsulları olan toksiki komponentlərlə deyil, həm də yanacaq buxarı, təkərlərin hərəkəti zamanı ayrılan toz ilə də çirkləndirir. Digər arzuolunmaz bir məsələ sənaye müəssisələri və nəqliyyat vasitələrindən atmosferə atılan C və $N_2$ oksidləri, S qazları, qurğuşun birləşmələri, toz və hisin havada toplanıb insan orqanizmi üçün öldürücü təsir göstərən “smoq” (görünən tüstü-hava) əmələ gətirməsidir. “Smoq” pis qoxuya malik olub havada görünüşü kəskin şəkildə aşağı salır, göz, ağ ciyər, bronxial astma kimi xəstəlikləri kəskinləşdirir. Atmosfer havasının işlənmiş qazlarla çirklənməsini azaltmaq üçün avtomobillərin texniki vəziyyətinə və daxiliyanma mühərriklərində yanacağın normal yanma tələblərinə uyğun olmasına ciddi nəzarət olunmalıdır.

Aşağıdakı cədvəldə avtonəqliyyat vasitələri üçün Avropa birliyi ölkələrində qəbul olunmuş müxtəlif ekoloji standartlar verilmişdir,[2].

**Cədvəl 1.Avtonəqliyyat vasitələri üçün ekoloji standartlar**

| Avropa standartı | Karbon-mono oksid (II) (CO) q/km | Karbo-hidrogen q/km | Uçucu üzvi birləşmələr q/km | Azot oksidləri ($NO_x$), q/km | HC+$NO_x$ q/km | Yanmamış bərk hissəciklər (PM), q/km |
|---|---|---|---|---|---|---|
| Dizel mühərrikləri üçün | | | | | | |
| Avro-1 | 2.72 (3.16) | - | - | - | 0.97 (1.13) | 0.14 (0.18) |
| Avro-2 | 1.0 | - | - | - | 0.7 | 0.08 |
| Avro-3 | 0.64 | - | - | 0.50 | 0.56 | 0.05 |
| Avro-4 | 0.50 | - | - | 0.25 | 0.30 | 0.025 |
| Avro-5 | 0.500 | - | - | 0.180 | 0.230 | 0.005 |
| Avro-6 | 0.500 | - | - | 0.080 | 0.170 | 0.005 |
| Benzin mühərrikləri üçün | | | | | | |
| Avro-1 | 2.72 (3.16) | - | - | - | 0.97 (1.13) | - |
| Avro-2 | 2.2 | - | - | - | 0.5 | - |
| Avro-3 | 2.3 | 0.20 | - | 0.15 | - | - |
| Avro-4 | 1.0 | 0.10 | - | 0.08 | - | - |
| Avro-5 | 1.000 | 0.100 | 0.068 | 0.060 | - | 0.005** |
| Avro-6 | 1.000 | 0.100 | 0.068 | 0.060 | - | 0.005** |

Hazırda mühəndis–ekoloqlar, kimyaçılar və bu sahəyə yaxın digər mütəxəssislər atmosfer havasının zərərli tullantılardan mühafizəsi yollarının işlənməsi istiqamətində elmi əsaslara söykənən tədqiqat işləri aparırlar.

Son illərdə yanacaq məhsullarının toksiki maddələrdən təmizlənməsində neytrallaşdırıcılar və katalitik süzgəclər tətbiq edilir. Qaz yanacağından ($CH_4$ və b.) istifadə olunmaqla kanserogen maddələrin atmosferə atılmasının yüz dəfəyə qədər azalmasına nail olunmuşdur, [3,4].

Bildiyimiz kimi Azərbaycanda 2014-cü il aprel ayının 1-dən “Avro-4” standartlarının tələblərinə cavab verən avtomobillərinin hərəkətinə icazə veriləcəkdir . Bunları nəzərə alaraq hər bir şəhər sakini Gəncə şəhərində bu tələblərin təmin olunması üçün öz vətəndaşlıq məsuliyyətini dərk etməli, şəhərimizin havasını, ekoloji durumunun yararlılığı naminə fəal vətəndaş mövqeyindən çıxış etməlidir. Əlbəttə bu yalnız Dövlət Avtomobil Müfəttişliyi, “Ekologiya və təbii sərvətlər” nazirliyi və Azərbaycan Respublikası Standartlaşdırma Komitəsinin yox, hər birimizin işidir. Xüsusilə də bu sahənin mütəxəssis və tədqiqatçıları daha böyük məsuliyyətlə məsələyə yanaşmalıdırlar. Bu baxımdan Gəncədə mövcud şəhər daxili nəqliyyatın sayı, istifadə etdikləri yanacaq, avtomobillərin və digər şəhər daxili nəqliyyat vasitələrinin texniki vəziyyətinə ciddi nəzarət olunmalıdır.

İlbəil artmaqda olan avtomobillərin və başqa şəhər daxili avtonəqliyyatların sayı, şəhərin atmosferinə atılan zəhərli tullantıların miqdarı, onların insanların səhhətinə təsiri tərəfimizdən elmi

araşdırmalar aparılmaqla müqayisəli təhlili verilmişdir.

Yaranmış problemlərin qarşısının alınması üçün aparılmalı profilaktik tədbirlər, nəzarətin təşkili strukturu hazırlanmışdır. Gəncə şəhərində avtonəqliyyat vasitələrinin 2013-cü ilə dair sayı “Şəhər statistika idarəsinin məlumatına görə aşağıdakı kimi olmuşdur [5]:

Yük avtomobillərinin sayı -2738
Minik avtomobillərinin sayı - 169630
Digər nəqliyyat növlərinin sayı-174577

Son üç ildə atmosfer havasına çirkləndirici maddələr ayıran stasionar mənbələrin sayı 236 olmuşdur. Həmin mənbələrdən şəhərin atmosferinə 362470 ton zəhərli maddə atılmış, o cümlədən 68159 ton (18,8%) bərk halda, 294311 ton (81,2%) isə qaz halında (SO2-14333 ton, CO-105364 ton, azot qazları-33545 ton) olmuşdur. 2011-ci il məlumatı ilə müqayisədə havaya atılan çirkləndirici maddələrin miqdarı 4,9% artmışdır. Adambaşına düşən zərərli tullantıların xüsusi çəkisi 1,1 kq olmuşdur. İl ərzində stasionar mənbələrdən ayrılan və tutulan (zərərsizləşdirmə) maddələrin miqdarı 564967 ton təşkil etmişdir.

Dünya iqtisadiyyatının sürətli inkişafı və trafik şəbəkələrinin əhəmiyyətli dərəcədə artması ilə nəqliyyat vasitələrinin sayı həyəcan verici bir sürətlə artır. Yol nəqliyyat vasitələrinin illik satışları 2009-cu ildə təxminən 13,64 milyondan 2016-cı ildə 28 milyona yüksəldi (Çin Avtomobil Texnologiyaları və Araşdırma Mərkəzi, 2017; Günəş, 2017). 2002 və 2009-cu illərdə artım tempi müvafiq olaraq 37,1% və 45,4%-ə çatmışdır.

Növbəti onillikdə bəzi inkişaf etməkdə olan şəhərlərdə şəxsi avtomobillərin sayı artmağa davam edəcək.

Nəqliyyat vasitələrinin əhəmiyyətli sayı və nisbətən sürətli artım tempi atmosferin çirklənməsinin pisləşməsinə səbəb olan əsas amillərdir. Məsələn, 2013-cü ildə çoxlu sayda yol nəqliyyat vasitələri 95 milyon ton (Mt) benzin və 172 Mt dizel istehlak etmişdir (Wu et al., 2017). Avtomobil satışlarının artması ilə bu rəqəmin davamlı olaraq artacağı təxmin edilir. Avtomobil mühərriklərində benzin və ya dizel yanacağının yanması müxtəlif zərərli kimyəvi emissiyalara səbəb olur. Xüsusilə, CO, HC, NOx və PM emissiyaları uzun illər Çində yüksək səviyyədədir (Çin Xalq Respublikasının Ətraf Mühitin Mühafizəsi Nazirliyi, 2017). Məsələn, 2014-cü ildə Çinin troposferində illik orta NO2 konsentrasiyası ABŞ və əksər Avropa ölkələrininkindən xeyli yüksək olmuşdur. Avtomobil emissiyalarının səbəb olduğu havanın çirklənməsi də Çin daxilindəki şəhərlər arasında dəyişir. Çində sorğu edilən 74 şəhərin əksəriyyəti (95,9%) PM2.5 emissiya standartına cavab vermədi və yalnız 3 şəhər nisbətən az nəqliyyat axını və sənaye çirklənməsi səbəbindən əhəmiyyətli dərəcədə təmizdir (Song, 2014). Pekin və Şanxay kimi böyük şəhərlər çox sıx trafik şəraiti və nisbətən əhəmiyyətli hava çirkliliyi səbəbindən əlavə diqqət aldılar. Məsələn, Pekində havanın keyfiyyəti indeksi (AQI) 2013-cü ilin yanvarında 993-ə yüksəldi, bu, sağlamlıq mütəxəssislərinin son dərəcə təhlükəli hesab etdiyi səviyyələrdən xeyli kənara çıxdı (Wong, 2013). Çinin cənub-qərbindəki bəzi əyalət paytaxtları, məsələn, Kunminq və Lhasa yaxşı çıxış etdi; onların illik AQI 2014-cü ilin üçdə biri üçün 64-dən aşağı olmuşdur (Xu et al., 2017). Buna görə də, sürətlə artan avtomobil sayına nəzarət avtomobil emissiyalarına nəzarətdə ilk mühüm addım hesab olunur. Bu tədqiqatda araşdırılan məqalələr jurnal məlumat bazalarından və mövzu ilə bağlı dövlət və peşəkar vebsaytlardan əldə edilmişdir. Web of Science, Google Scholar, Wanfang (Çin ədəbiyyatı məlumat bazası) və CNKI (Çin ədəbiyyatı bazası) proqramlarında aşağıdakı açar sözlərdən istifadə etməklə ədəbiyyat axtarışı aparılıb: trafik, avtomobil, nəqliyyat vasitəsi, yol, magistral, sürətli yol, yağ, dizel, benzin və ya benzin Havanın keyfiyyəti, havanın çirklənməsi, hissəciklər (PM), ozon, NOx, CO, HC, VOCs, SO2, ikinci dərəcəli çirklənmə və ya emissiyaya nəzarət /dizel. Bundan əlavə, Çin Xalq Respublikasının Nəqliyyat Nazirliyinin, Milli Neft Məhsulları və Sürtkü Yağlarının Standartlaşdırma Komitəsinin internet saytlarında nəqliyyat vasitələri haqqında müvafiq məlumat əldə etmək üçün xüsusi sayt yaradılıb. Keçmişdə avtomobillərin işlənmiş qazlarının emissiyasına nəzarət azot oksidi, karbon monoksit, uçucu üzvi birləşmələr və hissəciklərin emissiyalarını uğurla azaldıb. Bu, sənayeləşmiş ölkələrdə havanın keyfiyyətinin yaxşılaşdırılmasına və sağlamlığa təsirlərin azaldılmasına töhfə verib. Bununla belə, inkişaf etməkdə olan ölkələrdə çirkləndirici emissiyalar güclü şəkildə artır və bir çox əhaliyə mənfi təsir göstərir. Bundan əlavə, ozon və hissəciklər radiasiya balansını dəyişdirir və daha qısa zaman miqyasında qlobal istiləşməyə kömək edir. Quru nəqliyyatının qlobal istiləşməyə təsirinin miqyası haqqında ən son məlumatlar burada nəzərdən keçirilir.

Gələcəkdə bu çirkləndiricilərin avtomobil nəqliyyatı emissiyalarının durğunlaşacağı və sonra qlobal miqyasda azalacağı gözlənilir. Bu, xüsusilə inkişaf etmiş ölkələrdə havanın keyfiyyətinin yaxşılaşdırılmasına kömək edəcək. Əksinə, mobil kondisionerlərdən karbon qazı və halokarbon emissiyaları qlobal miqyasda artır və daha da artacağı gözlənilir. Nəticədə, avtomobil nəqliyyatının iqlimə təsiri əhəmiyyət kəsb edir.

Nəqliyyat vasitələrinin gözlənilən səmərəliliyinin artırılması və bioyanacaqların tətbiqi həm sərnişin, həm də yük daşımalarında gözlənilən güclü artımı kompensasiya etmək üçün kifayət etməyəcək. Texniki tədbirlər əhəmiyyətli yumşaldıcı potensial təklif edə bilər, lakin bazarlar lazımi dəyişikliklərə başlamadığı üçün güclü müdaxilələr tələb olunacaq. Sonrakı azalmalar aşağı karbonlu yanacaqların qəti şəkildə genişləndirilməsini, avtomobillərin yanacaq səmərəliliyinin üç dəfə artırılmasını və mütləq nəqliyyat həcmlərində durğunluğu tələb edəcək. Qarşıdakı onilliklərdə quru nəqliyyatı iqlim dəyişikliyinin azaldılmasında mühüm sektor olaraq qalmağa davam edəcəkdir.

Çin 2009-cu ildən bəri dünyanın ən böyük avtomobil bazarıdır. Avtomobil sənayesinin sürətli inkişafı ilə avtomobilin emissiyasına nəzarətin gecikməsi arasında dayanıqlılıq getdikcə populyarlaşır. Avtomobil tullantıları Çində əhəmiyyətli hava çirkliliyi mənbəyinə çevrilib. Avtomobil sənayesində mövcud maneələri başa düşmək, nəqliyyat vasitələrinin yaratdığı havanın çirklənməsini idarə etmək üçün effektiv və davamlı tədbirlərin və siyasətin işlənib hazırlanması üçün zəruridir. Bu icmal nəqliyyat vasitələrinin yaratdığı havanın çirklənməsinin halları və səbəbləri haqqında məlumat verir və siyasətçilərin uzunmüddətli strategiya və qaydalarında son irəliləyişləri təsvir edir. Çində havanın çirklənməsi ilə avtomobil bumu arasında yaranmış durğunluğu aradan qaldırmaq üçün nəqliyyat vasitələri, yanacaq və yollarda sosial iştirak, texniki inqilab və tənzimləyici innovasiyaların inteqrasiya olunmuş mexanizminin inkişafı təklif edilir; bu təhlilin nəticələri atmosferin çirklənməsi ilə bağlı oxşar problemlərlə üzləşən digər ölkələrə də şamil edilir.

Quru nəqliyyatından, ilk növbədə avtomobil nəqliyyatından və daha az dərəcədə dəmir yolu və daxili gəmiçilikdən gələn tullantılar, nəqliyyatdan uzunömürlü istixana qazlarının buraxılmasında üstünlük təşkil edir. Onlar ümumi antropogen istixana effektinə böyük və artan töhfə verirlər. Bundan əlavə, atmosferin tərkibinə və havanın keyfiyyətinə təsir göstərən çoxlu qısamüddətli qazlar və hissəciklər quru nəqliyyatı ilə buraxılır. Bu hesabat yerüstü nəqliyyatın getdikcə daha vacib rolu haqqında bildiklərimizi qiymətləndirmək üçün nəzərdən keçirilmiş ədəbiyyata, son illərin seçilmiş tədqiqatlarına və Avropa Kəmiyyəti layihəsində aparılan tədqiqatlara əsaslanır. Bu nəşrin konsepsiyasına uyğun olaraq, suallara cavab veririk: Nə buraxılır? Atmosferə hansı təsirlər var? Radiasiya büdcəsinə və iqlim dəyişikliyinə hansı təsirlər var? Hansı cavablar və gələcək inkişaf ehtimalı var?

Hidrogen qazından avtomobillərdə yanacaq kimi istifadə edilməsi, elektromobillərin daha da təkmilləşdirilmiş texnoloji sxemlərə uyğun işlənməsi və tətbiqi bu sahədə irəliyə doğru atılan addımlardandır. Elektromobillərdə sürətin 140 km/saata çatdırılması mümkündür.

Daha perspektivli, zərərsiz, tullantıları məhdud olan etanol (etil spirti), metanol kimi spirtlərdən istifadə bəzi ölkələrdə tətbiq olunmağa başlanmışdır. Alternativ enerji mənbəyi kimi topinamburdan (yerarmudu) etanolun alınması iqtisadi cəhətdən səmərəli olduğundan getdikcə bu məhsuldar bitkidən istifadə genişlənir.

## Nəticə

Bu sürətli inkişaf dövründə avtomobillərin yaratdığı çirklənmə mühüm ekoloji problemə çevrilmişdir. Bu gün demək olar ki, hər bir ölkədə əhalinin əksəriyyəti pis ekoloji keyfiyyətlə üzləşir. Bu, dolayısı ilə bir ölkə üçün iqtisadi itkiyə səbəb olur, çünki təsirə məruz qalan əhalini lazımi tibb müəssisələri ilə təmin etmək üçün maliyyə resurslarından istifadə edilməlidir. İnnovativ texnologiyaların, alternativ yanacaq növlərinin və dövlət tədbirlərinin istifadəsi nəqliyyat vasitələrinin çirklənməsini minimuma endirməyə kömək edir ki, bu da ətraf mühitin vəziyyətini əhəmiyyətli dərəcədə yaxşılaşdırmaq üçün düzgün istifadə edilməlidir. Əlçatan məlumatlara əsaslanan son araşdırma göstərir ki, havanın çirklənməsinə nəqliyyatın 25%-i, yanma və kənd təsərrüfatının 22%-i, məişət yanacağının yanmasının 20%-i, təbii və duz olan tozun 18%-i və sənaye fəaliyyətinin 15%-i töhfə verir. Havanı çirkləndirən çoxlu mənbələr olsa da, avtomobillərdən yollara atılan tullantılar havanı çirkləndirən ən böyük mənbə hesab olunduğundan, biz əsasən bu faktora diqqət yetirdik. Nəqliyyat vasitələrinin çirklənməsi bu yazıda izah edilən iqlimə və insan sağlamlığına təhlükəli təsirlərdən məsuldur. Müxtəlif ədəbiyyat sənədlərində sadalanan üsullar və ya cihazlar havada mövcud olan avtomobil çirkləndiricilərinin aşkarlanmasına və idarə olunmasına kömək edir. Avtomobil emissiyalarının müxtəlif səbəb və təsirləri ilə yanaşı, havanın keyfiyyəti ilə iqlim dəyişikliyi arasındakı əlaqə də müxtəlif sənədlər vasitəsilə aparılan araşdırmanın köməyi ilə müzakirə edilmişdir. Nəqliyyat vasitələrinin çirklənməsini azaltmaqla, avtomobil vergisi, yanacaq ödənişləri və s. kimi nəqliyyat xərclərini azaltmaq olar və qlobal istiləşmə də azalacaq. Nəqliyyat vasitələrinin çirklənməsinin minimuma endirilməsi həm də gələcək nəsillərimiz üçün ətraf mühitin qorunmasına kömək edir.

Təmiz ətraf mühitə nail olmaq üçün hamımız diqqət mərkəzində olmalı və şəxsi məsuliyyətimizi yerinə yetirməliyik.

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# Environmental problems of the Influence of vehicles on atmospheric air

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## Abstract

Emissions from land transport, especially road transport, have a significant impact on the atmosphere and climate change. Due to the intensive growth of the population, the use of cars is increasing day by day. On-road vehicles such as cars, bicycles and trucks are the main source of emissions. Emissions such as chlorofluorocarbons mixed into the atmosphere as a result of various human activities directly or indirectly affect the climate by causing ozone layer depletion. Due to these increased emissions, the global environment is facing immeasurable changes that can affect both the climate and human health. Air quality is one of the major problems of our society and there are many factors that affect air quality and one of them is vehicular emissions. This article mainly focuses on how vehicle emissions contribute to climate change from a review through various literature documents. Parameters and methodologies affecting human health as well as environmental change were extracted from the literature review and discussed in this article. The link between air quality and climate change is also addressed, as greenhouse gases affect air quality and cause ozone depletion. Thanks to this research, the causes of car emissions that cause climate change and therefore affect human health can be determined. The main objective of this study is to provide a structured analysis of the environmental and climate impacts of vehicular pollution and its various causes with the help of existing literature. According to the study, reducing vehicular pollution is not only positive for cities, but also important for ameliorating global climate change.

**Key words:** car transport; inner city; environmental; atmosphere; fuel, oxygen consumption; alternative.

# Global environmental problems of the 21st century

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## Abstract

The article discusses global environmental problems, which are among the most important and pressing issues of the modern world. The rapid increase in environmental pollution from year to year negatively affects the general condition of flora and fauna, which leads to the extinction of plants, the extinction of some animal species, as well as their mutation. The main environmental problems include global warming, depletion of the ozone layer, pollution of the oceans, the greenhouse effect, environmental pollution, soil degradation, and reduction of biodiversity. The role of anthropogenic factors such as industrialization, urbanization, and excessive consumption of resources in exacerbating these problems is assessed. The article also focuses on the consequences of global environmental change for human health, economic development, and social stability. The impact of global environmental problems on vulnerable groups of the population that are most dependent on natural resources and ecosystem services is studied. In the context of possible solutions, both local and international initiatives aimed at mitigating the consequences of these problems are considered, including achievements in the field of green economy, transition to sustainable energy sources and raising public awareness. The need to integrate environmental aspects into political, social and economic strategies at all levels of governance is emphasized. The concept of "environmental problems" is defined, the causes and consequences of environmental problems at different levels are identified, and possible ways to overcome them are presented. Based on the analysis of these problems, a conclusion is made that the efforts of the entire global community can ensure environmental well-being on Earth.

***Key words:*** *ecology, environmental problems, environment, biosphere, climate, atmosphere.*

Human existence is inextricably linked with certain environmental conditions (temperature, humidity, air composition, water quality, food composition, etc.). These requirements have been developed over many millennia of human existence. Changes in these factors or their deviation from the norm affect human life, which is the essence of global environmental problems. Among the global security threats facing humanity today, environmental problems are among the most pressing. Due to damage to nature, the very existence of humanity is in question [1,2].

Environmental problems are changes in the natural environment that occur as a result of anthropogenic impact or natural disasters, leading to the destruction of natural structures and functions [3]. Environmental problems have arisen as a result of man's irrational attitude to nature, as a result of, firstly, the unrestrained growth of consumption in developed countries aimed at satisfying secondary needs; secondly, the accelerated industrial modernization of developing countries according to the principle of “first you have to get dirty to get rich”; thirdly, the activities of transnational corporations that export dirty production to countries whose governments remain silent so as not to lose investments (“imported sustainability”) [4].

The progress and fate of civilization depend on solving environmental problems, and solving environmental problems of the modern world has become an important and urgenttask [5-7].

Environmental problems today are one of the most important and global. The multifaceted nature of the problems arising in the process of interaction between nature and society, their relationship with the problems of the public sphere determine the difference inapproaches and their classification [8].

The territorial level is the most common feature of the classification of environmental problems. According to the territorial level, the following problems are distinguished:

- global, having a planetary character. The solution of these problems is possible only atthe universal human level;
- regional, relevant for large territories. The

problem can be solved only at the interstate or national level;

• local problems have the most limited territorial character, they can concern both individual objects and territorial complexes.

The solution of these problems, with timely intervention, is possible at the level of local administrative or economic bodies, based on their financial potential, in some individual cases at the interregional and regional levels.

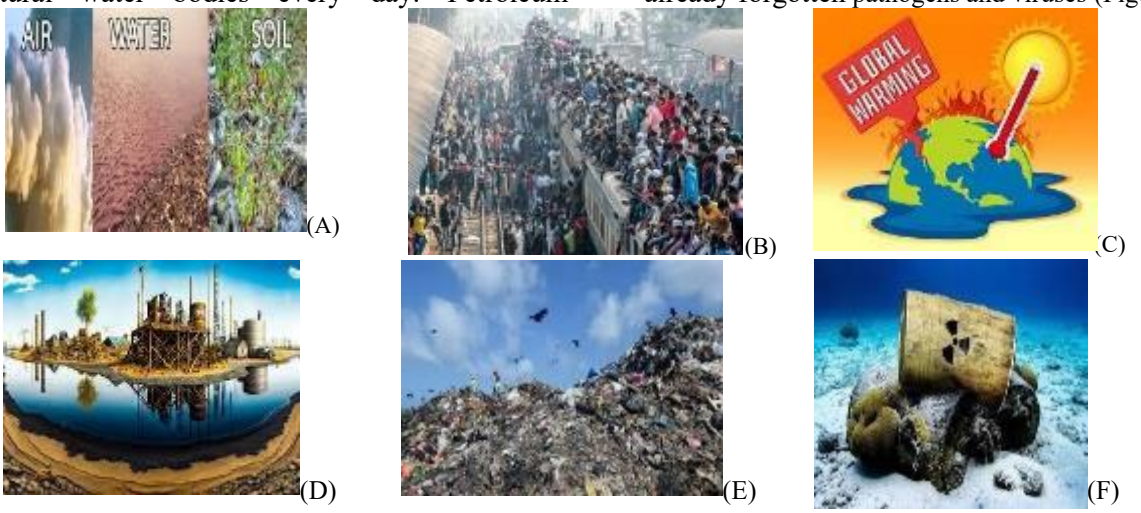
Local ones form regional problems in a complex, regional ones can develop into global ones.

The second feature of the classification of environmental problems is the sphere of influence, the analysis of changes, in particular, occurring in a specific natural area. Environmental problems, by spheres of origin, can be divided into the following groups: those arising in the biosphere and those arising in the field of inanimate nature. This article examines the causes, consequences and approaches to solving these problems. Environmental problems concern soil and water, the atmosphere and the biosphere, natural resources and landscape [9-14]. In total, about 15 global changes are distinguished, affecting almost all continents, islands and bodies of water:

• Pollution of fresh and salt water, soil, air. All kinds of waste are dumped into the ground or natural water bodies every day. Petroleum products and toxic chemical liquids are especially dangerous. The ecosystems of rivers and lakes are negatively affected by the waste of chemical plants dumped into them. Almost every year, an oil spill occurs in one sea or another, which leads to the destruction of marine animals and makes the water undrinkable (Figure 1, a);

• Overpopulation is a type of demographic crisis, which is characterized by an excess of population in relation to the means of subsistence (lack of resources to maintain hygienic standards of life) or an excess of population in relation to the demand for labor. According to calculations, after the number of people on earth exceeds 8.5 billion, natural resources will quickly be depleted, and people will simply not have enough drinking water, regular food, and natural fuel. Now the population is more than 8.17 billion and this figure is growing quite quickly (Figure 1, b);

• Warming. Global environmental problems are largely related to the fact that the climate is steadily changing. The normal life activity of the planet's population, greenhouse gases, industrial emissions, agriculture - are the main factors of excessive heating of the planet. Global warming can lead to the disappearance of many large cities, and the melting of glaciers will inevitably lead to a change in weather conditions and the release of already forgotten pathogens and viruses (Figure 1, c);




(A) (B) (C) (D) (E) (F)

**Figure 1.** a - pollution of fresh and salt water, soil, air; b – overpopulation; c –warming; d - depletion of natural resources; e - garbage collapse; f - radioactive waste.

• Depletion of natural resources. Large amounts of natural gas, oil, and coal are consumed daily. These resources are replenished over hundreds of years, and there is a high probability that in the coming decades there will be an acute problem of fuel shortage (Figure 1, d);

• "Garbage collapse". Waste disposal can be considered one of the largest environmental problems in the world. Modern safe waste processing plants are not built everywhere, so some of the garbage continues to end up in the soil and water bodies. Some types of packaging cannot be completely recycled, and radioactive waste is subject to multi-stage and very expensive cleaning and disposal (Figure 1, e);

• Extinction and destruction of biological species. Due to the global deterioration of the natural environment, urbanization, and poaching, the extinction of animal and plant species is occurring at a very rapid pace. This is especially true for such ecosystems rich in various animal and plant species as tropical forests, coral reefs, and

wetlands.

- Acidification of the waters of the seas and oceans. The reason is the increased production of carbon dioxide. If acidity continues to increase at the current rate, in about 80-100 years the water will become unsuitable for plankton and shellfish. The death of these marine inhabitants may also lead to the extinction of many species of fish, whales, and birds;
- Reduction in forest area. Deforestation is the process of converting forested land into land without tree cover, such as pastures, cities, wastelands, and others. The most common cause of deforestation is cutting down a forest without planting enough new trees. In addition, forests can be destroyed due to natural causes, such as fire, hurricane, or flooding, as well as anthropogenic factors, such as acid rain. Destruction of forests negatively affects the state of the atmosphere and biosphere, causing climate change;
- Decomposition and rarefaction of the ozone layer. The sun's rays and its radiation can lead to health problems. The ozone layer blocks the harmful spectrum of solar radiation, and the holes that form in it reduce the degree of protection;
- Decrease in the amount of fresh water. This is explained by the depletion of fresh water bodies and overpopulation. Already now in many African countries, water is a valuable resource. This may affect all countries in Europe, Asia and the USA;
- Acid rain. The term "acid rain" was first introduced in 1882 by the English scientist Robert Smith in his book "Air and Rain: The Beginning of Chemical Climatology". Pollution of the hydrosphere and atmosphere leads to the formation of precipitation with toxic substances. Falling on the ground, acid rain leads to the death of agricultural plant products, disrupts the biocenosis of natural zones. In addition, acid rain destroys buildings and cultural monuments, pipelines, renders cars unusable, reduces soil fertility and can lead to the seepage of toxic metals into soil aquifers.
- Urbanization (from Latin urbanus - urban). the historical process of increasing the roleof cities in the development of society, which covers changes in the distribution of productive forces, and, above all, in the settlement of the population, its demographic and socio-professional structure, lifestyle and culture. Just a couple of decades ago, the expansion of large cities was considered a good trend. Now scientists have already realized that the growth of megalopolises leads to a decrease in the territories necessary for agriculture. That is, plants, insects and animals are gradually forced out of their usual habitat, and this does not have a positive effect on nature;
- Deterioration of people's quality of life. Pollution of natural resources, smog, deterioration of water quality, spread of infectious diseases have a negative impact on human health. Chronic diseases appear in many people at a young age, and poisoning with toxic substances can cause disability.
- Radioactive waste is liquid, solid and gaseous waste containing radioactive isotopes (RI) in concentrations exceeding the standards approved on a national scale. The nuclear industry, the medical sector, a number of other industrial sectors, as well as various sectors engaged in research activities - all generate radioactive waste as a result of their activities (Figure 1, f).
- Land degradation and desertification. Desertification is the degradation of land in arid, semi-arid (semi-arid) and arid (sub-humid) regions of the globe, caused by both human activity (anthropogenic causes) and natural factors and processes. The term "climatic desertification" was proposed in the 1940s by the French researcher Auberville. Land degradation is a decrease or loss of biological and economic productivity of arable land or pastures as a result of land use. It is characterized by the drying out of the land, the withering of vegetation, a decrease in soil cohesion, which makes rapid wind erosion and the formation of dust storms possible. Desertification is a difficult-to-compensate consequence of climate change, since the restoration of one conventional centimeter of fertile soil cover in the arid zone takes on average 70 to 150 years.

To address these issues, global policies are needed that promote sustainable development, environmental protection, and raising public awareness of the importance of environmental issues. Both individual actions and efforts at the level of governments and international organizations are important. Education and research are key to addressing global environmental issues [15]. Investing in environmental technologies, renewable energy sources, and sustainable production practices can significantly reduce negative environmental impacts. Educational programs that raise awareness of nature and ecology can nurture a new generation of responsible citizens who are prepared to face these challenges [16].

Cooperation between states in the field of ecology is based on the relevant provisions of the UN Charter, the Universal Declaration of Human Rights adopted by the UN in 1948, the Covenant on Civil and Political Rights (1976), the Declaration of the Stockholm Conference on

Environmental Problems (1972), the Convention on Environmental Impact Assessment in Transboundary Space (1981), the Convention on Biological Diversity (1992) and other international acts and agreements.

The severity of global environmental problems arising under the influence of uncontrolled anthropogenic factors requires increased efficiency and more intensive use of environmental and legal instruments. Natural objects and systems that are not under the jurisdiction of individual countries and are not the national heritage of a particular state are considered as objects of international environmental cooperation. Formal international treaties, conventions, protocols and agreements concerning the use and protection of these objects are legally binding and form the basis of international environmental legislation. The most important international environmental documents include the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (1972), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973), the Convention on the Prohibition of Military or Any Other Hostile Intervention on the Natural Environment (1977), the Convention on the Conservation of Migratory Species of Wild Animals (1979), the Convention for the Protection of the Ozone Layer (1985), and the Kyoto Protocol on the Reduction of Greenhouse Gas Emissions into the Atmosphere (1997) [17-19].

The requirements of these time-tested agreements have been implemented in most cases into national legislation and have become an essential part of the legal system of many developed countries. Participation in environmental conventions and agreements almost always brings significant benefits to the participating state. It is necessary to integrate environmental goals into economic development. This implies a transition to sustainable production and consumption patterns that simultaneously take into account environmental safety and economic benefits. This approach will not only solve existing problems, but also prevent the emergence of new threats to the planet and its inhabitants. A key step towards achieving sustainable development is the introduction of environmentally friendly technologies into industrial processes. This not only helps reduce carbon emissions, but also increases the competitiveness of business in the global market, which is achieved through resource optimization and cost reduction. The introduction of innovative solutions, such as closed production cycles and waste recycling, will help significantly reduce the negative impact on the ecosystem. Equally important is the development of local communities through sustainable agriculture programs and natural resource management. This not only improves the quality of life of the population, but also contributes to the preservation of biodiversity. Local participation in environmental decision-making ensures more efficient and sustainable use of natural resources, taking into account traditional knowledge and practices.

## Solutions to environmental problems

Environmental issues are pressing worldwide and require a comprehensive approach.

Here are some ways to address environmental issues:

1. Reducing consumption and recycling:
   - Reducing the use of single-use plastic products.
   - Developing waste collection and recycling programs.
2. Switching to renewable energy sources:
   - Developing solar, wind and hydropower.
   - Reducing dependence on fossil fuels.
3. Improving energy efficiency:
   - Implementing energy-saving technologies in industry and everyday life.
   - Conducting energy audits and improving building insulation.
4. Preserving biodiversity:
   - Creating and supporting nature conservation areas.
   - Combating poaching and illegal logging.
5. Education and awareness raising:
   - Conducting environmental education programs and teaching children and adults aboutecology.
   - Supporting local environmental protection initiatives.
6. Promoting sustainable agriculture:
   - Encouraging organic farming and reducing the use of pesticides.
   - Supporting local producers and selling locally produced products.
7. Developing public transport:
   - Investing in environmentally friendly public transport.
   - Encouraging cycling and walking.
8. International cooperation:
   - Participating in international environmental agreements (e.g. the Paris Agreement).
   - Sharing technologies and best practices between countries.
9. Research and innovation:
   - Supporting scientific research in the field of ecology and sustainable development.
   - Developing and implementing new technologies to reduce the carbon footprint.
10. Political and economic measures:
    - Introducing carbon taxes and providing

subsidies for environmentally friendly technologies.
- Creating strict environmental standards and enforcing them.

The success of these measures depends on political will and the active participation of citizens. The unification of efforts at all levels – from individual actions to state programs – is the basis for creating a harmonious interaction between man and nature, which is extremely important for future generations.

## Conclusions

Most scientists who have studied environmental issues believe that humanity has about 40 years to return the natural environment to a normally functioning biosphere and resolve issues of its own survival. But this period is extremely short. And does man have the resources to resolve even the most pressing problems? The main achievements of civilization in the 20th century include the successes of science and technology. The achievements of science, including the science of environmental law, can also be considered the main resource in solving environmental problems. The thought of scientists is aimed at overcoming the environmental crisis. Humanity and states must make maximum use of existing scientific achievements for their own salvation. The authors of the scientific work "The Limits to Growth: 30 Years Later" Meadows D.H., Meadows D.L., Randers J. believe that the choice of humanity is to reduce the burden on nature caused by human activity to a sustainable level through reasonable policies, reasonable technology and reasonable organization, or wait until the changes occurring in nature reduce the amount of food, energy, raw materials and create an environment completely unsuitable for life. Given the lack of time, humanity must determine what goals it faces, what problems need to be solved, what the results of its efforts should be. In accordance with certain goals, objectives and expected, planned results, humanity develops the means to achieve them. Taking into account the complexity of environmental problems, these means have specifics in technical, economic, educational, legal and other spheres [20].

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# GLOBAL MOUNTAIN BIODIVERSITY ASSESSMENT

# Crop traits improvement through genetic modification and genome editing approaches

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## Abstract

CEMB, being pioneer in developing insect and weedicide resistant crops, is successful in approval of its insect and weedicide resistant cotton varieties on commercial basis. To further enhance the toxin level next generation Bt along with fusion gene strategy is also addressed to cope with challenges of resistance buildup in insect pests. Advancement of technology to edit different traits of crop plant is fundamental to be utilized for improvement of major traits of plants like dealing with challenge of CLCuV in cotton, enhancing the storage life of potato, development of potato with enhanced vitamin A and development of resistance in potato against fungus and PVX, PVY. Further abiotic stress tolerant crop is the challenge of current and years to come to be dealt with genome editing is also established at CEMB. Two success stories of genome editing through CRISPR Cas9 system includes knock out of CLCuV targeting DNA A and Beta satellite akong with improved shelf life of potato through knockout of Vlnv has been discussed in current presentation. The knockout efficacy of the 72% for DNA-A, 90% of betasatellite was achieved during this study. The qPCR confirmed the successful reduction of the vial titre and the feeding assay showed 90% of mortality in the whiteflies. The study results were also validated by the change in Alpha chain, Beta Chains, and loops of the 3D protein models of native and edited proteins predicted with Alpha Fold2. The knockout efficiency and the virus inoculation assay magnificently determined the faith in using this technology for plant virus control along with its vector. The amplicon sequencing data showed maximum indel frequency for potato plant T12 (14.3%) resulting in 6.2% gene knockout and 6% frame shift. While for plant B4, the maximum indel frequency of 2.0% was found which resulted in 4.4% knockout and 4% frameshift as analyzed by Geneious. The qRT-PCR data revealed that mRNA expression of VInv gene was reduced 90–99-fold in edited potato plants when compared to the non-edited control potato plant. Following cold storage, chips analysis of potatoes proved B4 and T12 as best lines. Reducing sugars' analysis by titration method determined fivefold reduction in percentage of reducing sugars in tubers of B4 transgenic lines as compared to the control.

## Introduction

Genetic modification and genome editing technologies have transformed agriculture sector, allowing for major improvements in crop attributes. Specifically, CRISPR/Cas9 has become an effective method for precise genetic modifications in plants [3]. With the use of this technology, desired qualities like disease resistance, stress tolerance, and nutritional quality can be improved by making precise modifications to specific genes. High precision gene editing not only speeds up the breeding process but also lowers the time and cost involved in developing improved crop varieties [7].

Cotton (*Gossypium hirsutum* L.) is a major cash crop in Pakistan and other nations, it is frequently referred to as "white gold" because of its significant economic influence [4,5]. However, diseases and pests pose serious risks to cotton production. One such disease is the cotton leaf curl virus (CLCuV) [6], which can cause catastrophic output losses. In the same way, potatoes (*Solanum tuberosum*) are prized for their adaptability and high nutritional value and are a staple food crop around the world. The quality of processed foods is impacted by cold-induced sweetening, which is one of the main problems with potato preservation [1, 2]. The activity of vacuolar invertase, which changes sucrose into reducing sugars during cold storage, is principally responsible for this phenomenon.

## Materials and Methods

CRISPR/Cas-9 mediated downregulation of stress responsive genes were targeted in cotton and potatoes for resistance against CLCuV and potato sweetening. In the study on cotton, gRNAs targeting specific regions of the CLCuV genome, including the DNA-A component (AC2 and AC3 genes) and the betasatellite (βC1 gene) were selected. The gRNA design followed the CRISPR-P workflow using a custom, variant-substituted

sequence for all begomoviruses. The designed gRNAs were ligated into a plant expression vector containing Cas9 under the U6-26 promoter using the gateway cloning method. The successful ligation was confirmed by PCR amplification, restriction digestion, and Sanger sequencing. The CRISPR/Cas9 plasmid was transformed into the Agrobacterium tumefaciens strain LB4404 and then introduced into the cotton variety CKC-1 using embryo transformation protocols. The presence of the plasmid in transformed cotton plants was verified by PCR. The knockout efficiency of the targeted viral genes (AC2, AC3, and βC1) in genome-edited cotton plants was determined using Sanger sequencing and next-generation sequencing (amplicon sequencing). An infectious clone of CLCuV was agroinfiltrated into the genome-edited cotton plants. The presence of the virus complex was confirmed by PCR using betasatellite and DNA-A-specific primers. The viral titer in the edited plants was quantified by real-time PCR. Proceed to functional analysis of KO proteins, Molecular dynamics simulations were performed using the AlphaFold2 software to predict the 3D structures of the wild-type and edited viral proteins. The structural refinement was carried out using the ModRefiner online server, and the secondary structure percentages were predicted using the RaptorX web tool. Similarly proceed in potatoes, two specific guide RNAs (sgRNAs) were designed to target the VInv gene. The CRISPR/Cas9 construct containing the sgRNAs was introduced into potato plants via Agrobacterium-mediated transformation. The effectiveness of gene editing was assessed through various molecular techniques, including PCR, Sanger sequencing, and digital PCR. Proceeding to biochemical analysis, the content of reducing sugars were observed in transgenic and control plants after cold treatment. Along with genetic and biochemicals evaluations, phenotypic characteristics of genome edited potato tubers were also monitored.

## Results

After successful transformation of cotton plants, we achieved editing efficiencies of 72% for AC2 and AC3, and 90% for βC1. Along with increased editing efficiencies, Genome-edited cotton plants demonstrated significantly reduced viral loads and remained asymptomatic despite exposure to CLCuV (Fig 1). Real-time PCR quantification revealed a substantial reduction in viral titter in the genome-edited cotton plants compared to non-edited controls. Molecular dynamics simulations showed higher RMSD values for the edited βC1 and AC3 proteins, indicating functional loss caused by denaturation.

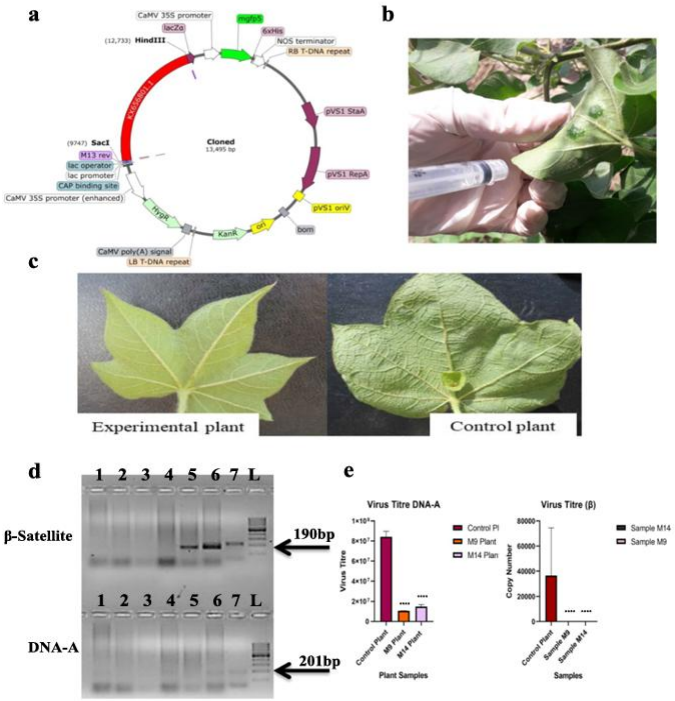


**Fig. 1.** Agroinfiltration of infectious CLCuV clone in leaves of genome-edited and non-edited control cotton plants to compare viral titer. a Chemically synthesized CLCuV Infectious Clone. b Agroinfiltrate the infectious clone into plant via syringe. c Transgenic and Control plants after 21 days of infiltration. d PCR detection of presence of Virus in transgenic plants. e determination of Virus copy number in control and transgenic plants by Absolute Real Time PCR.

And notably, the physiological traits of the genome-edited potatoes were comparable to conventional varieties, indicating no adverse effects on plant health or yield due to the genome editing event. In the case of Vln targeting potatoes, the transformation efficiency was reported as 11.7%. The edited plants showed a 90-99-fold reduction in VInv mRNA expression compared to non-edited controls (Fig 2). Along with that, the transgenic potato lines (B4 and T12) exhibited a fivefold decrease in reducing sugars compared to control plants, significantly improving their quality for processing (Fig 2).

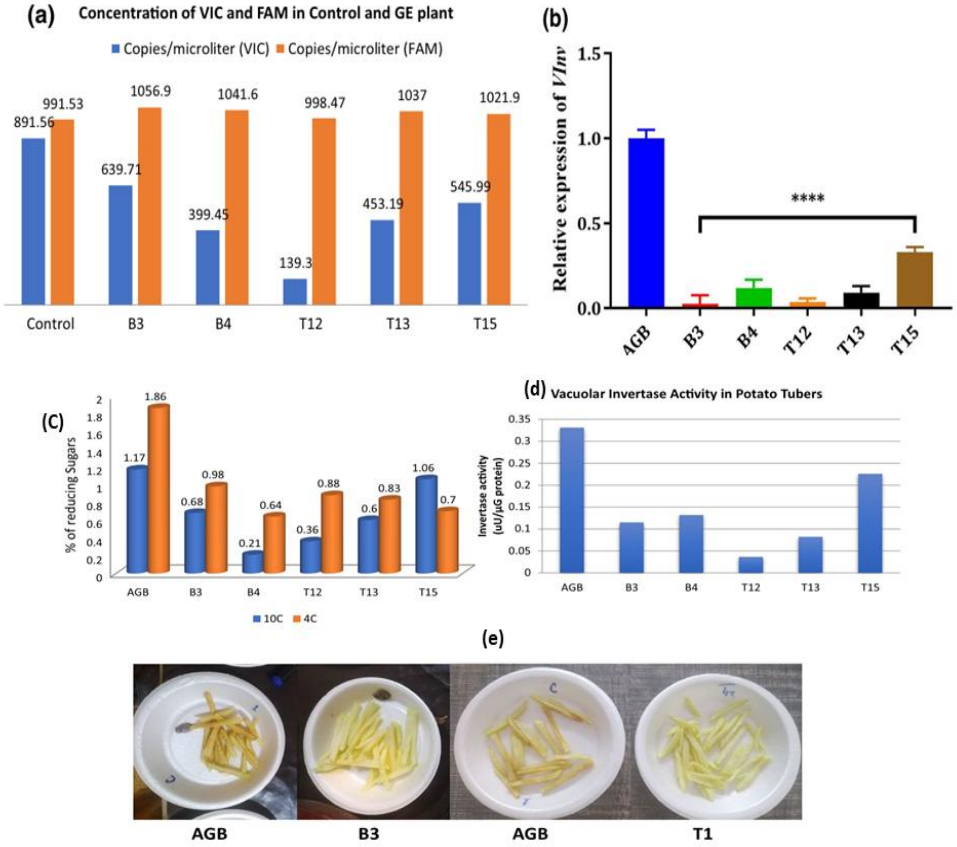


**Fig. 2.** Confirmation of genome-edited lines using digital PCR and qPCR and phenotypic assessments. (a) Concentration of VIC and FAM in control and genome edited plants. FAM concentration in control and genome-edited plants was found to be approximately in the same range, while a clear reduction in concentration of VIC was observed in case of genome edited potato plants. (b) qPCR assays revealed reduced VInv transcripts in genome-edited transgenic potato lines. (c) The percentage of reducing sugars in genome-edited lines following cold storage at 10 ºC and 4 ºC. The desirable level of reducing sugar was recorded in edited lines compared to the control. (d) the activity of vacuolar invertase in edited lines along with control, T12 showed minimum vacuolar activity. (e) A comparison of some of fries of edited lines along with the control. The potato fries after 10 min of preparation with the non-transgenic control have been shown.

## Discussion and Conclusion

The implications of this research extend beyond the immediate findings. By successfully employing CRISPR/Cas9 to target viral components, the study illustrates a potential pathway for developing resilient cotton varieties that can withstand viral infections without the need for chemical interventions. This aligns with global trends towards sustainable agriculture and integrated pest management practices. This study also highlights the importance of advanced molecular techniques, such as molecular dynamics simulations, in understanding the structural consequences of genetic modifications. This holistic approach not only validates the efficacy of the CRISPR/Cas9 system but also provides insights into the molecular mechanisms underlying viral resistance. This study also represents a pioneering effort in Pakistan to utilize CRISPR technology for improving potato storage quality by targeting the VInv gene. The successful knockdown of this gene not only addresses the issue of cold-induced sweetening but also paves the way for future applications of genome editing in enhancing crop resilience and quality.

To conclude, the research presented demonstrates the revolutionary potential of genetic modification and genome editing in the field of agriculture. These studies support the overarching

objective of improving food security and agricultural sustainability by tackling major challenges encountered by cotton and potato crops. The development of resilient crop cultivars that can flourish in the face of biological and environmental challenges is a promising future direction for genome editing technology, one that will eventually benefit both farmers and consumers.

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# Structural changes induced by gamma radiation in *Peganum harmala*

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## Abstract

For the first time, the qualitative and quantitative alkaloid composition of *P.Harmala* was thoroughly studied by identifying IR and radiothermoluminescence spectra. In order to identify alkaloids, a new combined and improved IR spectroscopy and radiothermoluminescence methods with high resolution were proposed. It is shown that the content and ratio of different types of alkaloids in the stems and seeds of *P.Harmala* differ significantly. More precisely, harmine prevails in the seeds, and peganine in the stems. In terms of the content and ratio of alkaloid components, *P.Harmala* growing in the Absheron has a number of advantages compared to the same plants growing in the Masalli and Ismailli regions. It was found that when *P. Harmala* samples were irradiated, the IR spectra were transformed. More precisely, in the region of small doses ($0.5 < D_\gamma \leq 2$ 5 Gy), the intensities of the absorption bands of alkaloids were redistributed, the intensities of the absorption bands of harmine and harmaline increased, and on the contrary- the intensities of the absorption bands of peganine and pegadinine decreased. A further increase in the irradiation dose from 25 to 50 Gy led to a decrease in the intensities of all absorption bands. It was assumed that structural changes in the dose range of $25 < D_\gamma \leq 50$ Gy are associated with partial decomposition of alkaloids.

**Keyword.** *P.Harmala;* alkaloid composition; γ- radiation; IR– spectroscopy; radiothermoluminescence

## Introduction

Azerbaijan has a rich flora. Over 4,500 species of flowering plants are widespread in Azerbaijan, including both rare and endangered ones. Almost all types of vegetation common in the world are found in a relatively small area, which are united into 125 orders and 920 genera. Plant species found in Azerbaijan make up 66% of the total number of species growing in the Caucasus. Along with species widespread in the Caucasus and other regions, the Azerbaijani flora includes plant species that grow only in Azerbaijan. Low-growing plant types are found on the mountain peaks of alpine meadows, on steep hills, and slightly less on saddle-shaped passes compared to subalpine glades. Alpine carpets consist of two groups of formations: true alpine carpets (caraway, plantain, lady's mantle, dandelion) and alpine carpets on rocky terrain (sibbaldia, bellflower).

Azerbaijan is also a country rich in medicinal plants. One of these plants is *Peganum Harmala* (*P.Harmala*). The plant contains a huge range of alkaloids [1]. Therefore, it has a wide range of medicinal properties. The therapeutic effect of this plant is due to the presence of β-carboline alkaloids in its composition, such as peganine, harmine, harmaline and their derivatives [2].

The pharmacological activity of alkaloids varies widely depending on their structure. Among them are analgesics - narcotics (morphine, codeine), powerful stimulants of the central nervous system (strychnine, brucine), mydriatic - pupil dilators (atropine, hyoscyamine) and miotic - pupil constrictors (physostigmine, pilocarpine) [3]. Some alkaloids, such as ephedrine, epinephrine, exhibit adrenergic activity, exciting the sympathetic nervous system, and thereby stimulating cardiac activity and increasing blood pressure [4, 5].

Different organs of *P.Harmala*, depending on the development phase and place of growth, have different qualitative properties and are widely used in traditional folk medicine. In particular, in the treatment of bronchial asthma [6], radiculitis, osteochondrosis [7], to normalize blood pressure,

insomnia [8], as well as in the treatment of various skin diseases [9], the use of a drug based on *P.Harmala* gave encouraging results.

Preparations prepared on the basis of *P. Harmala*, in addition to anti-inflammatory, diuretic, diaphoretic, also have diuretic, sedative, analgesic and antiseptic effects [10]. *P. Harmala* also has a stimulating effect on the central nervous system, lowers blood pressure, increases breathing, relaxes the muscles of the intestines, heart and dilates peripheral vessels [11].

*P. Harmala* is also recognized by official medicine. The pharmaceutical industry produces a drug based on this plant, which is called harmine hydrochloride. The alkaloid harmine of the above-ground part or seeds of this plant in the form of hydrochloric salt is used in the treatment of some diseases of the central nervous system (shaking palsy, consequences of epidemic inflammation of the brain - encephalitis, Parkinsonism) [12, 13], and other alkaloids, having a neuroprotective property, can affect the nervous system [14].

*P.Harmala*, containing some alkaloids, which, due to their physiological activity and being strong poisons, are also used in medicine [15]. Preparations based on *P.Harmala* also have antidiabetic, antihyperlipidemic [16, 17] and antileishmanial properties [18].

Preparations made from *P. Harmala* plants with different alkaloid contents in the countries of Central Asia, India, Russia, and Iran, in addition to traditional medicine, are used in different clinical purposes. In these countries, neoplasms are mainly obtained from plants containing β-carboline alkaloids [19].

Recently, *P. Harmala* has also found application in the treatment of a number of "serious" diseases. Research by various authors has shown that some isolated components of this plant exhibit cytotoxic [15, 20] and anticancer effects [11]. In particular, the use of these components revealed cytoplasmic vacuolization of cells [21]. It is assumed that drugs based on these components are a valuable sensitizer and in the future may find wide application as key regulators of cancer cells [22].

It should be noted that, despite the fairly wide use of alkaloids in modern therapeutic practice, their potential capabilities have not yet been fully revealed. Therefore, the search for new drugs based on medicinal plant raw materials containing alkaloids, as well as the production of new drugs with improved pharmacotherapeutic indicators based on existing drugs should take a worthy place in future research work.

Based on the literature on the pharmacotherapeutic effects of medicinal plants published in recent years, it can be concluded that targeted chemical or physical modification of alkaloid molecules, with the aim of synthesizing new derivatives of alkaloid-bearing natural compounds, will be a prerequisite for creating effective drugs with pharmacological action. Based on these considerations, it can be noted that the use of medicinal plants in industrial medicine, i.e. the transition from traditional medicine to industrial medicine, is of great relevance.

Here it is necessary to mention one important fact. It is known that external factors such as high and low temperatures, electromagnetic field, radiation background of the area of plant growth, as well as its surface pollution caused by atmospheric aerosols and microorganisms, play a significant role in the formation of the qualitative composition of the plant. Taking into account that the era in which we live is characterized by high electromagnetic radiation, as well as a daily increase in the number of locally contaminated zones with various radionuclides, in the presented work we tried to study the structural changes caused in *P.Harmala* under the influence of radiation.

## Materials and methods

### Research objects

The medicinal plant *P. Harmala* from the Absheron, Ismayilli and Masalli regions of the Republic of Azerbaijan was chosen as the research object.

*P. Harmala*, which belongs to the *Zygophyllaceae* family, is a perennial wild herbaceous plant with a strong specific smell, lush flowering and many useful substances. The plant is successfully used for medical purposes, observing precise dosages, since the plant is poisonous. The leaves and seeds are the most toxic.

The plant has a powerful, two- or three-headed taproot up to 2-3 meters long and up to 10 cm thick, which helps to penetrate the soil and provide the plant with moisture and nutrients. The stems are bare and green, grow to a height of 30 to 80 centimeters and branch out. The leaves are sessile, alternate. The flowers can be yellow or white, singly on peduncles or up to three at the ends of branches. The calyx is five-partite, almost to the very base. The corolla of 5 petals elliptical shape and length approximately 1.5 - 2 centimeters. The flower has 15 stamens. The fruit is 6-10 millimeters in diameter and looks like a spherical capsule with three nests and partitions. The seeds are angular, numerous, brown or brownish-gray in color, about 3 - 4 m long. One plant produces up to 120 thousand seeds. The weight of 1000 seeds is 2.5-3 g [23] (Fig. 1).

*P. Harmala* is not very demanding to growing conditions. It grows on saline, clayey soils and sands, near wells on desert pastures, along cattle drives, on rocky areas, on wastelands. Often forms pure thickets at an altitude of 450 - 3700 m [23]. In Azerbaijan, it grows in semi-desert areas. The most well-known are the Absheron, Ismailli and Masalli species of *P. Harmala*, which differ in alkaloid content [24]


**Fig.1. General appearance of the *P. Harmala* (1 - root, 2 - stem, 3 - leaves, 4 - flowers, 5 - fruit, 6 - seed).**

Pre-sowing γ-irradiation of the seeds of this plant was carried out using a $^{60}Co$ source. Irradiation was carried out using remote control of the radiation source in special concrete chambers that ensured protection of the working personnel. The dose rate of the source was 1.03 Gy/s. The absorbed dose was calculated using spectrometry (absorption band of $Fe^{3+}$ ions with a maximum at 305 nm) and taking into account the electron densities of the dosimetric solution and the sample under study.

Depending on the nature of the study, irradiation of the samples was carried out both at room temperature and at liquid nitrogen temperature.

Experiments on determining the quantitative and qualitative alkaloid composition of *P. Harmala* were conducted using dry samples of this plant. In order to obtain dry plant samples, a method of low-temperature microwave processing was used. Microwave drying and fermentation of the plant was carried out on a laboratory installation, which included a container with a cry solvent, a microwave oven and a source of UV radiation.

A quartz vessel with green raw *P.Harmala* (seeds, stems and leaves) was immersed in a volume of liquid nitrogen, cooled to a temperature of 77 K for 5-15 min, then placed on a microwave oven conveyor and subjected to eletromagnetic microwave field treatment at a frequency of 400-1000 MHz with generator power varying from 45 to 55 kW.

Microwave heating was carried out with simultaneous blowing with air previously purified from carbon dioxide and treatment with light with a wavelength of 400 - 700 nm and an intensity of 1 $mW/cm^2$.

The choice of the spectral range of 400 - 700 nm is due to the fact that the band of residual chlorophyll is at 665 nm, and photo irradiation of *P. Harmala* in this region does not lead to deterioration in the quality of the medicinal plant.

The method of drying *P.Harmala* proposed by us allowed us to obtain dry samples of a yellowish hue. The desired effect was achieved due to the fact that the plants were irradiated with light of a wavelength causing photo oxidation of the green pigments contained in them. At the same time, simultaneous blowing with air purified from carbon dioxide sharply suppressed natural photochemical processes in the seeds, stems and leaves of the plant, and the frequency of the electromagnetic field used ensured the necessary duration of processing and drying of the preparation.

The essence of this method is that as a result of intensive absorption of electromagnetic waves, dielectric heating of the plant (material with low thermal conductivity and heat resistance) occurs. In this case, photo- and thermochemical reactions occur both on the surface and throughout the entire volume.

The electromagnetic field, in addition to local thermal action, also initiates the uniform flow of

photochemical reactions, which is of no small importance for obtaining high-quality products. Additional UV irradiation accelerates the decomposition of residual chlorophyll.

It should be noted that the combined drying method proposed by us is currently the only way to obtain high-quality raw material. At the same time, a balance is achieved between the processes of yellowing and moisture release (hydration) in different organs of *P.Harmala*.

Structural changes occurring during heat treatment of *P.Harmala* were studied using differential thermal analysis. To record thermo grams of seeds, stems and leaves, the samples were crushed and filled into a ceramic crucible. Thermal analysis in combination with weight and differential gravimetric analysis was carried out using a derivatograph (Q-Derivatograff, MOM, Hungary). The heating mode selected was: temperature range 300 – 127 K, heating rate 5 K / min. Aluminum oxide ($Al_2O_3$) was used as a standard.

To study the structural changes in *P.Harmala* samples caused by γ -irradiation and microwave field treatment, we used our improved traditional IR spectroscopy technique based on measuring the transmission spectra of translucent pressed tablets. For this purpose, a special optical cell was developed and manufactured, allowing IR studies of the original and treated samples under vacuum $P=10^{-6}$ Pa in a wide temperature range: from T=300 K (room temperature) to 923 K.

In our experiments, the optical cell was connected to a vacuum unit used to clean the samples from adsorbed atmospheric gases and contaminants, as well as to dehydroxylate their surface.

For radiothermoluminescence analysis, tablets were made from finely ground samples of this plant and inserted into special metal holders with holes necessary for the passage of irradiation. Radiothermoluminescence curves of γ-irradiated and microwave-treated *P Harmala* samples were obtained in the temperature range of 80 – 450 K .

## Results and discussion

### Alkaloid content in native P.Harmala

Among the spectral methods for studying the molecular structure and composition of objects of plant origin and bio systems, the most informative is the method of IR spectroscopy. This method allows us to obtain more accurate data on the functional and structural groups that make up plants, to trace the structural changes that occur in plants as a result of the influence of various environmental factors and to identify their features.

In order to study the structural features, IR absorption spectra of *P.Harmala* growing in three different regions of Azerbaijan (Absheron, Masalli and Ismayilli regions) were obtained.

The listed regions are characterized by a unique climate, differences in soil and radiation background. Since the regions we selected belong to different geographical regions of our republic and differ greatly in soil cover. Being located in different climatic zones, they also differ in climatic conditions of the area.

Let us recall that the listed areas belong respectively to the type of dry subtropical climate, to the zone of humid subtropical climate, to the type of moderate dry subtropical climate zones. The soils in these areas are sandy-clayey, chestnut and gray, respectively.

It is known that the content of alkaloids in plants often fluctuates depending on climatic conditions, time of collection, stages of biological development of plants, and the specifics of its cultivation. However, in most cases, the highest content of alkaloids is determined during the period of budding and flowering of plant objects. It varies from insignificant amounts (traces of alkaloids) to 2-3% of the total mass of dry plant material [25].

Based on this, the content of alkaloids was determined during the period of budding and flowering of this plant.

Considering that different parts of *P. Harmala* (both underground and aboveground - roots, stems, leaves, seeds) differ in the composition of the content of alkaloids, we conducted a comparative molecular IR spectroscopic study of the structure of its individual parts.

IR absorption spectra were obtained from samples that were prepared in the form of tablets pressed in a solid matrix. To obtain more detailed information, relatively thin films of *P. Harmala*, without a binder, were studied.

Figure 2 shows the IR absorption spectra of the seeds and stems of this plant (curves 1 and 2, respectively) in the frequency ranges of 4000–2000 and 2000–650 cm-1, which include the main molecular-structural features of chemical compounds.

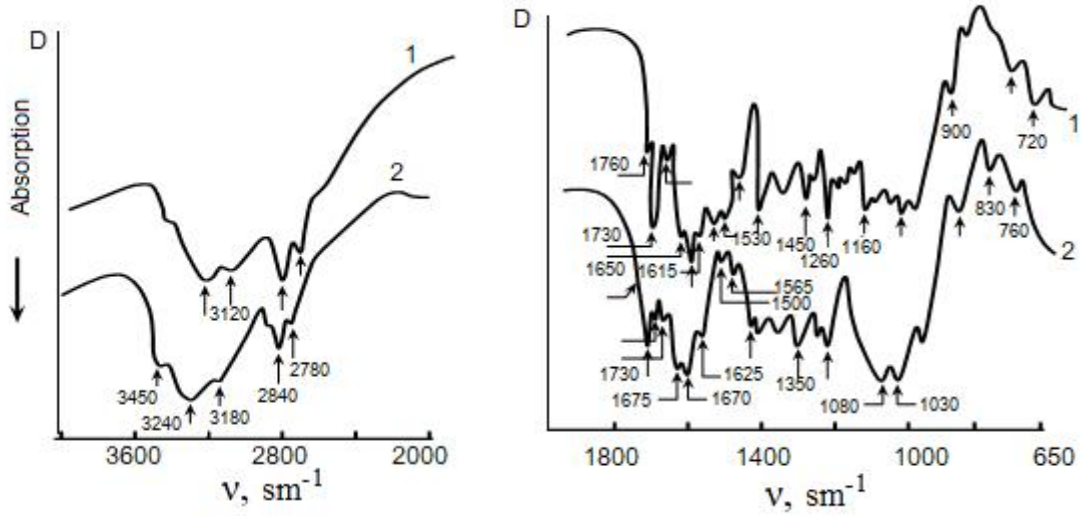


**Fig. 2. IR absorption spectra of *P. Harmala* (1 – seeds, 2 – stems).**

As can be seen from the figure, the most intense bands appear in the regions of 1800 - 1500, 1500 - 1250 and 1250 - 1000 $cm^{-1}$. When interpreting the absorption bands, we relied on reference data on the IR spectra of organic molecules and alkaloid-bearing plants.

In the region of 1800 - 1500 $cm^{-1}$ there are carbonyl-containing C = O (1750 - 1700 $cm^{-1}$), C = C and – N = C groups (1690 - 1500 $cm^{-1}$) in aromatic cycles. The presence of aromatic C = C, – N = C and carbonyl-containing C = O groups, including aceto groups (CH3 – CO – CH2) is associated with the alkaloids that are part of this plant.

The region of 1800 - 1500 $cm^{-1}$ has the finest structure and is characterized by a set of nearby absorption bands caused by different types of alkaloids.

It is known that the bands in the region of 1800 - 1200 $cm^{-1}$ characterize various valence vibrations of groups with multiple bonds (C = O, C = C). Here are also located the bands caused by deformation vibrations of the C–H bond and other groups. Conjugation with a double bond or aromatic ring leads to a shift of the bands to the region of lower wave numbers (up to 1660 $cm^{-1}$). The band 1720 $cm^{-1}$ corresponds to carboxyl groups, which, as can be seen from the figure, are also present in *P. Harmala* samples.

When the carboxyl group is converted into the ionic form, this band almost disappears, and two new bands (1555 and 1400 $cm^{-1}$) appear, which correspond to the asymmetric and symmetric valence vibrations of the carboxylate ion. The type of hydroxyl groups present in the compound can be determined from the acetylation spectrum of harmine derivatives. The absorption of the carbonyl group in phenol acetates appears in the region of 1765 $cm^{-1}$, and in acetates of non-conjugated alcohols - 1760 $cm^{-1}$. In addition, in the region of 1700-1660 $cm^{-1}$ the absorption of the valence vibrations of carbonyl groups in quinoid structures appears.

In the region of 1626 – 1608 $cm^{-1}$, ethylene α-, β-double bonds absorb. In the spectra, this vibration sometimes appears as a weak shoulder on the intense band of 1600 $cm^{-1}$, caused by vibrations of the aromatic ring [26].

The skeletal vibrations of the aromatic ring include four bands. These bands are bands corresponding to the frequency intervals 1605–1595, 1515–1505, 1490 and 1450–1420 $cm^{-1}$.

The bands 1470 – 1460 $cm^{-1}$ are attributed by many authors to asymmetric deformation vibrations of aliphatic C–H bonds. Note that the band 1430 $cm^{-1}$ is attributed to scissor vibrations of $CH_2$ groups associated with the carbonyl group, as well as to skeletal vibrations of the aromatic ring. The intensity of this band is insensitive to the influence of external factors.

The spectral region of 1800–1200 $cm^{-1}$ is characterized by a set of nearby absorption bands, related mainly to various types of alkaloids in the composition of the studied plant. This is evidenced by the presence of carbonyl-containing C = O (1750 - 1700 $cm^{-1}$), C = C and nitrogen-containing – N = C groups (1690 - 1500 $cm^{-1}$) in aromatic cycles. And the bands at 1600, 1580 (conjugated rings), 1500 and 1450 $cm^{-1}$ are characteristic of the ring itself.

Considering the complex chemical composition and reference data on the IR spectra of individual P. harmala alkaloids presented in Figure 2, the absorption bands with frequencies of 1725, 1700, 1690 and 1625 $cm^{-1}$ were assigned to harmine, peganidine, harmaline and peganine, respectively. The peaks corresponding to these compounds are also clearly visible in Figure 3.

Figure 3 shows a fragment from the spectrum of a thin film of *P. Harmala* in the region of 3800 - 1200 $cm^{-1}$, where the characteristic bands corresponding to the functional C = O, C = C, – N = C groups and associated with the presence of alkaloids are located in the region of 1800 - 1200 $cm^{-1}$.

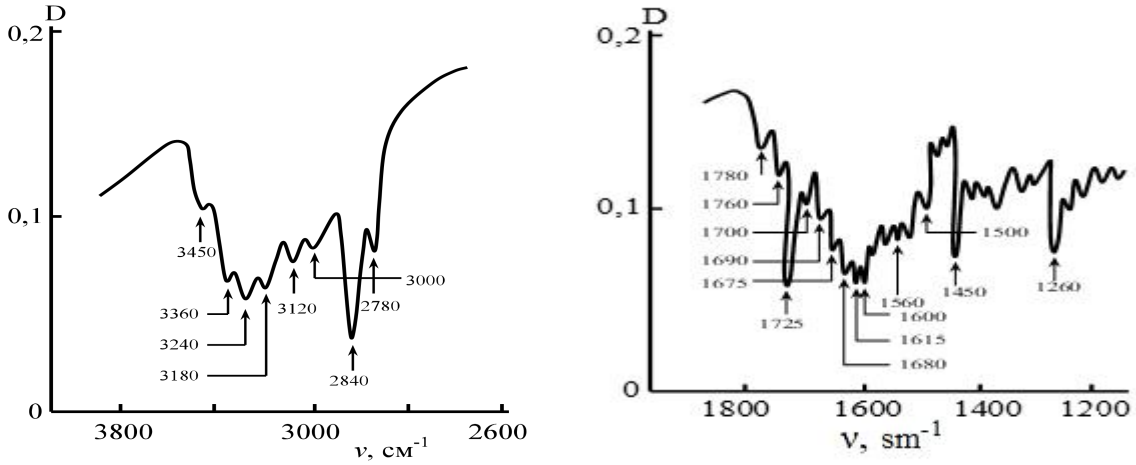


**Fig. 3. IR absorption spectra of *P.Harmala* in the frequency ranges of 3800-2600 and 1800 -1200 $cm^{-1}$.**

The bands at 1600, 1580 (conjugated rings) 1500, 1450 $cm^{-1}$ are characteristic of the aromatic ring itself, which together with the band of valence vibrations = C – H near ~ 3000 $cm^{-1}$ makes it easy to recognize the aromatic structure (benzene ring).

The absorption bands in the region of valence vibrations of –OH, –NH and alkyl $CH_3$, $CH_2$, CH - groups with different around also testify in favor of alkaloids. The bands with frequencies of 3120, 3180, 3240, 3360 and 3450 $cm^{-1}$ refer to OH or NH groups. The bands with maxima of 2840 and 2780 $cm^{-1}$ are characteristic of aceto ($CH_3$ – CO – $CH_2$) – and aldehyde (HC = O) – groups.

= C – O – groups absorb in the region 1270 - 1200 $cm^{-1}$, and bands 1040 - 1100 $cm^{-1}$ and 1100 - 1070 $cm^{-1}$ are associated with valence C – O – groups (ethers) and a five-membered heterocycle, respectively.

In the region of 988 - 960 $cm^{-1}$, deformation vibrations of the C – H bond with a double bond in the trans position are manifested. The low intensity of this band in the spectrum indicates a small number of double bonds in the structure of *P. Harmala*. Out-of-plane deformation vibrations of the C – H bonds of the aromatic ring of varying degrees and nature of substitution are manifested in the region of 900 - 720 $cm^{-1}$. In the samples of the studied plant, two bands were manifested, characterizing the vibrations of one or two hydrogen atoms – in the region of 880 - 850 $cm^{-1}$ and 855 - 800 $cm^{-1}$.

Based on the above, the content of alkaloids in two organs (seeds and stems) of this plant was determined.

Data on the content (both quantitative and qualitative) of alkaloids of *P. Harmala*, determined by the IR spectra of the samples, are presented in the Table.

**Table. Content of individual alkaloids in seeds and stems of *P.Harmala* of the Apsheron region.**

| Plant organs | Content, in % | | | | Total alkaloids, in % |
|---|---|---|---|---|---|
| | Harmine | Harmaline | Peganine | Peganidine | |
| Absheron region | | | | | |
| Seeds | 2.8 | 0.8 | 0.6 | 0.1 | 4.3 |
| Stems | 1.2 | 0.3 | 2.5 | 0.2 | 4.2 |
| Ismayilli region | | | | | |
| Seeds | 1.9 | 0.5 | 0.8 | 0.16 | 3.36 |
| Stems | 0.5 | 0.2 | 2.6 | 0.31 | 3.62 |
| Masalli region | | | | | |
| Seeds | 1.6 | 0.5 | 0.74 | 0.1 | 2.94 |
| Stems | 0.6 | 0.3 | 2.6 | 0.2 | 3.7 |

The analysis of the data presented in the table shows that *P. Harmala* contains a sufficient amount of alkaloids. Moreover, these alkaloids mainly include harmine, harmaline, peganine, pegadinine. From the IR spectra it is clear that the seeds and stems of this plant also contain traces of such alkaloids as harmalol and peganol (these alkaloids are not listed in the table).

The results of our research confirm the fact that different organs of this plant are characterized by different alkaloid content. Moreover, different organs differ not only in quantity, but also in the quality of alkaloids.

Comparison of IR spectra of seeds and stems shows that in all samples of *P. Harmala* harmine predominates in seeds, and peganine in stems. In other words, if the seeds of this plant, regardless of the place of growth, contain a large amount of harmine, then its stems have the greatest amount of peganine. [25, 27].

In terms of harmine content, *P.Harmala* of the Apsheron district ranks first (2.8%). Second place is occupied by P.Harmala of the Ismailli district (1.9%), and third place is occupied by *P.Harmala* of the Masalli district, for which the harmine content in percentage terms is 1.6%.

Unlike the harmine content, peganine is present in approximately the same amount in all *P.Harmala* samples. Since the peganine content in *P.Harmala* stems is approximately 2.5%, 2.6% and 2.6% of the total dry plant material mass for the Absheron, Ismailli and Masalli regions, respectively.

All samples of *P.Harmala* collected from different regions of our republic have a relatively small amount of peganidin in the seeds and stems.

We assume that the data on the content of alkaloids can serve as a kind of biomarker for identifying *P.Harmala*. In other words, the amount of alkaloids can be used to determine the place of growth of this plant.

### Alkaloid content in γ-irradiated *P. Harmala* samples

Structural changes in γ-irradiated *P. Harmala* samples were also monitored in this case using IR absorption spectra.

Figure 4 shows the IR absorption spectra of the initial (curves 1) and irradiated with γ-quanta at different doses (curves 2-3) *P. Harmala* samples in the frequency range of 1800 - 1200 $cm^{-1}$. The irradiation dose ranged from 0 to 50 Gy. The figure shows only irradiation doses of 10 and 50 Gy. The choice of these doses is due to the fact that 10 Gy and 50 Gy are the lower and upper limits of the interval of the stimulating dose for plant development [28].

As can be seen from the presented spectra, when irradiating *P.Harmala* samples, the IR spectra are clearly transformed. More precisely, in the region of relatively small doses ($0.5 < D_\gamma \leq 2$ 5 Gy), a redistribution of the intensities of the absorption bands of alkaloids occurs. More precisely, in this dose region, the intensities of the absorption bands of harmine and harmaline (1725 and 1690 $cm^{-1}$) increase. At the same time, the intensities of the absorption bands of peganine and pegadinine (1700 and 1625 $cm^{-1}$) (curve 2), on the contrary, decrease. A further increase in the irradiation dose from 25 to 50 Gy leads to a decrease in the intensities of all absorption bands (curve 3).

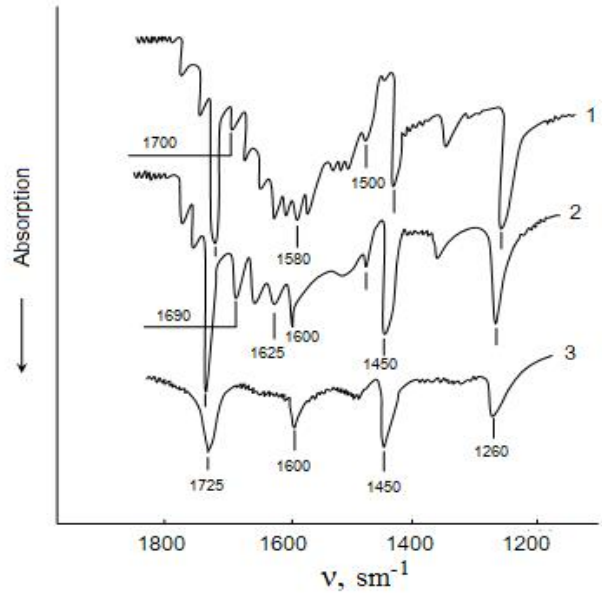


**Fig.4.** IR absorption spectra of *P. Harmala* samples in the frequency range of 1800 - 1200 $cm^{-1}$ (1– non irradiated, 2 – γ-irradiated at a dose of 10 Gy and 3 – γ-irradiated at a dose of 50 Gy.

The observed feature of harmine, harmaline and their derivatives in the IR spectra of γ-irradiated *P.Harmala* in the analytical region of alkaloids can be explained by structural conformational changes leading to an increase in the content of harmine and harmaline (in the region of relatively small doses – $0.5 < D_\gamma \leq 25$ Gy) and to their partial decomposition (in the region of $25 < D_\gamma \leq 50$ Gy).

The structural changes in *P. Harmala*, caused by γ - radiation, studied in this work, open up wide possibilities for its medical use.

The data we obtained show that pre-sowing γ-irradiation of *P. Harmala* leads to noticeable structural changes. In order to obtain more reliable information about the structural changes occurring during this, we considered it appropriate to study the structure of *P. Harmala*, the seeds of which were subjected to γ - irradiation also by the radiothermoluminescence method. The obtained data on these changes are presented in Figure 5.

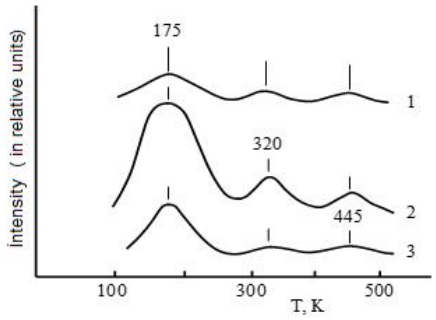


Fig. 5. *P.Harmala* radiothermoluminescence curves (1 – non-irradiated, 2 – irradiated at a dose of 25 Gy and 3 – irradiated at a dose of 50 Gy).

Radio thermoluminescence curves show that irradiation with γ-quanta leads to the appearance of one intense peak at 175 K and 2 weak peaks at 320 K and 445 K in the spectrum of *P. Harmala*.

We believe that the low-temperature broad peak (half-width $T_{1/2}$ = 110 K) at 175 K with activation energy $E_a = 0.07 \div 0.10$ eV may be associated with both the presence of alkaloids in *P. Harmala* and molecular water in the steric environment of the alkaloids. The broad low-temperature radio thermo luminescent peak with a maximum at 175 K has a number of features, since its spectral parameters (intensity and half-width) depend on the dose of γ - irradiation (curves 2 and 3).

With an increase in the γ-irradiation dose from 0.5 to 25 Gy ($0.5 < D_\gamma \leq 25$ Gy), the intensity of the thermal emission peak increases by almost one order of magnitude. A further increase in the irradiation dose to 50 Gy ($25 < D_\gamma \leq 50$ Gy) is accompanied by a monotonic decrease in the intensity of this peak and its narrowing by ~ 2 times (the half-width decreases by 60 K). In this case, the shape of the band remains unchanged and is close to Gaussian.

## Conclusion

By analyzing IR and radiothermoluminescence spectra, it is possible to identify the qualitative and quantitative alkaloid composition of P. Harmala with high reliability. The combined and improved IR spectroscopy and radiothermoluminescence method with high resolution that we proposed allowed us to show that P. Harmala contains a sufficient number of alkaloids. Moreover, these alkaloids mainly include harmine, harmaline, peganine and pegadinine. Traces of such rare alkaloids as harmalol and peganole are also found in the seeds and stems of this plant.

The fact that P. Harmala, growing in the Absheron region, has a number of advantages in terms of the content and ratio of alkaloid components over the same plants growing in the Masalli and Ismailli regions, is of particular interest.

Our results that different organs (seeds and stems) of this plant are characterized by different alkaloid content, as well as the fact that these organs differ not only in quantity but also in quality of alkaloids, are in good agreement with the results of various authors obtained for other plants.

The results on the change in IR spectra for gamma-irradiated samples are also of some interest. Since these results, or rather the results on the change in the components of the chemical composition of P. Harmala under the influence of radiation, can find application in medicine, or rather in the production of drugs based on this plant.

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# Planetimizdə biomüxtəliflik və onun qorunması

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**Xülasə**

Biomüxtəliflik həyatımızın və planetimizin həyatının əsas elementidir. Bizi qida, hava, su və yaşamaq üçün lazım olan digər resurslarla təmin edir. Biomüxtəliflik özümüz də daxil olmaqla bir çox canlı orqanizmin yaşadığı ekosistemləri də dəstəkləyir.

Bununla belə, çirklənmə, iqlim dəyişikliyi və təbii mühitin məhv edilməsi kimi müasir insanın hərəkətləri biomüxtəlifliyi təhdid edir. Qlobal ekoloji problemlər fonunda biomüxtəlifliyin qorunması getdikcə daha çox əhəmiyyət kəsb edir.

Təbii sərvətlərin mühüm tərkib hissəsi kimi bioloji müxtəliflik bütün yaşayış mühitlərində, o cümlədən quruda, dənizdə və digər su ekosistemləri və ekoloji komplekslərdə olan canlı orqanizmləri özündə birləşdirir.

**Açar sözlər:** Ekologiya, bioloji müxtəliflik, qoruq, milli park, təbii adidə

## Giriş

### Bioloji müxtəliflik nədir?

Biomüxtəliflik bütün formalarda həyatın müxtəlifliyidir. Dar çərçivədə biomüxtəliflik üç təşkilat səviyyəsində müxtəlifliyə aiddir: genetik müxtəliflik (genlərin müxtəlifliyi və onların variantları -allellər), ekosistemlərdə növlərin müxtəlifliyi və nəhayət, ekosistemlərin özlərinin müxtəlifliyi (Şəkil1).

**Şəkil 1. Canlıların biomüxtəlifliyi**

Təbiətimizi seyrək və çox şaxəsiz təsəvvür etmək çətindir. Bu gün növlərin və ekosistemlərin mövcudluğu üçün təhlükə həmişəkindən daha böyükdür. İnsanların yaratdığı növlərin yox olması həyəcan verici bir sürətlə davam edir, növlərin yox olma səviyyəsi dinozavrların nəsli kəsildikdən sonra 60 milyon il ərzində ən yüksək göstəricidir. BMT-nin himayəsi altında aparılan araşdırmalara görə, yaxın 30 il ərzində mövcud məməli növlərinin təxminən 25%-nin və quş növlərinin təxminən 12%-nin yox olacağı gözlənilir. Bəzi elm adamları hər il bir neçə on minlərlə tropik yağış meşəsi növünün məhv olması səbəbindən məhv olacağına və yaxın gələcəkdə yox olacağına inanırlar.

Məlumdur ki, iqlimin dəyişilməsi biomüxtəlifliyin itirilməsinin başlıca səbəbidir. Alimlər belə hesab edirlər ki, qlobal iqlim dəyişikliyi gələcəkdə yad növlərin yayılması və torpaqdan istifadə edilməsində baş verən dəyişikliklərlə birgə, bəzi növlərin miqrasiya imkanlarını məhdudlaşdıracaq və onların itməsini sürətləndirəcək. İqlimin dəyişilmələri ərzaq, həyat

üçün gəlir və vasitələrin vacib mənbəyi olan daxili su ekosistemlərinə də mənfi təsir göstərir. Belə ki, son 10 ildə dünyada balıqların 20 faizindən çoxu ya itmiş, ya da nadir hesab oluna bilər. Dəniz ekosistemləri də iqlim dəyişilmələrinə qarşı çox həssasdırlar. İqlim dəyişikliyi artıq Arktika xalqlarının həyatına ciddi təsir göstərir, onların balıqçılıqla və ovçuluqla məşğul olmalarına maneçilik törədir. Mal-qara otlaqlarının normadan artıq istifadəsi də torpaqların sıradan çıxması ilə nəticələnir. İqlim dəyişmələri kənd təsərrüfatında da mənfi izlər buraxır, zərərverici və xəstəliklərin yayılmasına şərait yaradır, bitkilərin məhsuldarlığına təsir göstərir. Eyni zamanda, yağıntıların rejiminin dəyişməsi, güclü yağış zamanı torpaqdan faydalı maddələrin daha intensiv yuyulması, küləklərin güclənməsi və daha quru rayonlarda təsadüfi meşə yanğınlarının sayının artması nəticəsində də ətraf aləm ciddi ziyan görür. Sənaye sahələrinin nəzarətsiz fəaliyyəti nəticəsində ətraf mühitə atılan tullantılar və yandırılan kimyəvi məhsullar Yer üzərində və atmosferin aşağı qatında çoxsaylı dəyişikliklər törədir. Alimlər hesablayıblar ki, insan yaranmazdan əvvəl hər min ildə bir canlı orqanizm növü orta hesabla yox olub. Məsələn, iqlim dəyişikliyi və təbii fəlakətlərlə bağlı təbii səbəblərə görə dinozavrların və digər iri kərtənkələlərin nəsli kəsildi. Amma indi növlər əsasən insan fəaliyyəti nəticəsində yox olur [1].

İnsanların təbiətə təsiri, növlərin nəslinin kəsilməsinə gətirib çıxarır, o özünü iki formada göstərir:

- orqanizmlərin birbaşa məhv edilməsi: ov, balıq ovu, ağacların kəsilməsi, buketlərin toplanması, həşərat və mollyuska qabıqlarının toplanması;
- nadir növlərin tipik yaşayış yerlərinin məhv edilməsi: ekosistemlərin çirklənməsi, meşələrin qırılması, çöllərin və çəmənliklərin şumlanması, tikinti.

Növlərin nəsli kəsilmək sürəti durmadan artır, xüsusən 18-ci əsrin sonunda texnoloji inqilabın başlanğıcından bəri sürətlənir. Bir sözlə, iqlimin dəyişilməsi biomüxtəlifliyə təhlükə törədir. Nə qədər acınacaqlı olsa da, XXI əsrin başlanğıcında bəşəriyyət iqlim dəyişiklikləri ilə üzbəüz qalıbdır. Odur ki, yaranmış vəziyyət biomüxtəlifliyin qorunub saxlanılması və davamlı istifadəsinə dair ciddi tədbirlər görülməsini tələb edir.

XX əsrin ortalarından etibarən bioloji müxtəlifliyə və ekosistemlərə təhlükə törədən amillərin sayı artmış, insan fəaliyyəti nəticəsində ekosistemlər deqradasiyaya uğramış, bir çox fauna və flora növləri, cinslər məhv olmuş və ya onların sayı kəskin surətdə azalmağa başlamışdır. Lakin, bəşəriyyətə belə itkilərdən olduqca böyük ziyan dəyir. Yer kürəsinin təbii zənginliyi gündən-günə azalır. Bioloji müxtəliflik təkcə növlərin müxtəlifliyi deyil, o, bütün canlı aləmin yaşayıb inkişaf etməsinə imkan verən əlamətlərin cəmindən ibarətdir. Ona görə də indiki və gələcək nəsillər üçün bioloji müxtəliflik misilsiz milli sərvətdir. Bioloji müxtəlifliyin belə sürətlə itkisi Yer kürəsində həyatın özünü təhlükədə qoymaqla qlobal faciəyə səbəb ola bilər. BMT-nin ekspertlərinin məlumatına görə, Yer kürəsində təbii meşələrin 45%-i əsasən son illərdə qırılaraq məhv edilib, son 400 ldə insanların canlı təbiətə zorakı münasibəti nəticəsində 150-dən çox vəhşi heyvan və quşların nəsli tamamilə kəsilib. Günümüzdə isə 600-dən artıq heyvan növünün nəslinin tamamilə kəsilməsi təhlükəsi var. Yenə də insanların təbiətə nizamsız müdaxiləsi nəticəsində çoxlu sayda qiymətli bitki növləri bərpa edilməsi mümkün olmayan şəkildə məhv edilib. Yer kürəsində bioloji müxtəlifliyin yalnız beynəlxalq əməkdaşlıq yolu ilə xilas etmək mümkünlüyünü nəzərə alaraq Rio-de-Janeyro şəhərində 1992-ci ilin iyun ayında keçirilmiş Yer Zirvə toplantısında ilk dəfə olaraq bioloji müxtəlifliyin qorunması, bütün bəşəriyyətin ümumi vəzifəsi və davamlı inkişafın tərkib hissəsi kimi qəbul olunmuş və müvafiq Konvensiya imzalanmışdır. Bioloji müxtəlifliyin belə itkisi onun qorunub saxlanılması və davamlı istifadəsinə dair ciddi tədbirlərin görülməsini tələb edir. Bioloji Müxtəliflik haqqında Konvensiya qlobal birliyin davamlı inkişaf prinsiplərinə artan sadiqliyini əks etdirir. Bu, bioloji müxtəlifliyin qorunması, onun komponentlərinin davamlı istifadəsi və genetik ehtiyatlardan istifadə nəticəsində yaranan faydaların ədalətli və ədalətli şəkildə bölüşdürülməsi istiqamətində irəliyə doğru atılmış mühüm addımdır.

Son illərdə bioloji müxtəlifliyin problemləri önə çəkilərək bu sahədə xeyli iş görülmüşdür. Belə ki, Ətraf mühitin mühafizəsi üzrə Milli Fəaliyyət Planı, "Ekoloji cəhətdən dayanıqlı sosial-iqtisadi inkişafa dair" Milli Proqram və digər dövlət proqramları qəbul edilərək həyata keçirilir. Bioloji müxtəlifliyin qorunması və davamlı istifadəsi ən mühüm qlobal problem olduğundan onun həlli, Azərbaycan da daxil olmaqla, dünya birliyi ölkələrinin birgə fəal səyi nəticəsində mümkündür. Buna baxmayaraq, biomüxtəlifliyin qorunub saxlanılması ilə bağlı problemlər ölkəmizdən də yan keçməyib.

Bildiyimiz kimi Respublikamız biomüxtəliflik baxımından dünyada zəngin ölkələrdəndir. Ərazilərimizdə faunanın 18 min növü, məməlilərin 97, quşların 357, balıqların 100-ə yaxın, amfibiya və reptiliyaların 67 növ və yarımnövü, həşəratların isə 15 minə yaxın növünü özündə cəmləşdirir. Təbii sərvətlərin ayrılmaz hissəsi olan bioloji müxtəliflik nəhəng, lakin hələ də tam qiymətləndirilməmiş zəngin ehtiyat mənbəyidir. O,

bütün ekosistemləri əhatə

etməklə həyatın mövcudluğunun əsasmı təşkil edir. Azərbaycanın əsas ekoloji problemləri sırasında biomüxtəlifliyin seyrəkləşməsi, meşə ehtiyatlarının, xüsusən də, faunanın azalması mühüm yer tutur. Bu isə öz növbəsində biomüxtəlifliyin qorunub saxlanılmasını zəruri edir. Bu baxımdan Azərbaycanda da ətraf mühitin mühafizəsi və təbii sərvətlərdən səmərəli istifadə olunması problemlərinin həllinə böyük diqqət yetirilir [2].

Azərbaycan Respublikasında bioloji müxtəlifliyin qorunması və davamlı istifadəsinə dair Milli Strategiya və Fəaliyyət Planı (bundan sonra - Milli Strategiya və Fəaliyyət Planı) bioloji müxtəlifliyin qorunması və davamlı istifadəsi sahəsində səmərəli tədbirlərin həyata keçirilməsinə və konkret müsbət nəticələrin əldə edilməsinə yönəldilmişdir.

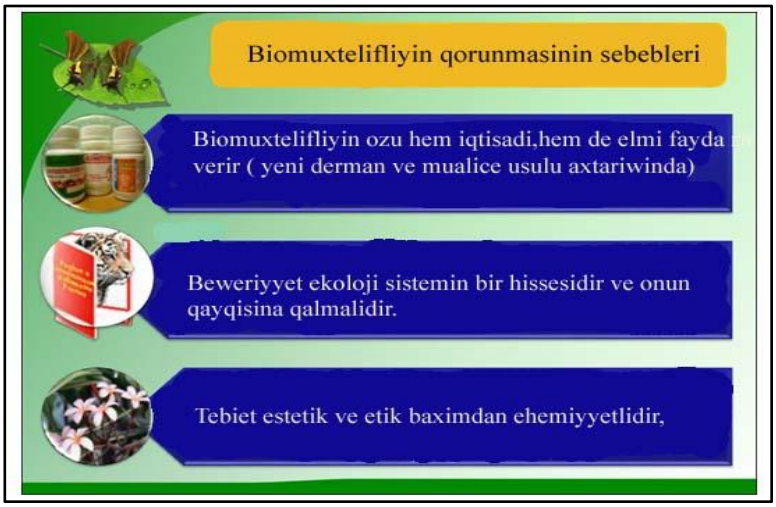
Bioloji müxtəlifliyin qorunması sahəsində beynəlxalq əməkdaşlığı genişləndirmək məqsədilə Azərbaycan Respublikası 2000-ci ildə BMT-nin "Bioloji müxtəliflik haqqında" Konvensiyasına qoşulmuşdur. Bioloji növ müxtəlifliyinin əsas səbəbi regionun geoloji tarixi və müxtəlif iqlim şəraitinin olmasıdır.

## Bioloji müxtəlifliyi qorumaq nə üçün vacibdir?

Biomüxtəlifliyin qorunması vəhşi təbiətin və onun ekosistemlərinin müxtəlifliyini qorumaq məqsədi daşıyan layihədir. Bu layihə təbiətin mühafizəsinə yönəlmiş bir sıra tədbirləri, o cümlədən qoruqların və milli parkların yaradılmasını, ekoloji cəhətdən təmiz turizmin və əhalinin maarifləndirilməsinin inkişafını özündə birləşdirir (şəkil 2.).

## Beynəlxalq ətraf mühit təşkilatları

Təbiətin qorunması və biomüxtəlifliyin qorunması ilə məşğul olan beynəlxalq təşkilatlar var. Belə bir təşkilata misal olaraq Təbiəti və Təbii Sərvətləri Mühafizə üzrə Beynəlxalq Birliyi (IUCN) göstərmək olar. IUCN dünyanın hər yerindən ətraf mühit təşkilatlarını birləşdirən beynəlxalq qeyri-hökumət təşkilatıdır. Biomüxtəlifliyin Qorunması Layihəsi təbiəti və onun ekosistemlərini qorumaq üçün vəsait və resursları yönəltməklə ətraf mühitin qorunmasına kömək edə bilər. Bu layihənin həyata keçirilməsinin bəzi yolları bunlardır: Beynəlxalq Qırmızı Kitabın (IUCN Qırmızı Kitabı) hazırlanmasına cavabdehdir.




**Şəkil 2. Biomüxtəlifliyin qorunması səbəbləri**

1. Qırmızı Kitab nadir və nəsli kəsilməkdə olan heyvan, bitki və göbələk növlərinin hazırkı vəziyyəti haqqında məlumatlarla tamamlanan siyahısıdır. Birdən çox Qırmızı Kitabın olduğunu bilirdinizmi? Əslində, çoxlu Qırmızı müxtəlif səviyyələrdə - dünyanın bütün nadir növlərini mühafizə edən beynəlxalq səviyyədən tutmuş regionlara kimi ayrılır. Ayrı-ayrı ölkələrin və hətta onların daxilində ayrı-ayrı bölgələrin Qırmızı Kitabları var. Bir bölgənin Qırmızı Kitabına daxil edilmiş bir növ başqa bölgədə yayılmış ola bilər. Ancaq canlı dünya sürətlə dəyişir. Buna görə də qorunan növlərin siyahısı daim dəyişir: sayı bərpa edilmiş növlər Qırmızı Kitabın səhifələrindən yoxa çıxır və təhlükə altında olan növlər ona daxil edilir.
2. Qoruqlar bütün təbii kompleksin təbii vəziyyətdə saxlandığı ərazi və ya akvatoriya sahələridir. Qoruğun ərazisində hər hansı insan təsərrüfat fəaliyyəti, o cümlədən ov, meşələrin qırılması, dərman bitkiləri, göbələk və giləmeyvə yığmaq qadağandır və torpaqlar istənilən formada istifadədən həmişəlik çıxarılır.Adətən qoruqlar turistlər üçün bağlıdır. Təbii qoruqların ərazilərində otlaq, ot biçən və balıq ovu kimi ətraf mühitin mühafizəsinin müəyyən növlərinə icazə verilə bilər.
3. Milli parklar ətraf mühitin mühafizəsi məqsədilə

insan fəaliyyətinin məhdudlaşdırıldığı ərazilərdir. Milli parklar adətən geniş ərazilərə malikdir, nadir təbiət obyektləri qorunur. Onların ərazisinin çox hissəsi istirahət və turizm üçün açıqdır, bəzən məhdud iqtisadi fəaliyyətə icazə verilən yaşayış məntəqələri ola bilər (şəkil 3).


**Şəkil 3. Azərbaycan Respublikasında yerləşən Milli Parklar**

4. Təbii parklar müəyyən landşaftları qorumaq üçün yaradılır. Onlar milli parklara nisbətən ziyarət və təsərrüfat fəaliyyəti üçün daha az istifadə ilə xarakterizə olunur. Təbii parklar turistlər tərəfindən aktiv şəkildə ziyarət edilir və onlar üçün tez-tez ekoturizm proqramları təşkil edilir.

5. İctimai maarifləndirmə: İnsanların ətraf mühitin mühafizəsi haqqında maarifləndirilməsi və cəmiyyətdə biomüxtəlifliyin qorunması ilə bağlı məlumatlılığın yaradılması layihənin effektivliyini artırmağa kömək edə bilər. Vahid təbiət hadisəsini qorumaq üçün təbiət abidələri yaradılır. Nəbatat bağları elmi-tədqiqat, tədris və tədris məqsədləri üçün dünyanın müxtəlif yerlərindən və iqlim qurşaqlarından bitki kolleksiyalarının yetişdirildiyi, tədqiq edildiyi və nümayiş etdirildiyi ərazidir [3].

## Biomüxtəlifliyə təhlükə yaradanlar

Yeni torpaqların mənimsənilməsi, təbii sərvətlərdən məqsədyönlü şəkildə istifadə edilməməsi və insan fəaliyyətinin bir çox digər sahələri planetimizin bioloji müxtəlifliyinə geri dönməyən ziyan vurur. Belə amillər çoxdur. Biz sizə onlardan bir neçəsini verəcəyik.

1. Su ehtiyatlarının yenidən bölüşdürülməsi ilə birlikdə torpaqların inkişafı. Səhralaşma güclənir, torpaqlar şoranlaşır və tərk edilir, torpaq pestisidlərlə, ağır metallarla çirklənir. Su elektrik qurğularının tikintisi suyun səviyyəsinin kəskin dəyişməsi və şoranlaşması ilə qeyri-sabit su rejimi ilə nəticələnir.
2. Heyvandarlığın inkişafı. Bu fakt otlaqların idarə edilməsinin və mal-qaranın həddindən artıq otarılmasının, meşələrin qırılmasının, bitki materiallarının tədarükü, brakonyerliyin və istirahətin intensivləşdirilməsini özü ilə gətirir.
4. Biomüxtəlifliyin əhəmiyyəti, biomüxtəlifliyin qorunub saxlanmasının zəruriliyi
5. Biomüxtəlifliyin qorunması üzrə tədbirlər və vəzifələr (Şəkil 4).

**Şəkil 4. Biomüxtəlifliyin qorunub saxlanmasının zəruriliyi**

Ekspertlər biomüxtəlifliyin qorunması sahəsində gələcək fəaliyyət üçün səkkiz prioritet istiqamət müəyyən ediblər.

• torpaqların və meşələrin mühafizəsi, o cümlədən torpağın deqradasiyası ilə mübarizə və meşə ekosistemlərinin bərpası;

• kənd təsərrüfatı təcrübələrində dəyişikliklər – biomüxtəlifliyə mənfi təsirləri minimuma endirməklə yanaşı, məhsuldarlığı artırmaq üçün aqroekoloji yanaşmanın tətbiqi;

• qida sisteminin dəyişdirilməsi, o cümlədən sağlam həyat tərzi və daha çox bitki mənşəli qidalar və daha az ət məhsulları yemək ehtiyacı haqqında məlumatların yayılması;

• dəniz ekosistemlərinin bərpası və akvakulturanın inkişafı;

• şəhərsalmada ekoloji cəhətdən təmiz yanaşmaların tətbiqi və “yaşıl” infrastrukturun yaradılması;

• qalıq yanacaqlardan imtina da daxil olmaqla iqlim dəyişikliyi ilə mübarizə;

• bütün ekosistemlərin ahəngdar qarşılıqlı əlaqəsi prinsipinin tətbiqi;

Biomüxtəlifliyin qorunmasının faydalarını aşağıdakı kimi təsnif etmək olar:

•Dərman. Əsrlər boyu dərmanların böyük əksəriyyəti bitki və heyvanlardan alınan maddələrdən hazırlanırdı. Bioloji xammal bu gün tibbdə öz aktuallığını itirməmişdir.

• İnsanların (və əksər digər orqanizmlərin, heyvanların və göbələklərin) mövcudluğu tamamilə əsas istehsalçıların, yəni bitkilərin fəaliyyətindən asılıdır. Bu gün insanlar qida üçün təxminən beş min bitki növündən istifadə edirlər. Ancaq praktikada əksəriyyəti on iki növdən azdır və bəşəriyyətin böyük bir hissəsi üçün karbohidrat pəhrizində 3-4 növ mədəni bitki üstünlük təşkil edir. Seleksiya zamanı becərilən sortların genofondunun zənginləşdirilməsi üçün yabanı bitkilərin genofondundan istifadə etməklə biomüxtəlifliyin qorunmasından birbaşa fayda əldə etmək olar. Vəhşi əcdadlardan olan genlər mədəni bitkilərin zərərvericilərə və xəstəliklərə qarşı müqavimətini, sortların məhsuldarlığını (məhsuldarlığını) artıra bilər, həmçinin onların müxtəlif ətraf mühit parametrlərinə uyğunlaşma diapazonunu genişləndirə bilər [4].

• Ağac hər yerdə istifadə edilən əsas əmtəədir və onun mənbəyi hələ də vəhşi təbiətdəndir. Tikintidə, mebel istehsalında istifadə olunur, kağız istehsalı üçün əsas xammal kimi xidmət edir, həm də yanacaq kimi istifadə olunur.

• Mümkün iqtisadi qiymətli orqanizmlərin ehtiyatı (gələcək resurslar). Bu gün heç kim biosferdə yaşayan canlı orqanizmlərin növlərinin dəqiq sayını bilmir. Bu günə qədər təxminən 1,7 milyon növ elmə məlumdur, lakin onların planetdəki ümumi sayı 5-30 milyon olaraq qiymətləndirilir. Elm inkişaf etdikcə, canlı orqanizmlərin daha çox yeni taksonları kəşf və təsvir edilərək insanların rifahının yüksəldilməsniə və insan fəaliyyətinə cəlb ediləcək.

• Bir çox bitki növlərindən bəzək məqsədləri üçün geniş istifadə olunur. Hər il yeni hibridlər və sortlar yaradılır və bazara çıxarılır. Tanınmış nümunələrdən biri Grevillea 'Robin Gordon'dur.

• Sudan qorunma. Su hövzələrini əhatə edən təbii bitki örtüyü hidroloji dövranın saxlanılmasına kömək edir, çayların axınını tənzimləyir, onu sabitləşdirir, quraqlıq və daşqınlar zamanı bir növ “su buferi” rolunu oynayır.

• Torpaqların əmələ gəlməsi və mühafizəsi. Torpaqların bioloji müxtəlifliyi saxlamaqla mühafizəsi onların münbitliyini qoruyub saxlamaq, sürüşmənin qarşısını almaq, okeanların, dənizlərin, çayların və göllərin sahillərini eroziyadan, mərcan riflərini isə lillənmədən qoruya bilər.

• İqlim sabitliyinin qorunması. Bitki örtüyü iqlimə makro, mezo və mikro səviyyədə təsir göstərir. Təhlükəsiz meşələr davamlı yağış modelini saxlamağa və yarpaqların buxarlanması, eləcə də hamar külək nümunələri vasitəsilə suyu atmosferə qaytarmağa kömək edə bilər. Digər, daha kiçik miqyasda, bitki örtüyü mikroiqlimə sabitləşdirici təsir göstərir. Bəzi orqanizmlər mövcudluğu üçün belə xüsusi mikroiqlim şəraitini tələb edir.

• Çirkləndiricilərin parçalanması və udulması. Bəzi ekosistemlər, xüsusən də bataqlıq ərazilər çirkləndiriciləri parçalamaq və udmaq üçün xüsusilə qiymətli olan keyfiyyətlərə malikdir. Təbii və texnogen bataqlıqlar axan suları süzmək və qida maddələrini, ağır metalları və asılı bərk maddələri çıxarmaq üçün istifadə olunur.

• Tədqiqat, təhsil və monitorinq. Təbii sahələr tədqiqat üçün əla canlı laboratoriyalar yaradır və çox vaxt canlı orqanizmlər üçün müxtəlif yaşayış yerlərinin toxunulmaz sahələrinə ehtiyac duyulur. Belə ərazilər bu və ya digər ekoloji idarəetmənin həyata keçirildiyi ərazilərlə müqayisə edilən nəzarət sahələri kimi xidmət edir.

• İstirahət. İnsanlar bu cür yerləri təklif etdikləri çoxlu istirahət fəaliyyətlərinə görə qiymətləndirirlər. Burada filmlər çəkə, vəhşi təbiətin fotoşəkillərini çəkə və ya ona həsr olunmuş ədəbi əsərlər yaza bilərsiniz. İnsanları burada orqanizmlərin təbii yaşayış mühiti, müəyyən ərazinin təbii xüsusiyyətləri cəlb edir, burada onlar quşların həyatını müşahidə edə, ekoloji tədqiqatlar apara və digər təhsil maraqlarını həyata keçirə bilərlər (Şəkil 5). Qısaca desək, biomüxtəlifliyin itirilməsi aşağıdakı səbəblərə görə ola bilər:

• ekosistemin sağlamlığı.

• bəşəriyyətin sağlamlığı.

**Şəkil 5. Canlılar arasındakı əlaqənin bərpası**

Biomüxtəlifliyin mühafizəsi sahəsində aşağıdakı vəzifələr nəzərdə tutulur.

İqtisadi-biomüxtəlifliyin ölkənin makroiqtisadi göstəricilərinə daxil edilməsi; biomüxtəliflikdən potensial iqtisadi gəlir, o cümlədən: birbaşa (damazlıq və əczaçılıq üçün dərman və xammal və s.) və dolayı (ekoturizm), həmçinin xərclər-məhv edilmiş biomüxtəlifliyin bərpası. İdarəetmə-dövlət və kommersiya təşkilatlarını, ordu və donanmanı, qeyri-hökumət təşkilatlarını, yerli əhalini və bütün ictimaiyyəti birgə fəaliyyətə cəlb etməklə tərəfdaşlığın yaradılması. Hüquqi – biomüxtəlifliklə bağlı termin və anlayışların bütün müvafiq qanunvericiliyə daxil edilməsi, biomüxtəlifliyin qorunması üçün hüquqi dəstəyin yaradılması. Elmi-qərarların qəbulu prosedurlarının rəsmiləşdirilməsi, biomüxtəliflik göstəricilərinin axtarışı, biomüxtəlifliyin inventarlarının tərtibi, monitorinqin təşkili.

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# Биоразнообразие и его сохранение на нашей планете

***Гейдарова А.В., Фараджова Л.Н. , Гаджиев Т. ,Миргасимова Н.А.***

***Резюме***

Статья посвящена биоразнообразию нашей планеты и его охране. При этом в статье были затронуты причины нарушения биологического разнообразия и указаны пути их решения. В наше время и в ближайшем будущем доказано, что благополучие всех живых существ зависит от стабильности биологического разнообразия.

**Ключевые слова:** Экология, биологическое разнообразие, природный заповедник, национальный парк, природная среда

# Biodiversity and its conservation on our planet

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## Abstract

The article is devoted to the biodiversity of our planet and its protection. At the same time, the article touched upon the causes of violation of biological diversity and indicated ways to solve them. In our time and in the near future, it has been proven that the well-being of all living things depends on the stability of biological diversity.

**Key words:** Ecology, biological diversity, nature reserve, national park, natural environment

# The biological resources and economic efficiency of wild vegetable plants in the Kukuchay basin

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**Abstract**

Kukuchay is one of the largest tributaries of Nakhchivanchay and originates on the southern slope of the Dareliyaz ridge, at an altitude of about 2100 meters above sea level. In terms of flora biodiversity, most representatives of wild vegetable plants differ sharply from other regions in their nutritional characteristics. Studying the stock of these plants and their effective use is one of the important issues. Wild vegetable plants are found in different zones of the region. The studies were conducted based on classical, floristic and systematic methods. Thus, biological, operational and annual reserves of five priority wild plants were calculated. *Allium rotundum* Onion - 294.50 s, *Lathyrus miniatus* - Small lily - 486.54 s, *Mentha longifolia* - Long-leaved mint - 317.6 s, *Ornithogalum ponticum* - Ponti's spurge - 182.38 s, *Urtica dioica* - Stinging nettle - 596.72 s. This makes it possible to supply and process wild vegetable crops for many years. The research found that 27 species of wild vegetable plants belonging to 12 family and 21 genus are sold on the markets as goods. The economic efficiency of priority wild vegetable plants common in the study area was calculated based on the following types of net income from plants: Onion (Allium *rotundum*) - 12934.6 manat, Onion (*Lathyrus miniatus*) - 9231.9 manat, Onion longleaf mint. (*Mentha longifolia*) - 10 463.4 manat, Milk of the Pontic bird (*Ornithogalum ponticum*) - 41 040 manat. and Stinging nettle (*Urtica dioica*) - 22059.4 manat, and the profitability was in the range of 280%-571%.

**Keywords:** Wild vegetable plants; biological stock; productivity; profitability; *Allium rotundum*; *Urtica dioica.*

## Giriş

Küküçay Dərələyəz silsiləsinin cənub yamacından, dəniz səviyyəsindən təxminən 2100 metr yüksəklikdən mənbəyini götürür və Naxçıvançayın ən böyük qollarından biridir. olan Küküçay boyunca eyniadlı kənd-Kükü kəndi yerləşir. Kükü Naxçıvan MR-in ucqar kəndlərindən biridir. Bu kənd öz bənzərsiz və nadir gözəlliyi ilə sanki Tanrı möcüzəsidir. Bu kənd gözəl təbiəti, xüsusən dadlı meyvələri ilə seçilir və geniş turizm potensialına malikdir. Kükünün tarixi çox qədimdir. Daş salnamələr, pirlər və qalalar buna sübutdur. Hər kəs Kükünü həm də “bulaqlar kəndi” kimi tanıyır [1].

Bitki ehtiyatlarını botanikanın ən yeni sahələrindən biri, bitki ehtiyatşünaslığı elmi öyrənir. Botaniki ehtiyatşünaslıq faydalı yabanı bitkilərin tədqiqi sahəsində qədim tarixə malikdir. Bu elm sahəsi sərbəst elm kimi XX əsrin ortalarından formalaşmağa başlamışdır. Bu elm bitkilərdən istifadə etmənin imkan və yollarını, onların faydalı xüsusiyyətlərini araşdıraraq tətbiq sahələrini müəyyənləşdirir. Botaniki ehtiyatşünaslığın tədqiqat obyekti, xüsusi metodları, öz tarixi və gələcək inkişaf yolları vardır.

Bitki ehtiyatşünaslığı və ya başqa sözlə desək, təbii təsərrüfat botanikası geniş mənada izah olunur. Burada dinamik inkişaf nəzəriyyənin açıqlanmasına təkan verir, təcrübə tərəfi isə bitkilərin faydalı xüsusiyyətləri ilə yanaşı, həm də ehtiyatını öyrənir. Bitki ehtiyatşünaslığının nəzəriyyəsi bitki orqanlarında təbii birləşmələrin ətraflı öyrənilməsi, bitkinin həyatında onların rolu, biosintezi və onun ekoloji şəraitlə əlaqəsinin öyrənilməsilə də bağlıdır. Bitki ehtiyatşünaslığının sahələrinin öyrənilməsində bitkilərin introduksiyası öndə olan məsələlərdən biridir. Bitkilərin bütün həyatı boyu ontogenez prosesinin təsviri və inkişaf dövrünün monitorinqi, bitkinin inkişafında orqanların böyümə dinamikasının öyrənilməsi, introduksiya dövründə iqlimləşdirmənin və digər təbii amillərin bitki həyatında rolu, bioloji fəal maddələrin torlanması və dinamikasının öyrənilməsi, toxum və xammal tədarükü, təbii şəraitdə bitən eyni bitki ilə müqayisəli analizi üçün bitkilər introduksiya olunmalıdır. [3]. Yabanı tərəvəz bitkiləri də bitki ehtiyatşünaslığı elminin tədqiqat obyektidir.

Flora biomüxtəlifliyində yabanı tərəvəz bitkilərinin əksər nümayəndələri qida xüsusiyyətləri ilə digər bölgələrdən kəskin fərqlənir. Bu bitkilərin

ehtiyatının öyrənilməsi və onlardan səmərəli şəkildə istifadə olunması vacib məsələlərdən biridir. Yabanı tərəvəz bitkilərinə regionun bütün zonalarında rast gəlir. Aparılan tədqiqatlar nəticəsində 5 növ yabanı tərəvəz bitkisinin təbii ehtiyatı öyrənilmişdir. Ehtiyatı öyrənilən növlər tədqiqat ərazisində geniş yayılmış əmtəə məqsədli növlərdir.

## Materiallar və üsullar

Tədqiqatlar klassik, floristik və sistematik metodlara əsaslanaraq aparılmış [M.M.İlin, [9]; İ.Q.Beydeman, [7], bununla bərabər bir sıra müasir üsullardan da istifadə edilmişdir [15]. Növlərin həyati formaları C.Raunker [18] sistemlərinə əsasən müəyyən edilmişdir. Geobotaniki araşdırmalar A.P.Şennikovun tədqiqatları əsasında [12] və internet saytına [20] görə aparılmışdır. Növlər üzərində fenoloji müşahidələr P.İ.Lapina [12], L.N.Zayko, M.E.Pimenova və B.Y.Maslikov [8] metodikaları ilə aparılmışdır.

## Müzakirə

Yabanı tərəvəz bitkilərinin təbii ehtiyatının müəyyənləşdirilməsi mühüm əhəmiyyət kəsb edir. Bu bitkilərin yeraltı və yerüstü orqanlarının məhsuldarlığı və ehtiyat sıxlığı konkret ərazilərdə məlum metodlarla həyata keçirilmişdir. Belə ki, 4 təkrarda, 8m2 (4x2m) sahədə olan bitkilərin sayı müəyyən edilmiş, eyni zamanda burada onların lahiyə örtüyü də öyrənilmişdir. Tədqiqat sahəsində digər növlərin sayı 15-20 arasıda dəyişmişdir. Lahiyə örtüyündə əsas bitkinin yayılmasına əsasən onun ehtiyat sıxlığı təyin edilir. Yabanı tərəvəz bitkilərinin bioloji ehtiyatı onların sıxlıq ehtiyatı ilə hesablanır. Bitkilərin istismar ehtiyatı bioloji ehtiyatın 50-55%-ni təşkil edir. İllik tədarük isə istismar ehtiyatının 10%-i həcmində götürülmüşdür. Aparılan tədqiqatlar və hesablamalar nəticəsində ərazi florasında geniş yayılmış bir sıra yabanı tərəvəz bitkilərin təbii ehtiyatları müəyyən edilmişdir [4, 5].

**Cədvəl 1. Küküçay hövzəsində geniş yayılmış əmtəə məqsədli yabanı tərəvəz bitkiləri növlərinin bioloji və illik tədarük ehtiyatı**

| № | Növlərin adı | Ümumi ayılma sahəsi (ha) | Ehti yatın sıxlığı ha/ sen. | Təbii ehtiyatı (sen.) | | İllik tədarük ehtiyatı (sen.) |
|---|---|---|---|---|---|---|
| | | | | Bioloji | İstismar | |
| 1. | *Allium rotundum* | 7,2 | 15,63±0,2 | 294,50±23,8 | 147,4±11,9, | 14,7±1,2 |
| 2. | *Lathyrus miniatus* | 9,7 | 2,84±0,2 | 486,54±40,5 | 243,31±20,2,8 | 24,31±2,1 |
| 3. | *Mentha longifolia* | 8,6 | 1,94±0,1 | 317,6±24,8 | 158,5±12,4 | 15,85±1,2 |
| 4. | *Ornithogalum ponticum* | 4,3 | 0,8±0,02 | 182,38±15,6 | 91,2±7,8 | 9,1±0,7 |
| 5. | *Urtica dioica* | 10,7 | 3,1±0,2 | 596,72±48,2 | 298,1±2,3 | 29,81±2,4 |

*Lathyrus miniatus* – Kiçik gülülcə növü dağlıq zonada yayılmışdır. Növün təbii ehtiyatının müəyyənləşdirilməsi 3 məntəqədə aparılmışdır. Məntəqələrdə bitkinin digər bitkilərlə birlikdə ümumi yayılma sahəsi müəyyənləşdirilmişdir. Növün lahiyə örtüyünün 10-15% olduğu təmiz sahə 9 ha təşkil edir. Sahələrin müxtəlif yerlərindən 4x2m-dən üç təkrarda nümunələr götürülərək bir hektar sahədə bitkinin sayı müəyyənləşdirilmişdir. Bir nəzarət nümunənin (n=20) kütləsinə görə bitkinin məntəqələr üzrə bir hektarda ehtiyat sıxlığı, bioloji, istismar və illik ehtiyatı hesablanmışdır. Belə ki, kiçik gülülcənin tədqiqat aparılan ərazilər üzrə cəmi ehtiyat sıxlığı 2,84 s, bioloji ehtiyatı 486,54 s, istismar ehtiyatı 243,31 s və illik tədarük ehtiyatı isə 24,31 s təşkil edir [14].

*Mentha longifolia* - Uzunyarpaq yarpız növü yabanı tərəvəz bitkisi kimi geniş istifadə edilir. Növ orta qurşaqdan yüksək dağlıq qurşağadək yayılmışdır. Bu səbəbdən də müxtəlif hündürlükdə yerləşən məntəqələr seçilmişdir. 4 məntəqədə bitkilərin təbii ehtiyatı hesablanmışdır. Növaltı təmiz sahə 8,6 ha olmuşdur. Bir hektarda bitkilərin, ehtiyat sıxlığı isə 1,94 s təşkil etmişdir. Aparılmış hesablamalarda növün bioloji ehtiyatı 317,6 s, istismar ehtiyatı 158,5 s, illik tədarük ehtiyatı 15,85 s olmuşdur.

*Urtica dioica* –İkievli gicitkən növü orta dağlıq qurşağa qədər yayılmışdır. Bitki əsasən, dincə qoyulmuş və ya yeni əkilmiş sahələrdə bitir. Alaq bitkisi sayılır, lakin qida bitkisi kimi geniş şəkildə istifadə edilir. Qeyd etmək yerinə düşərdi ki, Avropa ölkələrində növ mədəni florada böyük ərazilərdə becərilir. Amma muxtar respublikada bitkinin yabanı florada ehtiyatı kifayət qədər olduğundan bitkini kulturada artırmağa ehtiyac yoxdur. Növün təbii ehtiyatını müəyyənləşdirmək üçün 4 məntəqə seçilmişdir. Növaltı sahə 10,7 ha olmaqla, bir hektarda sıxlıq ehtiyatı 3,1 s olmuşdur. Aparılan hesablamalar nəticəsində ikievli giçitkanın bioloji ehtiyatının 569,72 s, istismar ehtiyatının 298,1 s, illik istismar ehtiyatının isə 29,81 s olduğu müəyyən edilmişdir [6, 16] .

Beləliklə, 5 prioritet yabanı tərəvəz bitkisinin bioloji, istismar və illik tədarük ehtiyatı hesablanmışdır. Növlər üzrə bioloji ehtiyatı

göstəricisi aşağıdakı kimi olmuşdur: *Allium rotundum* Yumru soğan- 294,50 s, *Lathyrus miniatus* – Kiçik gülülcə - 486,54 s, *Mentha longifolia* - Uzunyarpaq yarpız – 317,6 s, *Ornithogalum ponticum* -Ponti quşsüdü – 182,38 s, *Urtica dioica* İkievli gicitkan - 596,72 s. İstismar ehtiyatı bioloji ehtiyatın 50%-ni, bitkilərin illik tədarük ehtiyatı istismar ehtiyatının 10%-ni təşkil edir. Bu isə yabanı tərəvəz bitkilərinin tədarük və emalını uzun illər boyu həyata keçirməyə imkan yaradır.

Yabanı tərəvəz bitkilərinin əmtəə səciyyəsi. Ərzaq təhlükəsizliyi dünyanın qlobal problemlərindən biridir. İnsanların saf və təmiz qidaya ehtiyacı getdikcə daha çox artır. Belə ki, keçid bazar iqtisadiyyatı, qeyri-sağlam məhsul istehlakı rəqabəti bu tələbatı daha da aktuallaşdırır. Cəmiyyət yabanı floranın qida bitkilərindən daha çox istifadə etməyə başlamışdır. Artıq bazarlarda yabanı tərəvəz bitkiləri təzə, duza qoyulmuş və qurudulmuş halda satılır. Yabanı tərəvəz bitkiləri iqtisadiyyatımızda öz mövqelərini getdikcə möhkəmləndirirlər. Bu bitkilərin yeni xüsusiyyətləri - əmtəə xüsusiyyətləri ortaya çıxır [13].

Küküçay fiorasında yayılmış yabanı tərəvəz bitkiləri də əmtəə kimi istifadə olunur. Naxçıvan MR-in iqlim şəraiti kəskin kontinental olduğundan qışı soyuq və uzunmüddətli keçir. Eyni zamanda örtülü sahələrdə və istixanalarda tərəvəz yetişdirmək baha başa gəldiyindən, tərəvəz məhsullarına (göyərti) tələbat artır. Daxili tələbat xarici ölkələrdən gətirilmiş aşağı keyfiyyətli məhsullar hesabına qismən ödənilir. Yerli məhsul aprel, may aylarında bazarlara çıxarılır. Mədəni şəkildə becərilən tərəvəz məhsulları daxili tələbatı ödəmədiyindlən mart ayından başlayaraq bazarlarda yabanı tərəvəz bitkiləri satılmağa başlayır. 2021-20124-ci illərdə ilkin yazdan başlayaraq bölgənin müxtəltf rayonlarında bazarlarda və məhsul yarmakalarında tərəfimizdən müşahidələr aparılmışdır. İlk olaraq bazara cinsilim, şomu, qazayağı çıxarılır. Daha sonra isə körpə cacıq, çiriş, yemlik, çaşır, yarpız, güllücə (quşquyruğu), quşüzümü (mərəçöyürd), gicitkən və s. satılır. Bu məhsullar ticarət şəbəkələrində təzə halda satılır.

Dörderkəkcikli spanaq, qızılı cacıq, qarağat rəvəndi, gövdəsiz çaşırvə s. təzə halda, otvari kəvər, gövdəsiz çaşır, kiçiktoxum at boyanası, çılpaq dorema, yumru soğan duza qoyulmuş, adi əvəlik, yumrukök əvəlik, uzunyarpaq yarpız, ələyəz, qayalıq danaayağı qurudulmuş halda kütləvi surətdə bazarlarda satılır. Aparılan baxış və müşahidələr nəticəsində əmtəə məqsədli yabanı tərəvəz bitkilərinin növ tərkibi müəyyənləşdirilmişdir [10].

**Şəkil 1.Əmtəəlik yabanıtərəvəz bitkiləri**

**Cədvəl 2. Əmtəə xarekterli yabanı tərəvəz bitkilərinin növ tərkibi**

| № | Növlər | | Fəsilələr |
|---|---|---|---|
| | Latınca | Azərbaycanca | |
| 1. | *Spinacia tetrandra* | Dörderkəkcikli spanaq | *Chenopodiaceae* |
| 2. | *Rumex acetosa* | Adi əvəlik | *Polygonaceae* |
| 3. | *R. euxinus* | Yumrukök ə. | |
| 4. | *R. acetosella* | Turşəngvarı ə. | |

| | | | |
|---|---|---|---|
| 5. | *Rheum ribes* | Qarağat rəvəndi | |
| 6. | *Capsella bursa - pastoris* | Çoban çantası | *Brassicaceae* |
| 7. | *Urtica dioica* | İkievli gicitkən | *Urticaceae* |
| 8. | *Lathyrus miniatus* | Kiçik güllücə | *Fabaceae* |
| 9. | *Chaerophyllum aureum* | Qızılı cacıq | *Apiaceae* |
| 10. | *Prangos acaulis* | Gövdəsiz çaşır | |
| 11. | *Cachrys microcarpa* | Kiçiktoxum at boyanası | |
| 12. | *Falcaria vulgaris* | Adi qazayağı | |
| 13. | *Heracleum antasiaticum* | Ön Asiya baldırğanı | |
| 14. | *H. pastinasifolium* | Sürtükyarpaq b. | |
| 15. | *H. trachyloma* | Sərtkənaryarpaq b | |
| 16. | *Dorema glabrum* | Çılpaq dorema | |
| 17. | *Tragopogon.marginatus* | Zehli yemlik | *Asteraceae* |
| 18. | *T. latifolius* | Enliyarpaq y. | |
| 19. | *Achillea tenuifflia* | Nazikyarpaq boymadərən | |
| 20. | *Mentha aquatica* | Su yarpız | |
| 21. | *M longifolia* | Uzunyarpaq y. | |
| 22. | *Eremurus spectabilis* | Görkəmli çiriş | *Asphodelaceae* |
| 23. | *Ornithogalum ponticum* | Ponti quşsüdü laləsi | *Hyacinthaceae* |
| 24. | *Puschkinia scilloides* | Ələyəz | |
| 25. | *Allium rotundum* | Yumru soğan | *Alliaceae* |
| 26. | *Asparagus officinalis* | Dərman quşüzümü | *Asparagaceae* |
| 27. | *Arum rupicola* | Qayalıq danaayağı | *Araceae* |

Cədvəl 2-dən göründiyi kmi bazarlarda əmtəə kimi yabanı tərəvəz bitkilərinin 12 fəsilə, 21 cinsə aid 27 növü satilir. Cinslər üzrə: Rumex-3, Heracleum-3, Tragopogon-2, Mentha-2 qalan cinslərin isə hər biri bir növlə təmsil olunur. Yabanı tərəvəz bitkiləri məhsullarının tədarük və istehlakı kortəbii xarekter daşısa da tələbatın ödənilməsinə müsbət təsir göstərir.

Əmtəə xarekterli yabanı tərəvəz bitkilərinin fəsil-lərində cins və növlərin paylanması müxtəlifdir.

Yabanı tərəvəz bitkiləri bazarlarda müxtəlif əmtəə formalarında (təzə, duza qoyulmuş və qurudulmuş halda) satılır. Bu bitkilərin məhsuları təzə halda mart-may aylarında, duza qoyulmuş və qurudulmuş halda isə demək olar ki, bütün il boyu tədavülə buraxılır [17, 19] .

Duza qoyulmuş və qurudulmuş halda yabanı tərəvəz məhsulları uzun müddət əlavə xərc çəkmədən saxlandığı üçün onlar ticarət dövriyyəsində əsaslı mövqe tuturlar. Belə ki, təzə halda istifadə edilən yabanı tərəvəz bitkiləri məhsullarından fərqli olaraq bu məhsulları saxlamaq üçün soyuduculara ehtiyac yoxdur. Adi şəraitdə ambarlarda saxlamaq mümkündür. Eyni bitki məhsul müxtəlif əmtəə formasında satıla bildiyindən onların çeşidi artır. Bu isə bir məhsulu müxtəlif əmtəə formalarında realizə etməklə daha çox xalis gəlir əldə etməyə imkan verir.

**Cədvəl 3.Yabanı tərəvəz bitkilərinin əmtəə formaları (növlər üzrə)**

| № | Əmtəə məqsədli növlər | Əmtəə formaları | | |
|---|---|---|---|---|
| | | Təzə | Duza qoyulmuş | Qurudulmuş |
| 1. | *Spinacia tetrandra* | + | | |
| 2. | *Rumex acetosa* | + | | + |
| 3. | *R. euxinus* | + | | + |
| 4. | *R.acetosella* | + | | |
| 5. | *Rheum ribes* | + | | |
| 6. | *Capsella bursa - pastoris* | + | | |
| 7. | *Urtica dioica* | + | | |
| 8. | *Lathyrus miniatus* | + | | |
| 9. | *Chaerophyllum aureum* | + | | |
| 10. | *Prangos acaulis* | + | + | |
| 11. | *Cachrys microcarpa* | + | + | |

| | | | | |
|---|---|---|---|---|
| 12. | *Falcaria vulgaris* | + | | + |
| 13. | *Heracleum antasiaticum* | | + | |
| 14. | *H. pastinasifolium* | | + | |
| 15. | *H.trachyloma* | | + | |
| 16. | *Dorema glabrum* | + | + | |
| 17. | *Tragopogon.marginatus* | + | | |
| 18. | *T. latifolius* | + | | |
| 19. | *Achillea tenuifjlia* | + | | |
| 20. | *Mentha aquatica* | + | | + |
| 21. | *M longifolia* | + | | + |
| 22. | *Eremurus spectabilis* | + | | |
| 23. | *Ornithogalum ponticum* | + | | |
| 24. | *Puschkinia scilloides* | | | + |
| 25. | *Allium rotundum* | + | + | |
| 26. | *Asparagus officinalis* | + | | |
| 27. | *Arum rupicola* | | | + |
| Cəmi | | 25 | 7 | 7 |

Cədvəl 3-dən göründüyü kimi əmtəə məqsədli yabanı tərəvəz bitkilərinin 25 növü təzə, 17 növü duza qoyulumüş və 7 növü isə qurudulmuş halda satılır. Bu bitki növlərindən yalnız 11-i təzə, 3-ü duza qoyulmuş və 2-ü isə qurudulmuş halda, 4-ü həm təzə, həm də duza qoyulm uş, 4-ü həm təzə, həm də qurudulmuş halda bazarlarda satılır.

Bu bitkilər heç bir ekoloji tarazlıq gözlənilmədən əhali tərəfindən toplanılaraq tədavülə buraxılır. Bu bitkilərin əmtəə səciyəsi, məhvolma təhlükəsinin qarşısının alınması və ticarət dövriyyəsində davamlılığını möhkəmləndirilməsi ilə əlaqədar əsaslı nəticələr əldə olunmuş və konkret təkliflər verilmişdir.

Yabanı tərəvəz bitkilərinin iqtisadi səmərəliliyi. İnsan cəmiyyətinin inkişafının bütün mərhələlərində məhsul istehsalının neçəyə başa gəldiyi iqtisadiyyatın əsas məsələsi olmuşdur. Cəmiyyətin inkişafının ilk mərhələlərində hər hansı məhsulun istehsalına sərf olunan xərcləri ayrı-ayrı istehsalçılar aşağı salmağa çalışmışlar. Təbii ehtiyatların getdikcə azalması nəinki ayrı-ayrı istehsalçıları, eyni zamanda cəmiyyəti bu və ya digər məhsullrın istehsalının neçəyə başa gəlməsi maraqlandırmışdır. Ən az xərc çəkməklə daha çox məhsul istehsal etməklə istehsalın səmərəliliyini yüksəltmək olar. İstehsalın səmərəliliyi daha az xərc çəkməklə daha çox məhsul tədarük və istehsal etmək, keyfiyyətli məhsul istehsalı üçün ehtiyatlardan mümkün qədər qənaətlə istifadəni təmin etməkdir. İstehsalın səmərəli olması hər şeydən əvvəl, daha ucuz, keyfiyyətli və kəmiyyətcə daha çox məhsul hazırlamaq deməkdir. Müəyyən miqdar məhsul istehsalı üçün nə qədər az maddi vəsait və əmək sərf edilərsə, nə qədər çox və keyfiyyətli məhsul buraxılarsa istehsalın səmərəliliyi də bir o qədər yüksək olar. İstehsalın səmərəliliyi olmadan iqtisadi artımı həyata keçirmək mümkün deyil. Əldə olunan nəticə istehsal xərclərindən nə qədər çox olarsa, iqtisadiyyatın səmərəliliyi də bir o qədər yüksək olar. Göründüyü kimi iqtisadi artımın başlıca meyarı səmərəlilikdir. Səmərəlilik iqtisadiyyatın hərəkətverici qüvvəsidir. İstehsalın səmərəliliyinin yüksəldilməsinin bir neçə amilləri və istiqamətləri vardır. Əsas istiqamətlərdən biri müasir elmi-texniki tərəqqinin nailiyyətlərindən hərtərəfli istifadə etməkdir. İstehsalın səmərəliliyinin yüksəldilməsinə təsir göstərən amillərdən biri tədarük və istehsal sahələri arasında əlaqələrin təkmilləşdirilməsidir. Bir-biri üçün məhsul istehsal edən sahələr arasında optimal nisbət yaradılmalıdır. Tədarük və istehsal edilən məhsul dərhal istehlaka daxil ala bilmir. Onun çeşidlənməsi, qablaşdırılması, nəqliyyat vasitələri ilə daşınması, anbarlara yığılması və orada müəyyən müddət saxlanılması lazımdır. Bu işlərin görülməsinə sərf edilən məsariflərə əlavə tədavül xərcləri deyilir. Bu xərclər də istehsal xərcləri ilə bağlıdır və məhsula çəkilən xərclərə əlavə edilir. Buna görə də insanların getdikcə artan tələbətlarını ödəmək üçün daha çox məhsul istehsal etmək və istehlakın səmərəliliyini təşkil etmək lazımdır. Eyni zamanda təbii ehtiyatlar da məhduddur. Məhdud ehtiyatlarla artan tələbatı ödəmək çox çətindir. Bunun yeganə yolu ehtiyatlardan səmərəli və qənaətlə istifadə etməkdir. İstehlakın səmərəli təşkili tədarük və istehsalın inkişafına təsir göstərən amillərdən biridir. Küküçay florasında yayılmış yabanı tərəvəz bitkilərindən 27 növü bazarlarda satışa çıxarılır. Bu bitkilərin tədarükü və satışını planlı şəkildə təşkil etməklə yüksək iqtisadi səmərə əldə etmək mümkündür. Bunun üçün ilk növbədə bitkilərin təbii ehtiyatını müəyyən etmək lazımdır. Aparılan tədqiqatlar nəticəsində 5 proritet bitkinin bioloji, istismar və illik tədarük ehtiyatı öyrənilmişdir. İstismar ehtiyatı hesablanmış bitkilərin satış qiymətləri aparılan müşahidələr zamanı müəyyən edilmişdir. Yabanı tərəvəz bitkiləri məhsullarının bir kiloqramının ilkin satış qiyməti 3-2,5 manat

təşkil edir. Məhsullar bollaşdıqca və çeşid artdıqca satış qiyməti 2-0,5 manat arasında dəyişir [2].

**Cədvəl 4. Yabanı tərəvəz bitkilərinin iqtisadi səmərəliliyi**

| № | Bitkilər | Cəmi məhsul (sentnerlə) | Bir sentner məhsulun satış qiyməti (manatla) | Ümumi gəlir (manatla) | Bir sen. çəkiləən xərc | Ümumi xərc (manatla) | Xalis gəlir (manatla) | Rentabellik (%-lə) |
|---|---|---|---|---|---|---|---|---|
| 1 | *Allium rotundum* | 147,4 | 110 | 16177,4 | 22 | 3242,4 | 12934,6 | 498,9 |
| 2 | *Lathyrus miniatus* | 243,3 | 50 | 12151,5 | 12 | 2919,6 | 9231,9 | 416,2 |
| 3 | *Mentha longifolia* | 158,5 | 80 | 12682,4 | 14 | 2219,0 | 10463,4 | 571,53 |
| 4 | *Ornithoga-lum ponticum* | 91,2 | 70 | 6384,0 | 25 | 2280,0 | 4104 | 280,0 |
| 5 | *Urtica dioica* | 298,1 | 90 | 26829,0 | 16 | 4769,6 | 22059,4 | 562,5 |

Bitki məhsullarının satış qiymətləri ilk yazda yüksək, məhsul bollaşdıqca isə aşağı olur. Hesablamalar zamanı orta qiymət götürülür. İqtisadi səmərəliliyin əsas elementlərindən biri də məhsulun maya dəyəridir. Məhsulun tədarükünə nə qədər az xərc çəkilərsə, xalis gəlir də bir o qədər çox olar. Lakin mədəni şəkildə becəərilən bitkilərdən fərqli olaraq yabanı faydalı bitkilərdə toxuma, şum işlərinə aqrotexniki qulluq edilməsinə, suvarılmaya, xərc çəkilmir, yalnız nəqliyyat xərcləri sərf olunur.

Bitki məhsulları əllə toplandığından bir adam-günə 15-25(35) kiloqram təzə məhsul tədarük etmək mümkündür. Tədarük edilmiş məhsulların nəqliyyat və tara xərcləri bir sentener məhsulun satış qiymətinin 15-20 %-ni təşkil edir [8]. İqtisadi səmərəliliyin hesablanması zamanı bitkilərin istismar ehtiyatına dair göstəricilərdən istifadə edilmişdir. Beləliklə, istismar ehtiyatları üzrə iqtisadi səmərəliliyi hesablanmış bitkilərdən əldə oluna biləcək xalis gəlir növlər üzrə aşağıdakı kimi olmuşdur: Yumru soğan (*Allium rotundum*) – 12934,6 manat, Kiçik gülülcə (*Lathyrus miniatus*) – 9231,9 manat, Uzunyarpaq yarpız (*Mentha longifolia*) – 10463,4 manat, Ponti quşsüdü (*Ornithogalum ponticum*) – 41040 manat. və İkievli gicitkan (*Urtica dioica*) – 22059,4 manat, Rentabellik isə 280 % - 571% aralığında olmuşdur.

## Nəticələr

Beləliklə, Küküçay hövzəsində 5 prioritet yabanı tərəvəz bitkisinin növlər üzrə bioloji ehtiyatı göstəricisi aşağıdakı kimi olmuşdur: *Allium rotundum* Yumru soğan- 294,50 s, *Lathyrus miniatus* – Kiçik gülülcə - 486,54 s, *Mentha longifolia* - Uzunyarpaq yarpız – 317,6 s, *Ornithogalum ponticum* -Ponti quşsüdü – 182,38 s, *Urtica dioica* İkievli gicitkan - 596,72 s. Bu isə yabanı tərəvəz bitkilərinin tədarük və emalını uzun illər boyu həyata keçirməyə imkan yaradır.

Tədqiqat ərazisində yayılmış prioritet yabanı tərəvəz bitkilərini istismar ehtiyatları üzrə iqtisadi səmərəliliyi hesablanmış və rentabellik səviyyəsi.280 % - 571% aralığında olmuşdur.

Əmtəə məqsədli yabanı tərəvəz bitkilərinin tədarükünü həyata keçirmək üçün ehtiyatı bol olan ərazilərdə mini sexlərin, istehlakı üçün isə şəhərlərdə və sanatoriya-turizm bazalarında kiçik market və milli mətbəxlərin yaradılması məqsədəuyğundur.

Daxili və xarici tələbatı ödəmək və ticarət dövriyyəsini möhkəmləndirmək üçün əmtəə məqsədli yabanı tərəvəz bitki növlərinin mədəni florada introduksiyası və çoxaldılmasını həyata keçirmək məqsədəmüvafiqdir.

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# Küküçay hövzəsinin yabanı tərəvəz bitkilərinin bioloji ehtiyatı və iqtisadi səmərəliliyi

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**Xülasə**

Küküçay Naxçıvançayın ən böyük qollarından biri, olub, mənbəyini dəniz səviyyəsindən təxminən 2100 metr yüksəklikdən, Dərələyəz silsiləsinin cənub yamacından götürür. Flora biomüxtəlifliyində yabanı tərəvəz bitkilərinin əksər nümayəndələri qida xüsusiyyətləri ilə digər bölgələrdən kəskin fərqlənir. Bu bitkilərin ehtiyatının öyrənilməsi və onlardan səmərəli şəkildə istifadə olunması vacib məsələlərdən biridir. Yabanı tərəvəz bitkilərinə regionun müxtəlif zonalarında rast gəlir. Tədqiqatlar klassik, floristik və sistematik metodlara əsaslanaraq aparılmışdər. Beləliklə, 5 prioritet yabanı tərəvəz bitkisinin bioloji, istismar və illik tədarük ehtiyatı hesablanmışdır. *Allium rotundum* Yumru soğan- 294,50 s, *Lathyrus miniatus* – Kiçik gülülcə - 486,54 s, *Mentha longifolia* - Uzunyarpaq yarpız – 317,6 s, *Ornithogalum ponticum* -Ponti quşsüdü – 182,38 s, *Urtica dioica* İkievli gicitkan - 596,72 s.Bu isə yabanı tərəvəz bitkilərinin tədarük və emalını uzun illər boyu həyata keçirməyə imkan yaradır. Tədqiqtlar zamanı müəyyən edilmişdir ki, bazarlarda ərazinin əmtəə kimi yabanı tərəvəz bitkilərinin 12 fəsilə, 21 cinsə aid 27 növü satilir. Tədqiqat ərazisində yayılmış prioritet yabanı tərəvəz bitkilərini istismar ehtiyatları üzrə iqtisadi səmərəliliyi hesablanmış bitkilərdən əldə oluna biləcək xalis gəlir növlər üzrə aşağıdakı kimi olmuşdur: Yumru soğan (*Allium rotundum*) – 12934,6 manat, Kiçik gülülcə (*Lathyrus miniatus*) – 9231,9 manat, Uzunyarpaq yarpız (*Mentha longifolia*) – 10463,4 manat, Ponti quşsüdü (*Ornithogalum ponticum*) – 41040 manat. və İkievli gicitkan (*Urtica dioica*) – 22059,4 manat, Rentabellik isə 280 % - 571% aralığında olmuşdur.

**Açar sözlər:** Yabanı tərəvəz bitkiləri, bioloji ehtiyat, məhsuldarlıq, rentabellik, *Allium rotundum*; *Urtica dioica.*

# Azərbaycanda müharibənin floraya mənfi təsiri

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**Xülasə**

Aparılan araşdırmalara əsasən qədim dövrlərdə baş vermiş müharibələr planetimizin ekosisteminə o qədər də mənfi təsir etməyib. Lakin sonrakı müharibələr təbiətə, ətraf mühitə amansız divanlar tutub, hesablamalara görə, son 600 ildə dünyada 14 min 513 müharibə baş verib. Belə ki, müharibə vaxtı təkcə canlı qüvvə deyil, bir çox flora və fauna növləri məhv olur. Müharibə aparılması vasitələri inkişaf etdikcə isə təbiətə daha ciddi və daha geniş sahədə təsir göstərir.

Qeyd edək ki, 30 ilə yaxın Azərbaycanın 17,3 min km$^2$-lik bir ərazisi işğal altın olduğundan, həmin ərazilərdə 40 faiz mineral sularımız, 23,8 faiz meşə fondu (247,352 hektar meşə sahəsi), 152 dövlət təbiət abidəsi, 13197,5 hektarlıq qiymətli meşə sahəsi, 5 ədəd geoloji obyekt, 155 növ faydalı qazıntı yatağı ermənilər tərəfindən vəhşicəsinə istismar edilib.

Aparılan müharibə vəziyyəti, sərhəd bölgəsində səngərlərin qazılması, hərbi-texniki qurğuların yerləşdirilməsi Naxçıvan Muxtar Respublikasında da eyni effekti yaradır. Belə ki, regionun xüsusilə dağlıq zonasında nadir, endemik, relikt ağaclar, kollar erməni işğalçıları tərəfindən kəsilir.

İndi 1992-2020-cu ilə qədər olan dövrdə ermənilər tərəfindən təbiətimizə vurulan ziyanla bağlı yeni bir hesabatın hazırlanaraq ictimaiyyətə təqdim olunması ən vacib məsələ olmalıdır. Burada əsas məqsəd tarixi faktları bir yerə toplamaqla ermənilərin xalqımızın başına gətirdiyi müsibətləri, təbiətimizə vurduğu zərərləri dünya ictimaiyyətinin diqqətinə çatdırmaqdır.

**Acar sözlər:** Ekoloji terror, meşə fondu, endemik ağaclar, relikt ağaclar

Dünya əhalisinin istifadə etdiyi qida məhsullarının 80%-i, insanların tənəffüs etdiyi oksigenin isə 95% bitkilər aləmi tərəfindən ödənilir ki, bu da bitki sağlamlığının və ehtiyyatının qorunmasının zəruriliyinin ifadəsidir. Planetin çirklənməsinə, ekologiyanın korlanmasına müharibələr, hərbi təlimlər, sınaqlar daha çox mənfi təsir göstərir. Mütəxəssislərin fikrincə, qədim dövrlərdə baş vermiş müharibələr planetimizin ekosisteminə o qədər də mənfi təsir etməyib. Lakin sonrakı müharibələr təbiətə, ətraf mühitə amansız divanlar tutub, hesablamalara görə, son 600 ildə dünyada 14 min 513 müharibə baş verib. Belə ki, müharibə vaxtı təkcə canlı qüvvə deyil, bir çox flora və fauna növləri məhv olur. Müharibə aparılması vasitələri inkişaf etdikcə isə təbiətə daha ciddi və daha geniş sahədə təsir göstərir.

Torpaqlarımızın 30 ilə yaxın bir müddətdə mənfur ermənilərin işğal altında saxlaması, təbii resursların talanması və digər cinayət əməlləri ilə yanaşı, həmin ərazilərdə fauna və floraya külli miqdarda ziyan vurmasına, nadir növlərin məhv olmasına gətirib çıxarıb. Çünki Erməni işğalçılarının tək xalqımıza qarşı deyil, təbiətimizə və təbii sərvətlərimizə qarşı da böyük terrorçuluq siyasəti həyata keçirmələri onların necə qəddar millət olduğunu bir daha sübut edir. Artıq 30 ilə yaxındır ki, ermənilər işğal etdikləri torpaqlarımızda ətraf mühitə, fauna və floraya çox ciddi yaralar vurmaqdadırlar. Onlar gec-tez Azərbaycan torpaqlarından çıxarılacaqlarını yaxşı bildiklərindən təbii sərvətlərimizdən mümkün qədər çox gəlir əldə etməyə, varlanmağa çalışırlar.

Təəssüflə qeyd etməliyik ki, işğal olunmuş ərazilərimizdə yanğınların törədilməsi, meşələrimizin qırılması, çaylarımızın zərərli maddələrlə hədsiz çirkləndirilməsi, yeraltı və yerüstü təbii sərvətlərimizin talan edilməsi

nəticəsində günbəgün ölkəmizə vurulan zərərin miqdarı artmaqdadır. Bunda bəzi xarici şirkətlərin də rolu az deyil.

Qeyd edək ki, 30 ilə yaxın Azərbaycanın 17,3 min km$^2$-lik bir ərazisi işğal altın olduğundan, həmin ərazilərdə 40 faiz mineral sularımız, 23,8 faiz meşə fondu (247,352 hektar meşə sahəsi), 152 dövlət təbiət abidəsi, 13197,5 hektarlıq qiymətli meşə sahəsi, 5 ədəd geoloji obyekt, 155 növ faydalı qazıntı yatağı ermənilər tərəfindən vəhşicəsinə istismar edilib.

İşğal nəticəsində ölkəmizə dəyən ən böyük zərərlərdən biri də meşələrimizin kütləvi şəkildə qırılmasıdır. Çoxillik yaşı olan nadir ağac növləri qazanc götürmək məqsədilə məhv edilir. Bir fakta diqqət yetirmək lazımdır ki, son illər ərzində Ermənistan Qərb ölkələrinin şirkətlərinin köməyi ilə meşəçilik sahəsində öz istehsalını 10 dəfə artırıb. Aydındır ki, onlar buna Azərbaycan meşələrinin qırılması hesabına nail olublar.

Son məlumatlara görə, Qarabağ bölgəsində erməni işğalı altında qalan 269 min hektar meşə sahəsi qəddarcasına qırılıb, həmin ərazilərdə nadir bitki və heyvanat aləmi məhv edilib. Qubadlı və Laçın rayonlarında qırmızı palıdların, Kəlbəcərdəki “Ayı fındığı meşələri”nin yerində boş ərazi qalıb. Xatırladaq ki, işğal altındakı ərazilərimizdə 247 min 352 ha meşə sahəsi qalıb ki, bu da Ermənistanın bütün meşələrinin 55 faizindən çoxdur. Bu meşələrdə 152 ağac növü, 13 min 200 hektara yaxın qiymətli meşə sahəsi mövcud idi. Yanğınlar zamanı həmin ərazilərin faunası və florası kütləvi surətdə məhv edilib. Həmin ərazilərdə məskunlaşmış müxtəlif növ heyvan və quşlar öz yuvalarından didərgin düşüblər. Bu isə o deməkdir ki, müharibə yalnız insanları deyil, digər canlıları da məcburi köçkün vəziyyətinə salır.

Ermənilərin təbiətimizə vurduğu ciddi zərərlərdən biri də 1999-cu ildən başlayaraq işğal olunmuş ərazilərdə və həmin ərazilərə yaxın olan torpaqlarımızda yanğınların törədilməsidir. Yanğınlar nəticəsində həm torpaq qatı, həm də fauna və flora növləri məhv edilir. Mənfur qonşularımız 2006-cı ildə 63414 hektar, 2007-ci mildə 31097 hektar, 2008-ci ildə 380 hektar, 2009-cu ildə 250 hektar ərazi ermənilər tərəfindən yandırılıb. Təkcə Füzuli rayonunun təxminən 15.000 hektar sahəsində yanğınların törədildiyi qeydə alınıb. 2010-cu ildə ermənilər iki yanğın törədiblər. Birinci yanğın iyunun 15-də Tərtər rayonunun Şıxarxı kəndi ərazisində baş verib. İkinci yanğın isə iyulun 3-də yenə də Tərtər rayonunda törədilib. Nəticədə rayonun Çaylı və Şıxarxı kəndlərində ümumilikdə 1000 ha ərazi tamamilə yanaraq külə dönüb.

Emənistan silahlı qüvvələri humanitar atəşkəs rejimini kobudcasına pozaraq 28 oktyabr 2020–ci il tarixdə döyüş zonasından kənarda yerləşməsinə baxmayaraq, Göygöl rayonunun ağır artilleriya qurğularının və raketlərinin atəşlərinə məruz qalması nəticəsində meşəlik ərazidə yanğın baş verib. Bununlada ermənilərin ölkəmizə qarşı həyata keçirdiyi ekoloji terror siyasətinin necə böyük həddə çatdığını daha aydın görürük. Baş verən yanğınlar nəticəsində Azərbaycana milyon dollarlarla ziyan dəyib və yeni yanğınların törədilməsi ilə bu rəqəm artmaqda davam edir.

Elmi araşdırmalara görə, bir tank tırtılının səsindən 50-100 metr məsafədə kollarının 70-i, kiçik çay yataqlarından 2-si, bulaqlardan 5-i, davamlı immunitetli ağaclardan 20-si quruyub məhv olur. Havadan atılan kiçik ölçülü bombaların təsiri ilə ətraf mühitin normal iqlim şəraiti 16 gündə pozulur, bir hərbi vertolyotun atdığı mərmilərin nəticəsində həmin ərazinin torpaq qatı çat verir və həmin qat bir daha bərpa olunmur, yağış yağarsa 15, yağmazsa 9 gün sonra mərmi düşən zolaq “ölü zona”ya çevrilir, 30 il o yerlərdə heç nə bitmir, ətrafdakı yaşayış məntəqələrində “vərəm sindromu” 2,5 dəfə artır. Bu isə o deməkdir ki, silahlar təbiəti də insan kimi həmişə “qorxu” içində saxlayır. Onu da qeyd edək ki, saydıqlarımız müharibənin ekologiyaya vura biləcəyi zərərlərin cüzi bir hissəsidir. Lokal müharibələr zamanı bir sıra mühafizə olunan təbii ərazilər hərbi əməliyyatların bir hissəsinə çevrilir, nəticədə onların fəaliyyəti pozulur, planetin bioloji və mədəni müxtəlifliyi azalır, həm də ətraf mühitin məhvinə, yaralanmasına gətirib çıxarır. Qeyd etdiklərimiz yalnız quru üçün deyil, su hövzələrinə və çaylara da aiddir.

Ekoloji terror siyasəti zəngin bitki örtüyü və flora biomüxtəlifliyi ilə Qafqazın digər regionlarından kəskin fərqlənən Azərbaycan Respublikasının ayrılmaz tərkib hissisi olan Naxçıvan Muxtar Respublikasından da yan ötməyib. Kiçik Qafqazın cənub-qərb hissəsində yerləşən Naxçıvan MR-in sahəsi 5363 km$^2$, sərhəd xəttinin ümumi uzunluğu isə 398 km olub, cənubdan və qərbdən İran və Türkiyə ilə həmsərhəddir. İranla 163 km-lik, həmçinin Türkiyə ilə 11 km-lik sərhəd xətti Arazçayı boyunca keçir. Muxtar Respublikanın 224 km-lik sərhəd xətti isə Dərələyəz və Zəngəzur dağlarının suayrıcısı boyunca Ermənistanladır.

Aparılan müharibə vəziyyəti, sərhəd bölgəsində səngərlərin qazılması, hərbi-texniki qurğuların yerləşdirilməsi muxtar respublikada da eyni effekti yaradır. Belə ki, regionun xüsusilə dağlıq zonasında nadir, endemik, relikt ağaclar, kollar erməni işğalçıları tərəfindən kəsilir, gəvənliklər, otluqlar yandırılır, qədim dövrlərin yadigarı olan seyrək arid meşəliklərini əmələ gətirən qiymətli Ağıriyli ardıc, Hündür ardıc, Adi ardıc və Əyilən tozağacı növləri

məhv edilir. Hərbiçilərimiz tərəfindən ərazimizin alp və subalp zonalarında səngərlərin qazılması, hərbi texniki qurğuların yerləşdirilməsi, yolların çəkilməsi həyati vacib məsələlər olsa da belə, yenə həmin zonalarda eroziya prosesi güclənir, torpaq strukturu pozulur. Nəticədə bütöv bitki kompleksi dəyişir, o cümlədən də zəhərli və zərərli bitkilərin yaşam tərzi pozulur. Heyvanlar tərəfindən yeyilməyən və insanların istifadə etmədiyi zəhərli və zərərli bitkilər faydalı bitkilərə nisbətən, iqlimin əlverişsiz şəraitinə daha tez uyğunlaşır və eyni zamanda külli miqdarda toxum verərək yeni yaşayış ərazilərini zəbt edir. Zərərli bitkilərin fon yaradaraq (qanqallıqlar, yovşanlıqlar, gicitkanlıqlar, cil və qamışlıqlar) zəhərli bitkilərin inkişafına stimul verir. Bu isə heyvandarlıq təsərrüfatının inkişaf etdirilməsi ilə əlaqədar yay və qış otlaqlarından normadan artıq və intensiv istifadə olunmasına gətirib çıxarır. Güclü ekoloji və antropogen amillərin birbaşa və ya dolayı yolla təsiri torpaqların səhralaşma meylini artırır, bitkilərin botaniki tərkibinin pisləşməsinə və məhsuldarlığın azalmasına səbəb olur(2.s. 42- 48).

Azərbaycanın işğal altında olan ərazilərində təbii abidələrə və təbiətə qarşı erməni vəhşiliklərinin son həddə çatması, Ermənilərin təbiətimizə qarşı terrorçuluq siyasətinin bariz nümunəsidir. Azərbaycan təbiətinə dəyən zərər onilliklər ərzində bərpa olunmayacaq. İşğal olunmuş ərazilərdə torpağın münbit qatı məhv edilib, flora və faunamız ciddi itkilər verib. Bir çox bitki və heyvan növləri müasir silahlı erməni quldurları tərəfindən tamamilə məhv edilib və yaxud məhv olmaq təhlükəsi ilə üzləşib. Azərbaycanın yüz illər boyu ekoloji tarazlıq naminə qoruyub bəslədiyi meşə örtüyü, habelə qiymətli, nadir ağaclardan ibarət yaşıllıq zolaqları qəddarlıqla məhv edilib. Azərbaycan hidrobioloji mühiti zəhərlənib və ekoloji böhran həddinə çatıb. Planetin mühafizəsində duran 300-dən çox beynəlxalq konvensiya müddəaları aşkar kobudluqla pozulub.

İndi 1992-2020-cu ilə qədər olan dövrdə ermənilər tərəfindən təbiətimizə vurulan ziyanla bağlı yeni bir hesabatın hazırlanaraq ictimaiyyətə təqdim olunması ən vacib məsələ olmalıdır. Burada əsas məqsəd tarixi faktları bir yerə toplamaqla ermənilərin xalqımızın başına gətirdiyi müsibətləri, təbiətimizə vurduğu zərərləri dünya ictimaiyyətinin diqqətinə çatdırmaqdır(2.s. 42- 48).

Qeyri-qanuni qurum olan Dağlıq Qarabağ işğal olunmuş ərazilərdə ekoloji şəraitin qorunması haqqında beynəlxalq təşkilatlar qarşısında heç bir məsuliyyət daşımadığına görə bu ərazilərdə ekoloji mühit getdikcə daha da ağırlaşıb. Mən inanıram ki, tezliklə Ali Baş Komandan İlham Əliyevin apardığı düzgün siyasətlə, rəşadətli ordumuzun şanlı zəfərinin şahidi olacağıq. Qələbədən sonra işğaldan azad olunan ərazilərin ekologiyasının yaxşılaşdırılması, vurulan ziyanın bərpası, işğalçı tərəfin hesabına aparılmalıdır. Özü də uzun illər boyunca, böyük miqdarda ödənilməsi tələb olunmalıdır.

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# Влияние войны на флору Азербайджана


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**Резюме**

Согласно исследованиям, войны, имевшие место в древности, не оказали негативного влияния на экосистему нашей планеты. Однако последующие войны нанесли жестокий урон природе и окружающей среде, и, по оценкам, за последние 600 лет в мире произошло 14 513 войн. Так, во время войны уничтожается не только живая сила, но и многие виды флоры и фауны. По мере развития средств ведения войны они воздействуют на природу все более серьезно и в более широкой области.

Следует отметить, что почти 30 лет под оккупацией находилась территория Азербайджана площадью 17,3 тыс. км2, 40 процентов наших минеральных вод, 23,8 процента нашего лесного фонда (247 352 га лесной площади), 152 государственных памятника природы, Армяне зверски эксплуатировали 13 197,5 га ценных лесных массивов, 5 геологических объектов, 155 видов месторождений полезных ископаемы

Текущее состояние войны, рытье траншей в приграничной зоне, размещение военной техники создают такой же эффект в Нахчыванской Автономной Республике. Так, особенно в горной зоне области армянскими

захватчиками вырубаются редкие, эндемичные, реликтовые деревья и кустарники

Теперь самым важным вопросом должно стать подготовка и представление общественности нового доклада о вреде, нанесенном армянами нашей природе в период с 1992 по 2020 годы. Здесь главная цель – собрать исторические факты и довести до сведения мировой общественности беды, которые армяне принесли нашему народу, и вред, который они нанесли нашей природе

**Ключевые слова:** Экологический терроризм, лесной фонд, эндемичные деревья, реликтовые деревья.

# Impact of the war on Azerbaijan flora

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## Abstract

According to the studies, the wars that took place in ancient times did not have a negative impact on the ecosystem of our planet. However, subsequent wars took a cruel toll on nature and the environment, and according to estimates, 14,513 wars took place in the world in the last 600 years. So, during the war, not only manpower, but also many types of flora and fauna are destroyed. As the means of warfare develops, it affects nature more seriously and in a wider area.

İt should be noted that for nearly 30 years, an area of 17.3 thousand km2 of Azerbaijan was under occupation, 40 percent of our mineral waters, 23.8 percent of our forest fund (247,352 hectares of forest area), 152 state natural monuments, 13,197.5 hectares of valuable forest area, 5 geological objects, 155 types of mineral deposits were brutally exploited by Armenians.

The current state of war, the digging of trenches in the border region, and the deployment of military-technical facilities create the same effect in the Nakhchivan Autonomous Republic. So, especially in the mountainous zone of the region, rare, endemic, relict trees and bushes are cut down by the Armenian invaders.

Now, the most important issue should be to prepare and present to the public a new report on the damage caused by Armenians to our nature in the period from 1992 to 2020. Here, the main goal is to collect the historical facts and bring to the attention of the world community the misfortunes Armenians have brought to our people and the damage they have caused to our nature.

**Keywords**: Ecological terrorism, forest fund, endemic trees, relict trees

# Stratigraphic Evaluation of Petrographic Indicators in Shamakhi-Gobustan Area

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**Abstract**

In the article, the lithological and petrographic data of chalk sediments in Shamakhi-Gobustan NQR region are mentioned. Also, stratigraphic divisions were made based on the studied sections. According to the obtained data, it can be said that it confirms the diversity of the geodynamic situation in that area.

**Key words:** chalk sediments, petrography, carbonate rocks, geological sections.

The study area is geographically located in the middle mountainous part of the southeastern foothills of the Greater Caucasus. The most prominent elements of the orographic structure of Shamakhi-Gobustan lowland are plateaus (Gurjuvan, Shamakhi, Meraza) and low ridges (Meysari) in the west (from Girdmanchay to Meraza).

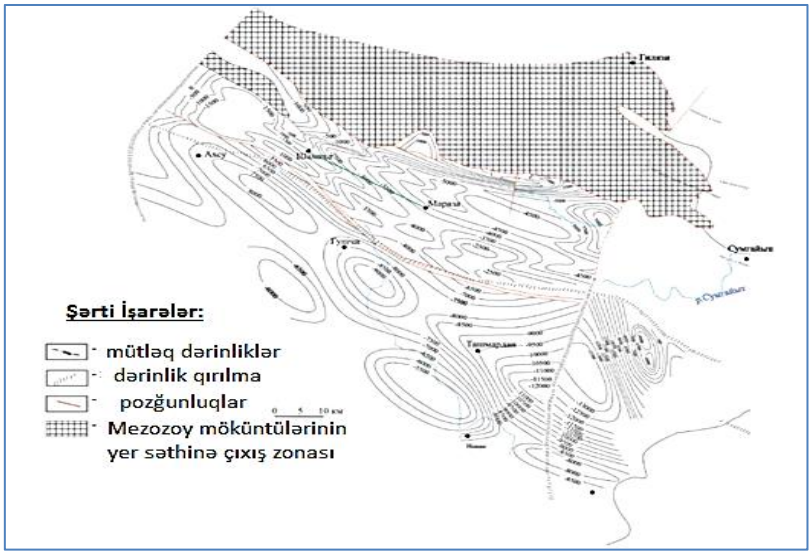
The formation of the modern relief in Shamakhi-Gobustan territory is closely related to tectonic, lithological, neotectonic, accumulation processes as well as denudation factors and physical-geological phenomena.

All sediments from the Middle Jurassic (Bayos floor) to the Quaternary are involved in the geological section of the Gobustan area.

The Shamakhi-Gobustan oil and gas region also allows us to draw some conclusions based on the study of the Cretaceous sediments.

The changes that occurred in the northern part of the ceiling of the Cretaceous sedimentary complex from 0 m and up to 13 km in the southeastern part have attracted great attention (Fig. 1).

**Figure 1.** Structural map of Shamakhi-Gobustan region according to Mesozoic ceiling




Based on the data, the study of the mineral composition, as well as the composition of some minerals, the Cretaceous sediments are divided into upper and lower parts (photo 2).

Magnetite, ilmenite, granite, zircon The upper part of the chalk is separated from the lower part (photo 2). Staurolite, picotite, titanium, glauconite are completely absent from neocoma.

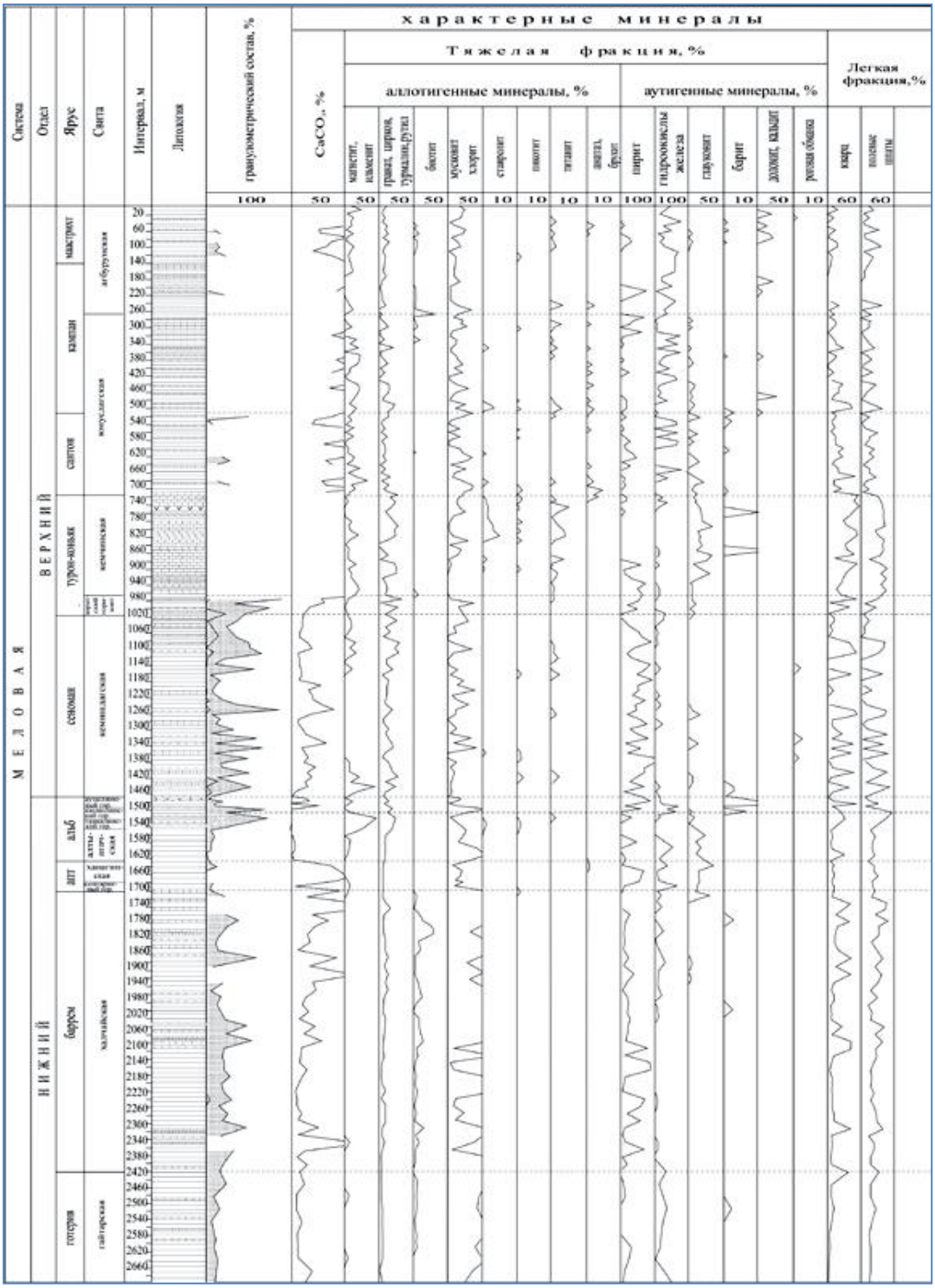



**Figure 2.** Lithological and petrographic characteristics of the Cretaceous sediments of the northern part of Shamakhi-Gobustan NQR region.

Glauconite occurs in the apt section and is very thick. Aptian sediments are distinguished from other sub-sediments by their petrographic composition. The lowest quartz and feldspar contents are noted here (Figure 3).

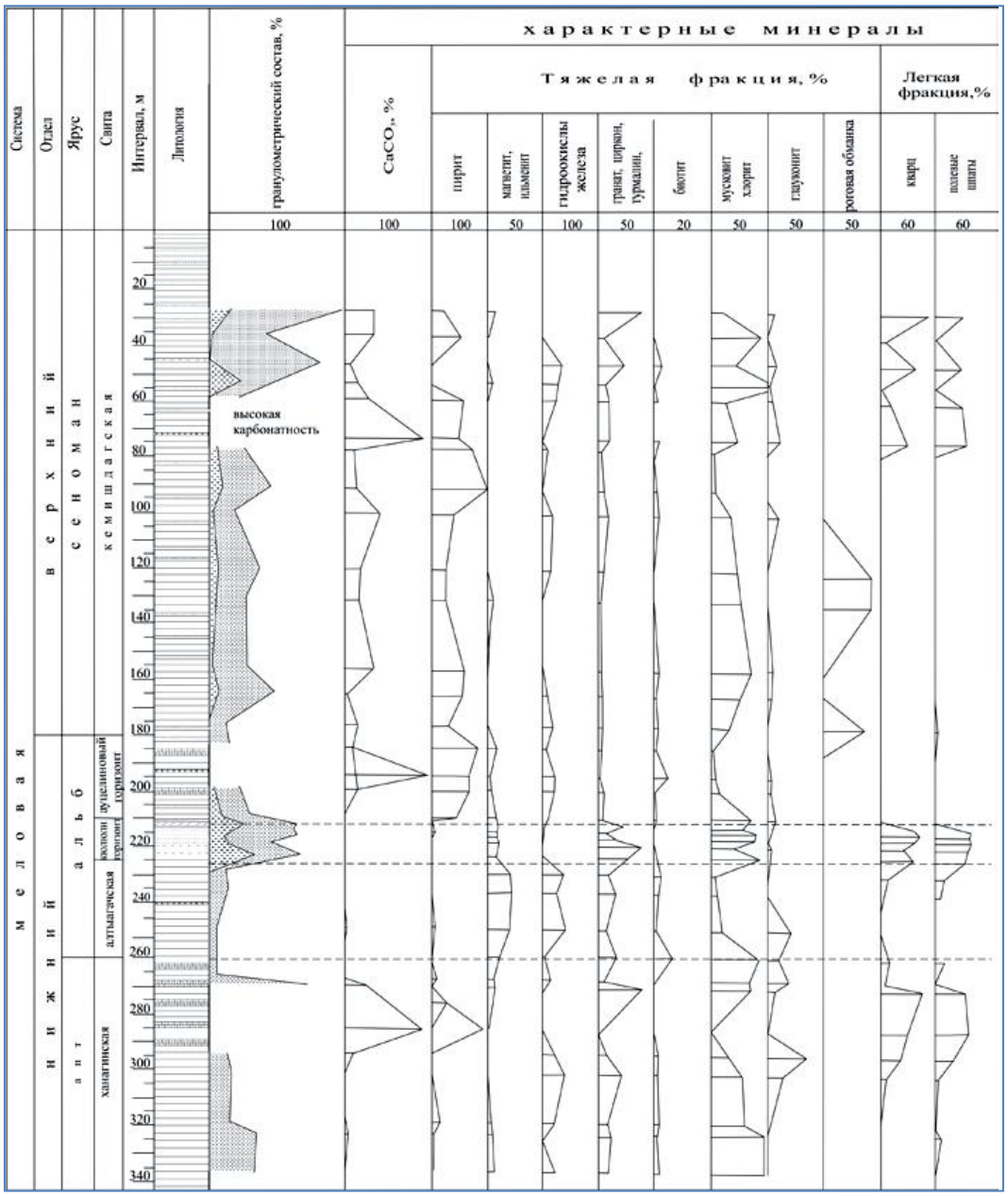



**Figure 3.** Lithological and petrographic characteristics of Cretaceous sediments of the Pibeyli area of the northern part of Shamakhi-Gobustan NQR region.

The following layers (Valangin, Hoteriv, Barrem, Apt, Alb) are distinguished in the section of Lower Cretaceous sediments:

The floor of Valangin spread in the watershed zone of North Gobustan and was formed by the alternation of cracked, clayey-sandy limestones, marls and clay layers. At the bottom of the cut, there is a conglomerate layer composed of pieces of limestone and pieces of marls. The thickness of this floor reaches 500-850 m in the upper parts of the Gozluchay and Pirsahat rivers, and 1500-2000 m in the northern part of the Dübrar geosyncline.

**The Hoteriv floor** corresponds to the Valangin floor in the central part of the Dübrar geosyncline. On the Hoteriv floor, it consists of gray, dark-gray clays and thin marl, siltstone aragats, lenses. The thickness of this layer reaches 250-450 m in North Gobustan.

**The barrem floor** consists of alternating layers of greenish-gray clay, marl, siltstone, poorly cemented sandstone and limestone. The sediments of the Barrem floor are composed of siltstone and clay rocks in the upper area of Pirsahat River and Gozlu River. The thickness of this layer varies in the range of 500-1000 m.

**Apt floor** is divided into two sub-floors according to the lithological composition. The lower half-floor consists of gray and light gray clays, interspersed with marly limestones. The thickness of this floor is 50-60 m. The upper half-floor consists of thick, reddish-brown bituminous clays, marls, siltstones and pomegranate-grained sandstones. The thickness of this basement is 70-90 m.

**Albian floor** sediments are more widespread than Aptian sediments in North Gobustan and are divided into two sub-floors. The lower half-floor is made of red, greenish-brown bituminous clays and greenish-gray siltstones. The thickness of this basement is 60-75 m. The upper half-floor is divided into two horizons (lower and upper horizons) according to the proportion of sandy siltstone and clay-marl sediments involved in the section:

*The upper horizon* consists of limestone, sandstone, argillite, siltstone and bentonite. The thickness of this horizon is 20-60 m, and the total thickness of sandy-siltstone layers is 8-15 m.

*The sub-horizon* consists mainly of sandstones, silty sands, siltstones and some thin layers of clay. The thickness of this horizon varies between 0.5-1.5 m and 80-100 m, and the thickness of sandy layers reaches 45 m.

The Upper Cretaceous sediments are spread over a wide area, conformably covering the Lower Cretaceous sediments. Cenomanian, Turonian, Cognac, Santonian, Campanian, Maastrichtian layers belong to Upper Cretaceous sediments. The sediments of the mentioned floors were opened in some areas of North Gobustan by structural mapping and structural-exploration wells.

## CONCLUSION

Taking into account the above mentioned in the studied area, it can be concluded that the Upper Cretaceous sediments and Lower Cretaceous sediments are spread over a wide area, creating the basis for the field to be oil and gas prospective.

## PROPOSAL

For this reason, it is necessary to carry out seismic works for the investigation of oil and gas fields in the investigated area of Shamakhi-Gobustan.

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## Xülasə

### Şamaxı-Qobustan Sahəsində Petroqrafik Göstəricilərin Stratiqrafik Qiymətləndirilməsi


Məqalədə Şamaxı-Qobustan NQR rayonunda təbaşir şöküntülərinin litoloji-petroqrafik məlumatlar qeyd edilmişdir. Həmçinin, öyrənilmiş kəsilişlərə əsasən stratiqrafik bölgilər aparılmışdır. Əldə olunan məlumatlara görə demək olar ki, həmin sahədə geodinamik vəziyyətin müxtəlifliyini təsdiq edir.


## Абстракт

### Стратиграфическая Оценка Петрографических Показателей Шамахи-Гобустанской Района


В статье приведены литолого-петрографические данные меловых отложений Шамахи-Гобустанского региона НКР. Также на основе изученных разрезов произведены стратиграфические подразделения. По полученным данным можно сказать, что они подтверждают разнообразие геодинамической ситуации в этом районе.

# Evaluation of the effect of exogenous application of indole-3-acetic acid on morphophysiological parameters under salt (NaCl) stress in cotton (*G. Hirsutum* l.)

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**Abstract**

Soil salinity is caused by a high concentration of soluble salts that retain water in the soil and accentuate the problem of desertification. In this research, the effect of Indole-3-Acetic Acid (IAA) on germination parameters, total chlorophyll content and morphometric parameters of cotton seedlings under stress conditions of 100 mM and 200 mM NaCl was evaluated in 5 cultivars. An increase in final germination percentage (FGP) was determined in all cultivars affected by IAA in the control variant, and in 3 cultivars under both stress conditions. Among the genotypes treated with IAA under 250 mM concentration of NaCl, the highest value of germination index was observed in Bless (176) and Livzara (181) varieties. Treatment with IAA at a concentration of 250 mM salt caused an increase in total chlorophyll content (TCC) in all genotypes. The application of IAA in Ayzek variety caused an increase in the height and mass of the root and shoot only under the condition of plant growth regulator (PGR) + without NaCl. The results of this study show that exogenous application of IAA can be effective way to increase different morphophysiological parameters in cotton varieties under salt stress conditions.

**Keywords***:* *Gossypium hirsutum,*, salt stress, total chlorophyll content, germination rate index

## Introduction

Salinity is an edaphic stress that has affected 45 million hectares of irrigated land out of 230 million hectares, causing annual losses of approximately US$ 12 billion globally and is a major threat to global agricultural productivity (12, 44). Excessive concentration of soluble salts in soils negatively affects agricultural lands and crops and subsequently the livelihood of people all around the world (36-38). Agriculture is one of the mainincome sector of the economy of developing countries (34, 35, 47) and more than 100 countries are facing the problem of soil salinity along with salinization of groundwater (39, 40). Excessive salts primarily disrupt the cellular osmotic balance by lowering the water potential inside cells. The salts like chlorides and sulphates of sodium, calcium and magnesium along with sodium carbonate and sodium bicarbonate prevailed in saline soils negatively affect plant growth and productivity as they change the osmotic balance between plant roots and soil and interfere with physiological and metabolic processes of plant (32). The reduction in plant growth exposed to saline environments could be due to either adverse water relations or the effects of ions on metabolism.

Phytohormoness are active members of the signal compounds involved in the induction of plant stress responses (19, 20, 31). IAA is the most common phytohormone of the auxin class and it regulates various aspects of plant growth and development (41). IAA can control cell elongation, vascular tissue development and apical dominance (49).

The IAA signal transduction pathway in plants has been described in detail (28). Also, it has been reported that IAA responds -to salinity in plants (1, 8, 21). GA3 application during the salinisation period partly overcome the effect of salinity on reducing IAA levels and this shows that salinity

may influence hormone balances by affecting plant growth and development. Significant reduction in IAA levels in rice five days after NaCl treatment (11) and also salinity caused 75% reduction in IAA levels of tomato (18, 22).

However, little information seems to be available on the relationship between salinity stress and auxin levels in plants. The variations in indol asetic acid (IAA) content under stress conditions appeared to be similar to those of abscisic acid (15), and increased levels of IAA have also been correlated with reduced growth (16). Therefore, reduction in plant growth under stress conditions could be an outcome of altered hormonal balance and, hence, their exogenous application provides an attractive approach to counter the stress conditions.

Among industrial crops, cotton is one of the most valuable as it is used as raw material for textile industruy, to make biofuel and edible oil (17, 33, 43, 50). Throughout its lifespan, cotton is subjected to a variety of biotic and abiotic stresses, with salinity being one of the most serious threats to global cotton production. Salinization of the cultivated land is the major cause of less yield production of cotton that is a great economical loss worldwide. This current research was conducted to show the effect of exogenous application of indole-3-acetic acid on germination parameters, total chlorophyll content and vegetative growth parameters in cotton under salt stress (NaCl) conditions.

## Materials and methods

The research was carried out in the Department of Industrial and Forage Crops of the Institute of Genetic Resources of the Ministry of Science and Education of Azerbaijan. Five cotton varieties (Bless, Livzara, Lodos, Turkan, Ayzek) belonging to the *G. hirsutum* L. species were used as the research material. The seeds of cotton genotypes were pre-treated with 0.2% potassium permanganate for 8 minutes. For evaluation germination and morphophysiological parameters experimental design was based on a combination of two factors: stress (0, 100 and 250 mM NaCl) and treatment of IAA (1 µM). There were six treatment conditions as follows: control (C), 0 mM NaCl; 100 mM NaCl; 250 mM NaCl; 0 mM NaCl + IAA; 100 mM NaCl + IAA; 250 mM NaCl + IAA.

For the study of germination parameters, 25 seeds of each genotype were planted in 6 variants in Petri dishes in 4 replications and germinated seeds were counted every day for 10 days.

Final Germination Percentage (1) calculated as follows:

$$\mathrm{FGP} = \frac{Na}{Nt}\, x\, 100 \qquad (1)$$

Where, *Na* is the number of germinated seeds and *Nt* is the total number of planted seeds. Coefficient of velocity of germination (2) (CVG or Kotowski`s) calculated by the formula proposed Bewley and Black (13, 14, 42):

$$\mathrm{CVG} = \frac{\sum_{i=1}^{k} N_i}{\sum_{i=1}^{k} N_i T_i}\, x\, 100 \qquad (2)$$

Where, *Ti* is the time from the start of the experiment to the *i*th interval, *Ni* is the number of seeds germinated in the *i*th time interval and *k* is the total number of time intervals.

Mean germination (3) time (MGT or *T*) calculated by the formula proposed Ranal and Santana (24):

$$\mathrm{MGT} = \frac{\sum_{i=1}^{k} N_i T_i}{\sum_{i=1}^{k} N_i}\, x\, 100 \quad (3)$$

Where, *Ti* is the time from the start of the experiment to the *i*th interval, *Ni* is the number of seeds germinated in the *i*th time interval (not the accumulated number, but the number corresponding to the *i*th interval), and *k* is the total number of time intervals.

Germination Index (*GI*) (4) estimated as follows (3):

$$GI = \sum_{\mathrm{i=0}}^{\mathrm{k}} \frac{|(T_k - T_i)\, N_i|}{N_t} \quad (4)$$

Where, *Ti* is the time from the start of the experiment to the *i*th interval (day for the example), *Ni* is the number of seeds germinated in the *i*th time interval (not the accumulated number, but the number corresponding to the *i*th interval), *Nt* is the total number of seeds used in the test, and *k* is the total number of time intervals.

Germination Rate Index (Speed of germination or index of velocity of germination or Emergence rate index) (5) calculated as follows (9):

$$GRI = \sum_{\mathrm{i=0}}^{\mathrm{k}} \frac{N_i}{T_i} \quad (5)$$

Where, *Ti* is the time from the start of the experiment to the *i*th interval, *Ni* is the number of seeds germinated in the *i*th time interval (not the accumulated number, but the number corresponding to the *i*th interval), and *k* is the total number of time intervals.

For evaluation morphophysiological indicators 4 seeds for each genotype were planted in 7 cm plastic cups containing perlite in five replications. The seedlings were grown in a phytotron (Taisite, GZX-300 E) at relative humidity of 65–75% and average night and day temperature ranging from 22 to 24 °C. The light length was 14/10 hours day/night. After germination, plants were thinned out and each pot contained 2 cotton plants.

As a nutrient medium was used Steiner's solution (https://s3-eu-west-1.amazonaws.com/pstorage-acs-6854636/5112742/es0501971_si_001.pdf) during the entire growth period, starting from the first days

of planting. IAA priming variants were treated with 1 µM solution of IAA. The experiment was designed as a completely randomized model with three replications for each treatment and each replication contained 10 cotton plants. The plants were grown under these treatment conditions for 28 days.

After 28 days of salinization, measurement of the root fresh weight (RFW), shoot fresh weight (SFW), root dry weight (RDW) and shoot dry weight (SDW), root fresh height (RFH), shoot fresh height (SFH), root dry height (RDH) and shoot dry height (SDH) were recorded from 10 plants. The dry weights were measured after drying in an aerated oven at 80 °C for 96 h to reach a constant weight.

Total chlorophyll content determinations was carried out by using the method proposed by Rosyara (46).

The mean ± SD values were calculated using statistical functions of Microsoft Excel 2010 (Microsoft Corporation, USA). One-way analysis of variance (ANOVA) was performed using SPSS software (IBM SPSS v.25).

## Results and discussion

### Evaluation of germination parameters

The salts in the soil prevent the water from entering the seed by either constituting osmotic pressure which creates a barrier to the seed or toxic effects caused by $Na^+$ and $Cl^-$ ions. Germination and growth of seedlings under stress conditions, an indicator routinely employed to assess the degree of damage to plant cells (30).

Pre-soaking treatment may be used to mitigate the impact of many stresses on seed germination. Seed treatment with plant growth regulators (PGR) is sometimes an easy and low-cost approach to alleviate the detrimental effects of stresses (10).

The main effects of IAA and salinity on cotton variety germination parameters were shown in Table 1. Increasing of salinity level caused a significant decrease in final germination percentage, coefficient of velocity of germination, germination rate index and germination index in all studied genotypes while mean germination time delayed. After the application of IAA, no significant change in the FGP parameter was recorded in 100 mM concentration of NaCl in the Turkan variety, and a decrease was observed in the Ayzek variety under both salt concentration conditions. After the application of IAA, the GI index increased in all samples, except for the 100 mM salt concentration of NaCl salt in the Livzara variety, and both salt variations in the Ayzek variety.

The CVG gives an indication of the rapidity of germination. It increases when the number of germinated seeds increases and the time required for germination decreases (23). As a result of the comparative analysis of stress and stress + IAA variants, a decrease in the MGT indicator and an increase in the CVG indicator were observed in all genotypes.

**Table 1.** Germination parameters of cotton genotypes

| Genotype | Treatment | FGP% | CVG | MGT | GRI | GI |
|---|---|---|---|---|---|---|
| **Lodos** | Control | 91 | 28.17 | 3.55 | 27.67 | 678 |
| | Control + IAA | 94 | 28.39 | 3.52 | 28.83 | 703 |
| | 100 mM NaCl | 69 | 26.74 | 3.74 | 20.45 | 501 |
| | 100 mM NaCl + IAA | 72 | 25.99 | 3.84 | 20.91 | 515 |
| | 250 mM NaCl | 18 | 18.37 | 5.44 | 3.59 | 100 |
| | 250 mM NaCl + IAA | 20 | 16.28 | 6.14 | 3.71 | 102 |
| **Bless** | Control | 95 | 30.45 | 3.28 | 30.93 | 733 |
| | Control + IAA | 98 | 30.25 | 3.31 | 31.68 | 754 |
| | 100 mM NaCl | 70 | 29.54 | 3.39 | 22.83 | 533 |
| | 100 mM NaCl + IAA | 75 | 27.57 | 3.63 | 23.55 | 553 |
| | 250 mM NaCl | 27 | 19.85 | 5.04 | 6.21 | 161 |
| | 250 mM NaCl + IAA | 32 | 18.18 | 5.51 | 6.85 | 176 |
| **Livzara** | Control | 94 | 27.17 | 3.68 | 27.87 | 688 |
| | Control + IAA | 97 | 26.94 | 3.71 | 28.53 | 707 |
| | 100 mM NaCl | 68 | 24.19 | 4.13 | 18.08 | 467 |
| | 100 mM NaCl + IAA | 73 | 19.16 | 5.22 | 14.83 | 422 |
| | 250 mM NaCl | 31 | 17.22 | 5.81 | 5.71 | 161 |
| | 250 mM NaCl + IAA | 35 | 17.16 | 5.83 | 6.43 | 181 |
| **Turkan** | Control | 94 | 25.89 | 3.86 | 26.5 | 671 |
| | Control + IAA | 95 | 26.46 | 3.78 | 27.37 | 686 |
| | 100 mM NaCl | 70 | 22.74 | 4.39 | 18.69 | 482 |
| | 100 mM NaCl + IAA | 70 | 22.58 | 4.43 | 17.48 | 460 |
| | 250 mM NaCl | 29 | 18.23 | 5.48 | 5.58 | 160 |
| | 250 mM NaCl + IAA | 30 | 17.44 | 5.73 | 5.48 | 158 |
| | Control | 92 | 28.53 | 3.51 | 27.82 | 682 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Ayzek** | Control + IAA | 93 | 29.81 | 3.35 | 29.77 | 711 |
| | 100 mM NaCl | 67 | 24.36 | 4.11 | 18.04 | 462 |
| | 100 mM NaCl + IAA | 60 | 23.91 | 4.18 | 15.87 | 409 |
| | 250 mM NaCl | 28 | 16.57 | 6.04 | 4.95 | 139 |
| | 250 mM NaCl + IAA | 25 | 16.44 | 6.08 | 4.38 | 123 |

In general, with the application of IAA, the increasing of the FGP parameter under 100 mM concentration of NaCl was observed in Bless and Livzara varieties, and at 250 mM salt concentration it was observed in Bless variety. The results obtained on the change of germination indicators with the increase of the severity of stress were similar to the results of the experiments conducted by Hmissi et al. (25) on wheat (*Triticum durum* Desf.), Ergin et al. (21) on the cotton plant. In cotton the application of 20 mg $L^{-1}$ IAA in the medium without NaCl caused an increase in Germination index, Germination rate, and Mean germination time (45). Furthermore, the interaction between application of IAA and salinity levels significantly affected final germination percentage in wheat (27).

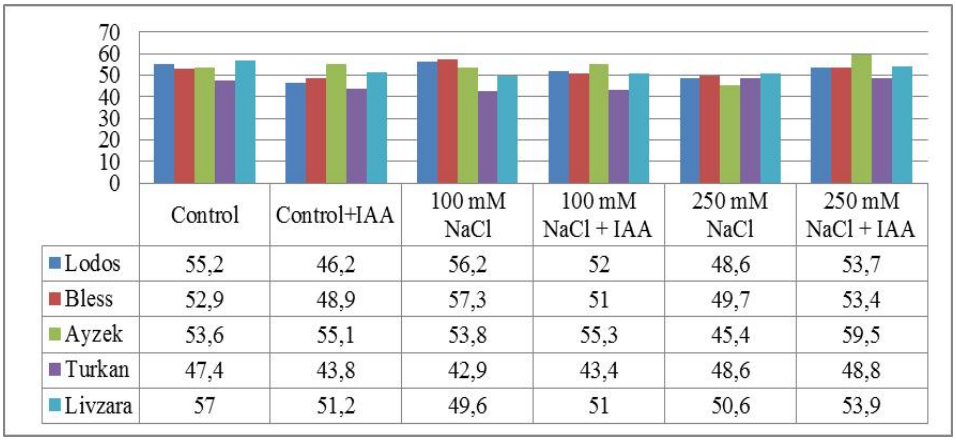
## Evaluation of morphophysiological parameters

Chl content is considered to be one of the parameters of salt tolerance in crop plant (2) and Chl *a* and *b*, and chlorophyll SPAD can be used to discriminate between salt-tolerant and salt-sensitive varieties (6). Among the studied samples a significant difference between variants in total chlorophyll content was determined in Lodos, Bless and Ayzek varieties (Table 2.).

**Table 2.** Analysis of the variance of the data of chlorophyll content

| | | df | Sum of Squares | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Lodos | Between Groups | 5 | 151.937 | 30.387 | 5.006 | .038 |
| | Within Groups | 6 | 36.420 | 6.070 | | |
| | Total | 11 | 188.357 | | | |
| Bless | Between Groups | 5 | 93.040 | 18.608 | 4.487 | .048 |
| | Within Groups | 6 | 24.880 | 4.147 | | |
| | Total | 11 | 117.920 | | | |
| Ayzek | Between Groups | 5 | 214.057 | 42.811 | 7.467 | .015 |
| | Within Groups | 6 | 34.400 | 5.733 | | |
| | Total | 11 | 248.457 | | | |
| Turkan | Between Groups | 5 | 75.137 | 15.027 | 1.663 | .276 |
| | Within Groups | 6 | 54.220 | 9.037 | | |
| | Total | 11 | 129.357 | | | |
| Livzara | Between Groups | 5 | 75.377 | 15.075 | 2.743 | .126 |
| | Within Groups | 6 | 32.980 | 5.497 | | |
| | Total | 11 | 108.357 | | | |

Among the samples, an increase in the total chlorophyll content was determined in the control + IAA only in Ayzek variety. The increase of total chlorophyll content in 100 mM NaCl + IAA variant compared to 100 mM NaCl was determined in Ayzek, Turkan and Livzara varieties. In variant 250 mM NaCl + IAA, the TCC was higher than the 250 mM NaCl in all varieties. After application of IAA, the highest chlorophyll contents were recorded in Ayzek variety for all variants (Fig. 1.).




| | Control | Control+IAA | 100 mM NaCl | 100 mM NaCl + IAA | 250 mM NaCl | 250 mM NaCl + IAA |
|---|---|---|---|---|---|---|
| Lodos | 55,2 | 46,2 | 56,2 | 52 | 48,6 | 53,7 |
| Bless | 52,9 | 48,9 | 57,3 | 51 | 49,7 | 53,4 |
| Ayzek | 53,6 | 55,1 | 53,8 | 55,3 | 45,4 | 59,5 |
| Turkan | 47,4 | 43,8 | 42,9 | 43,4 | 48,6 | 48,8 |
| Livzara | 57 | 51,2 | 49,6 | 51 | 50,6 | 53,9 |

**Fig. 1.** Total chlorophyll content in different variants by varieties

In all samples, except the Turkan variety, it was determined that the total chlorophyll content was lower than the control at high salt concentration (250 mM). Under 100 mM concentration of NaCl, the reduction of the total content of chlorophyll was determined in Lodos, Bless and Ayzek varieties.

In cotton compared to control plants, under 150 mM concentration of NaCl stressed plant had significantly greater chlorophyll content (SPAD value). The plants grown under salt stress environment had 11.64% higher SPAD, than those grown under control (48). In maize foliar application of IAA improved the chlorophyll level in salinity-stressed plants. Foliar application of IAA, especially at 2 mM, counteracted some of the salt induced adverse effects by enhancing essential inorganic nutrients as well as by maintaining membrane permeability (7). During the research conducted on two okra genotypes, Esan et al. (5) observed increasing of chlorophyll b content under 100 mM NaCl treated than the control group.

Application of IAA led to the increase of FSH, FSW, DSH and DSW parameters in Lodos cultivar under both stress conditions (Table 4.). In Bless variety, treatment with IAA led to an increase in FRH index in both stress variants, DRH and DRW under concentration of 100 mM NaCl, and FSW and DSW parameters under stress of 250 mM NaCl concentration.

**Table 4. Morphometric parameters of cotton genotypes**

| Genotype | Variants | FRH | FSH | FSW | FRW | DRH | DSH | DSW | DRW |
|---|---|---|---|---|---|---|---|---|---|
| Lodos | Control | 11.1±0.566 | 13.8±1.061 | 1.690±0.059 | 0.142±0.011 | 8.0±0.354 | 12.2±0.990 | 0.128±0.009 | 0.010±0.001 |
| | Control + IAA | 3.4±1.058 | 7.8±1.106 | 0.688±0.059 | 0.090±0.027 | 2.5±0.252 | 6.5±0.954 | 0.057±0.006 | 0.006±0.003 |
| | 100 mM NaCl | 4.1±1.485 | 5.8±2.192 | 0.652±0.035 | 0.109±0.024 | 3.2±1.202 | 4.1±1.485 | 0.065±0.008 | 0.007±0.003 |
| | 100 mM NaCl + IAA | 2.7±0.557 | 7.8±2.326 | 0.919±0.292 | 0.057±0.032 | 1.7±0.361 | 6.5±1.819 | 0.089±0.023 | 0.005±0.005 |
| | 250 mM NaCl | 1.7±0.495 | 3.4±0.424 | 0.262±0.042 | 0.019±0.002 | 1.4±0.495 | 3.0±0.424 | 0.025±0.005 | 0.004±0.001 |
| | 250 mM NaCl + IAA | 1.3±0.424 | 4.7±1.202 | 0.410±0.037 | 0.019±0.004 | 1.1±0.212 | 3.4±0.566 | 0.048±0.005 | 0.003±0.002 |
| Bless | Control | 3.7±1.404 | 8.2±2.895 | 0.894±0.395 | 0.105±0.025 | 3.0±1.252 | 6.2±2.959 | 0.073±0.026 | 0.009±0.003 |
| | Control + IAA | 3.2±1.445 | 5.5±1.882 | 0.486±0.158 | 0.073±0.030 | 2.8±1.839 | 5.4±2.030 | 0.046±0.011 | 0.005±0.004 |
| | 100 mM NaCl | 2.7±0.600 | 8.5±2.626 | 0.963±0.400 | 0.075±0.014 | 1.9±0.239 | 6.6±2.616 | 0.072±0.027 | 0.007±0.001 |
| | 100 mM NaCl + IAA | 3.6±1.606 | 7.7±1.086 | 0.670±0.208 | 0.032±0.013 | 2.7±1.273 | 6.1±0.760 | 0.065±0.014 | 0.008±0.003 |
| | 250 mM NaCl | 4.3±0.636 | 5.5±1.697 | 0.297±0.121 | 0.056±0.008 | 2.7±1.980 | 4.9±1.273 | 0.030±0.002 | 0.009±0.005 |
| | 250 mM NaCl + IAA | 5.3±2.116 | 3.9±1.178 | 0.381±0.111 | 0.050±0.024 | 2.4±1.064 | 3.4±1.721 | 0.046±0.007 | 0.006±0.003 |
| Livzara | Control | 4.5±2.227 | 7.2±1.751 | 0.557±0.147 | 0.067±0.020 | 3.2±1.681 | 5.2±1.598 | 0.048±0.009 | 0.007±0.002 |
| | Control + IAA | 2.0±0.700 | 7.9±1.652 | 0.473±0.221 | 0.060±0.007 | 1.8±0.656 | 6.3±1.562 | 0.042±0.011 | 0.005±0.004 |
| | 100 mM NaCl | 2.1±0.071 | 9.3±1.556 | 0.928±0.132 | 0.075±0.026 | 1.9±0.566 | 8.0±1.697 | 0.067±0.008 | 0.006±0.001 |
| | 100 mM NaCl + IAA | 3.4±0.905 | 6.2±2.461 | 0.575±0.178 | 0.077±0.019 | 2.3±1.349 | 5.1±2.367 | 0.055±0.012 | 0.009±0.003 |
| | 250 mM NaCl | 2.8±1.344 | 5.3±0.212 | 0.391±0.018 | 0.032±0.005 | 2.1±1.202 | 4.4±0.354 | 0.038±0.006 | 0.010±0.001 |
| | 250 mM NaCl + IAA | 3.6±2.033 | 4.3±0.987 | 0.429±0.063 | 0.039±0.013 | 2.3±1.389 | 3.4±1.084 | 0.054±0.007 | 0.008±0.001 |
| Turkan | Control | 3.9±0.354 | 10.0±0.919 | 0.732±0.023 | 0.067±0.006 | 3.2±0.424 | 8.5±0.495 | 0.059±0.005 | 0.010±0.002 |
| | Control + IAA | 4.1±0.141 | 11.7±0.283 | 0.801±0.026 | 0.069±0.004 | 3.3±0.141 | 10.0±0.212 | 0.061±0.011 | 0.012±0.002 |
| | 100 mM NaCl | 2.4±0.849 | 8.9±0.566 | 0.714±0.091 | 0.074±0.030 | 1.7±1.202 | 7.3±1.061 | 0.062±0.003 | 0.007±0.003 |
| | 100 mM NaCl + IAA | 2.5±0.283 | 9.8±0.495 | 0.668±0.016 | 0.050±0.004 | 2.0±0.283 | 7.9±0.283 | 0.059±0.004 | 0.005±0.003 |
| | 250 mM NaCl | 2.4±0.283 | 5.2±0.141 | 0.397±0.035 | 0.047±0.008 | 1.8±0.354 | 4.2±0.212 | 0.052±0.005 | 0.009±0.004 |
| | 250 mM NaCl + IAA | 1.9±0.764 | 3.6±1.411 | 0.313±0.169 | 0.028±0.019 | 1.1±0.513 | 2.7±1.457 | 0.047±0.008 | 0.003±0.001 |
| Ayzek | Control | 4.2±0.424 | 12.1±0.778 | 0.612±0.043 | 0.055±0.008 | 3.5±0.354 | 9.8±1.202 | 0.052±0.004 | 0.009±0.003 |
| | Control + IAA | 4.5±0.071 | 12.8±0.990 | 0.714±0.040 | 0.060±0.006 | 3.8±0.071 | 11.4±0.778 | 0.061±0.005 | 0.010±0.002 |
| | 100 mM NaCl | 4.1±0.354 | 9.9±0.707 | 1.004±0.032 | 0.067±0.006 | 3.4±0.141 | 8.7±0.636 | 0.083±0.008 | 0.006±0.002 |
| | 100 mM NaCl + IAA | 4.0±2.043 | 6.9±2.021 | 0.664±0.241 | 0.032±0.021 | 3.4±1.563 | 5.4±1.659 | 0.067±0.017 | 0.006±0.002 |
| | 250 mM NaCl | 4.7±0.354 | 5.6±0.212 | 0.333±0.016 | 0.043±0.016 | 3.9±0.283 | 4.2±0.141 | 0.043±0.004 | 0.009±0.002 |
| | 250 mM NaCl + IAA | 4.4±1.862 | 3.9±0.518 | 0.322±0.072 | 0.025±0.014 | 3.1±1.610 | 2.8±0.643 | 0.040±0.009 | 0.003±0.003 |

Application of IAA increased FSH and DSH in control variant of Livzara variety, under 100 mM salt concentration of salt of DRW, under 250 mM concentration of salt of FSW and DSW, and under both

stress conditions FRH, FRW and DRH parameters. Treatment with IAA in the control variant of the Turkan cultivar caused an increase in all studied morphometric parameters, however, under concentration of 100 mM of NaCl, only the height of the shoot and root were increased. The application of IAA in the Ayzek variety led to an increase in the values of all studied morphometric parameters only in the control variant. Latef et al. determined that FRW, FSW, DRW, and DSW increased as a result of application of 1.15 mM IAA in faba plant (*Vicia faba* L.) under 150 mM concentration stress of NaCl salt. (1). During the study of the combined effect of 0, 40, 60, or 80 mM NaCl with 0, 7, or 14 µM IAA on in vitro-grown *Solanum tuberosum* L. cultivars, it has been determined that IAA successfully alleviated the harmful effects of salt stress on all of the studied growth parameters (4). During the application of IAA to olive plantlets (*Olea europaea* L.) plants under 0 mM, 100 mM, and 200 mM concentrations of NaCl, it was observed that DRW was decreased under 0 mM of NaCl, increased under 100 mM NaCl, and remained unchanged under 100 mM NaCl (26).

## Conclusion

During the conducted research, it was determined that salt stress causes different changes in morphometric indicators in different cotton varieties. At the same time, the application of IAA under stress conditions was found to cause different changes in morphophysiological parameters in different cotton varieties. The results obtained in this study can help in determining the effective dose of exogenous application of IAA to eliminate the harmful effect of salt stress. Therefore, more work needs to be done to determine the effect of exogenous application of IAA in open field conditions on biometric parameters under salt stress.

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# Investigation of scale formation on glass tube coatings

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**Abstract**

The results of theoretical and experimental studies of the influence of scale deposits on heat exchange processes in vitrified pipes washed by seawater are presented. Experimental studies have shown that during long-term operation of heat exchangers, minor scale deposits with a layer thickness of up to 0.4 mm are observed on the surface of glass coatings of tubes, while a strong scale layer up to 2 mm thick is formed on the inner surfaces of metal tubes.

The practical absence of deposits in vitrified tubes is explained by the increased cleanliness of the glass surface and its resistance to aggressiveness of substances dissolved in sea water. This eliminates the formation of large foci of scale on the glass surface and washing off the formed scale with a stream of seawater.

**Keywords**: glass coatings, experimental study, scale deposition, scale thickness, temperature difference, scale thermal resistance, glass surface cleanliness.

Investigations carried out in thermal power plants (TPPs) have shown that intensive formation of scale deposits is observed in tubes of various diameters, made from steel of different grades. As a rule, these processes occur on the inner surface of tubes in a wide range of temperatures, pressures and flow rates. [1, 2]

To protect tubes from corrosion-mechanical wear and scale deposits in a highly mineralized environment (sea water), the method of applying inorganic coatings (enamel, glass, ceramics, etc.) to the metal surface of the tube is widely used [3].

It is known that glass coatings are resistant to highly mineralized environments. As a result of appropriate contact, the breakdown and slight leaching of sodium, potassium and calcium ions from the surface layers of the glass coating occurs while maintaining its integrity.

It should be noted that when studying the process of scale deposition, the need to study a number of additional issues is revealed, in particular, the influence of the physicochemical properties of glass and the degree of mineralization of the medium on the thickness of the resulting deposit. Note that the presence of scale deposits on the surface of the glass coating has a significant impact on the thermal conductivity and heat transfer process in vitrified pipes [3, 4].

In this regard, determining the thermal conductivity of a glass tube coating is difficult, and there are no accurate reference data on the thermal conductivity of glass pipe coatings at high temperatures.

At the same time, researchers are faced with the important task of developing methods that make it possible to predict the rate of increase in the thickness of the deposit layer on the surface of the glass coating of a tube. Solving this problem will make it possible to establish the thermal operating conditions of vitrified pipes and determine the average thickness of scale deposits.

It should be noted that the growth rate of such deposits without covering pipes reaches up to 2 mm per year, which reduces the open cross-section of the heat exchanger tubes, thereby reducing seawater consumption, leads to excessive fuel consumption, and in some cases, to limiting the power of energy sources.

The purpose of this research is a comparative study of the process of scale formation in vitrified and metal pipes of heat exchangers with an assessment of the thickness of scale deposits depending on the operating time and sea water temperature under conditions close to production.

The research methodology involved studying the influence of the thickness of the glass coating and a durable layer of deposits on the surface of metal tubes on the coefficients of thermal resistance (heat transfer coefficients) and thermal conductivity of coated and uncoated pipes.

It should be noted that the ratio of the thickness of the scale layer formed on the inner surface of the heat exchanger of metal tubes and glass coatings to the total operating time is the linear coefficient of scale formation and is calculated by the equation. [5, 6]

$$C = \frac{\delta}{\tau}, \quad \text{mm/day.} \qquad (1)$$

where – C is the linear coefficient of scale deposition; τ - operating time of the heat exchanger (days), δ - average scale thickness (mm).

The use of the linear coefficient of scale deposition in thermal calculations makes it possible, for any moment in time of operation, to determine the thermal resistance (R) of the layer formed by scale using the formula.

$$R = \frac{C\tau}{\lambda} \qquad (2)$$

where - λ- coefficient of thermal conductivity of the scale layer, W/m· $^0$C

On the other hand, the thermal resistances of metal tubes and their glass coatings are determined by the well-known formulas [6, 7]:

- thermal resistance of the wall of metal tubes

$$R_m = \frac{1}{d_{out}\alpha_1} + \frac{1}{2\lambda_m}\ln\frac{d_{out}}{d}; \qquad (3)$$

-thermal resistance of the wall of the glass coating of the tube

$$R_c = \frac{1}{\alpha_3 d_{in}} + \frac{1}{2\lambda_c}\ln\frac{d}{d_{in}} \qquad (4)$$

where $\alpha_1$, $\alpha_2$, $\alpha_3$ are the heat transfer coefficients, from the coolant to the outer surface of the metal tubes, from the inner surface of the metal tube to the outer surface of the glass coating and the inner surface of the glass coating to sea water, accordingly; $d_{in}$, $d_{out}$, d – the internal diameter of the glass coating, the outside and internal diameters of the metal pipe, correspondingly; $\lambda_m$, $\lambda_c$ – thermal conductivity coefficients of a metal tube and glass tube coatings, respectively.

In connection with this phenomenon, to determine the minimum coefficient of thermal resistance of the glass coating of tubes, we equate the coefficients of thermal resistance of layers of scale deposits of brass (copper) or steel pipes, i.e. $R_м = R$, $R_c = R$. Taking these equalities into account and substituting expressions (2), (3) and (4), we can determine the thermal conductivity coefficients of scale layers of glass coatings and metal tubes:

$$\frac{1}{d_{in}\alpha_1} + \frac{1}{2\lambda_m}\ln\frac{d_{in}}{d} = \frac{C\tau}{\lambda_m}$$

$$\frac{1}{\alpha_3 d_{in}} + \frac{1}{2\lambda_c}\ln\frac{d}{d_{in}} = \frac{C\tau}{\lambda_c}$$

After solving equations (5) we obtain:

$$\lambda_m = (C\tau - \frac{1}{2}\ln\frac{d_{in}}{d})\alpha_1 d_{in} \qquad (6)$$

$$\lambda_c = (C\tau - \frac{1}{2}\ln\frac{d}{d_{in}})\alpha_3 d_{in} \qquad (7)$$

As can be seen from the obtained expressions, to determine the thermal conductivity coefficients ($\lambda_m$, $\lambda_c$) it is necessary to know the heat transfer values $\alpha_1$, $\alpha_3$.

Heat transfer ($\alpha_1$) in smooth metal tubes during liquid flow is calculated using M.A. Mikheev's equation [4, 7]:

$$Nu = 0{,}021\ Re^{0.8}\ Pr^{0.43}\left(\frac{P_{r_l}}{P_{r_w}}\right)^{0{,}25} \qquad (8)$$

Similarly, with a parallel flow of liquid along the inner surface of the glass coating of the tube, the heat transfer ($\alpha_3$) of the glass coating is determined by the equation:

$$Nu = 0{,}023\ Re^{0.8}\ Pr^{0.4} \qquad (9)$$

where - Nu, Re, Pr - Nusselt, Reynolds and Prandatel criteria. Subscripts "l" – liquid (sea) and "w" denote - wall of the glass coating of the tube, respectively.

Thus, taking into account formulas (6), (7), (8) and (9), the thickness of scale layers on the surface of glass coatings and metal tubes can be determined using known equations as follows: [6,7]

$$\delta_c = \frac{\lambda_c \Delta T}{q} \qquad \delta_m = \frac{\lambda_m \Delta T}{q}$$

where q, and $\Delta T = T_2 - T_1$ – respectively, the heat flux density in sea water and the temperature difference between the coolant ($T_2$= 60-80 °C) and sea water ($T_1$=18-20°C);

By substituting the expressions of the thermal conductivity coefficients from (6) and (7) into

equation (10), it is possible to determine the thickness of the scale layers of glass coatings and metal tubes at different values of the temperature difference (ΔT) and specific thermal flow $q = \alpha_3 (t_c - t_f)$ of sea water.

It`s significant to mention that to determine the rate of formation of scale deposits on the surface of metal pipes and their glass coatings (v), the well-known formula can be used [5, 7]

Taking into account the influence of the factors under consideration on the rate of formation of a layer of scale deposits on the heat exchange surface, it is necessary to determine the average thickness of scale deposits in vitrified and metal tubes. This task was accomplished experimentally. The experiments were carried out on a stand that includes a hydraulic system and a measurement system [7, 8]. The hydraulic system consists of a pressure tank, cold water tubes, a measuring tank and hot water tubes. The measurement system includes thermocouples with lead wires and potentiometers. Differential pressure gauges are used to measure the speed of water movement. Samples of vitrified and metal tubes in pipe-in-pipe heat exchangers with diameters of 19-159 mm were used [9, 10]. The mass of the test pipes in their pure form and after scale deposition was determined. In the experiments, changes in temperature ($T_1$) and water flow were measured to calculate the heat flux density [11].

After each test, the tubes were cleaned with rags and then washed with a 5-8% hydrochloric acid solution. After cleaning, the surfaces of the tubes had their original appearance [12].

Table 1 presents the results of comparative studies of the thickness of scale deposits in vitrified and metal tubes of thermal power plants.

Experimental studies have shown that during long-term operation of the heat exchanger, minor scale deposits are observed on the surface of the glass coatings of the tubes, the thickness of which is in the range of 0.14-0.42 mm, while on the metal surfaces of the tubes a strong layer of scale with a thickness of 1.24 - 1.98mm is formed.

The vitrified pipes were washed with a rag and then purified with a 5-8% solution of hydrochloric acid. After cleaning the surface of the glass coating, the pipes had the original appearance of glass.

**Table 1.** Scale deposits in vitrified and metal tubes with glass thickness is δ=0.15-0.25 mm, coolant temperature is $T_2$=60-80$^0$C

| Tube size, in mm | Temperature drop, $\Delta T$, *in* $^0$C | Average rate of scale deposition *v*, in g/(m$^2$·days) | Test duration, in days. | Mass difference before and after scale deposition, $m_2 - m_1$, in g. | | Deposit thickness $\delta_i$, in mm | |
|---|---|---|---|---|---|---|---|
| | | | | Vitrified | Metal | Vitrified | Metal |
| Ø19x1,5 | 45 | 0,20 | 45 | 1,08 | 1,80 | 0,14 | 1,24 |
| Ø25x2,5 | 50 | 0,35 | 60 | 1,21 | 1,46 | 0,18 | 1,42 |
| Ø32x4,0 | 55 | 0,42 | 70 | 1,42 | 1,64 | 0,19 | 1,34 |
| Ø38x4,0 | 60 | 0,50 | 75 | 1,64 | 1,80 | 0,16 | 1,48 |
| Ø57x3,5 | 62 | 0,60 | 80 | 1,71 | 1,85 | 0,18 | 1,52 |
| Ø76x3,0 | 57 | 0,65 | 85 | 1,78 | 1,82 | 0,20 | 1,62 |
| Ø89x4,5 | 68 | 0,72 | 84 | 1,82 | 1,95 | 0,26 | 1,72 |
| Ø108x4,0 | 64 | 0,82 | 86 | 1,86 | 1,98 | 0,28 | 1,78 |
| Ø125x2,5 | 56 | 0,86 | 89 | 1,92 | 2,12 | 0,38 | 1,82 |
| Ø159x4,5 | 61 | 0,92 | 90 | 1,98 | 2,42 | 0,42 | 1,98 |

The use of glass coating pipes in ship heat exchangers poses the problem of studying the influence of the thickness of the glass coating on the heat transfer process. It is known that the presence of a glass coating is associated with a decrease in the heat transfer coefficient in heat exchangers caused by the low thermal conductivity of vitrified pipes. The low thermal conductivity of the glass coating is caused by the low density of free electrons, so heat transfer occurs in them mainly by vibrations of the atoms of the crystal lattice.

One of the main ways to improve the heat transfer of vitrified tubes is to obtain a minimum coating thickness for all types of glass. At the same time, the glass coating should not have less strength. Previously, the process of balloon glass pipe vitrification technology was noted; as experiments show, the diameter of the sealed glass pipe must be at least ¾ of the internal diameter of the metal pipe. In this case, the set of glass cylinder and metal pipe reaches a vitrification temperature of 600-800 C and creates a pressure in the range of 0.15-0.20 MPa of heated air inside the sealed glass cylinder. These vitrification pressures and temperatures are considered to be the strength of the glass coating of the pipe.

When using a sealed glass pipe of smaller

diameters, it is necessary to increase the coating application temperature and supply additional air from the outside into its internal cavity. However, this does not always give positive results. Therefore, the pressure and strength properties of vitrified pipes mainly depend on the choice of glass pipe thickness. In addition, a decrease in the heat transfer coefficient for vitrified pipes in heat exchangers makes it necessary to determine the required thickness of the glass coating of the pipe.

It is known that in the technology of vitrification by the advancing method there are no restrictions on the diameter of the glass cylinder, hermetically sealed and attached to the pipe wall. In this case, a piece of glass cylinder length up to is heated to the glass softening temperature.

The length of the heating zone does not exceed the length of the heated hermetically sealed glass cylinder. The temperature at the end of vitrification is evenly distributed along the length of the pipe.

The glass balloon, after vitrification, evenly covers the inner surface of the metal pipe.

Thus, to ensure continuity and other performance indicators of the coating, it is necessary to comply with certain technological regulations, the parameters of which in most cases are interrelated and depend on the properties of the glass used.

At the same time, an important task today for researchers is to develop methods for operating ship heat exchangers that make it possible to determine in advance the rate of increase in the thickness of the deposit layer, the composition and thermal conductivity of the scale that should form under the given operating conditions of the ship power plants. Solving this problem will make it possible to establish the operating modes of the apparatus and determine the average thickness of scale deposits during operation of ship heat exchangers.

Indeed, with a change in the concentration of sea water, the overall heat transfer coefficient gradually decreases with the formation of deposit thickness in the metal and glass coatings of pipes. However, the thermal conductivity of scale increases due to increased density, i.e., ordering of its crystalline structure, as well as an increase in thermal conductivity reduces the thermal resistance of scale and causes an increase in the stability of the heat transfer coefficient.

Taking into account the influence of these parameters, it is necessary to determine the average value of scale formation in vitrified and metal pipes.

The increase in sediment thickness over time can theoretically be determined using a mathematical model.

During long-term operation of the apparatus, the comparative average assessment of the thickness of the scale formed in vitrified and metal pipes was determined by the volumetric method using the formula.

$$S_i = \frac{V_{2i} - V_{1i}}{L_i} \quad (11)$$

where – $V_{2i}$ and $V_{1i}$ internal volumes of pipes before and after testing; Li - length of pipe sections; i=1,2-index corresponding to vitrified and metal pipe samples.

To find the volumes $V_{2i}$ and $V_{1i}$, distilled water with a known volume is poured from the flask into the tested pipe sample. The cross-sectional area of the pipe sample, taking into account the thickness of the scale deposit layer, is equal to.

$$S_i = \pi\left(R_{2i} + \delta_i\right)^2 \quad (12)$$

Taking into account expression (11), equation (12) takes the form.

$$R_{2i}^2 + 2R_{2i} \cdot \delta_i + \delta_i^2 = \frac{V_{2i} - V_{1i}}{\pi L_i} \quad (13)$$

Since, after simplification $\pi R_{2i}^2 L_i = V_{2i}$ we have:

$$\delta_i^2 + 2R_{2i} \cdot \delta_i = -\frac{V_{1i}}{\pi L_i} \quad (14)$$

Solving this equation for $\delta_i$ , we get:

$$\delta_i = R_{2i} \pm \sqrt{R_{2i}^2 - \frac{V_{1i}}{\pi L_i}} \quad (15)$$

The resulting formula allows us to determine the average thickness of scale deposits on the inner surface of a glass coating and a metal pipe for given lengths $L_i$ and radii $R_{2i}$.

Moreover, to facilitate and simplify the calculation, the cross-sectional area of the pipe is determined by the formula:

$$S_1 = \pi\left[R_{2i}^2 - \left(R_{2i} - \delta_i\right)^2\right] \quad (16)$$

Neglecting the value $\delta_i$ as small of the second order compared to the value $R_i$, we obtain

$$S_1 = 2\pi R_{2i} \cdot \delta_i$$

Then the formula for determining the thickness of scale deposits looks like:

$$\delta_i = \frac{V_{2i} - V_{1i}}{2\pi L_i R_{2i}} \quad (17)$$

Considering $V_{2i} = \pi R_{2i}^{\ 2} L_i$ that we finally get

$$\delta_i = \left(1 - \frac{V_{1i}}{V_{2i}}\right)\frac{R_{2i}}{2} \quad (18)$$

The virtual absence of deposits in vitrified pipes is explained by the increased cleanliness of the glass surface and its resistance to the aggressiveness of substances dissolved in sea water.

This eliminates the formation of pockets of scale with glass so small that it is washed away by the flow of sea water. As already noted, scale formation reduces the performance of ship heat exchangers by 30-50%.

It should be noted that desalinated water with a salt content of up to 1000 mg/l can be used to cool ships. Typically, desalinated domestic water is used on ships only as washing water; the supply of drinking water is sufficient for drinking water consumption. Desalinated seawater can also be used as drinking water. To do this, it is subjected to special treatment, bringing its taste to drinking water standards. Despite these measures, the use of sea water is harmful.

## Conclusion

The study showed that during long-term operation (45-90 days) and elevated seawater temperatures (60-90$^0$C) on the surface of the glass coatings of tubes, the formation of small amounts of scale deposits with a layer thickness of up to 0.4 mm is observed, in while a strong layer of scale with a layer thickness of up to 2.0 mm is formed on the metal surfaces of the tubes.

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# Rare irises of the Darelayaz range

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**Abstract**

The purpose of the research is to study the genera and species of the rare and endangered *Iridaceae* Lindl. family of the Deraleyaz range. Daraleyaz ridge, located in the territory of the Nakhchivan Autonomous Republic of the Republic of Azerbaijan, stretches from the west and northwest to the east along the border of Armenia and Nakhchivan AR, and is located between Arpachay and Nakhchivanchay. The Garagush mountain (2600.5 m), one of the highest peaks of the Deraleyaz range, has an absolute height of 1200-2600 m, and is located between the upper reaches of Gabalichay and the village of Chalkhangala, south of Kechaltape mountain.

**Key words:** Darelayaz rangei, Iridaceae Lindl., Crocus Adamii J. Gay, İris L., Iris Caucasica Stev., Iris Iberica Subsp. Lycotis (Woronow) Takht., Gladiolus L., Gladiolus Halophilus Boiss. Et Heldr.

## Materials and methods

There is no generalized research work on the study of flora and vegetation in the territory of Deraleaz range of Nakhchivan Autonomous Republic. The fundamental study of the Karagush mountain areas of the range was carried out by N.A.Novruzi. It was conducted by Novruzi and his dissertation work was successfully defended. The taxonomic composition of the rare species of the flora in the territory of the Deraleaz range has been specified, the phytocenological characteristics of the discovered species have been studied, and the cenozoological (dominant, subdominant, edificator) species have been distinguished, and rare or threatened species included in the national and international Red Books have been identified. In addition to determining the current status of the remaining species in the mountain range, suggestions and recommendations were given for the effective use of vegetation, such as summer pastures, based on the collected materials.

## Results and discussion

Up to 1,500 species of *Iridaceae* Lindl., which are included in 70 genera, are distributed on Earth. Most of them are geophytic plants with rhizomes, tuberous and bulbous roots. There are about 40 species of the family in 5 genera in Azerbaijan, of which 23 species belonging to 3 genera grow in the territory of the Nakhchivan Autonomous Republic. Among those species, rare and endangered ones were discovered, protection measures, suggestions and recommendations were prepared.

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**There is no conflict of interests.**

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## Introduction

Daraleyaz ridge, located in the territory of the Nakhchivan Autonomous Republic of the Republic of Azerbaijan, stretches from the west and northwest to the east along the border of Armenia and Nakhchivan AR, and is located between Arpachay and Nakhchivanchay. This range starts from the western part of Gelingaya mountain (about 2800 m) and extends to Bichenak pass and connects with Zangezur range. The total length is about 70 km, the highest peak is Kukudag (3120 m). In the west of the range, the peak of Karagush (Karagurt) (2600 m) rises on the ridge extending south from Gelingaya mountain. The southwestern slope of both mountains descends steeply to the Karabakhlar-Tananam sloping plain. The height of the ridge between Gelingaya Mountain and Kükudağı is up to 2500 m. This part creates a watershed between Arpachay and Jahrichay. The highest peak here is Mount Keshaltepe (2740 m). The part of the Deraleaz range, which is included in the territory of the autonomous republic, has a complex orographic structure. This complexity is

more evident in the terrain, especially south of Kechaltepe mountain. Garangush, Jahri, Garaultape, Ramler and Buzgov tributaries are separated from the ridge. The main part of the Deraleaz ridge north of the Jahri River stretches east and south-west. The absolute height here is 2900-3110 m (Mount Sipar - 3117 m, Kecheldag - 3118 m, Kükudag 3120 m). The watershed of the ridge is sometimes narrow and sometimes wide and smooth. The north-eastern end of the Deraleaz range joins the Zangezur range near the nameless peak with a height of 3087 m [1].

The Garagush mountain (2600.5 m), one of the highest peaks of the Deraleyaz range, has an absolute height of 1200-2600 m, and is located between the upper reaches of Gabalichay and the village of Chalkhangala, south of Kechaltape mountain. In the transition area of the Karagush mountain range to the Duzdag range, Kukudag (3120 m), Kechaldag (3118 m), Almalikdag (2155 m), Gabagtepe (2175 m), Kechaltepe (2744 m), Ardagy (2230.4 m) with a height above 2000 meters. ), Ramler (2289 m), Aghgaya (1758 m), Komuruldag (2065 m), Hinedalı (2101 m) and Anabadgadik (2081 m), standing in the third place, it is located between the last two mountains. There are also peaks below 2000 meters in height: Garabullu mountain -1125 m, Garaburundag (1239 m), Gabagdag -1719 m, Mehridag -1869 m and Gabagyaldag -1824 m.

Mountain-grassy steppe soils prevail in Darelaez range. The vegetation of the area is grouped in the form of desert and semi-desert, phrygana, gariga, scrub and mixed forests, mountain xerophyte, subalpine meadows and tall grasses, petrophilic (rock-debris) vegetation type, adapting to these altitude and climate factors. Here, starting from early spring, one plant species replaces another. Annual rhizomes, bulbous plants and a number of perennial grasses grow rapidly, flower and set seed in the area.

The territory of Nakhchivan MR has rich plant resources and its modern flora is represented by 160 families, 910 genera and 3020 species of high-spore, gymnosperm and angiosperm plants. This amount is 60.4% of the flora of Azerbaijan (5000). Among the mentioned species, according to T.H. Talibov and A.Ş. Ibrahimov's researches, 1078 species are distributed in plains, 1942 species are distributed in mountainous and highland botanical-geographic zones. 340 species of these plants are found in both plains and mountainous zones.

There is no generalized research work on the study of flora and vegetation in the territory of Deraleaz range of Nakhchivan Autonomous Republic. The fundamental study of the Karagush mountain areas of the range was carried out by N.A. Novruzi. It was conducted by Novruzi and his thesis work was successfully defended [3]. At the same time, compared to Ardıdag, Kükudag, Keçaldag, Tekelik (2892 m), Almalikdag, Gabagtepe, Keçaltepe, Ardağı, Ramler, Aggaya, Hinedalı and Anabadgedik mountains, Garagush mountain ranks third. Flora and vegetation of these zones it was studied by T.H. Talibov, A.S. Ibrahimov, A.M. Ibrahimov and other authors, especially from the point of view of studying the modern state of populations of rare plants [6].

The taxonomic composition of the rare species of the flora in the territory of the Deraleaz range has been specified, the phytocenological characteristics of the discovered species have been studied, and the cenozoological (dominant, subdominant, edificator) species have been distinguished, and rare or threatened species included in the national and international Red Books have been identified. In addition to determining the current status of the remaining species in the mountain range, suggestions and recommendations were given for the effective use of vegetation, such as summer pastures, based on the collected materials.

For the first time, the taxonomic spectrum of the rare species of high-spore, gymnosperm and angiosperm plants in the Deraleyaz range of Nakhchivan AR was drawn up and a systematic analysis was carried out. N.A. Novruzi [3. etc. 11-12] as a result of the research conducted in the area of Karagush Mountain, it became clear that 19 species of the Bryophyta branch, which are included in 13 families and 17 genera, are distributed in the research area. Accordingly, Pteridophyta (Polypodiophyta) includes 5 species in 4 families and 5 genera, Equisetophyta includes 2 species in one family and one genus, Gnetophyta includes 2 species in one family and one genus, and Pinophyta (Gymnospermae) includes one family and one genus. 3 species included, 199 species included in 20 families and 108 genera in the class Magnoliophyta (Angiospermae) Monocotyledoneae, and 624 species included in 49 families and 351 genera in the class Dicotyledoneae were found. In total, there are 856 species in 484 genera belonging to 89 families in the study area.

Up to 1,500 species of *Iridaceae* Lindl., which are included in 70 genera, are distributed on Earth. Most of them are geophytic plants with rhizomes, tuberous and bulbous roots. There are about 40 species of the family in 5 genera in Azerbaijan, of which 23 species belonging to 3 genera grow in the territory of the Nakhchivan Autonomous Republic. Among those species, rare and endangered ones were discovered, protection measures, suggestions and recommendations were prepared.

## Materials and methods

*Crocus Adamii* J. Gay- is included in the Red Book with the status VU B1ab(i,iii). In the upper mountain belts, it is spread around the village of Garagush and Kechaltepe of Sharur district, Batabat of Shahbuz district and Kizilja village of Julfa district. It grows on stony, gravelly and grassy slopes. It has few natural resources in a limited area. It is propagated by seeds and bulbs.

*Biological characteristics:* It is a perennial herb. The bulb is spherical-egg-shaped, covered with numerous leathery, brown coverings. It is separated from the lower part in the form of a ring. The leaves are 3-7 pieces, appear at the same time as the flower, narrow linear, 2 mm wide, naked, equal to the flower. The inflorescence is golden-yellow in the fold, furrowed on the outside, the stamens are yellow-orange in color, the tip of the female is orange, longer than the pollen. Depending on climatic factors, the period of flowering and fruit formation occurs in April-May.

No special protection measures are taken. In order to reduce the anthropogenic impact, it is important to organize personal protection in places of spread, that is, to search for places of spread.

Mainly anthropogenic and natural climatic factors have caused the change of natural resources. Some avid nature lovers cultivate in their field for a living. Since it was recently included in the Red Book of Azerbaijan, protective measures have not been prepared for its protection, efficient and sustainable use. In order to reduce the anthropogenic impact, it is important to organize personal protection in places of spread, that is, to search for places of spread.

Recent periods *Iris* L. - Serious nomenclature changes have been made within the iris genus, Iridodictyum Rodionenko and Yuno Tratt were previously separated from this genus. genera and included species were re-united into the genus Iris. There are 13 species of this genus in the territory of Nakhchivan AR. *Iris Caucasica* Stev. Lower Risk - LR [a - Conservation Dependent - CD] status is included in the Red Book. In the lower and middle mountain belts, it is spread around Ardych and Garagush mountains of Sharur district, Batabat of Shahbuz district and Kyzilca village of Julfa district. Grows on stony and grassy slopes. Since it is a species distributed in a limited area, it has little natural resources. It is propagated by seeds and bulbs.

*Biological characteristics*: It is a perennial plant. The bulb is egg-shaped or oblong, 2-2.5-(3.5) cm wide, covered with a dark brown-gray membrane-like sheath. Continuing from the root throat, there are rope roots. The height of the stem varies from 7-15 (20) cm, it has leaves up to the top, 1-3 flowers. The leaves are grayish-green or blue, sword-shaped, gradually pointed, sickle-shaped, usually jagged along the veins, the edges are bordered with a white line, densely short ciliated, the inflorescence tube is 4-5 times longer than the ovary. Inflorescence is 3.5-4.5 (5) cm long, greenish or bluish-yellow, pale, funnel-shaped, the outer parts are wide, oblong, the base is narrowed to a wedge-like shape, bright yellow along the middle line, narrowly combed, the middle parts are small, 15 -20 mm long, spade-shaped or inverted, with a downwardly curved nail. The stamens are slightly shorter than the inflorescences, broad and obtuse. The box is 3 cm long, cylindrical in shape, elongated and with a short nose. It blooms and gives seeds in April-May. Geophyte is an ornamental plant. It is a mesoxerophyte. Iran is included in the geographical area type.

Due to the small number of species and population, environmental and anthropogenic factors have changed the natural resources. It is cultivated in the collection of rare plants of the Botanical Garden of the Nakhchivan Department of the Bioresources Institute of ANAS. Since it was newly included in the Red Book of Nakhchivan AR, protective measures have been prepared for its protection, efficient and sustainable use. Since its population is relatively threatened, the areas where it spreads in ADTY and ZMP areas should be taken under control as an important species to protect.

*Iris Iberica* Subsp. Lycotis (Woronow) Takht. (*I. Lycotis* G. Woronow) - Near Threatened – included in the Red Book with NT status [4]. In Azerbaijan, it is spread only in the plain, low and middle mountain zones in the territory of Nakhchivan AR. It is spread in very small groups starting from the middle mountainous zone of Sharur district of Nakhchivan MR to the territory of Ordubad district. It is described on the basis of materials collected from the Daridag area of Julfa region. It grows on low-fertile dry clayey, gravelly slopes and wormwood semi-deserts. Although the areas where it is spread are wide, it has little natural resources as it is found in small groups everywhere. It reproduces by seeds and rhizomes.

*Biological characteristics:* It is a perennial polymorphic plant, its inflorescences are of different colors. The rhizome is dense, short and creeping. Its stem is 10-20 (25) cm long, and ends with a large flower. The leaves are grayish, dull, narrow-line. 2-4 mm wide, often sickle-curved, usually shorter than the stem. The outer part of the inflorescence is bent down, 4.5-5.5 (8) cm long, wide-elliptical or spherical, reddish-brown in color, with a velvety spot in the middle. The inner part is directed upwards. It is large, 5.5-8 (3) cm long, with numerous red-purple veins. The parts of the

female are dark red - brown, shorter than the outer part of the inflorescence, the slices are toothed. The box is oblong-cylindrical, three-lobed, 7 cm long and has a long nose. It flowers and produces seeds in April-May. It is an ornamental plant with rhizomes. In the area, this species has a dark blackish-brown color, which differs from the usual species. magnifica Grossh. is in the form It is a mesoxerophyte. It is endemic. Atropatan is included in the geographical area type

Natural resources have been changed mainly due to human activity and some abiotic factors. AR ETN is cultivated in the collection of rare plants of the Botanical Garden of the Institute of Bioresources (Nakhchivan). For its effective and continuous use, it was included in the Red Books of the former USSR, Azerbaijan, and including Nakhchivan AR. The protection of its population in the main places where it grows in the Arpachay, Ordubad and Arazboyu State Nature Reserves should be strengthened, and its biological characteristics should be studied, as its range is gradually decreasing, its biology is poorly studied, and it is close to danger.

*Gladiolus* L. - There are 6 species (one species is cultivated) in the Caucasus, Azerbaijan, including the flora of Nakhchivan MR, out of 150 species of the onion genus distributed in the Cape and Mediterranean provinces, North America and Europe.

*Gladiolus Halophilus* Boiss. Et Heldr.-Near Threatened – included in the Red Book with NT status. In Nakhchivan AR, it is found on the Araz coast, at the foot of Garagush and Kechaltepe mountains in Saderak district, in the salinized areas around Kotam village in Buyukduz and Ordubad districts in Kangarli district. It grows on infertile dry slopes and saline areas in the lower mountain belt. Since it is found singly or in small groups in unfavorable areas, its reserve is low. It reproduces by seeds and bulbs.

*Biological characteristics:* The bulb is egg-shaped, 15-18 mm high, 10-15 mm wide, scales are reticulated and hairy. The height of the stem is 20-25 cm, thin, sometimes curly, greenish. The leaves are bluish, straight - linear, pointed, 3 - 7 mm wide, with 3 - 4 veins. The flower group is two-sided, rarely one-sided spike, 4-6 flowers. The inflorescence is lanceolate, 1.5 - 2 cm long, unequal. The inflorescence is pale purple, wide open, the upper lateral part is shorter than the remaining parts. The anther is slightly shorter than the stem. It blooms and its seeds ripen in May - June. Geophyte is an ornamental plant. It is a xeromesophyte. Front Asia is included in the geographical area type.

Natural resources have been changed mainly due to human activity and some abiotic factors. AR ETN is cultivated in the collection of rare plants of the Botanical Garden of the Institute of Bioresources (Nakhchivan). It is included in the Red Books of Azerbaijan and the former USSR for its protection, efficient and sustainable use. As an endangered species whose range is gradually decreasing, its biology is poorly studied, ADTY and Arazboyu State Nature Reserve should be protected and its biological characteristics should be studied.

## Results and discussion

1. 23 species belonging to 3 genera of the family Iridaceae Lindl. grow in the territory of Nakhchivan Autonomous Republic, of which 4 species belonging to 2 genera are rare and endangered.

2. Iridaceae Lindl found in the Deraleyaz range. Crocus Adamii J. Gay, Iris Caucasica Stev., Iris Iberica Subsp. Lycotis (Woronow) Takht. (I. Lycotis G. Woronow), Gladiolus Halophilus Boiss. Et Heldr. Includes.

3. Those species are included in the Red Book with the status of VU B1ab(i,iii), LR [a - Conservation Dependent - CD] and NT.

4. Crocus Adamii J. Gay has changed its natural resources mainly due to anthropogenic and natural climatic factors. Since it was newly included in the Red Book of Azerbaijan, protective measures have not been prepared for its protection, efficient and sustainable use.

5. Iris Caucasica Stev. the number of species, their population is small, the natural resources have been changed due to the influence of ecological and anthropogenic factors. It is cultivated in the collection of rare plants of the Botanical Garden of the Nakhchivan Department of the Bioresources Institute of ANAS. Since it was newly included in the Red Book of Nakhchivan MR, protective measures have been prepared for its protection, efficient and sustainable use.

6. Iris Iberica Subsp. Lycotis (Woronow) Takht. (I. Lycotis G. Woronow) natural resources have been changed due to human activity and some abiotic factors. It is cultivated in the collection of rare plants of the Botanical Garden of the Institute of Bioresources (Nakhchivan). It is included in the Red Books of the former USSR, Azerbaijan and the Nakhchivan Autonomous Republic for its effective and sustainable use.

7. Gladiolus Halophilus Boiss. Et Heldr has changed its natural resources mainly due to human activities and some abiotic factors. It is cultivated in the collection of rare plants of the Botanical Garden of the Institute of Bioresources (Nakhchivan). It is included in the Red Books of Azerbaijan and the former USSR for its protection, efficient and sustainable use.

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# The impact of global urbanization on natural resources and the environment

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**Abstract**

Urbanization, as a result of rapid population growth and economic development, has a multifaceted impact on ecosystems. An increase in urban population density leads to a deterioration in air and water quality, as sources of pollution are transport, industry and insufficient infrastructure for wastewater treatment. Attention is also focused on the loss of biological diversity due to the development of natural territories and fragmentation of ecosystems. Soil pollution and the scarcity of natural resources such as water and minerals are becoming serious problems threatening sustainable development. Global urbanization exacerbates climate change, as it concentrates greenhouse gas emissions and creates "thermal islands", which leads to higher temperatures and changes in the local climate. Social problems such as inequality and deteriorating living conditions are also becoming a consequence of urbanization, which highlights the need for sustainable urban development and effective resource management.

**Key words:** global urbanization, urban pathology, the global ecological balance, economic progress, technological development, population growth.

## Introduction

In the modern world, urbanization has become an indispensable phenomenon that has a significant impact on the economy, social sphere and the environment. In a geographical context, urbanization is studied as an important phenomenon that shapes the spatial organization of our planet. The features of urbanization include many factors that influence its development and character. Firstly, it is the volume of the population living in cities. Rapid population growth and migration from rural areas to cities lead to an increase in population concentration and density of residential areas. Secondly, urbanization affects the structure and functions of cities. More and more people are choosing urban life, which leads to changes in infrastructure, transport system and public services.

## Results and discussion

Global urbanization is a complex process that has a significant impact on natural resources. This influence covers various aspects, including economic, social and environmental factors. Let's take a closer look at exactly how global urbanization affects natural resources:

1. Increased resource consumption

• Population growth: Global urbanization is leading to more and more people being concentrated in cities. According to the UN, by 2050, more than two thirds of the world's population will live in cities. This causes a sharp increase in demand for basic resources such as water, electricity and food.

• Building materials: Urbanization requires significant amounts of building materials such as concrete, steel and wood. This, in turn, leads to an increase in deforestation, mining and other types of resource exploitation.

2. Environmental pollution

• Air quality: In large cities, the concentration of motor vehicles and industrial enterprises leads to air pollution, increasing the level of carbon dioxide and other harmful substances such as sulfur and nitrogen oxides.

• Water resources: Industrial and domestic wastewater pollute rivers and lakes. According to the World Health Organization, water pollution is one of the leading causes of disease in developing countries.

3. Water scarcity

• Increased consumption: The urban population requires a large volume of fresh water. Studies show that urban water consumption can be several times higher than rural consumption.

• Increasing scarcity: In regions with limited water resources, such as the Middle East and North Africa, urbanization exacerbates already existing scarcity, creating tensions between different sectors using water (e.g. agriculture and domestic use).

4. Destruction of natural ecosystems

• Destruction of the natural environment: The

construction of new residential and commercial facilities often leads to deforestation, drainage of swamps and landscape changes. This harms ecosystems and reduces biological diversity.

• Land degradation: Changes in land use can lead to erosion, loss of soil fertility and a decrease in its quality, which makes agricultural production difficult.

5. Climate change

• Greenhouse gas emissions: Urban areas are significant sources of carbon emissions due to the high concentration of transportation and production facilities. This leads to global climate change, which all of humanity is facing.

• Thermal islands: Urban infrastructure such as asphalt and concrete absorb and retains heat, which creates so-called "thermal islands", increasing the average temperature in cities and affecting the microclimate.

6. Increased waste

• Garbage volume: An increase in urban population leads to an increase in waste production. It is estimated that cities produce more than 1.3 billion tons of solid waste per year, and this figure will grow.

• Recycling problems: Many cities face problems with waste disposal and recycling, which leads to the accumulation of garbage and pollution of the environment.

7. Improper use of land

• Functional segregation: The division of cities into functional zones (residential, commercial, industrial) can lead to inefficient use of land, when some areas are left without proper use, while others become overloaded.

• Generation of "empty" spaces: As a result of incorrect zoning, "empty" spaces arise, which become ineffective and hinder the development of communities.

8. Social and economic inequalities

• Access inequality: Global urbanization can lead to social inequalities where some groups of the population have access to natural resources and others do not. This creates tension and can lead to social conflicts.

• Living conditions: In conditions of low availability of resources, some segments of the population may suffer from a lack of clean water, housing and medical care, which worsens the overall quality of life.

Global urbanization also has a significant impact on the environment. Let's look at the key aspects of this influence in more detail:

1. Air pollution

• Sources of pollution: In large cities, sources of pollution are road transport, industrial emissions and the burning of fossil fuels. These factors lead to high levels of smog, fine particles and toxic gases (e.g. carbon dioxide, nitrogen oxides and sulfur).

• Public health: Polluted air negatively affects the health of residents, causing respiratory diseases, cardiovascular diseases and even premature deaths.

2. Pollution of water resources

• Wastewater: An increase in population leads to an increase in the amount of wastewater, which often leads to pollution of rivers and reservoirs. Improper waste management and insufficient wastewater treatment exacerbate this problem.

• Ecosystems: Pollution of water bodies has a negative impact on aquatic flora and fauna, leading to a decrease in biodiversity and destruction of ecosystems.

3. Loss of biological diversity

• Harmony with nature: Urbanization leads to the loss of natural habitat for many species of animals and plants. Deforestation, development of natural areas and pollution put pressure on biodiversity.

• Fragmentation of ecosystems: Urban areas create isolated ecosystems, which complicates the migration and reproduction of species, increasing the risk of their extinction.

4. Climate change

• Greenhouse gas emissions: Urbanization leads to an increase in greenhouse gas emissions, which contributes to global climate change. The concentration of transport and industrial facilities in cities enhances this process.

• Thermal islands: Urban infrastructure (asphalt, concrete) absorbs and retains heat, creating "thermal islands", which increases average temperatures and affects the local climate.

5. Soil pollution

• Waste: An increase in population and consumption leads to an increase in the volume of solid waste. Many cities are unable to cope with their disposal, which leads to the accumulation of garbage in landfills and in natural ecosystems.

• Pesticides and chemicals: Agriculture around cities often uses chemical fertilizers and pesticides that can contaminate soil and groundwater, which also has an impact on human health.

6. Lack of natural resources

• Changing demand: An increase in the urban population leads to an increase in demand for water, energy and food, which can lead to depletion of natural resources and shortages.

• Environmental burden: Intensive use of resources in cities causes environmental stress, which makes sustainable development difficult.

7. Social and economic problems

• Inequality: Global urbanization is often accompanied by social inequality, where some groups of the population have limited access to resources and services, which can lead to a

deterioration in living conditions.

• Living conditions: In conditions of high population density, there may be problems with access to clean water, sanitation and medical services, which affects the general health of the population.

8. Sustainable development and environmental solutions

• Sustainable planning: To minimize the negative effects of urbanization, it is necessary to implement sustainable urban planning methods such as green buildings, public transport and waste management systems.

• Environmental initiatives: Global environmental initiatives such as reducing greenhouse gas emissions and creating protected natural areas can help address the challenges of urbanization.

Classical socio-philosophical approaches consider urbanization as a natural consequence of the industrialization of society, which is part of the modernization process associated with the transition from traditional to modern social structures. Max Weber believed that the basis of urbanization is market relations, which contribute to the development of cities as economic and economic centers. According to his theory, urbanization is accompanied by the deepening of labor specialization, the growth of industrial production and the concentration of population in urban areas. These ideas describe the initial stages of urbanization, when industrialization was the main factor in the formation of urban agglomerations, which led to the quantitative growth of cities and an increase in population density. The leaders of this process were the countries of Western Europe and North America, where urbanization and industrialization took place at a high pace. By the middle of the 20th century, these changes had reached their peak, which foreshadowed the transition to the post-industrial era and new global changes. In modern Western theories of urbanization, the emphasis is shifted to the study of not only urban growth, but also aspects such as social heterogeneity, population mobility and the process of megapolization. Modern research marks a new stage of urbanization associated with the introduction of information technology and the processes of globalization. In this context, special attention is paid to global cities, which are becoming key centers of global economic and political governance, reflecting the characteristic features of post-industrial urban development.

American researcher Saskia Sassen believes that global cities are important hubs for financial flows, business transactions, scientific connections and other contacts that shape the dynamics of the global economy. According to Manuel Castells, a global city is not only a large populated place, but also a process in which the centers of production and consumption of highly developed services are integrated into global networks through information flows, while severing ties with remote areas far from the industrial center. This leads to new urban trends related to the restructuring of urban spaces and the expansion of their functional role. As a result of globalization, many megacities have acquired a global status. Some of them, such as London, New York, Tokyo and Paris, are already comparable to successful states in terms of their economic potential. The environmental problems of megacities are complex and affect various aspects of the environment, including the atmosphere, water resources and soil. Today, one of the main environmental threats to large cities is air pollution caused by the activity of industrial enterprises and the massive use of motor vehicles. The researchers note that the level of aerosols in the atmosphere of cities exceeds the norm by 10 times, and the content of harmful gases by 25 times. At the same time, vehicles account for 60-70% of gas emissions. The water resources of megacities are also severely depleted, which is associated with a high level of water consumption both in industry and in everyday life. Experts identify two main sources of pollution of reservoirs in large cities: a) water pollution in water intake areas; b) discharge of industrial and domestic wastewater into urban reservoirs. Pollution of surface and groundwater occurs due to effluents from industrial and municipal enterprises that do not have effective treatment systems or emergency discharges occur, bypassing treatment facilities. In addition, the high population density in megacities contributes to an acute shortage of water resources. Over the past hundred years, the water needs of cities have increased 10 times, and in megacities such as Paris, Rome, Moscow, Berlin and New York - more than 100 times. At the same time, with a high level of population density and a corresponding increase in consumption in large cities, the issue of recycling industrial and household waste is acute. In recent years, it is the problem of household garbage that has come out on top among other environmental problems in large cities. This is due to the fact that modern household waste has either a long decomposition period or does not decompose at all. These circumstances significantly complicate the problem of their recycling and lead to the fact that at the moment "about 90% of all waste is disposed of by simply burying in the ground. This leads to irreversible environmental consequences.: the loss of significant areas of agricultural land, poisoning of groundwater and, accordingly, leads to the

unusability of underground drinking water sources." As a result, the soil cover of urban areas is negatively affected, since it is completely destroyed under landfills, highways and residential areas, and in recreational areas it is polluted with household waste and harmful substances present in the atmosphere. Harmonious personal development is impossible without constant interaction with nature, therefore, its preservation and improvement represent a key task of the rational organization of territories. Population growth, efficient use of natural resources and environmental protection are closely interrelated and mutually affect each other. Economic progress, technological development and population growth have a significant impact on the state of ecosystems. Environmental problems such as air and water pollution, soil erosion, destruction of flora and fauna in the process of developing new territories, as well as the irrational use of land, oil, gas, coal and other natural resources are of particular concern. With increasing needs, industry's demand for raw materials increases, but many natural resources, although vast, are not unlimited at all. The rational use of these resources and environmental protection directly affect people's health, working conditions and lives. In the context of the scientific and technological revolution, one of the most important problems is the threat of a violation of the balance between man and nature. The process of industrialization and urbanization increases this impact, worsening the environmental situation. The researchers warn that the uncontrolled growth of urbanism can upset this balance if planning does not take into account the limitations associated with natural resources and human biological characteristics. According to experts, there is a real danger that humanity may go beyond the limits of acceptable interaction with the environment, which could lead to an environmental crisis. The negative impact of pollution and climate change on natural resources, although not yet fully proven, is already being observed in the world's largest cities. Preserving the global ecological balance and preventing a crisis depends on humanity's ability to manage its relations with nature in an organized and responsible manner. The problem of the relationship between natural resources and population affects not only the growth of production, but also the increase in population. The main increase occurs in developing countries, which face serious shortages of food, means of production and financial resources. The issues of demographic growth and economic resources are directly related to solving socio-economic problems. In modern conditions, one of the temporary measures to improve the balance of "population-resources" may be the promotion of limiting population growth in third world countries, taking into account state sovereignty and respect for family rights. With the growing population, the issue of environmental management is becoming acute, especially in connection with the concentration of people in large cities. The crisis of urbanization is one of the manifestations of the global crisis. The problems of urbanization are mainly of a social nature, and their solution requires centralized government measures to combat pollution in cities. Migration of the population should be stimulated to those regions where it meets the needs of economic development and preservation of ecological balance. A promising direction is the creation of a unified settlement system that takes into account the requirements of the economy, the need to protect the environment and improve people's living and working conditions. In recent years, a new scientific field has appeared in the West and in our country — the pathology of urbanization. The concept of "pathology" can be interpreted in two ways: in everyday speech, this is behavior that deviates from the norms of morality and the law. In a broader context, "social pathology" encompasses phenomena such as economic conflicts (e.g. strikes), crime, alcoholism, drug addiction, prostitution, mental illness, corruption, and other social problems. All these phenomena are not only symptoms, but also causes of social diseases, which require a more thorough analysis to develop effective solutions. Pathological phenomena occur both in cities and in rural areas, but they are more typical for cities, since the urban environment contributes to their spread. Urban pathology itself includes those problems that arise as a result of the specific organization of the urban environment. These include housing problems, environmental pollution, insufficient transport development, poor performance of public services, poor quality of service and other aspects. The reason for these phenomena is the very structure of the urban organization, which creates conditions unfavorable to human health, reduces their ability to work and prevents more efficient reproduction of social systems. It also leads to social disorganization, which can contribute to deviant or even criminal behavior. Thus, the roots of urban pathology lie in the very structure of modern urbanized society, which is insufficiently adapted to solve problems related to human activity. Approaches to solving these problems may differ in different social systems. The pathology of the city covers both social problems specific to the city and those that are directly related to the characteristics of the urban environment. To determine the pathology of urbanization, you must first: 1) define urbanization; 2) create a model of "normal"

urbanization; 3) consider the pathology of urbanization as a deviation from this norm. Normal urbanization assumes a harmonious relationship with the processes of industrialization. There are three possible scenarios: a) urbanization and industrialization run in parallel; b) urbanization is ahead of industrialization; c) industrialization is ahead of urbanization. Variants b) and c) can be considered pathological situations. Too rapid industrialization with insufficient urban development leads to an imbalance, when industrial workers outnumber the urban population, and the development of urban infrastructure lags behind. This causes a redistribution of labor from agriculture to industry without actual migration of the population to cities, which worsens living and working conditions. The question arises: to what extent are urbanization pathologies related to the general trend of urban-industrial civilization, and to what extent to specific processes of industrialization? And to what extent do these pathologies depend on the characteristics of individual societies, political systems and urban policies? Among the key problems associated with urbanization and urban structures, there are: insufficient urban development, housing difficulties, negative consequences of the functional division of cities, as well as the perception of block developments. Each socio-economic system organizes space in its own way, forming a certain attitude towards it both among individuals and social groups. This can be represented in the form of various oppositions: personal versus public, central versus peripheral, ritual versus secular. For the healthy functioning of society, it is important to maintain harmony between these oppositions. The primary space is housing and its immediate surroundings, which must meet the needs of people, while the secondary space, such as public spaces and infrastructure, must be rationally organized. Problems arise when the secondary space begins to displace the primary one, which leads to a conflict between the technical organization and the organic development of human society. This new line of research helps to identify the negative aspects of urbanization and seek solutions to minimize these problems in different countries, which contributes to the development of international scientific relations and a deeper understanding of current urbanization processes. To solve the problems of the pathology of urbanization, it is necessary to implement comprehensive and sustainable urban planning strategies. This includes the development of green areas, effective resource management, the creation of affordable housing and the improvement of social infrastructure. It is also important to take into account the needs of all population groups and ensure their participation in decision-making processes. An important aspect is the integration of modern technologies into urban management. Smart cities offer innovative solutions aimed at optimizing urban infrastructure and improving the quality of life. This may include the use of data for planning transportation systems, energy and waste management, and the development of digital platforms to involve citizens in urban processes.

## Conclusion

Global urbanization, as a consequence of economic growth and population migration in search of better living conditions, significantly affects ecosystems and natural resources. An increase in urban population density leads to significant environmental problems, such as deterioration of air and water quality, loss of biodiversity, as well as depletion of resources necessary for life. At the same time, without proper management and planning, cities become the main sources of pollution and greenhouse gas production, which contributes to climate change and an increase in the frequency of extreme weather events. Social consequences, such as inequality and deteriorating living conditions, also deepen the problems associated with urbanization. To mitigate these negative impacts, comprehensive strategies are needed that take into account environmental, social and economic aspects. It is important to develop sustainable urban planning practices, invest in green technologies and involve the population more actively in environmental protection processes. This is the only way to achieve harmonious coexistence of man and nature, ensuring the future for future generations and preserving the natural resources of the planet.

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# Assessment of relationship in chickpea (C*icer arientinum* L.) based on productivity characteristics and SSR markers in Azerbaijan

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**Abstract**
Genetic diversity and marker–trait association (SSR) with yield-related components were assessed in 43 chickpea (*Cicer arietinum* L.) accessions from a germplasm collection with autumn-sown seeds in Azerbaijan. Chickpea accessions originated from Azerbaijan, Iran and the International Center for Agricultural Research in the Dry Areas (ICARDA). Ten SSR markers were used for molecular genotyping. Yield and yield components were evaluated in eight traits in experiments with autumn seed sowing. An analysis of correlation relationships between yield-related traits in chickpea revealed the dependence of yield on plant height, branching, and the setting of a large number of beans. These traits showed maximal values in experiments with chickpea plants from autumn seed sowing. As a result of SSR marker analysis, the number of alleles recorded was 4-7, the largest polymorphism was in markers TA46 (PIC = 0.88), H1A12 (PIC = 0.84), H3E04 (PIC = 0.82), and the least polymorphism was Recorded in markers NCPGR6 (PIC = 0.42), H4E04 (PIC = 0.44). The greatest polymorphism was found in the studied chickpea genotypes using SSR marker TA142, TA46, TA71, H1B09, H1A12 and H3E04 SSR primers, cluster analysis grouped the samples into 5 clusters. These unique alleles can be used as an identification code in the passporting of the genotypes in which they are identified. Correlation analysis was performed between 10 SSR primers and yield components, several informative SSR primers related to important traits such as plant height, first pod height, number of branches, number of fertile branches, number of pods per plant were found.

**Keywords:** SSR, molecular markers, yield-related components.

## Introduction

Chickpea (Cicer arietinum L.) is an annual, self-pollinated diploid legume plant species, from the Fabaceae family, providing high-quality plant protein for more than 30% of the world’s population. In 2018, 17.2 million tons of chickpeas were produced from 17.8 million hectares of land throughout the world [7, 8]. As in the world, chickpea production in Azerbaijan is increasing year by year and in 2022 it covered more than 6,189 thousand hectares. Especially in the Southern regions of Azerbaijan, it is successfully cultivated in non-irrigated conditions on an area of 4,642 thousand ha [6]. The ability of chickpea plants to withstand drought and moisture deficiency is a key to its successful cultivation in non-irrigated conditions of Azerbaijan [12, 13]. Additionally, chickpea plants can be tolerant to cold stress from low temperatures and even a short time of freezing. Autumn-sown chickpea, therefore, is also used in Central regionswhere there are mild-cold winters, and plants grow and overwinter in these conditions [18].

The genetic diversity germplasm collections of crops including chickpea can be an essential resource for the identification and use of required genotypes adapted to specific regional growing conditions, resulting in their successful application in breeding [14,16]. Applying molecular markers in genetic diversity studies can enable germplasm collections to be used more effectively [5].

The discovery of molecular markers closely linked to the studied breeding traits has made it possible to carry out marker-assisted selection, MAS [3]. In the breeding of chickpea and other legume crops, microsatellite markers, SSR, have been successfully used for the assessment of genetic diversity and further selection, including MAS [3, 11, 15, 17, 20]. SSR markers have a codominant inheritance type, which is very

important for hybrid population analyses [11]. A very high polymorphism of SSR loci and allele distribution throughout the genome provides very diverse information about the genetic polymorphism among studied germplasms [1,14].

The purposes of this research were (1) to assess the genetic diversity in a chickpea germplasm collection in Azerbaijan using SSR markers; and (2) to analyze associations between SSR allelic variants and yield components in chickpea genotypes for better productivity in plants grown in autumn and spring sowing periods.

## Materials and methods

In this study, 43 chickpea accessions were used from the legume germplasm collection by National Gene Bank of Azerbaijan Genetic Resources Institute.Chickpea accessions originated from Azerbaijan, Iran and the International Center for Agricultural Research in the Dry Areas (ICARDA) ( Table 1). All studied chickpea accessions were of the Kabuli ecotype with bigger and light-colored seeds. Samples were planted and studied according to international descriptors, seeding was done by hand, plots were 5 m long, 2.5 m wide, 30 cm between rows, 5 cm between plants, with a total of two replicates for each chikpea genotype in a completely randomized block design for each sample. 100 seeds were sown, local standard Jamila variety was used for comparison.

### Molecular Analysis

For each genotype, 3 g of leaf tissue collected from five plants were pulverized using pre-cooled nitrogen, and then 400 µL of extraction buffer was added, kept in a water bath for 40 min, and 200 µL of chloroform was added and precipitated by vortexing. Then, 180 µL of isopropanol alcohol stored at -20 $^0$C was added to the DNA and washed twice with 76% ethanol. DNA was dissolved in 100 µL of ddH2O. The quality and quantity of extracted DNA was determined by measuring absorbance at 260 and 280 nm using a Jenway 635031 spectrophotometer (Bibby Scientific, Ltd., Staffordshire, UK). The DNA concentration was diluted to 100 ng/µL using ddH2O. PCR was carried out in a total volume of 15 µL containing 1.5 µL of 10 × PCR buffer, 2 mM MgCl2, 0.15 µM of each dNTP, 0.7 µM of each primer, 0.5 U of Taq DNA polymerase ) and 0.07 µg/µL BSA (final concentration). The reactions were carried out in a Bio-Rad iCycler system (Bio-Rad Laboratories, Hercules, CA, USA) with the following program: an initial step of 94 °C for 3 min; 30 cycles of 94 °C for 1 min; 55 °C for 1 min and 72 °C for 1 min; and a final step of 72 °C for 5 min.

Table 1. Origin and morphological characteristics of studied chickpea germplasm collection.

| № | Genotypes | Origin | № | Genotypes | Origin |
|---|---|---|---|---|---|
| 1 | Narmin | Azerb. | 23 | Jalilabad 11 | Azerb. |
| 2 | Jamila St. | Azerb. | 24 | Flip 97-32 | İCARDA |
| 3 | Ağdənli | Russian | 25 | Shamakha 25 | Azerb. |
| 4 | F.13-154 C | ICARDA | 26 | Yardımlı 29 | Azerb. |
| 5 | F.13-227 C | ICARDA | 27 | Agdash18 | Azerb. |
| 6 | F.13-234 C | ICARDA | 28 | Sultan | Azerb. |
| 7 | F.13-320 C | ICARDA | 29 | Yardımlı 27 | Azerb. |
| 8 | F.13-358 C | ICARDA | 30 | Masallı 30 | Azerb. |
| 9 | F.13-364 C | ICARDA | 31 | Masallı 51 | Azerb. |
| 10 | F. 88-85 C | ICARDA | 32 | Bilasuvar 58 | Azerb. |
| 11 | F. 93-93 C | ICARDA | 33 | Lerik 33 | Azerb. |
| 12 | F.13-53 | ICARDA | 34 | Absheron 35 | Azerb. |
| 13 | F.13-55 | ICARDA | 35 | Lankaran 1 | Azerb. |
| 14 | F.11-08 C | ICARDA | 36 | Lankaran 2 | Azerb. |
| 15 | F.11-01 C | ICARDA | 37 | Flip03-48 | ICARDA. |
| 16 | Ordubad 39 | Azerb. | 38 | Jalilabad50 | Azerb. |
| 17 | Ordubad 41 | Azerb. | 39 | Iran 48 | İran |
| 18 | Qusar 43 | Azerb. | 40 | Jalilabag 55 | Azerb. |
| 19 | Qusar 44 | Azerb. | 41 | Sabirabad59 | Azerb. |
| 20 | Agstafa 42 | Azerb. | 42 | Ordubad 47 | Azerb. |
| 21 | Flip 03-22 | ICARDA | 43 | Yardımlı 28 | Azerb. |
| 22 | Bakı 30 | Azerb. | | | |

PCR products were visualized on 8% polyacrylamide gel at a constant rate of 200 V for 70 min and detected via staining with ethidium bromide. Electrophoresis images were obtained using a Quantum ST4 gel-documenting system (Vilber, Lourmat, Collégien, France). The

amplicon size was determined using the computer program Quantum Capture Image Analysis (Vilber, Lourmat, Collégien, France).

10 SSR markers previously used and recommended for the study of chikpea genetic diversity were used to assess the genetic diversity of the studied chikpea genotypes (Table 2). For scoring each polymorphic band, the patterns of SSR loci were evaluated using the following codes: '1' for the presence of the band and '0' for band absence. A data matrix for bands' presence or absence was used for further analysis. The number of alleles major allele frequency, genetic diversity and polymorphism information content (PIC) were calculated using PowerMarker 3.25 software [10,16]. Cluster analysis using the unweighted pair group method with arithmetic mean (UPGMA) and Pearson's correlation analysis was conducted in R software [12].

## Results and discussion

Chickpea samples were studied and evaluated in a comparative manner with the regionalized new Standard Jamila variety. The vegetation period of the plants is 230-240 days, the flowering phase was recorded on April 15-30, and the bean formation phase was recorded on May 5-18. The height of the plants was 55-89 cm, the number of branches was 2-5. The height of the first bean is 19-45 cm, the number of beans per plant is 24-65, the weight of 100 seeds is 20.6-48.5 g, the weight of one seed is 20.0-68.0 g, the yield per 1 m2 spot is 205.5-521. It was between 7 g. In the studied chikpea accessions, the samples superior to the standard by 2-3 parameters in terms of the main productivity elements are F.13-320 C, F.13-227 C, F.13-358 C, F.13-364 C, F.88-85 C, F.93-93 C, F.13-53 and Jalilabad 11.

### Correlation Analysis.

During autumn sowing, the correlation analysis of studied yield-related traits showed significant accessions (Figure 4). Plant height and plant vegetation period (0.47**), first bean height (r = 0.63**), number of branches (r = 0.36*), seed mass per plant (0.48**), yield per 1m2 ( 0.58**) and the number of pods per plant (r = 0.33*), seed mass per plant with the number of fertile branches (r = 0.71***) , the number of pods per plant (r = 0.69***) and productivity per 1m2 (r = 0.36*) was significantly correlated. Correlation between plant height and first bean height was also significant (r = 0.63***) (Figure 1). A significant correlation (r = 0.55**) was also observed between the vegetation period and the height of the first bean. Correlation analysis of yield components in chickpea genotypes showed that seed mass, number of pods and number of fertile branches per plant showed a positive correlation with yield. These characteristics have maximum value in tall and branched plants. Such chikpea plants can be adapted to winter growth by taking advantage of early spring rains and avoiding drought stress during heat and moisture deficit sensitive reproductive organ development [10.14].

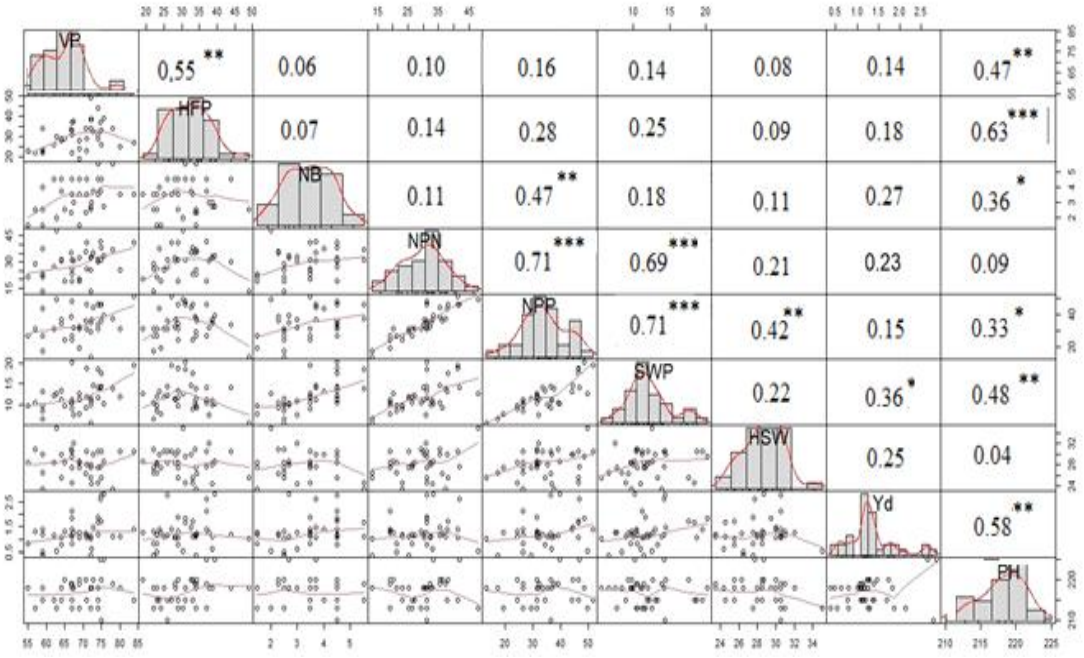


**Figure 1.** Correlation coefficients among the nine studied traits in 39 chickpea accessions in the germplasm collection (autumn sowing). Traits: VP, vegetation period (days);PH, plant height (cm); HFP, height to first pod (cm);NB, number of branches; NPN, number of productive nodes; NPP, number of pods per plant; SWP, seed weight per plant (g); HSW, 100 seed weight (g); Yd, yield (q/m$^2$); Units of measured traits are shown on the perimeter of the figure. For each trait, the histogram distribution is present in the diagonal squares. Below the diagonal, scatterplots for correlations between trait pairs are shown as dots with corresponding curve lines for correlations. Above the diagonal, values of the correlation between trait pairs are presented. Higher correlation

values are indicated by the bigger font and accompanied by red asterisks showing the level of significance of the correlations, which is as follows: * $0.01 < p < 0.05$; ** $0.001 < p < 0.01$; and *** $p < 0.001$.

### Marker–Trait Association (MTA) Analysis SSR Markers

As a result of marker–trait association analysis, studied chickpea germplasm, genetic polymorphism was studied with 10 SSR primers, as a result, rare alleles were recorded in some loci, and the average value of polymorphic information index (PIC) was 0.68, and the value of Nei Genetic diversity index was 0.62. The highest value of PIC was recorded in primer TA46 (0.88), H1A12 (0.84), H3E04 (PIC = 0.82), and the lowest value was recorded in primers NCPGR6 (0.42), H4E04 (0.44). New amplicons of 128, 135, 142 bp length were found for the TA142 marker, which is smaller than the amplicons (125, 137, 143, 145 bp) reported in our previous studies [11, 19]. Large amplicons were also recorded with TA22, TA71, TA46 and NCPGR 6 primers. 7 amplicons with high gene diversity and PIC values were synthesized with TA46 and H3E04 primers. The least number of amplicons (4 amplicons) was recorded with H4E04, NCPGR6 primers (table 2).

**Table 2.** Genetic polymorphism of SSR primers, number and size of amplicons studied chickpea germplasm

| Praymer | Motif | Amplikon length b.p. | Allells | PIC | Nei genetik diversity index |
|---|---|---|---|---|---|
| TA46 | (TAA)22 | 145-176 | 7 | 0,88 | 0,73 |
| TA142 | (TTA)15 | 128-142 | 5 | 0,79 | 0,70 |
| TA71 | (AAT)32 | 184-232 | 5 | 0,72 | 0,66 |
| TA22 | (ATT)40 | 200-280 | 6 | 0,52 | 0,65 |
| H3E 04 | $(TTA)_{36}$ $(CTA)_5$ | 174-216 | 7 | 0,82 | 0,65 |
| H4E 04 | $(TTA)_{56}$ $(TTTA)_3$ | 107-114 | 4 | 0,44 | 0,36 |
| H1B09 | (TAA)14 (AT)3 | 181-213 | 6 | 0,80 | 0,73 |
| H1A 12 | (TAA)29 | 129-330 | 6 | 0,84 | 0,77 |
| NCPGR12 | (CT)35 | 213-259 | 5 | 0,53 | 0,44 |
| NCPGR6 | (CA)12 | 230-268 | 4 | 0,42 | 0,47 |
| Mean | | | 5,5 | 0,68 | 0,62 |

In total, with all SSR primers 55 amplicons were identified, the average number of amplicons was 5.5 and the size varied from 107 to 330 bp.

Among the SSR markers, the value of the Nei genetic diversity index varied from 0.36 (H4E04) to 0.77 (H1A12), and the average genetic diversity for all primers was 0.62, which indicates the high allelic diversity of the SSR primers selected for the study (Table 2 ).

Based on the general results of the study, primers TA142, TA46, TA71, H1A12, H1B09 and H3E04 can be considered the most polymorphic microsatellite primers for chikpea genotypes.

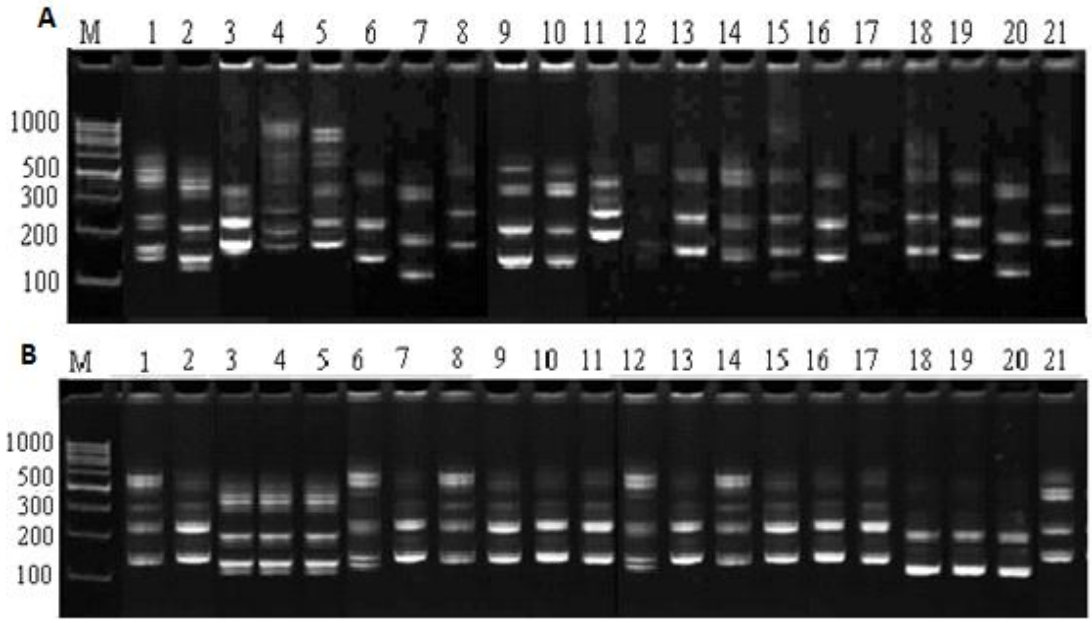


**Figure 2.** The example of genetic polymorphism identification in molecular markers with band separation on 8% polyacrylamide gel

without any adjustment. SSR amplification products from (**A**)-TA46; and (**B**)-H1A12 1-Nərmin, 2-Cəmilə, 3-Sultan , Ağdənli, 4-F.13-154 C, 5-F.13-227 C, 6-F.13-234 C, 7-F.13-320 C, 8-F.13-358 C, 9-F.13-364 C, 10-F. 88-85 C, 11-F. 93-93 C, 12-F.13-53, 13-F.13-55, 14-F.11-08 C, 15-F.11-01 C, 16-Ordubad 39, 17-Ordubad 41,18-Qusar 43, 19-Qusar 44, 20-Ağstafa 42, 20-Flip 03-22, 21-Bakı 30.

## Cluster Analysis

Various algorithms and tools, such as the unweighted pair group method with arithmetic mean (UPGMA), a Bayesian approach (STRUCTURE analysis), etc., have been used on genetic clustering depending on the study design and marker types. In the current study, UPGMA was used to differentiate accessions based on their genetic distance. Furthermore, a Bayesian approach (STRUCTURE analysis) was also used to infer genetic structure and validate and compare the results obtained using UPGMA methods. The genetic diversity of the studied chickpea germplasm collection was assessed via a cluster analysis of SSRs. The results showed a precise distribution of studied genotypes among three clusters according to the allelic composition of the analyzed markers (Figure 3).

The first cluster consists of 15 samples, including samples with specific alleles of 230 and 214 bp length of TA71 and H3E04 primers. Among the samples in the first cluster, 5 are chikpea genotypes from Azerbaijan, one from Iran, and the rest from ICARDA. ICARDA-introduced Flip 13-55 (№ 13) with Azeri-origin Sultan 98-178 (№ 28), Iranian-origin IRAN 48 (№ 39) with Azerbaijani-origin Agdash18 (№ 27) and ICARDA-introduced Flip 97- 32 (№ 24) and samples of Jamila (№ 2) of Azerbaijani origin were located in the first cluster at a close genetic distance.

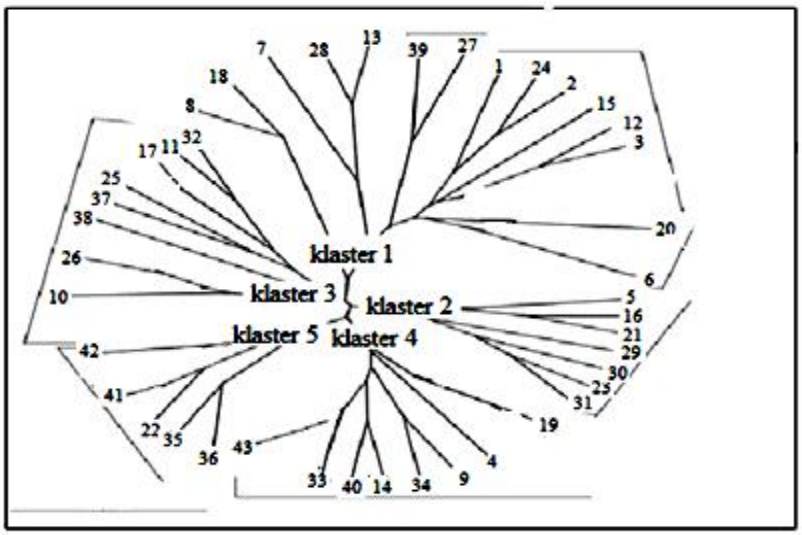


**Figure 3. Dendrogram derived from UPGMA cluster analysis of 10 SSR marker alleles of 43 chickpea accessions distributed in five clusters.**

The second cluster consisted of 7 samples carrying specific alleles of markers TA46 and TA142 with a length of 146 and 142 bp, respectively, 5 samples (Ordubad 39, Yardimli 27, Masalli 30, Masalli 51, Jalilabad 11) of Azerbaijani origin, two samples (Flip 13-227, Flip 03-22) is of ICARDA origin. In this cluster, the genetic similarity index of Flip 03-22 and Ordubad 39 samples, where a specific allele of 146 bp length was recorded with TA 46 primer, was high.

In the third cluster, 181 bp long allele was recorded with primer H1B09 in all 8 chikpea samples. 3 samples of the samples are from ICARDA and 5 samples from Azerbaijan.

The fourth cluster also consisted of 8 samples, carrying specific alleles of 193 bp and 213 bp recorded with H1B09 primer.

The fifth cluster consists of only 5 samples (Ordubad 47, Sabirabad 59, Baku 30, Lankaran 1 and Lankaran 2) carrying the 114 bp allele of primer H4E04 and originating from Azerbaijan. In this cluster, Lankaran 1 (№ 35) and Lankaran 2 (№ 36) samples had a high similarity coefficient and were located at a long genetic distance with other samples.

**Marker–Trait Association (MTA) Analysis between SSR Markers and Morphological Traits.** As a result of marker–trait association analysis, several significant correlations were found between yield-related traits of first pod height, number of fertile tillers, number of pods per plant, 100-seed mass, seed mass per plant, plant height and NCPGR 12, TA71, TA142, and TA46 SSR primers. (Table 3). Primer TA71 showed positive correlation with

three traits and other primers with two traits each were identified as promising markers. Our results are consistent with the results obtained by S. Mazkirat and colleagues [8]. Primer TA142 showed a positive correlation with the number of fertile branches and number of pods per plant, primer TA71 with mass of 100 seeds and mass of seeds per plant and yield, and primer NCPGR 12 with traits of mass of seeds per plant and mass of 100 seeds.

**Table 3.** Marker–trait associations with MLM models using TASSEL.

| Traits | SSR marker | Allels (bp) | pValu |
|---|---|---|---|
| Plant height | TA46 | 160 | 0,036* |
| Height to first pod | TA142 | 144 | 0,086** |
| Number of branches | TA142 | 255 | 0,047* |
| Number of productive nodes | TA46 | 166 | 0.038* |
| Number of pods per plant | TA142 | 155 | 0.044* |
| | NCPGR12 | 225 | 0.052* |
| Seed weight per plant | TA71 | 246 | 0,092** |
| 100 seed weight (g) | NCPGR12 | 215 | 0.034* |
| | TA71 | 249 | 0,652** |
| 1 $m^2$ yeald | TA71 | 233 | 0,366* |

The significance level of the associations is indicated as follows: * $0.01 < p < 0.05$; and ** $0.001 < p < 0.01$.

TA46 marker was associated with number of pods per plant and number of branches per plant. Thus, the study of genetic diversity and relationship between SSR primers and yield traits in chickpea plant collection is important for development of breeding strategy under specific agro-ecological conditions.The importance of SSR markers in the study of genetic diversity was also mentioned in previous studies [11, 15, 19, 20, 22]. Using eleven SSR markers, 9 main productivity traits of 39 chikpea samples of different origins were studied, genetic diversity in the chikpea plant was evaluated, and a significant relationship between SSR markers and productivity indicators was emphasized [11]. Our study included markers used by previous researchers, and the polymorphism was lower than the results obtained in other studies, which is mainly due to the small number of samples. Specific alleles of TA46, TA71, H1A12, H3E04, H1B09 and TA142 primers were recorded in the chikpea samples we studied. A polymorphic information index (PIC) was calculated to demonstrate the utility of the primers. The UPGMA method, which is the most reliable type of cluster analysis, was used, and the samples were grouped into 5 clusters. The reliability of this method depends on the number of samples and primers. No clear differentiation was observed between the samples according to their origin. This result was also recorded in other studies, which is due to gene flow, exchange of genetic material and mutations occurring during hybridizations [11, 17, 22].

## Results

High allelic diversity was recorded during the SSR marker study of 43 chikpea samples cultivated in Azerbaijan. Moderate genetic diversity (0.62) was observed with all SSR primers, and primers TA142, TA46, TA71, H1B09, H1A12 and H3E04 were recorded as the most polymorphic microsatellite primers for chikpea genotypes. Correlation analysis revealed several significant correlations between yield indicators and NCPGR 12, TA71, TA142, and TA46 SSR primers.

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# Polymorphism of gliadin proteins in local (*triticum durum*) wheat genotype in Azerbaijan

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**Abstract**

The impact of breeding on grain yields of wheat varieties released during the 20th century has been extensively studied, whereas less information is available on the changes in gluten quality associated with effects on the amount and composition of glutenins and gliadins. Assessment of genetic diversity based on electrophoretic profiles of seed storage proteins is still considered one of the most precise, simple and economical methods in the marker-assisted selection. The genetic diversity of gliadins has been studied among 30 genotypes of T. durum, using acid polyacrylamide-gel electrophoresis (Acid-PAGET.Gli 1A, Gli 1B, Gli 6A and Gli 6B allelic component blocks of gliadin-encoded loci were identified. The polymorphism of gliadin storage proteins in the grains of local durum wheat samples was determined by the patterns created by the protein components. In the ω-, γ-, β- and α-zones of the electrophorograms of gliadin spare proteins, 53 spectra and 96 patterns (combinations formed by the spectra in different zones in each genotype) were detected, which were followed by high polymorphism Cluster analysis based on Jaccard coefficient of similarity divided the analyzed collection into six clusters. The data obtained from electrophoretic analysis of gliadins is highly useful for identification of genotypes and selection of genetically distant varieties for breeding.

**Keywords:** durum wheat, gliadin, marker, polymorphism,electrophoretic analysis.

## Introduction

In modern times, the reliable supply of food to the population is one of the most global problems of mankind. Grain farming plays a key role in solving the problem. In the world practice, the state of grain production and its position in the grain market are considered as the main indicators of food security. Wheat grain contains an average of 12-19% protein, 65-75% starch, 2% fat, 1.2% cellulose, 2.1% ash. [3, 6]. Wheat grain contains phosphorus, valuable potassium compounds, iron and many vitamins. The proteins and aqueous carbohydrates in the grain are very easily absorbed by the human body. The baking quality of wheat flour depends on the amount and quality of gluten (viscosity). Gliadin and gluten reserve proteins, called gluten proteins, which determine the baking quality of wheat flour, make up 80% of the endosperm of wheat grain [4,7]. Comparative analysis of gliadins (Gliadin is a class of proteins present in wheat and several other cereals within the genus Triticum. Gliadins, which are a component of gluten, are essential for giving bread the ability to rise properly during baking) in diverse wheat varieties have revealed numbers of allele blocks on gliadin coding locus. Catalogues of protein constituents of gliadin blocks have been developed for bread (*Triticum aestivum* L.) [10] and durum (*Triticum durum* Desf.) wheats and using them may allow identifying more than 20 million of genotypes [2]. Mass screening of the introduced into commercial grow-ing and perspective wheat varieties using electrophoresis of their reserve proteins may purposefully allow to select samples for crossings and develop wide spectrum of variability in hybrid populations, and this could allow select forms having expected properties [8]. Based on the identification of allelic component blocks encoded by allelic genes that control the synthesis of gliadin and gluten reserve proteins, and the selection of raw material in the selection process based on these protein genetic markers associated with grain quality is possible to create high-yielding and high-quality grains [1].

## Materials and methods

Thirty genotypes of durum wheat (Triticum durum Desf.) listed in Table 1 were provided by National Gene Bank of Azerbaijan Genetic Resources Institute, Azerbaijan National Academy of Sciences.

**Table 1**. List of durum wheat genotypes used in the study.

| № | Code | Genotypes | Place of collection | № | Code | Genotypes | Place of collection |
|---|---|---|---|---|---|---|---|
| 1 | Sort | *Shiraslan* | Sort | 16 | 6121 | var. *boeufii* | Shamaxa |
| 2 | Sort | *Mugan* | Sort | 17 | 6160 | var. *reichenbachii* | Zaqatala |
| 3 | Sort | *Barakatli 95* | Sort | 18 | 6310 | var. *leucomelan* | Absheron |
| 4 | 6123 | var.*melanopus* | Tovuz | 19 | 6119 | var. *hordeiforme* | Nakhchıvan |
| 5 | 6086 | var.*leucurum* | Gazakh | 20 | 6128 | var. *melanopus* | Qazakh |
| 6 | 6157 | var. *apulicum* | Nakhchivan | 21 | 6124 | var. *melanopus* | Goranboy |
| 7 | Sort | *Karakilchig 2* | Sort | 22 | Sort | *White wheat* | Sort |
| 8 | 6148 | var. *apulicum* | Ismayıllı | 23 | Sort | *Sharg* | Sort |
| 9 | 6165 | var. *niloticum* | Akhsu | 24 | Sort | *Shirvan* | Sort |
| 10 | 6144 | var. *leucomelan* | Lerik | 25 | Sort | *Terter* | Sort |
| 11 | 6138 | var. *leucomelan* | Yevlakh | 26 | Sort | *Vuqar* | Sort |
| 12 | Sort | *Mirbashir 50* | Sort | 27 | 6102 | var. *leucurum* | Shamaxa |
| 13 | 6154 | var. *apulicum* | Nakhchıvan | 28 | 6231 | var. *leucurum* | Jalilabad |
| 14 | 6158 | var. *obscurum* | Zakatala | 29 | 6114 | var. *hordeiforme* | Yevlakh |
| 15 | 6089 | var. *leucurum* | Yevlakh | 30 | 6134 | var. *alborovinciale* | Masallı |

The extraction of gliadins has been performed using A-PAGE method (Acid PolyAcrilamide Gel Electrophoresis) of Bushuk and Zillman with modifications proposed by Poperelya and colleagues (Bushuk & Zillman1978; Sozinov & Poperelya 1979) [9]. From each of the 30 durum wheat genotypes selected for the extraction of gliadin reserve proteins, 1 seed was ground into flour, 2.5 ml of 70% ethanol solution was added for 15 minutes. then 5 minutes. centrifuged at 2,500 rpm. After these procedures, 0.1 ml of supernatant was transferred to the new Eppendorf, 0.2 ml of 9 molar extraction solution (0.9% acetic acid, 18% urea, 0.01% pyronin "J") was added and the mixture stained overnight at room temperature. The gel for electrophoresis of gliadin proteins was prepared in the following sequence: 60 ml of basic solution [8% acrylamide (4.8 g), 0.3% methylene bisacrylamide (200 mg), 2% acetic acid, 8 M urea (28.8 g) ], auxiliary solutions in a certain sequence (initially, 0.12 ml of TEMED, then 6 ml of 1% glycine, 2.5 ml of 1% ascorbic acid, 0.71 ml of 0.07% iron 2-sulphate solutions and finally 1 ml of 2% potassium sulfate solution containing polymer). Following electrophoresis, the gel was fixed with 60% trichloroacetic acid (TCA)for at least 20 min and stained overnight in a solution containing 0.04% Coomassie Brilliant Blue R-250 and 60% TCA. Jamila cultivar has been used as a standard for identification of the alleles of gliadin-coding loci. The presence and absence of each band in the electrophoregrams obtained was codedas "1" and "0", respectively. The genetic distance and similarity were computed with the PAST software [5].

Cluster analysis was conducted based on the Jaccard similarity coefficient. The genetic diversity for each gliadin pattern was calculated according to Nei formula (1973) as H =1 - ΣPi2, in which H is the genetic variation index, and Pi is the proportion of a particular pattern in each group of α, β, γ and ω-gliadins separately. The mean value of H was calculated for all the four groups of gliadins[7].

## Conclusion and their discussion

Figure 1 shows electrophoregrams of the genotypes obtained by Acid-PAGE method. Among the 30 genotypes analyzed, 30 different bands were detected assuming that the bands with the same relative mobility represent the same protein. These bands were grouped into patterns at each of the four zones of gel (α-, β-, γand ω-gliadins). Each zone (α, β, γ and ω) was considered as a single locus and different patterns as allelic variants. The patterns within each gliadin zone were identified by comparing banding patterns of each genotype with all the other genotypes. As a result of electrophoresis analysis of gliadin proteins, 53 spectra and 96 patterns (combinations of spectra formed in different zones in each genotype) were found for 30 zones in 30 durum wheat genotypes.

Figure 2 shows ideogram of patterns observed in the ω-zone. In the ω-zone, 20 different spectra (bands) and 30 different patterns were found, of which spectrum 4 was selected with high frequency following 25 samples, while spectra 6, 9, 15 and 19 were observed in only one genotype.

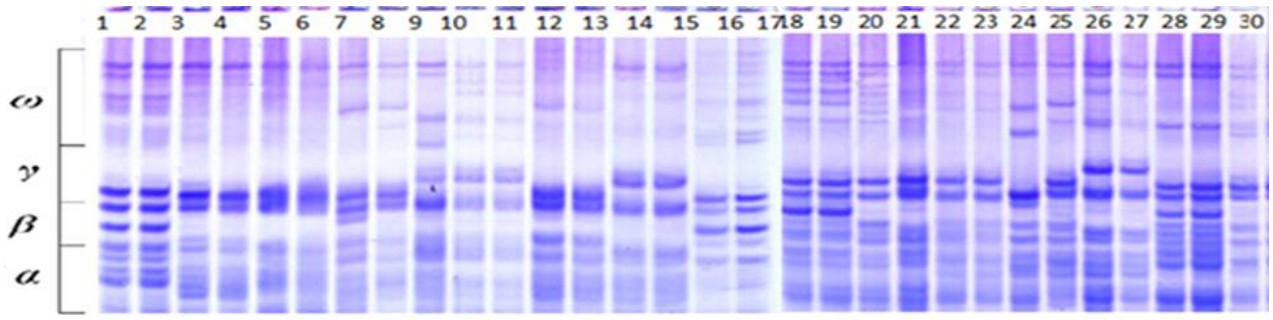


Figure 1. Results of electrophoresis of gliadin reserve proteins in 30 durum wheat genotypes

The value of the Nei genetic diversity index, calculated on the basis of the frequency of occurrence of patterns determined in the ω-zone of gliadin reserve proteins, is 0.94, indicating a very high genetic diversity of the studied genotypes.

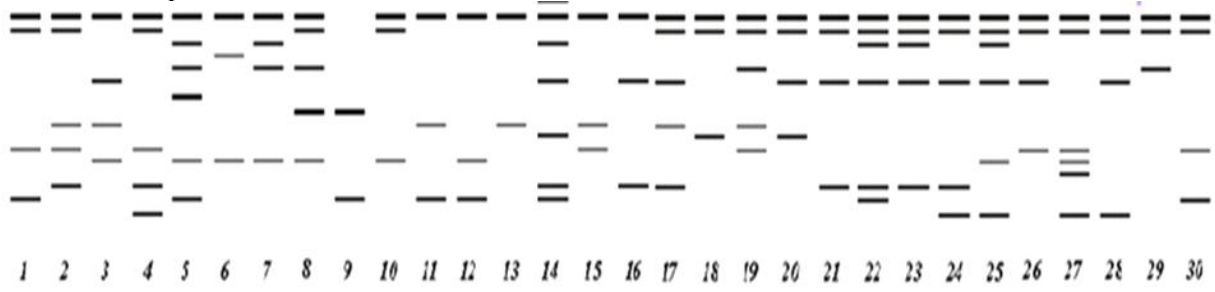


**Figure 2. Ideogram of patterns observed in the ω-zone of gliadin reserve proteins.**

Figure 3 shows ideogram of patterns observed in the γ-zone. In the γ-zone 12 spectra and 19 different patterns were identified. Among the monitored spectra found in 27 genotypes, Spectrum №7 was rated as a high-frequency spectrum. Spectra № 1, 8 and 12 were characterized by low frequency, recorded in only one sample. Among the identified patterns, pattern number 10 was selected with a high frequency, recorded in 27% of genotypes, and the frequency of other patterns was between 5-15%. It should be noted that the weakest genetic diversity (H = 0.896) among the gliadin zones of the studied genotypes belongs to the γ-zone.

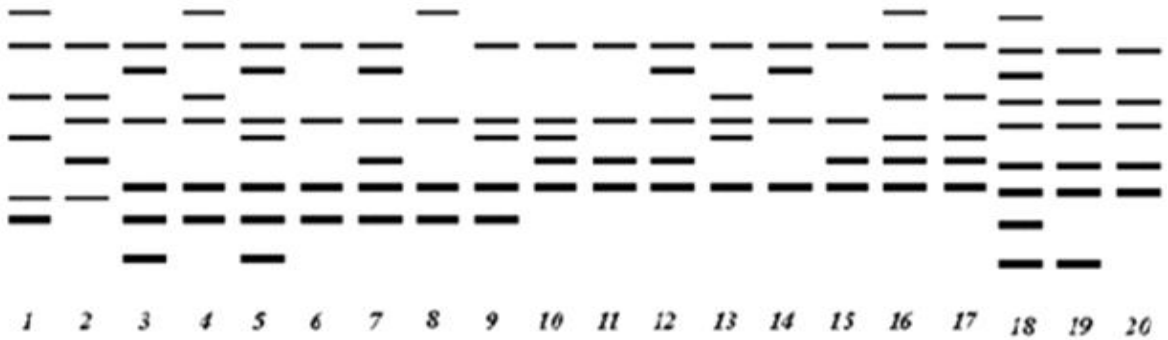


**Figure 3. ideogram of patterns observed in the γ-zone of gliadin reserve proteins.**

9 spectra and 20 patterns were observed in the β-zone of gliadins of 30 studied durum wheat genotypes. Of them, spectra № 6 and № 1 were observed with a higher frequency in 33.3% and 30% of the samples, respectively, and the lowest frequency was detected in spectra № 4 and № 9 (each in one genotype). As for the patterns, pattern number 8 was observed in more than 23% of the samples and was detected with high frequency, patterns № 3 and №16 were recorded in three genotypes each. Patterns № 6, 11, 12 and 13 were observed in two genotypes, while other patterns were determined in only one genotype.

Figure 4 shows the ideogram of 19 patterns found in the β-zone of gliadin storage proteins. The value of the Nei genetic diversity index calculated for the β-zone was equal to 0.891.

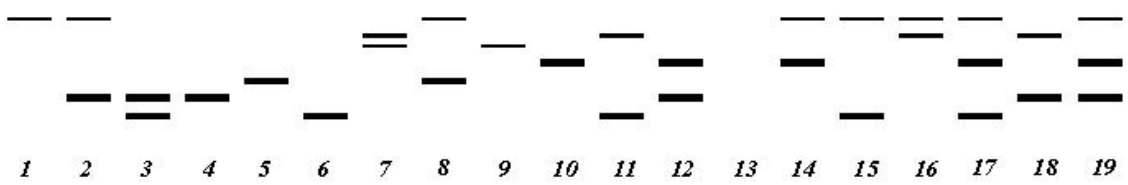


**Figure 4. Ideogram of patterns found in the β-zone of gliadin reserve proteins**

Each of the 27 different patterns found in the α-zone is unique and specific to only one genotype. The specificity of the patterns for each genotype plays a very important role in the identification and certification of the specimens, serving to distinguish them from each other. In the α-zone of gliadin reserve proteins, 12 different spectra were observed, spectra 3, 6 and 11 were observed in 28 genotypes each, with high frequencies, and spectra № 9, 10 and 14 were recorded in genotypes № "2, 3 and 4, respectively low soon characterized.

**Determination of genetic distances between genotypes based on polymorphism of gliadin storage proteins.** In addition, cluster analysis has been conducted based on Jaccard coefficient of similarity (Figure 2). This method of grouping divided the genotypes analyzed into six clusters **(** Figure 5).

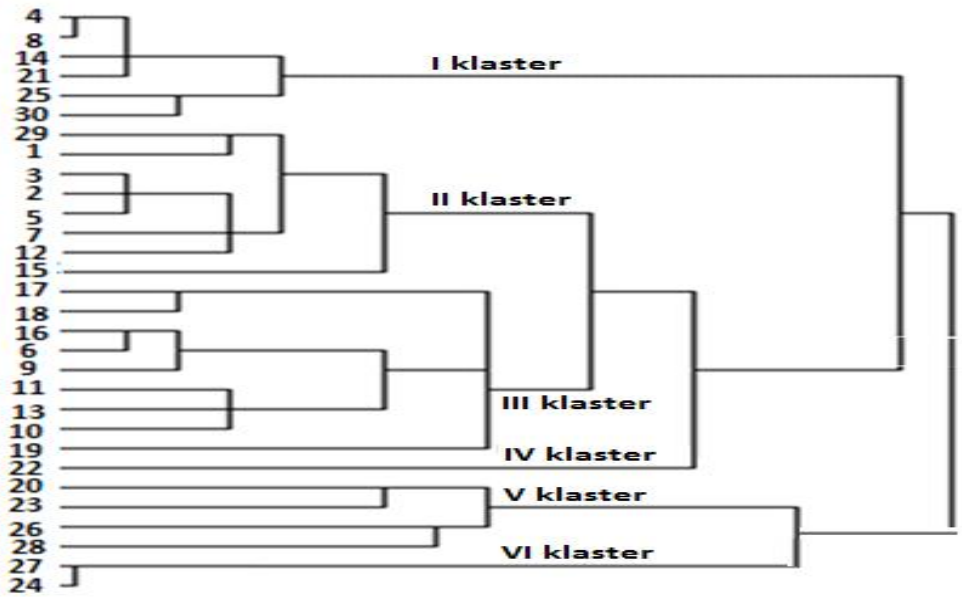


**Figure 5. Clustering of the genotypes based on Jaccard coefficient of similarity**

The first cluster includes two genotypes belonging to the genus v.*obscurum*, *Tartar,* v.*alborovinciale* and v.*melanopus*. In this group, v.*melanopus* and v.*apilucum* samples are joined by pattern number 4 in the ω-zone, and *Tartar* and v.*alborovinciale* patterns are joined by pattern number 2 in the γ-zone. The genetically closest examples in the first cluster are the genotypes v.*melanopus* and v.a*pilucum*; the Nei genetic distance between them was 0.19. In addition to the listed samples, the genotypes v.*obscurum* and *Tartar*, as well as v.*melanopus* and v.*alborovinciale* were found to be quite different at a genetic distance of 0.403.

In the second cluster, 8 samples were grouped (*Shiraslan, Mugan, Barakatli 95, v.leucurum-Gazakh, Karakilchig2, Mirbashir 50, v.leucurum-Yevlakh var. Hordeiforme*). Pattern No. 5 found in the zone *Shiraslan, v.leucurum*-Gazakh*, and v.leucurum*-Yevlakh) is present in each of the genotypes. It was also found that *Mugan* and *Barakatli 95* specimens had the same pattern number 8 in the γ-zone. In the second cluster, the *Mugan, Barakatli* 95 and v.*leucurum*-Gazakh genotypes are genetically closer with a value (Jaccard index of similarity is 0.122) while the v.*hordeiforme* and v.*leucurum*-Yevlakh genotypes are genetically based on a value (Jaccard index of similarity is 0.401) are more distant examples.

In the third group v.*apulicum* (Nakhchivan) v.*niloticum*, v.*leucomelan* (Lerik) v.*leucomelan* (Yevlakh) v.*murciense* (Saatli), v.*boeufii* (Shamakhi), v.*reichenbachii* (Zagatala), v.*leucomelan*, v. *hordeiforme*, v.*alborovinciale*

(Jalilabad) genotypes are located. V.l*eucomelan* (Yevlakh) and v.*murciense* (Saatli) grouped in this cluster, samples № 15 in the γ-zone, v.*leucomelan* and v.*hordeiforme* samples № 2 in the β-zone, v.*apulicum* (Nakhchivan) v.*niloticum* and v.*leucomelan* genotypes have a pattern number 13 in the β-zone. Within this group, the genotypes v.*apulicum* and v.*boeuffi* are genetically similar (Nei genetic distance index is 0.133), v.*boeufii* and v.*reichenbachii*, v.*leucomelan* and v.*hordeiforme* genotypes (Nei genetic distance index between them is 0.342) as well as v.*boeufii* and v.*apilucum* (Nei genetic distance index between them is 0.398) are genetically different genotypes.

In the fourth group there is only one sample - the local White Wheat variety. This genotype distinguished pattern № 4 in the γ-gliadin zone. The smallest genetic distance (0.103) was recorded between this sample and other samples, and the largest genetic distance was 0.545 between v.*apulicum* and v.*boeuffi* genotypes.

In the fifth cluster, 4 samples (v.*melanopus*-Gazakh, v.*leucurum*-Shamakha, Sharq and *Vugar* varieties) were found. With the exception of the v. *melanopus*-Gazakh genotype, pattern № 8 was observed in the γ-gliadin zone in each of the samples collected in this group. *Sharg* and *Vugar* varieties have a pattern № 2 in the β-gliadin zone, v.*melanopus*-Gazakh, v.*leucurum*-Jalilabad, and genotypes have a pattern № 8.

In the fifth cluster, the smallest genetic distance (0.231) was determined between *Sharg* and *Vugar* varieties, and the largest genetic distance (0.486) was determined between v.*melanopus*-Gazakh and *Vugar* genotypes.

In the sixth cluster there are two samples v.*leucurum* (Shamakhi) genotype and *Shirvan* variety. The genetic distance between these samples was recorded as 0.122.

Separate analysis of the clusters in the dendrogram shows that the genotypes belonging to the same region are distributed in different groups, not within one group. In other words, the application of the cluster analysis method has shown that the genetic diversity of gliadin reserve proteins of durum wheat genotypes selected as the object of study is incompatible with the geographical diversity of genotypes.

Thus, the data obtained from analysis of electrophoretic patterns and subsequent clustering of the genotypes based on these patterns allows identification of genetically distant samples which can be used for breeding and increase of genetic variation. Because of simplicity, reproducibility and high efficiency, electrophoretic analysis of gliadins in polyacrylamide gel can be used as a powerful method for evaluation of genetic diversity.

## Results

As a result of the study, the genetic diversity of 30 durum wheat samples was certified according to electrophoresis of gliadin- and gluten-encoding loci (Gli 1A, Gli 1B, Gli 6A and Gli 6B, Glu 1A and Glu 1B), which control the synthesis of reserve proteins.

Based on the study of the polymorphism of gliadin reserve proteins, Gli 1A, Gli 1B, Gli 6A and Gli 6B allelic component blocks of gliadinkoding loci were found in 30 samples of durum wheat.

The polymorphism of gliadin reserve proteins in grains of local durum wheat samples was determined by patterns generated by protein components, followed by high polymorphisms in ω-, γ-, β- and α-zones of gliadin reserve proteins, followed by 30, 19, 20 and 27 different patterns, respectively was found.

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# Sustainable development of biodiversity in sericulture

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## Abstract

One of the most extensively employed natural resources in the food and textile industries globally is the mulberry silkworm, which stands out for its economical effectiveness. The primary goal of the study project is to raise awareness of the unique technique used to boost mulberry silkworm (Bombyx mori) productivity. A comparative analysis was conducted on the productivity of silkworms fed mulberry leaves that were enriched with varying concentrations of dimethylsulfoxide (DMSO) solutions. Four groups of mulberry silkworm samples were used in the study for this purpose, and as a result, there was a significant variation in the cocoon weights, survival rates, and morbidity rates of the silkworms that were fed a high concentration of DMSO.

**Keywords:** DMSO, productivity, silkworm, survival and morbidity rate

## Introduction

An important member of the Lepidoptera order of insects, the silkworm Bombyx mori is widely used in agriculture. Many benefits, including low raising costs, short generation times, and diverse genetic background, make the silkworm Bombyx mori (L.) (Lepidoptera: Bombycidae) an important economic insect in the natural sciences. Silkworms also have vast genetic resources linked with them. The silkworm has become a modern model organism in the natural sciences even faster after the completion of its genome [1].As the primary byproduct of the silkworm, silk is regarded as the most exquisite textile in the world and is referred to as the "queen of textiles" because of its inherent sheen, capability to absorb color (dye absorption), lightness, gentle texture, and outstanding longevity [2].

Biomaterials used in weaving and medicine both frequently employ silk fibroin (SF), which is derived from mulberry silkworms. Its fibrillar structure is connected to this. Furthermore, because of their biocompatibility, silk fibroin materials have particular disadvantages such as deformation, deterioration, and aging. Due to market demands for natural and intelligent materials based on the availability of sufficient raw materials globally, numerous attempts have been made to modify and improve the functionality of silk fibroin cloths and fiber [3]. Because silk fibroin is hydrophobic, Oguz Bayraktar and other researchers have demonstrated that it is a potential adsorbent for polyphenols. Through the use of FTIR, the researchers were able to confirm that olive leaf antioxidant polyphenols were adsorbed on silk fibroin. It has been demonstrated that modified silk fibroin possesses antibacterial and antioxidant properties[4].

With the chemical formula (CH3)2SO, dimethylsulfoxide (DMSO) is a complicated molecule (Fig. 1). This liquid is a valuable solvent that dissolves both polar and non-polar substances. It is miscible with water and a variety of organic solvents. DMSO is employed as a carrier for topical drug administration because of its capacity to cross biological membranes. Industrially, dimethyl sulfoxide is produced by oxidizing dioxide in the presence of oxygen or nitrogen from dimethyl sulfide, a by-product of the Kraft process.

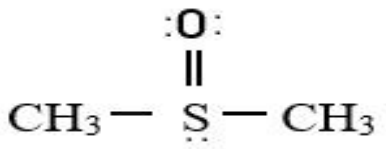

**Fig. 1**.Chemical configuration of DMSO

This molecule possesses idealized CS symmetry with respect to its chemical structure. DMSO's methyl groups have a moderate acidity. This is the reason why this solvent has been used to study the significant characteristics of numerous weakly basic organic compounds.Despite being thoroughly investigated in the United States since antiquity, it remains one of the least known medicines.

DIMETHYL SULFOXIDE is a transparent, nearly odorless liquid. The vapors generate more weight than air. It burns and irritates skin when it comes into touch with it, and it can leave the tongue tasting like garlic. Toxic, soluble chemicals can be transported through the skin with the help of DMSO. Reduced nervous system activity, headaches, and dizziness can all be brought on by high vapor concentration. Dimethyl sulfoxide possesses strong antibacterial, antifungal, and antioxidant qualities in addition to these [5-10].One of the most important aspects of raising silkworms is feeding. Healthy host plant leaves that are supplied with vital nutrients are a prerequisite for optimal feeding. The foundation of a silkworm's growth and development is its nutrition. Gaining an understanding of the fundamentals of insect nutrition is crucial, especially when researching the life cycle of certain insects or worms. The dietary needs of insects are similar to those of other plants and animals, including those for carbohydrates, protein, and vitamins. When compared to other living beings like humans or other animals, insects require comparatively fewer fundamental nutrition. The amount of nutrients that insects take in depends on the size of their bodies. .Since silkworms are a type of insect that belongs to the lepidopteron group, they also need the same nutrients to grow more rapidly. Silkworms ingest water and vital nutrients from their food. The several silkworm instars show the results of depriving healthy hostplant leaves of vital nutrition[11].

Silk fibroin is one of the most prevalent and significant examples of fibrillar proteins. There are two phases to silk fibroin: amorphous and crystalline. The crystalline phase of silk fibroin (Gly-Ala-Gly-Ala-Gly-Ser)n makes up around 60% of its substance, with the remaining portion being the amorphous phase. The amino acid sequences determine whether the crystalline and amorphous phases develop. Additionally dependent on the amino acid sequences are the properties that make the crystalline phase hydrophobic and the amorphous phase hydrophilic. The five amino acids that predominate in Bombyx mori silk fibroin (measured in moles percent) are Ala (30.0%), Gly (42.9%), Ser (12.2%),Val (2.5%), and Tyr (4.8%). Bombyx mori fibroin is made up of a glycoprotein known as P25 and two heavy-chain and light-chain proteins connected by disulfide links. Compared to the L-chains (26 kDa) and P25 (30 kDa), the molecular weight of the H-chain is around 350 kDa. A 6:6:1 molar mass ratio characterizes the H-heavy, L-light, and P25 chains.The second structure of fibroin is made up of hydrogen-bonded antiparallel β-sheets. Fibroin's β structure predominates, which imparts considerable mechanical strength to materials made from it, while the protein's amorphous portion provides fibroin its flexibility. In terms of strength, silk fibers approach even one of the greatest synthetic materials: Kevlar (paraaramid) [3, 12-14].

The aim of the research is to positively influence the health and productivity of silkworms in sericulture. Both physical, biological and pharmacological effects of the substance were taken into account in the selection of the applied substances.

## Materials and Methods

The native species of the Bombyx mori family, ShZEM-4, is the mulberry silkworm that was used this investigation. The Sericulture Department of Sheki Regional Scientific Center provided the silkworm eggs required for the experiment. Fresh mulberry leaves were given to the larvae along with suitable quantities of warmth under nonlaboratory conditions, where they were raised in individual containers at 23 ± 5 °C [11]. Until the third sleep, the silkworms were feeding with regular, fresh mulberry leaves. Starting from the next sleep, five groups (one of them is control) of one hundred silkworms in each were divided apart. DMSO (sigma Aldrich) used in the experiment was prepared with 4 different concentrations (0.2%, 0.4%, 0.7%, 1%) and mulberry leaves were soaked in those solutions twice a day and silkworms were fed DMSO-enriched mulberry leaves until cocooned process. During the experiment, the temperature of the room was 23-24$^0$C, and the relative humidity was 65-75 % (Fig. 2).

## Preparation of solutions

DMSO is supplied by Sigma Aldrich with a 99.9% purity level.$C_1$ = 0.282 mmol/l, $C_2$ = 0.566 mmol/l, $C_3$ = 0.983 mmol/l, $C_4$ = 1.414 mmol/l, $C_5$ = 1.837 mmol/l, and $C_6$ = 2.25 mmol/l DMSO, respectively, are used to create 0.2%, 0.4%, 0.7%, 1%, 1.3%, and 1.6% DMSO solutions in 100 ml of distilled water. Fig. 2 depicts feeding silkworms with various concentrations DMSO-soaked mulberry leaves.

**Fig. 2.** Silkworms feeding DMSO enriched mulberry leaves

## Results and Discussion

Measurements demonstrated that mulberry leaves supplemented with 0.7% and 1% DMSO concentration had a high productivity. Furthermore, an increase was noted in the cocoon weights of silkworms that were given higher percentages of DMSO, both at the start and during the silking process. Tables 1 and 2 represent the aforementioned parameters

**Table 1.** Dependence of the average weight of the silkworm on the percentage of DMSO

| | After third sleep (g) | After fourth sleep (g) | Before starting silking (g) |
|---|---|---|---|
| **Control** | 2.1 | 2.91 | 3.72 |
| **0.2% DMSO** | 2.1 | 2.93 | 4.01 |
| **0.4% DMSO** | 2.1 | 3.07 | 4.12 |
| **0.7% DMSO** | 2.1 | 3.43 | 4.31 |
| **1% DMSO** | 2.1 | 4.01 | 4.48 |
| **1.3% DMSO** | 2.1 | 4.25 | 4.56 |
| **1.6% DMSO** | 2.1 | 3.87 | 4.07 |

**Table 2.** Dependence of DMSO concentration on average weight of surviving, cocooning silkworms and average cocoon weight

| | Amount of surviving silkworms (number) | Amount of cocooned silkworms (number) | Average weight of one cocoon (g) |
|---|---|---|---|
| **Control** | 71 | 70 | 3.83 |
| **0.2% DMSO** | 73 | 72 | 4.11 |
| **0.4% DMSO** | 76 | 76 | 4.15 |
| **0.7% DMSO** | 88 | 87 | 4.33 |
| **1% DMSO** | 90 | 89 | 4.45 |
| **1.3% DMSO** | 92 | 91 | 4.51 |
| **1.6% MSO** | 81 | 72 | 3.98 |

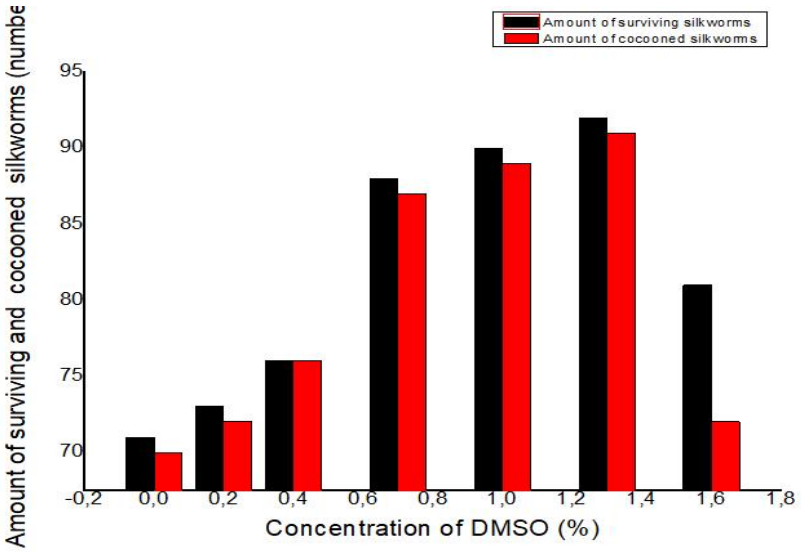


**Fig. 3.** Amount of surviving and cocooned silkworms

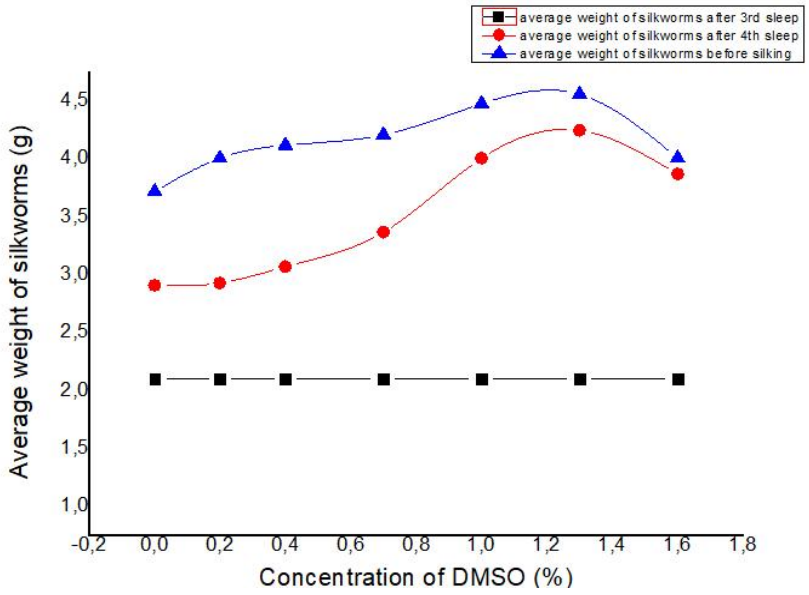


**Fig. 4.** Dependence of average weight of silkworms on various concentration of DMSO

Figure 1 and Figure 2 show the DMSO dependency graph of the surviving and silkworms at the end of the process, as well as the average weight of 1 cocoon.

Looking at the graphs, it is clear that there was a significant increase in the weights (2.1±0.05g) of the 3rd sleep silkworms fed with DSMO-soaked mulberry leaves compared to the control sample: thus, when the silkworms woke up from the 4th sleep, the weight of the control samples was 2.91g, while the weight of the silkworms receiving 0.2%, 0.4%, 0.6%, 0.7% ,1%, 1.3% and 1.6% DMSO was 2.93g, 3.07g, 3.43g, 4.25g,4.18g, 3.87 g respectively and their weight before silking (control sample 3.72g) was 4.01g; 4.12g; 4.31g; 4.56g, 4.35g, 4.07g. As a result, compared to the control sample, the average weight of the silkworm increased by 22%, the number of surviving silkworms increased by 21%, the number of silkworms wrapped in cocoons increased by 21%, and the average weight of 1 cocoon increased by 18%, and high-quality silkworms were obtained when silkworms feeding with 1% of DMSO. These data demonstrate that all surviving silkworms are capable of producing silk, as seen by the equal percentage of surviving and silking silkworms. Apparently, DMSO stimulates the activity of enzymes that facilitate yellowing.

This increase is believed to be due to the antioxidant antifungal properties of DMSO. The hygroscopic qualities of DMSO are thought to be one of the causes of the high productivity under non-laboratory and hot temperature environments. Because DMSO retains water molecules, it keeps leaves from drying out. Because of this, silkworms can eat more leaves at this time (5,15).

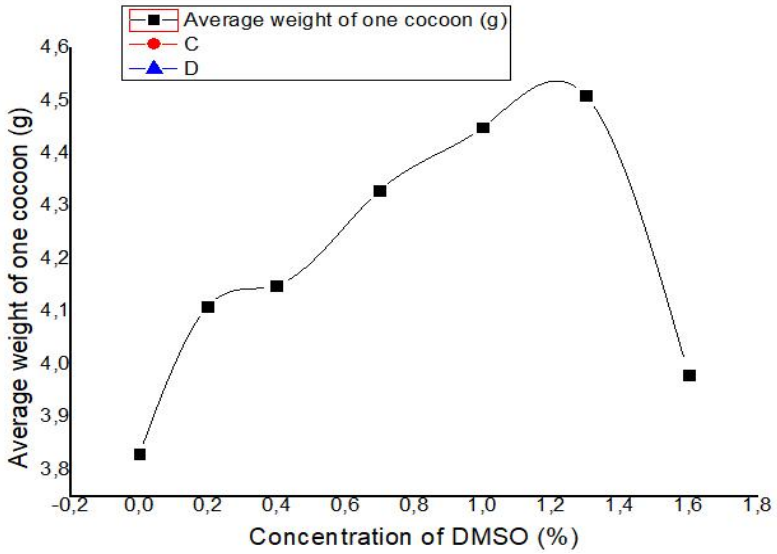


**Fig 5**. Dependence of average weight of 1 cocoon on various concentration of DMSO

Worm feeding was reduced when a 1.6% concentrated solution was applied. This had an impact on their survival, silking process, and overall production, or the weight of each cocoon. This is a result of DMSO's distinct garlic-like odor [16]. In terms of the amount of silking silkworms and the average weight of the cocoon, the results of the 1.6% DMSO feeding are similar to those of the control sample. High DMSO concentrations should be toxic to living organisms and have adverse consequences. This is among the causes of the minimizing effects of high DMSO concentrations.

## Conclusion

Feed composition, environmental conditions and added nutritional additives improve the quality and efficiency of the cocooning process. The advantage of using DMSO solution as a food supplement is that it provides moisture retention during silkworm development and protects the worms from disease.DMSO can be one of the important components of artificial feed in maintaining the sustainable biodiversity of local species in sericulture Eventually, the present investigation shows that 1.3% DMSO is ideal for all indicators.

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# Биогенетические и психосоциальные основы происхождения интеллектуальной недостаточности у детей

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**Резюме**

В статье рассматриваются причины возникновения интеллектуальных нарушений у детей, исследованные с биогенетической и психосоциальной точек зрения. Автор анализирует биосоциальные факторы, которые играют ключевую роль в развитии детского интеллекта, и приводит мнения ведущих ученых, изучающих проблемы умственных дефектов, возникающих в результате врожденных заболеваний и наследственных факторов. Также внимание уделяется влиянию внешней среды, включая социальное взаимодействие и жизненные обстоятельства, на развитие интеллектуальных способностей детей. В статье подчеркнута важность учета взаимосвязи генетики и окружающей среды, что также отражает последние достижения в области психологии и дефектологии. В частности, рассматриваются связи генотипа и среды, а также онтогенетические закономерности развития. Исследования К.М. Дульнева и А.Р. Лурии выделяют ключевые условия, необходимые для полноценного психосоциального развития ребенка.

**Ключевые слова:** биогенетические, психосоциальные, интеллектуальная недостаточность, атипичные отклонения, психокоррекция, дефектология, генетика.

## Введение

Современные теории психического развития детей основываются на признании значимости как биогенетических, так и психосоциальных факторов. В коррекционной психологии вопрос о взаимодействии этих факторов остается одной из самых актуальных проблем. По мнению А.Н. Леонтьева, для научной психологии понимание роли биологических и социальных факторов имеет решающее значение.

Глубокое изучение причин интеллектуальных недостаточностей у детей, основанное на биогенетических и психосоциальных аспектах, находит отражение в работах таких известных ученых, как Г.М. Дульнев, С.Д. Забрамная, К.С. Лебединская, В.И. Лубовский, С.М. Мирский, М.С. Певзнер, Л.И. Переслени и других. Тем не менее, несмотря на значительные достижения в области дефектологии, некоторые аспекты этой проблемы остаются недостаточно исследованными, что открывает новые перспективы для дальнейших научных изысканий.

Психолог, исследующий природу отклонений в развитии детей с интеллектуальными нарушениями, сталкивается с необходимостью учета множества факторов, влияющих на развитие. В частности, даже незначительные нарушения могут существенно повлиять на психическое состояние ребенка, и это нельзя игнорировать при анализе конкретных случаев. Как отмечал А.Н. Леонтьев, несмотря на использование диалектического подхода, такие концепции часто сводятся к упрощенным теориям, предполагающим, что личность является продуктом лишь совокупности внутренних и внешних факторов. Леонтьев подчеркивает, что развитие человека невозможно свести только к взаимодействию этих факторов.

Мы также поддерживаем это мнение и возвращаемся к анализу биологических основ интеллектуальных нарушений, с учетом генетического влияния на развитие личности.

Работы С.Л. Рубинштейна сыграли ключевую роль в преодолении теории двух факторов, решая проблему соотношения

биогенетического и психосоциального в контексте интеллектуальных нарушений. По его мнению, внешние факторы оказывают влияние через внутренние условия. Это означает, что поведение человека не является результатом исключительно внутренних или исключительно внешних факторов. Внешняя среда воздействует на индивидуумов через особенности их внутреннего мира, влияя на их психическое развитие.

Под руководством А.Н. Леонтьева были проведены эксперименты, в ходе которых изучалось соотношение биологических и социальных факторов в формировании психических функций человека. Результаты этих исследований показали, что наследственные биологические особенности играют важную роль в развитии психических функций, но не определяют их полностью. Важнейшим условием полноценного психического развития является социальная среда, сформированная на протяжении поколений людей. Это подчеркивает важность взаимосвязи биологических и социальных факторов в развитии личности.

Таким образом, для понимания интеллектуальных нарушений важно рассматривать три ключевых реальности: биологическую, социальную и психическую. Сначала необходимо проанализировать взаимодействие биологической и психической реальностей, а затем рассмотреть влияние социальной среды на психическое развитие.

Рассмотрим важность третьей реальности — мира предметов и явлений, а также социальной среды, в которой происходит общение и борьба людей. Эта реальность, являясь внешней и социальной, имеет решающее значение для формирования психики человека, поскольку она определяет содержание психических процессов. Важно подчеркнуть, что влияние социальной реальности не переходит напрямую в психическую реальность. Как справедливо утверждал С. Л. Рубинштейн, внешние причины оказывают воздействие на психику через внутренние условия, которые, в свою очередь, не сводятся к совокупности биологических и психологических особенностей индивида. "Внутреннее" в данном контексте представляет собой психическую, душевную реальность человека, однако конкретные психические процессы всегда протекают в рамках тех условий, которые определяются биологической природой личности.

Формула «внешнее через внутреннее» отражает общий механизм влияния социальной среды на психику. Однако для более глубокого понимания нужно рассмотреть другой важный аспект — активное преобразующее влияние психики и личности на социальные процессы и собственное развитие. А. Н. Леонтьев предложил формулу: «внутреннее действует через внешнее и этим само себя изменяет». Мы считаем, что эти формулы адекватно отражают динамику развития личности, постоянное кольцевое взаимодействие внутреннего и внешнего, бытия и сознания.

С учетом современных достижений смежных наук психология рассматривает связь дефектологии и генетики как многоаспектный процесс. Именно в этом направлении проводятся исследования онтогенетических закономерностей взаимодействия генотипа и среды.

Как отмечала Б. В. Зейгарник, биологическая природа человека входит в кольцевое взаимодействие не как отдельный компонент, а как необходимое условие протекания психических процессов. Это означает, что изменения физиологических параметров могут повлиять на ход и характер сложных психических процессов. Однако стоит вновь подчеркнуть, что биологическое не является причиной или фактором психического развития, а лишь условием, которое необходимо для его формирования.

## Основная часть

Для понимания различных интеллектуальных отклонений у детей, необходимо выделить те факторы, которые оказывают влияние на их биогенетическое и психосоциальное развитие. Рассмотрим условия, которые способствуют нормальному развитию ребенка.

Г.М. Дульнев и А.Р. Лурия выделили четыре ключевых условия, которые необходимы для нормального развития ребенка:

1. Нормальная работа головного мозга и его коры. При наличии патологических изменений, вызванных различными патогенными факторами, нарушается баланс между возбуждающими и тормозными процессами в мозге. Это ведет к трудностям в реализации сложных форм анализа и синтеза информации, а также нарушению взаимодействия между различными мозговыми зонами, отвечающими за разные аспекты психической деятельности.

2. Нормальное физическое развитие и сохранение нормального уровня работоспособности, что напрямую связано с поддержанием тонуса нервных процессов. Это условие подразумевает, что тело и нервная

система ребенка должны развиваться гармонично, что способствует адекватной психической активности.

3. Сохранность органов чувств, что обеспечивает полноценное восприятие и взаимодействие ребенка с окружающим миром. Без должной чувствительности и восприятия внешних стимулов невозможно полноценное развитие когнитивных функций.

4. Систематическое и последовательное обучение в разных социальных и образовательных учреждениях, таких как семья, детский сад и школа. Регулярное и целенаправленное обучение играет важную роль в формировании интеллектуальных способностей и социальной адаптации ребенка.

Множество ученых, в том числе Л.С. Выготский, С.Л. Рубинштейн, Ж.Пиаже и другие, многократно анализировали понятие интеллекта. В данной статье мы не будем углубляться в теоретические дебаты по поводу его точного определения, а сосредоточимся на том, как это понятие используется в психогенетике.

Существует несколько подходов к изучению интеллекта, и в зависимости от теоретической базы, его характеристики могут варьироваться. И. В. Равич-Щербо условно разделил существующие подходы на две большие группы:

1. Подходы, ориентированные на выявление коррелятов когнитивной активности. Это методы, которые рассматривают такие параметры, как скорость выполнения простых задач (например, время реакции), как косвенные индикаторы когнитивных особенностей и, соответственно, уровня интеллекта.

2. Подходы, которые выделяют компоненты интеллекта. Здесь внимание уделяется специфике выполнения различных видов деятельности, что позволяет выявить отдельные составляющие интеллекта. Такой подход зависит от цели исследования и теоретических взглядов исследователей. Например, в одних случаях используется дихотомическая схема (например, вербальный и невербальный интеллект, флюидный и кристаллизованный интеллект), в других — многомерные модели.

В биосоциальных и психогенетических исследованиях интеллекта часто используется компонентный подход, который реализуется в рамках различных теоретических направлений, изучающих индивидуальные различия человека. Эти направления связаны как с теорией тестов, так и с методами факторного анализа. Теория тестов в психогенетике имеет богатую историю, и в последнее время активно развиваются новые методы анализа, такие как ANOVA (анализ вариативности). Хотя факторный анализ не занимает центрального положения, он также находит применение в психогенетических исследованиях.

Это кажется закономерным, поскольку трудно предположить, что факторный анализ может четко выделить характеристики, связанные с пара- и генотипическими факторами, так как корреляция между признаками может быть следствием как генетических, так и средовых причин.

В биосоциальных и психогенетических представлениях о тестировании интеллекта рассматривается следующий подход: уровень интеллекта является функцией как генотипа, так и среды, в первую очередь той социальной среды, в которой находится ребенок в раннем возрасте. Влияние как окружения, так и генотипа определяет онтогенетическую стабильность уровня интеллекта, которая понимается не как отсутствие развития, а как сохранение относительного уровня интеллекта индивида, то есть его рангового положения среди сверстников.

Результаты проведенных исследований показывают, что уровень интеллекта следует рассматривать как относительную характеристику, отражающую лишь положение индивида в группе людей одного возраста и с схожими условиями жизни. При этом стоит отметить, что изменения условий могут повлиять на индивидуальные результаты тестов интеллекта, но они не изменят относительное положение участников в группе, которые подверглись одинаковым изменениям среды. Корреляция между показателями различных тестов интеллекта подтверждает существование общего фактора интеллекта.

Наследуемость интеллекта определяется как отношение генотипической дисперсии показателей интеллекта к общей фенотипической дисперсии (наблюдаемой в эксперименте). Это важное замечание: наследуемость представляет собой популяционную характеристику, а не свойство самой изучаемой черты. Она зависит от того, насколько широко в популяции представлены генетические и средовые факторы, влияющие на интеллект. Эти факторы могут увеличиваться или уменьшаться, что отразится на показателе наследуемости. Например, изменение распределения генотипов, влияющих на интеллект, может повлиять на уровень наследуемости, особенно в случае положительной ассортативности, когда люди с близким уровнем интеллекта чаще вступают в

брак.

По мнению И.В. Равич-Щербо, средовые факторы оказывают влияние на фенотипическую дисперсию показателей интеллекта. Эта дисперсия уменьшается в тех случаях, когда среда воздействует на всех членов популяции одинаково. Неблагоприятные условия среды, если они одинаковы для всех членов популяции, также могут снизить фенотипическую дисперсию, тем самым уменьшив корреляцию между генотипом и фенотипом. Таким образом, изменения в представленности генетических и средовых факторов в популяции изменяют показатель наследуемости интеллекта.

При обсуждении понятия наследуемости интеллекта важно выделить два ключевых момента. Во-первых, большинство методов генетики поведения предоставляют информацию не о наследуемости характеристик, а о роли наследственности в межиндивидуальных различиях. Это означает, что популяционный характер наследуемости интеллекта часто игнорируется, что приводит к ошибочным выводам о связи интеллекта с социальным положением индивида. Во-вторых, даже если существует генотипическая обусловленность вариативности интеллекта, это не означает, что интеллект нельзя изменить под влиянием внешней среды. Этот момент очень важен, так как наследуемость интеллекта часто воспринимается как нечто неизбежное, предопределяющее судьбу. В реальности же все психологические признаки подвергаются не только количественным, но и качественным изменениям. Оптимальное взаимодействие генетических и средовых факторов является залогом успешного интеллектуального развития.

В своей работе О.Н. Усанова также рассматривает проблему соотношения наследственности и среды в изменчивости различных аспектов психической деятельности. Она подчеркивает, что каждый из исследуемых параметров (интеллектуальный, мнестический, речевой и другие) характеризуется уникальными компонентами фенотипической дисперсии, в которых генетические и средовые факторы играют разные роли. Это означает, что вклад генетических и средовых составляющих в развитие психических нарушений может значительно варьировать в зависимости от конкретного случая. Такая закономерность особенно ярко проявляется в динамике психического развития в разные возрастные периоды.

Цель данной статьи — показать, как уровень интеллектуальной недостаточности зависит от условий среды, в которых развивается ребенок, и какое влияние эти условия оказывают на проявление атипичного развития и его социальные последствия.

При формировании интеллектуальной недостаточности активируются те же психологические механизмы, что и при нормальном интеллектуальном развитии. Однако в случае интеллектуальной недостаточности эти механизмы подвергаются искажению из-за специфических биологических и физиологических условий. Это положение подтверждает общепринятый подход к пониманию атипичного развития. При исследовании процессов интеллектуальной недостаточности можно наблюдать качественные различия по сравнению с нормальным интеллектуальным развитием.

Результаты нашего исследования, проведенного в Бакинском детском психоневрологическом диспансере в период с 2010 по 2019 годы, позволяют выделить основные причины возникновения интеллектуальной недостаточности у детей дошкольного возраста. Статистический анализ данных выглядит следующим образом:

1. Общее количество обследованных детей дошкольного возраста с интеллектуальной недостаточностью: 3000 человек.
2. Дети с диагнозом олигофрения: 540 человек (18%).

а) Олигофрения в степени дебильности — 388 человек (72%).

б) Олигофрения в степени имбецильности — 135 человек (25%).

в) Олигофрения в степени идиотии — 17 человек (3%).

3. Биогенетические факторы:

а) Хромосомно-генетические отклонения (как наследственно обусловленные, так и вызванные генными мутациями, хромосомными аберрациями) — 7,6%.

б) Инфекционные и вирусные заболевания матери во время беременности (краснуха, токсоплазмоз, грипп) — 8%.

в) Венерические заболевания (гонорея, сифилис) — 0,03%.

г) Эндокринные заболевания матери, в том числе диабет — 0,8%.

д) Алкоголизм и употребление наркотиков родителями, особенно матерью — 0,002%.

е) Биохимические вредности (радиация, экологическое загрязнение окружающей среды) — 5%.

ж) Серьезные отклонения в соматическом здоровье матери, включая недоедание, гиповитаминоз, опухолевые заболевания,

общая соматическая ослабленность — 5%.

з) Гипоксические состояния (кислородная недостаточность) — 26%.

и) Токсикозы матери в период беременности, особенно во второй половине — 23%.

к) Патологическое протекание родов, особенно если оно сопровождается травмами головного мозга — 21%.

л) Мозговые травмы и тяжелые инфекционные заболевания, перенесенные ребенком в раннем возрасте — 13%.

м) Хронические заболевания (астма, заболевания крови, диабет, сердечно-сосудистые заболевания, туберкулез и др.), начавшиеся в раннем и дошкольном возрасте — 5%.

4. Этиологические факторы:

а) Природовая патология (родовая травма, асфиксия) — 20%.

б) Внутриутробная патология (токсикоз, инфекции матери) — 25%.

в) Сочетанная патология — 23%.

г) Соматические заболевания раннего детства — 10%.

д) Черепно-мозговые травмы в раннем детстве — 22%.

5. Наследственное отягощение как фактор риска:

а) Близкородственные браки — 136 случаев.

б) Речевые нарушения у родителей — 127 случаев.

в) Психические заболевания у родителей — 101 случай.

г) Алкоголизм одного из родителей — 28 случаев.

д) Патологические черты характера у родителей — 120 случаев.

Эти данные подчеркивают важность комплексного подхода в понимании факторов, влияющих на развитие интеллектуальной недостаточности. Они показывают, как биогенетические, этиологические и наследственные факторы взаимодействуют, влияя на развитие ребенка. Важно понимать, что изменения условий среды, в которой растет ребенок, могут существенно повлиять на развитие его психики и интеллектуальных способностей.

6. Кесарево сечение - 104 случая.

По данным проведенного исследования, из 3000 обследованных детей в возрасте от 2 до 6 лет, 540 имеют диагноз олигофрения, что составляет 18%. Это свидетельствует о том, что диагностика олигофрении в основном происходит после достижения детьми 2-летнего возраста, а в каждом случае интеллектуальная недостаточность является основным компонентом, лежащим в основе олигофрении.

Кроме того, на сайте EUDI (www.eudi.az) была опубликована статья, в которой приведена информация о распространенности расстройств аутистического спектра (РАС). Согласно данным Сети мониторинга аутизма и нарушений развития, примерно у 1 из 36 детей было выявлено расстройство аутистического спектра. Примечательно, что РАС встречается во всех расовых, этнических и социально-экономических группах.

Также сообщается, что расстройства аутистического спектра встречаются почти в 4 раза чаще среди мальчиков, чем среди девочек. Примерно у 1 из 6 детей (17%) в возрасте от 3 до 17 лет было диагностировано нарушение развития, о котором сообщали родители в ходе исследования с 2009 по 2017 гг. К этим нарушениям относятся аутизм, синдром дефицита внимания и гиперактивности, слепота, детский церебральный паралич и другие расстройства.

Социальная ситуация развития по Л.С. Выготскому

Исследования Л.С. Выготского, начиная с его работ о влиянии социальных отношений на развитие ребенка, подчеркивают важность окружающей среды для формирования интеллекта. В контексте исследования факторов, влияющих на интеллектуальное развитие, Л.С. Выготский ввел понятие "социальная ситуация развития", которое стало основным в психологии благодаря работам Л.И. Божович (1968) и Б.Г. Ананьева (1968). Это понятие помогло на новом уровне осмыслить влияние внешней среды, социальной ситуации и отношений на развитие ребенка, в том числе и его интеллектуальные способности.

Понимание атипичного развития, включая расстройства аутистического спектра и интеллектуальные недостаточности, невозможно без учета как биологических, так и социальных факторов. Важно отметить, что Л.С. Выготский, изучая механизмы развития у детей с отклонениями, отметил, что для детей с аномалиями развития характерна дивергенция — расхождение, несовпадение двух планов развития: биологического (физиологического) и социального. У нормального ребенка эти планы развиваются в синхронности, а у детей с отклонениями они могут сильно расходиться, что приводит к возникновению атипий развития, таких как расстройства аутистического спектра и другие формы интеллектуальных нарушений.

Влияние среды на интеллектуальное развитие

Таким образом, генетические и средовые

факторы играют ключевую роль в формировании интеллектуальных отклонений. Важность среды и социальных факторов особенно подчеркивал Л.С. Выготский, считая их определяющими в развитии ребенка. В случае детей с аутизмом или интеллектуальной недостаточностью, социальные и культурные условия, в которых происходит развитие, могут как компенсировать, так и усугублять уже существующие нарушения, что делает раннюю диагностику и помощь особенно важными.

## Заключение

Анализ соотношения биогенетических и социально-психологических факторов в процессе отклоняющегося развития продолжает приобретать все большее значение в психогенетических и психодиагностических исследованиях. В заключение следует подчеркнуть, что процесс формирования интеллектуальной недостаточности имеет свои уникальные внутренние механизмы, отличные от механизмов нормального интеллектуального развития. Это различие, однако, не отменяет принципиального единства законов интеллектуального развития, действующих как в норме, так и в атипии. Единство этих законов заключается в том, что несмотря на различия в конечных результатах, как развитие, так и отклонение имеют схожие закономерности функционирования психических процессов. Однако, трудность, а порой и невозможность прямого соотнесения этих процессов, обусловлена качественными и количественными отличиями в их течении. Важно отметить, что процессы распада и развития в условиях интеллектуальной недостаточности всегда происходят в необычных для психики условиях, что накладывает отпечаток на их характер и результаты.

Для понимания сущности интеллектуальной недостаточности необходимо проанализировать взаимодействие биогенетических факторов и психосоциального влияния. И, хотя это взаимодействие можно рассматривать как два аспекта одного процесса, важно отметить, что их соотношение имеет свою специфику в зависимости от конкретного типа нарушения развития. Так, степень выраженности неблагоприятных влияний может варьироваться в зависимости от типа атипичного развития. Например, для детей с умственной отсталостью эти неблагоприятные влияния (как биогенетические, так и социальные) оказываются более разрушительными, чем для детей с задержкой психического развития. В этом контексте социальная микросреда (например, семья или ближайшее окружение ребенка) играет решающую роль, особенно для детей с более выраженной интеллектуальной недостаточностью. В случае таких детей неблагоприятные условия, такие как дисфункциональная семья, асоциальные группы или неудовлетворительные условия обучения, могут значительно быстрее способствовать развитию деструктивных форм поведения и социального взаимодействия.

Дети с умственной отсталостью, как правило, более восприимчивы к таким деструктивным условиям и быстрее оказываются вовлечены в формы отклоняющегося поведения по сравнению с детьми с задержкой психического развития. Это связано с низким уровнем интеллекта, который служит барьером для их адаптации в социально сложных ситуациях. Таким образом, умственная отсталость делает ребенка более уязвимым в условиях неблагоприятной социальной среды.

Подтверждением этого является результат нашего исследования, которое показало, что ресурс развития детей с интеллектуальными нарушениями в значительной степени определяется особенностями окружающей среды, в которой они находятся. Это подчеркивает важность ранней диагностики и комплексного подхода в работе с детьми, имеющими отклонения в развитии, а также необходимость создания поддерживающей и развивающей среды для таких детей.

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## Xülasə

## Uşaqlarda intellektual çatışmazlığın biogenetik və psixososial əsasları

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Məqalədə uşaqlarda aşkar olunan problemlərin mənşəyinin biogenetik və psixososial əsaslara malik olması haqqında müəllif tərəfindən geniş məlumat verilib. Məqalənin əsasını uşağın intellektinin inkişafında dominant rol oynayan biososial problemlər təşkil edir. Burada anadangəlmə irsi və residivi xəstəlikləri olan uşaqlarda intellekt qüsurlar problemi ilə əlaqəli dünyaca məhşur alimlərin fikirləri öz əksini tapıb. Biososial gerçəkliklə yanaşı digər bir reallığın - insanın yaşadığı əşya və hadisələr, ünsiyyət və mübarizə aləminin rolu məqalədə qeyd olunub. Müasir dövrdə elmi nailiyyətləri nəzərə alan klassik psixologiya elmi bir çox məsələlərdə defektologiya ilə genetika arasında əlaqənin olması məqalədə göstərilir. Məhz bu istiqamətdə genotip-mühit əlaqələrinin ontogenetik qanunauyğunluqlarının tədqiqi məqalədə əks olunub. Q.M.Dulnev və A.R. Luriya tərəfindən normal bir uşağın biogenetik- psixososial inkişafı üçün təyin olunan dörd şərtlər göstərimişdir.

**Açar sözlər:** *Biogenetik, psixososial, atipik, intellekt, çatışmazlıq, təsnif etmək. psixokorreksiya.*

## Abstract

## Biogenetic and psychosocial foundations of the origin of intellectual disability in children

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The article provides detailed information on the biogenetic and psychosocial foundations of the problems identified in children. The main focus of the article is on biosocial problems, which play a dominant role in the development of a child's intellect. The article presents the views of renowned scholars regarding the issue of intellectual disabilities in children with congenital hereditary and recurrent diseases.Alongside the biosocial reality, the article also highlights the role of another reality - the world of objects and events, communication, and struggle in which humans live. In the context of modern scientific achievements, the article demonstrates the connection between defectology and genetics in classical psychology, addressing many issues. Specifically, it discusses the study of genotype-environment interactions and ontogenetic regularities.The article also presents the four conditions defined by K.M. Dulnev and A.R. Luria for the biogenetic-psychosocial development of a normal child.

**Keywords:** Biogenetic, psychosocial, atypical, intelligence, deficiency, classification, psychocorrection.

# Liquid-phase catalytic oxidation of higher fatty acids extracted from various vegetable oils

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**Abstract**

The process of liquid-phase catalytic oxidation of a mixture of higher fatty acids isolated from various vegetable oils in the presence of transition metal naphthenates of manganese and chromium has been studied. The oxidation process was carried out with atmospheric oxygen at a temperature of $80^0$C for five hours. The amount of catalyst to the feedstock was 0.5%. The primary components, as well as the products of the oxidation reaction, were studied by IR spectroscopy on a BRUKER ALPHA IR-Fourier spectrometer in the wave frequency range 600-4000 $cm^{-1}$. Based on the spectra, the change in the optical densities of C=C, C=O (acid) and C=O (aldehyde) bonds in the initial and obtained products was studied. Analysis of the data obtained showed that both in the presence of manganese naphthenate and in the presence of chromium naphthenate, the optical density of the C=C bond decreases and the optical density of the C=O bond of acids increases, as well as the formation of a new C=O bond (1740 $cm^{-1}$), a characteristic C=O bond of saturated aldehydes, which in turn indicates a partial opening of C=C bonds during oxidation with the formation of aldehyde acids and dibasic acids with a smaller number of carbon atoms than those of higher fatty acids.

**Keywords:** fatty acids, transition metal naphthenates, liquid-phase oxidation, chemical bonding, optical density

## Introduction

Chain reactions of organic compound oxidation are divided into fast chain branching reactions in the gas phase and slow chain gas-phase and liquid-phase processes with degenerate chain branching. Slow chain oxidation reactions of organic substances are the most common subjects of research in the field of chain reactions. This is because the direct oxidation of organic compounds underpins many technological processes for producing important chemical products. For example, the production of phenol and acetone is based on the liquid-phase oxidation of cumene [1-4]. Terephthalic, adipic, and acetic acids, used in the production of synthetic and artificial fibers [5], along with many other products, are obtained by oxidizing organic substances in the liquid phase. Under normal conditions, the C-C bond in organic substances is quite stable, and the initiation of chains involving the cleavage of this bond typically does not occur. Therefore, chain initiation is possible through the involvement of oxygen and initiating additives that attack the weakest π-C-C and C-H bonds. Oxidation processes consist of a large number of parallel and sequential macroscopic and elementary stages. The active centers of oxidative reactions are free radicals of various types, structures, and reactivities. In an advancing oxidation process, the main source of free radical formation becomes the reaction of degenerate chain branching. The products responsible for branching are intermediate peroxide compounds ROOH. The formation of radicals from hydroperoxides occurs not only through the unimolecular decomposition of hydroperoxides

$$ROOH \rightarrow RO\cdot + OH \quad (1)$$

but also through the interaction of two saturated molecules:

$$ROOH + RH \rightarrow RO\cdot + R\cdot + H_2O. \quad (2)$$

The catalysts for liquid-phase oxidation processes are metals of variable valency (such as manganese, cobalt, chromium, etc.) [6-10], which initiate and participate in chain-breaking reactions during the process. Molecular oxygen in the form of air is used as the oxidizing agent in most types of oxidation reactions. Liquid-phase oxidation is carried out by bubbling air through the starting organic reagent, in which reaction products gradually accumulate.

As is known, natural higher fatty acids are obtained by hydrolysis of fats and vegetable oils. They are used in the production of detergents, lubricants, paints and varnishes, fuel additives, and for the synthesis of aliphatic amines, amides, etc. [11-13]. The oxidation of a mixture of higher fatty acids extracted from vegetable oils is based on a free radical oxidation process under the influence of air oxygen. The fatty acid composition of vegetable oils mainly consists of saturated fatty acids (≈13%), monounsaturated fatty acids with one double C=C bond (≈16-39%), and polyunsaturated fatty acids

with multiple double C=C bonds (≈48-72%). The peroxide oxidation of higher fatty acids is a typical free radical chain process initiated by OH, OR and other radicals. Under the influence of variable valency metal ions, free radicals attack methylene groups at the double bond, forming new allylic-type radicals, which further interact with a molecule of oxygen to produce a more polar superoxide radical, which in turn decomposes to form an aldehydic acid [14]. The oxidation products may also include hydroperoxides, aldehyde alcohols, oxo- and ketoacids, dibasic carboxylic acids with fewer carbon atoms than those in the higher fatty acids, and other compounds [15]. This study investigates the process of liquid-phase catalytic oxidation of a mixture of higher fatty acids extracted from various vegetable oils.

## Experimental Part

The raw materials were corn, cotton, and palm oils. The process of extracting fatty acids from vegetable oils was carried out using hydrolysis with 20% sodium hydroxide solution at a temperature of 95-98°C, followed by neutralization with hydrochloric acid. The extracted acids were washed several times with hot water and then dried from excess water by constant stirring with a magnetic stirrer at a temperature of 120-130°C.

The oxidation process of the extracted acids was carried out with air oxygen at a temperature of 80°C in the presence of manganese and chromium naphthenates as catalysts, at a concentration of 0.5% relative to the raw material, for 5 hours. The primary products, as well as the products subjected to oxidation, were analyzed using infrared (IR) spectroscopy on a BRUKER ALPHA Fourier-transform IR spectrometer in the wavelength range of 600-4000 $cm^{-1}$.

Let us consider the IR spectrum using the example of a mixture of acids extracted from cottonseed oil (AECSO) (Fig. 1).

In the IR spectrum of AECSO, the following absorption bands were observed: deformation (1378, 1412, 1459 $cm^{-1}$) and valence (2853, 2922 $cm^{-1}$) vibrations of C-H bonds in the $CH_3$ and $CH_2$ groups, deformation (937 $cm^{-1}$) vibrations of the O-H bond of the acid, valence (1708 $cm^{-1}$) vibrations of the C=O bond of the acid, valence (2577, 2674 $cm^{-1}$) vibrations of the carboxylic acid group, and valence (3008 $cm^{-1}$) vibrations of the C=C bond.

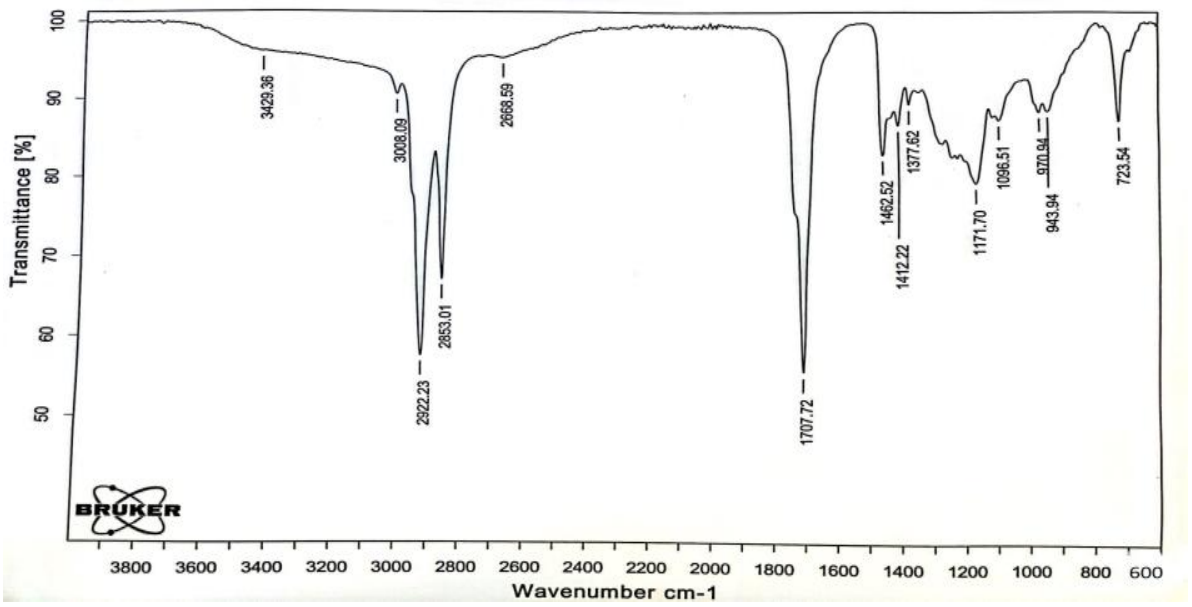


**Fig. 1. IR spectrum of** AECSO

The analysis of the IR spectra of AECSO and the mixture of acids extracted from corn oil (AECO) and palm oil (AEPO) proved their practical identity.

The IR spectra of the samples subjected to the oxidation process in the presence of Mn and Cr naphthenates of higher fatty acids extracted from various vegetable oils are presented in Fig. 2 and 3.

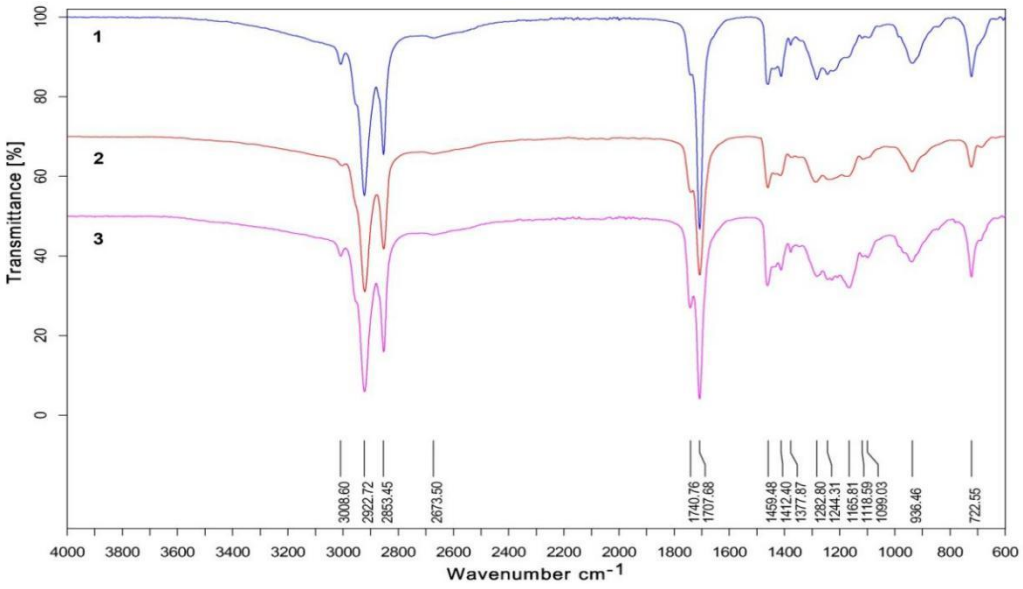


**Fig. 2.** IR spectrum of acids oxidized in the presence of manganese naphthenate extracted from: 1 - corn oil, 2 - palm oil, 3 - cottonseed oil

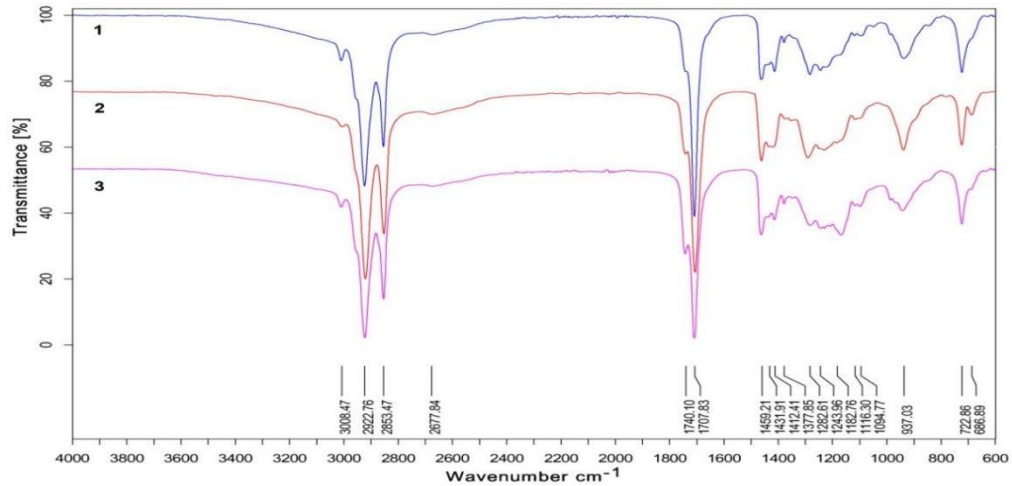


**Fig. 3. IR spectrum of acids oxidized in the presence of chromium naphthenate extracted from: 1 - corn oil, 2 - palm oil, 3 - cottonseed oil**

The analysis of the IR spectra of the AECSO mixture and those subjected to oxidation in the presence of manganese naphthenate proved their practical identity. However, the spectrum of the latter contains an absorption band at 1740 $cm^{-1}$, characteristic of the C=O bond in saturated aldehydes [16]. The IR spectra of the oxidized samples of corn oil and palm oil are identical to each other.

## Results and Discussion

Based on the obtained spectra, the changes in optical densities of C=C, C=O (acid), and C=O (aldehyde) bonds in the starting and resultant products were investigated.

The comparison of optical density ($D_{3008}$) of C=C bonds at 3008 $cm^{-1}$ in the studied starting acids showed a decrease in the following order: AECO ($D_{3008}$) = 0.062 → AEPO ($D_{3008}$) = 0.044 → AECSO ($D_{3008}$) = 0.042. In the oxidation products obtained in the presence of manganese naphthenate, the change in optical densities is reflected in the following sequence: AECO ($D_{3008}$) = 0.055 → AECSO ($D_{3008}$) = 0.034 → AEPO ($D_{3008}$) = 0.032. The optical densities of C=C bonds in the oxidation products conducted in the presence of chromium naphthenate change in a similar order: AECO ($D_{3008}$) = 0.055 → AECSO ($D_{3008}$) = 0.034 → AEPO ($D_{3008}$) = 0.033.

The investigation of the optical densities (D1707) of the C=O bonds of acids at 1707 $cm^{-1}$ in the studied acids showed a decrease in the accumulation of C=O groups in the following sequence: AECO ($D_{1707}$) = 0.255 → AEPO ($D_{1707}$) = 0.173 → AECSO ($D_{1707}$) = 0.154.In the oxidation products obtained in the presence of manganese

naphthenate, the change in optical density occurs in the following increasing order: KBXΠ ($D_{1707}$) = 0.264 → AEPO ($D_{1707}$) = 0.276 → AECO ($D_{1707}$) = 0.325.The accumulation of C=O groups in the oxidation products conducted in the presence of chromium naphthenate occurs in the following sequence: AECSO ($D_{1707}$) = 0.269 → AECO ($D_{1707}$) = 0.281→ AEPO ($D_{1707}$) = 0.296.

The analysis of the optical density values ($D_{1740}$) of the peaks at 1740 $cm^{-1}$ corresponding to the C=O group of saturated aldehydes in the acids oxidized in the presence of manganese naphthenate from various vegetable oils revealed that accumulation of C=O group of aldehyde occurs in the order: AECO ($D_{1740}$) = 0.069 → AEPO ($D_{1740}$) = 0.077 → AECSO ($D_{1740}$) = 0.109. Similar indicators for samples oxidized in the presence of chromium naphthenate showed a more intense accumulation of C=O groups of aldehydes: AEPO ($D_{1740}$) = 0.065 → AECO ($D_{1740}$) = 0.069 → AECSO ($D_{1740}$) = 0.114.

## Conclusions

Analyzing the obtained results, it can be stated that in the presence of both manganesenaphthenate and chromium naphthenate, a decrease is observed in the optical density of C=C bond and an increase in the optical density of C=O bond of the acids, as well as the formation of a new C=O bond (1740 $cm^{-1}$), characteristic of the C=O bond of saturated aldehydes. Therefore, infrared spectroscopy has shown that the oxidation process involves partial cleavage of the C=C bond according to the following proposed scheme: $CH_3 – (CH_2)_n – COOH \rightarrow HOOC – (CH_2)_n – COOH + HOC – (CH_2)_n - COOH$

Thus, infrared spectroscopy has confirmed the structure of the samples obtained by the oxidation process.

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# Regarding the biological diversity of Shahdagh area

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**Abstract**

The study is devoted to the study of flora biodiversity of Shahdag area. As a result, it was observed that more than 1600 plants were distributed in the area. In the area, relict, endemic and rare species have been identified in the ancient areal type. In terms of vegetation, the results of the analysis were as follows: 25 formation classes, 72 formations, 98 associations formed in 6 vegetation types. The distribution of the plants on belts has been determined, and while some species of plants are found in several zones, there are also species that are found in only one belt. Biological reserves have been investigated and their prospects of use have been analyzed. During the research, in addition to taxonomic analysis, special attention was paid to ecological analysis, analysis of the biotopes where the studied species spread in the area, their distribution in zones, ecological groups (mainly according to the relationship with water) and other ecological issues were also investigated. As a result of floristic studies conducted by us, it has been determined that there are more than 250 species of medicinal plants in the Shahdag area. It is possible to conditionally divide the medicinal plants spread in the area into 4 groups.

**Keywords**: Shahdagh National Park, biodiversity, flora, ecology, vegetation cover, rare plants

## Introduction

Biodiversity is the sum of the diversity of all living things on Earth, from genes to ecosystems. In order to protect biological diversity, the Milli Majlis of the Republic of Azerbaijan joined the International Convention on Biological Diversity and approved a plan of measures for the restoration and reintroduction of endangered species in their natural habitats. Identification and preservation of ecosystems where rare and endemic plants are distributed across regions is one of the important issues. According to scientists, in the modern era, as a result of climate disasters occurring in the world, species of fauna and flora are constantly declining, which leads to the destruction of biodiversity. From this point of view, it is very important to study areas from time to time, one of such unique areas is Shahdag. The main area where Shahdag is located is in the Greater Caucasus Mountains, in the territory of Gusar region, with height of 4283 m a.s.l. There are folk tales about the origin of the name of this mountain, but according to researchers, since this oronym represents a high, majestic, tall mountain, Shahdag means "king of the mountains", "the highest". The word Shah is used in Azerbaijani toponymy in the meaning of "high", "tall". This oronym, which is distinguished by the fact that it is the highest of the existing mountains on the territory of Azerbaijan, confirms the opinion of researchers. In honor of this mountain, Shahdag National Park was created and named after the mountain. Hundreds of flora and fauna have been formed in the area, dozens of rare and relict plants are inhabited. SHNP was established under the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan according to the Order of the President of the Republic of Azerbaijan No. 1814 dated December 8, 2006 [Order of the President of Azerbaijan I.Aliyev.., 2006]. According to the requirements of the Law of the Republic of Azerbaijan "On Specially Protected Natural Areas and Objects", any economic activity, including grazing and use of hayfields, is completely prohibited in the Park territory. This is also important in terms of protecting the rare flora and fauna of the area.

In modern times, a special place is occupied by the development of applied ecology and botany, the organization of long-term global and regional forecasting and monitoring of components of the natural environment. In recent years, environmental conservation, ecosystem protection and natural resources have increased to a high level. Destruction of forests due to lack of energy resources and especially fuels, unplanned grazing of farm animals, destruction of soil and vegetation

as a result of merciless anthropogenic impact on nature have caused its degradation, in other words. The erosion process has been intensified by forest depredation particularly as a result of the use of trees for furniture and fuel and the loss of the landscape's water-protecting role.

Shahdag is a side ridge parallel to the Main Caucasus Range in the GC mountains. The highest point in Azerbaijan is Shahdag peak The highest part of the Side range in the territory of the Republic of Azerbaijan. It is separated from the Kyzylgaya plateau by the Gusar river valley. It is composed of deposits of the Jurassic and Cretaceous systems. There are alpine and subalpine meadows, glaciers with an area of more than 1 square km.

## Material and methodology

During the study of the area, information was collected about a number of ecological factors (water system, soil cover, relief, etc.). Geobotanical analyzes were conducted during the routes organized in different belts (medium, subalpine and alpine). The sources such as "The Red Book of Azerbaijan" [2023]; meterials of A.M. Askerov [2003-2006]; O.B. Ibadli [2005]; V.J.Hajiyev [1994, 2004, 2005] were used. Life forms of plants were developed according to C.C.Raunkier [1937] and I.G.Serebryakov [1964], and ecological groups according to A.R.Shennikov [1950]. Areal types, classes and groups were given according to A.A. Grossheim [1936, 1948], and N.N. Portenier [200] The specification of systematic taxa was mainly carried out according to the "Conspect of the flora of Caucasus" [2003-2006] and other works.

The works of A.A. Grosheim [1939-1967] were used for the purpose of clarifying the typology and classes of areals, as well as determining the species of unknown plants and their classification.

Rare and endangered species were reviewed and categorized according to the International Union for Conservation of Nature (IUCN) format [2007].

## Experiments and discussions

It was determined that 31 sporous and 1572 seeded species (12 species of gymnosperms, 1560 species of angiosperms, including 294 species of monocotyledons, 1266 species of dicotyledons) are distributed in Shahdag flora. Geographical-areological analysis of the region shows that the flora of the Shahdag region is formed by the predominance of boreal and xerophilic species. Xerophilic areal type species make up almost most of the flora of the region with 571 species (35.5%), boreal areal type with 538 species (33.6%), Caucasian areal type with 329 species (20.5%). Steppe areal type is represented by 48 species (3%). Undetermined areal type is represented by 41 species (2.5), ancient areal type by 24 species (1.5%), adventive areal type by 21 species (1.3%), desert areal type by 17 species (1.1%) and cosmopolitan areal type by 14 (0.9%) species.

There are 24 species (Anizantha tectorum (L.) Nevski, Chenopodium foliosum Aschers, Ch. vulvaria L., Krascheninnikovia ceratoides (L.) Gueldents., Rumex scutatus L., Platanus orientalis L., Juglans regia L., Viola sicheanaW.Beck., Datisca cannabina L., Thymelaea passerina (L.) Coss. et Germ. and etc.) of relict plants in the ancient areal type in the area.

There are 9 main and 7 transitional groups in 3 classes of the xerophilic areal type (Mediterranean, Western Asia, Central Asia) represented by more species. Most species are distributed in the Western Asian (69 species), Mediterranean (74 species), Irano-Turanian (53 species), Atropatan (38 species), Iranian (34 species) and Mediterranean-Irano-Turanian (33 species) groups. Turanian group of the desert areal type is represented by Lonicera iberica Bieb., Viburnum opulus L., Adonis bienertii Butk. species, Eastern Transcaucasian group by Nonnea rosea (Bieb.) Link, Acer laetum C.A.Mey., A. hyrcanum Fisch. et C.A.Mey., Lonicera iberica Bieb., Papaver arenarium Bieb., Melandrium latifolium (Poir.) Maire, Sclerochloa dura (L.) Beauv, Sakharo-Iranian group by Lepidium sativum L. species. The Caucasian areal type includes 329 species in one class and 2 groups, of which Callicephalus nitens, Xeranthemum longepapposum, X. cylindraceum, Centaurea behen, Achillea tenuifolia species are more common. The cosmopolitan areal type is represented by only 41 species such as Cerastium glomeratum Thuill., Triglochin palustre L.,Botrychium lunaria (L.) Sw., Ophioglossum vulgatum L., Poa palustris L., P. caucasica Trin., P.annua L., Sonchus oleraceus L., Veronica biloba Schreb. , Lemna minor L., L. trisulea L. etc. Sisymbrium altissimum species belonging to the steppe areal type of the region is included in Pontic-Sarmatian, Stipa lessingiana species in Pannonian-Sarmatian, Phlomis pungens Eastern Mediterranean–Pontic transition group, Eremopyrum triticeum, Catabrosella humilis, Ceratocarpus arenarius, Atriplex cana species to Sarmatian main group. In the boreal areal type, which takes the second place in terms of the number of species, Palearctic with 142 species and European areal elements with 176 species take the main place. In the flora of the region, the Holarctic is represented by 87 species, and the Western Palearctic by 65 species. Thus, the vegetation of the Shahdag area was formed due to the elements of Western Asia, the Mediterranean Sea, Iranian, Turanian elements, and on the other hand, the

elements of the Palearctic, European, Holarctic boreal. Local aboriginal species with Atropathan and Caucasian elements also play an important role in the formation of the area's flora.

Ecological groups of plants of Shahdag NP territory are diverse - xerophytes dominate the flora of the region with 473 species (29.5%). Mesophytes are represented by 438 species -27.3%, mesoxerophytes by 434 species - 27.1%, xeromesophytes by 196 species -12.2%. This is a manifestation of the diversity of the area.

Endemism is the main indicator of the originality of the flora. The comprehensive study of endemic plants, first of all, allows to correctly explain the formation of flora, taxa, the history of the region, the formation, development and evolution of its vegetation. On the other hand, it plays an important role in the protection of the natural gene pool of plants, in their transmission to future generations, in the organization of nature reserves and sanctuaries, botanical gardens, and dendrological parks.

In botanical geography, the study of the endemism of the area flora is of great importance. The large number of endemic and relict species distributed in a certain area is the main indicator of the specificity and originality of that flora. It is also a proof that this area is different from other areas. As a result of the study of the composition of endemic taxa, the regularity of flora formation, phylogenetic status, chorological and eco-phytocenological characteristics, as well as genesis become clear. Endemics are understood as taxa of different ranks distribution of which is limited within a certain area. The geographical distribution of endemic taxa can be different. The species range of which is beyond the boundaries of the studied area and are not limited to a certain area are called subendemic. Endemic and relict plants of Azerbaijan and Caucasus vegetation were studied by a group of scientists. G.F. Akhundov reported about 240 endemic species for the flora of Azerbaijan. He noted the existence of 1153 endemic species in Caucasian flora in "Analysis of Caucasian flora" of A.A. Grossheim's work. In recent years, as a result of the studies conducted in the direction of studying the endemic plants of Azerbaijan, some of the endemic species have been evaluated as subendemic.

There are endemic and relict plants belonging to various floristic elements in the vegetation of Shahdag area. A total of 277 endemic plant species are distributed in the flora of the area [Flora of Azerbaijan, 1950-1961], of which 252 species (91%) are endemic to the Caucasus, 25 species are endemic to Azerbaijan. This is 17.28% of the area's flora.

Endemism can be characterized by a relatively small area. Among the endemics of Azerbaijan, elements of the Caucasian group dominate with 9 species, Palearctic, Irano-Turanian, Atropatan and Mediterranean elements with 2 species each, adventive, Holarctic, Asia Minor, Pontic, Caucasus-Central Asia, North Iranian elements are very few (all 1 species), and the areal of one species is unknown. They are mainly distributed in the forests of the Shahdag area, in the forest edge cenoses, in the subalpine, alpine and subnival zones. Azerbaijan endemics include Astragalus lunatus Pall., Erodium schemachense Grossh., Stachys pauli Grossh., Iris lycotis, Asperula hirsutiuscula Pobed., Rosa azerbaidzhanica Novopokr. et Rzazade, Silene caespitosa Stev., Delphinium arcuatum L., Astragalus kubensis Grossh., A.caspicus Bieb., Alchemilla amictaJuz., Angelica sachokiana (Karjag.) M.Pimen. et V.Tichomirov, Seseli cuneifoliumBieb., Euphrasia karjaginii Kem.-Nath., Nepeta supina Stev., N.cyaneaStev., Pimpinella aromaticaBieb., Galium vartanii Grossh. and other species. Among the endemics of Caucasus, Thesium procumbens C.A.Mey., Sedum involucratum Bieb., Gagea chanae Grossh., Sorbus caucasica Zinserl., Haplophyllum villosum (Bieb.) G. Don fil., Alchemilla epipsila Juz., Trinia leiogona (C.A.Mey.) B.Fedtsch., Pulsatilla albana (Stev.) Bercht. et J.Presl., Malabaila sulcata Boiss., Scabiosa owerini Boiss., Delphinium flexuosum Bieb., Draba siliquosa Bieb., Astragalus polyphyllus Bunge., Cephalaria media Litv., Tanacetum leptophyllum (Stev.ex Bieb.) Sch.Bip., Carduus seminudus Bieb., Dracocephalum botryoides Stev., Veronica minuta C.A.Mey.,Campanula caucasica Bieb., İnula orientalis Lam., Psephellus daghestanicus Sosn. in Grossh., Serratula caucasica Boiss., Anthemis fruticulosa Bieb., Thymus collinus Bieb., Ziziphora puschkinii Adams and etc. can be mentioned. Caucasian endemics are more common on the Caucasus, Western Asia, Asia Minor, Palearctic, Atropathan, Iran, Mediterranean, and European elements.

The analysis of recent studies conducted in the direction of the examination of the flora of Azerbaijan and neighboring countries shows that 96 subendemic species are found in the flora of the Shahdag area. Thus, some species mentioned in the flora of Azerbaijan have already been transferred to the subendemic level. These subendemics are also considered Caucasian endemics and are species described for the first time from Azerbaijan.

Evaluation of rare plants according to criteria can be done according to the smallest taxonomic unit. At this time, taking into account the geographical or political area, the status of the

populations should be assessed based on the distribution range of the assessed taxon in the wild flora. Each taxon should be assessed against all criteria and adjusted to an appropriate level of threat. In general, the assessment on criteria should be carried out not only through personal expeditions, but also through comparison with available scientific materials, clarification of the flora and consultation with other specialists. Thus, during the floristic studies conducted in the area, the areals and bioecological characteristics of the rare and endangered species were determined, the few taxa with narrowing areals and endangered were selected, and herbarium materials were collected from different areas of the area. In order to assess the current status of rare and endangered species, taking into account all the above and the latest edition of the "Red Book", areal maps were drawn up by territory.

Thus, in accordance with the criteria and subcriteria of the International List of 50 species identified as rare or endangered in the study area, the assessment was carried out in 4 categories. In general, in Shahdag area, 26 species were evaluated as vulnerable (VU), 14 species as "Near Threatened" (NT), 8 species as endangered (EN), and 2 species of critically endangered species (CR) categories. Ecological aspects of current flora in dry areas and swamps, alpine and subalpine ecosystems found in Shahdag territory were analyzed, their species were determined and indicator species were selected. Identification of species, inclusion in the category, determination of vegetation periods of useful and medically important species, development of vegetation map and identification of target species in the project area are essential. A number of rare and endemic species have been collected in the study area. Of the studied legumes, 11 species (Onobrychis cyri, O.biebersteinii, O.iberica, O.bobrovii, O.petraeae, O.vaginalis, Lotus caucasica, Vicia grossheimii, V.boissieri, Lathyrus miniatus, Medicago glutinosa)of 5 genera were found to be rare, endangered and endemic plants. It became known that these species are included in the list of rare and endangered species of the International Union for Conservation of Nature.

During the monitoring of Shahdag vegetation located within the Greater Caucasus, 25 formation classes, 72 formations, and 98 associations formed in 6 vegetation types were identified. The main elements forming the vegetation are forests and bushes. Meadow, subalpine and alpine carpets are also widely developed in the area, but tugai, floodplain and wetland groups are relatively poorly characterized.

Vegetation of the forest ecosystem was thoroughly inspected, and it was determined that the main elements of the forest here are trees and shrubs. Broad-leaved trees such as Drooping birch - Betula pendula Roth., Oriental beech– Fagus orientalis Lipsky., Tillet-Tilia cordata Mill., English oak- Quercus robur L. trees, European dewberry-Rubus saesius L., small-flowered black hawthorn - Crataegus pentagyna Waldst., China rose-Rosa chinensis Jacq., European blueberry-Vaccinum myrtillus L.shrubs, grass plants, grasses, legumes and forbs Marshmallow– Althaea officinalis L., Common origanum – Origanum vulgare L., Saint-John's-wort– Hyperecum perforatum L., Red clover – Trifolium pratese L., Mullein – Verbascum flavidum (Boiss) Freyn. and Bornm. medicinal and aromatic plants dominate the forest.

The eco-phytocenotic regularity of plants' adaptation to climate and soil conditions is characterized by their distribution across altitudinal zones.

Table 1. Distribution of Shahdag flora and vegetation by altitude zones

| № | Belts | Absolute altitude from sea level in m | Vegetation types | Species | |
|---|---|---|---|---|---|
| | | | | Number | By % |
| | Foothills | 1000-1200 | Semi-desert, mountain-xerophyte | 60 | 1.9 |
| | Low highlands | 1200-1500 | Mountain-xerophyte, oasis | 579 | 18.6 |
| | Middle highlands | 1500-2000 | Steppe, forest and thicket | 1083 | 34.7 |
| | Upper highlands | 2000-2500 | Forest, thicket and meadow | 309 | 9.9 |
| | Subalpine | 2500-3000 | Meadow, subalpine meadows | 320 | 10.3 |
| | Alpine | 3000-3500 | Alpine meadows and carpets | 172 | 5.5 |
| | Subnival | 3500-3800 | Subnival and petrophile | 4 | 0.1 |
| | Nival | 3800-3906 | Nival and petrophil | 4 | 0.1 |

A number of difficulties have arisen in the precise determination of the boundaries of the species in the mentioned zones. Thus, while some plant species are found in several zones, there are also species that are found in only one zone. Therefore, the belts were compared with each other, and their floristic composition was calculated using the Serensen-Chekanovsky similarity coefficient (Ksc) (table 2).

Table 2.Similarity coefficient of floristic composition compared across belts

| Belts | Plain | Foothills | Low highlands | Middle highlands | Upper highlands | Subalpine | Alpine | Subnival Nival |
|---|---|---|---|---|---|---|---|---|
| Foothills | | - | 0.02 | 0.04 | 0.01 | 0.03 | - | 0.05 |
| Low highlands | | | - | 0.37 | 0.09 | 0.06 | 0.01 | - |
| Middle highlands | | | | - | 0.02 | 0.10 | 0.01 | - |
| Upper highlands | | | | | - | 0.10 | 0.07 | 0.01 |
| Subalpine | | | | | | - | 0.45 | - |
| Alpine | | | | | | | - | - |
| Subnival, Nival | | | | | | | | - |
| | | | | | | | | |

It was found that the degree of similarity (Ksc =0,45; 0,39; 0,37) was high in comparison of subalpine with alpine and low highland with middle highland. During the research, in addition to taxonomic analysis, special attention was paid to ecological analysis, analysis of the biotopes where the studied species spread in the area, their distribution in zones, ecological groups (mainly according to the relationship with water) and other ecological issues were also investigated. These studies were conducted on the basis of literature and fund materials, and were clarified during expeditions to the area. During the biotopological analysis of the studied species, it was determined that 40 species of legumes were studied in bushes, 38 species in forests, forest clearings, forest edges, arid forest biotopes, 28 species in cultivated fields, and 7 species of cereals on roadsides, 4 species in gardens, vineyards, fields, 4 species in stony, gravelly and rocky biotopes. The distribution of these species in belts is uneven. 78 species are mostly found in the lower mountain belt, 27 species in the middle mountain belt, and 13 species in the upper mountain belt.

Shahdag National Park is rich in flora, and the agriculturally important plant species are also widespread in the area. The flora of the area is rich in medicinal, essential oil, wild vegetables, dyes, fruits and berries, decorative, fodder and melliferous plants.

As a result of floristic studies conducted by us, it was determined that there are more than 250 species of medicinal plants in the Shahdag area. It is possible to conditionally divide the medicinal plants spread in the area into 4 groups.

The first group includes medicinal plants that are abundantly available in the area and are mass-collected following the rules of collection. It is possible to show plants like urtica dioica, bitter wormwood, different species of hawthorns and rosehips, yarrow.

The second group of plants includes plants stock of which has decreased due to mass gathering. These plants should be collected within certain limits in the territory and their collection should be controlled. These includes plants such as horsetail, coltsfoot, barberry, elecampane, Saint-John's-wort, origanum, different species of thyme etc.

The third group of plants includes plants that are scarce in the area, isolated or in small groups, and plants that are about to be depleted. These plants include orchis, violet, althea, immortelle, water pepper and etc.

The fourth group of plants includes rare, endangered plants and plants in need of protection. These plants include pine, and etc.

Thus, the flora biodiversity of Shahdag has been fully inspected, which can be helpful in revealing negative situations caused by climate and anthropogenic factors in the future.

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# Assessment of the state of Kelbadjar forests and distribution of hazelnut

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**Abstract**
The current state of forest communities in the Kelbajar region, including hazel, is studied in the work. The characteristics of the entire forest fund of this region are given and compared with the state of these forests before the occupation. It was found that the forests of the region have been subjected to unsystematic catting for 30 years, forests have been destroyed mainly in accessible places, which makes it necessary to carry out large-scale forest restoration work. The state of the bear nut was also assessed here. As a result, it was found that most of the trees were cut down, the restoration process of this species has almost stopped. Therefore, it is necessary to adopt a special program for the restoration of this species and the biodiversity of this area as a whole.
**Key words:** biodiversity, restoration, tree-like, special program, assessment of the state, wood texture, ecosystems.

## Introduction

In Azerbaijan, research work on the study of bioecological, forestry and economic characteristics and significance of bear nuts was carried out in various directions, including:

• Adaptation to local climatic conditions.

• Growth and development in various zones of the Lesser Caucasus.

• Resistance to diseases and pests.

• Role in ecosystems, especially in mountain and foothill forests.

These studies are important for developing methods for the conservation and sustainable use of forest resources, as well as for understanding the ecosystem role of bear nuts in preserving biodiversity.

One of the key areas of research concerns the use of bear nuts in reforestation programs. Azerbaijani forestry scientists are studying its effectiveness in restoring degraded lands and preventing soil erosion, especially on the mountain slopes of the Lesser Caucasus. Bear nuts, with their powerful root system, help stabilize soils, making them important for ecological rehabilitation in regions with active erosion.

One of the researchers working in this direction is Aliyev R.G., who has conducted several studies on the restoration of forest areas and the role of bear nuts in these processes.

Azerbaijani scientists are also studying the use of bear nuts in agroforestry systems. In this context, the intercropping of nuts with other crops is being explored, which improves soil fertility, controls erosion, and creates sustainable agricultural ecosystems. Although bear nuts are less developed in terms of commercial production than other nut species (e.g. hazelnuts), scientists from Azerbaijan are exploring the possibilities of their industrial use. In particular, issues of selection, increasing productivity, and the economic benefits of bear nut cultivation in the context of the local economy are being studied.

Some of the research by Azerbaijani scientists is aimed at studying the genetic diversity of bear nuts in local populations. This is important for creating resistant varieties that could better adapt to climate change and other environmental challenges. Joint research with scientists from other countries also allows for a better understanding of the genetic resources of this species.

Used for street and alley plantings. Also looks impressive in solitaires and group plantings. The nuts, despite the thick hard shell, are eaten fresh and dried and have high taste qualities. As a food plant, this species has been cultivated since the times of Ancient Greece and Rome. The wood has a beautiful pinkish pattern, is hard and durable, used for the production of furniture and joinery. The wood is well processed and finished. Dries well, without cracking. Can be used in selection.

This work was carried out due to the changes that occurred about 30 years ago in the Kelbajar region during the first Karabakh war. After the return of this territory to the jurisdiction of Azerbaijan in 2020, it was discovered that huge changes had occurred in the forest fund, incl. In

some places, forest stands were completely cut down, most forest areas turned into sparse forests, soils were degraded, many areas appeared in which mineral layers of soil were carried away by water erosion, etc. Therefore, it became necessary to assess the current state of forest communities in the Kelbajar region, including the distribution area of the bear nut.

The purpose of the work is to assess the current state of forest communities in the Kelbajar region, including the distribution area of the bear nut.

To do this, it is necessary to solve the following tasks:

To assess the current state of the entire forest community in the study area;

To establish the bioecological, silvicultural and economic significance of the bear nut.

## Object of study

Natural conditions. The relief of the Kelbajar region mainly consists of the following mountain systems: Murovdag, Shahdag, Eastern Sevan (Goycha), Vardenis, Mikhtoken, part of the Karabakh massif and the Karabakh plateau. The highest peaks are the Jamysh (3724 m) and Delidag (3616 m) mountains. Jurassic, Cretaceous, Paleogene, Neogene and anthropogenic sediments, volcanogenic-sedimentary and volcanic rocks are widespread in the territory. The Kelbajar region is rich in rivers. The largest rivers are the Terter with its tributaries (the Lev, Tutgunchay and other rivers) and the Bazarchay, and they originate in the Kelbajar region (Fig.1).

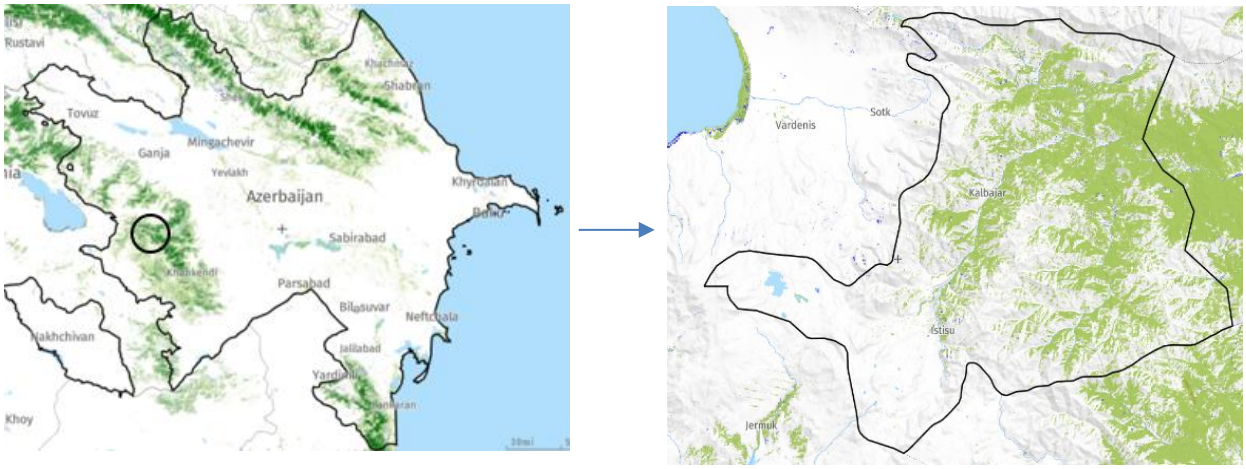


Fig. 1. Geographical location of the Kelbajar region

The climate in the region is predominantly cold and mountain-tundra. The average temperature in January is from -3°C to -10°C, in July from 5°C to 20°C. The annual precipitation is 700-900 mm. The duration of sunshine is 2000-2400 hours per year. In warm seasons (April-October) the possible evaporation is within 400-800 mm. In June-September the number of dry days is from 5 to 25 or less. The average annual wind speed is 2-3 m/second or less. The forest fund of the region is widely distributed soil of chestnut, light chestnut, mountain forest coffee, mountain forest brown, black mountain meadow colors, etc.

## Current state of forest communities in the Kelbajar region

Vegetation. In the center and northern part of the district, vast areas are occupied by broad-leaved forests (oak, beech, hornbeam), forest-field plants, on the high and middle mountains there are alpine and subalpine meadows. The total area of forests is 32,774 hectares. More than 4 thousand plants grow on the territory of the district, 200 of which are medicinal. In the flat areas, a huge place is occupied by thickets of common wormwood and other semi-desert plant species, at the foot of the mountains - steppe plant species predominate, on the mountain slopes - shrubs and deciduous forests (pistachio, oak, etc.). In places located above 2000-2300 meters, there are alpine and subalpine meadows. The fauna abounds in mountain goats, brown bears, wild boars, squirrels, eagles, etc.

Changes that have occurred in the forest fund of the region. Before the conflict in the 1990s, the Kalbajar region was known for its rich forests, which occupied significant areas. The forests were mainly composed of oak, beech, hornbeam and other tree species, which played an important role in the region's ecosystem, as well as in the economy (wood processing industry, agriculture). The forests also served as a habitat for various animal and plant species. During the Armenian occupation, significant violations in the use of natural resources occurred. Part of the Kalbajar forests were intensively cut down. This happened both for the needs of the Armenian families who remained there

and due to the economic activities of the occupation forces. Deforestation led to ecosystem degradation and soil erosion, especially on the mountain slopes, which affected the environment. In the absence of environmental control and protection, many areas of the forest were damaged.

After the return of the Kalbajar region to Azerbaijani control in 2020, attention to the restoration of natural resources, including forests, has become an important part of the region's rehabilitation strategy. Azerbaijan has begun assessing the state of the forest fund after decades of occupation. Many forest areas are in a deplorable state due to deforestation and degradation. This situation is recorded in a forest area where the hazel tree is widespread, which is a relict species for this region and is an endangered plant listed in the Red Book of the Republic. Therefore, the Government has begun active work to study the ecological state of forests and plan their restoration, including planting with hazel tree. As part of the territory restoration program, the Government of Azerbaijan plans to carry out large-scale landscaping and restoration of forest cover. This includes both the restoration of natural forest areas and the creation of new forest park zones to protect the environment.

Bioecological, forestry and economic values of the bear nut Hazelnut (Córylus colúrna) - Hazel, or Bear's nut, or Bear's hazel is a deciduous tree, a species of the genus Hazel (Corylus) of the Birch family (Betulaceae).

The bear nut is a deciduous tree with a beautiful, pyramidal crown directed upwards. It is used for forest plantings, shelterbelts, and urban landscaping. The bear nut prefers fertile, well-drained soils, but can also grow on poorer soils, carbonates, limestones, and on slopes. Being a forest species, it tolerates partial shade and shade, especially at a young age (Fig. 2).

**Fig.2. Bear nut tree species**

Spreading - in Azerbaijan, Georgia, Russia, Northern Iran, the Balkan Peninsula, in Asia Minor and Western Asia. In Azerbaijan, the bear nut is found in the mountainous regions of the Lesser Caucasus at altitudes from 1,000 to 1,700 meters above sea level. It prefers fresh, humus-rich, mainly carbonate soils with sufficient moisture (pH 5-7.3). It is drought-resistant, does not like salinization and waterlogging. Shade-tolerant. Its natural habitats are associated with such regions as: Gakh, Zagatala, Kelbajar and Balaken regions in the west of Azerbaijan, which border the Caucasus Range and have suitable climatic conditions for the growth of bear nut. Here, a moderately warm climate and sufficient precipitation create a favorable environment for forests with this species. The Sheki and Ismayilli districts, also located on the slopes of the Lesser Caucasus, have rich forest zones where bear nut is found as part of mixed forests with oak, hornbeam and other trees. The Gabala district is known for its vast forests, where bear nut is also a common species. Forests with bear nut here play an important role in the ecology of the region, holding the soil and preventing erosion.

Bioecological features of bear nut. Unlike most other types of hazel, this species is not a shrub, but

a tree up to 20-30 meters high, living up to 200 years with a dense, broad-pyramidal crown. Frost resistance is -30 ° C. The roots are deep, taproot. Hazel does not produce root suckers.

The leaves are round, dark green, broadly ovate or oval, 7-12 cm long, 5-9 cm wide. Stipules are lanceolate, pointed. The base of the leaf blade is cordate, narrowed towards the top, shortly pointed, the edge of the leaf is twice serrated. Young leaves are pubescent above, hairy below mainly along the veins, later becoming bare. Petioles are 1.5-4.5 cm long, glandular pubescent (Fig. 3).

Fig. 3. Leaves and shoots of bear nut.

Annual shoots are yellowish-gray, with bristly-hairy pubescence. The bark on the trunk and old branches is gray, deeply cracked, separated in plates. The buds are oblong-ovoid, with reddish-brown pubescent scales.

Flowering and fruits. It blooms in early spring (March-April). Like other species of hazel, male flowers are collected in cylindrical catkins 6-10 cm long and up to 6 mm thick. Female flowers are hidden in small buds, from under the scales of which only the stigmas are exposed during flowering (Fig. 4).

The fruits are single-seeded nuts, collected together by 3-8 pieces. The nut wrapper (pluska) is glandular, wide open, its leaves are much longer than the nut itself and are repeatedly dissected into linear-lanceolate sharp segments. The pluska (nut wrapper) is wide open, velvety, the leaves are much longer than the nut itself and are dissected repeatedly into sharp segments of a linear-lanceolate sickle-shaped curved shape. The weight of one nut is 0.8-2.7 g. The shell is thick, strong, reaching 0.6-2.5 mm in thickness. The nuts are small, compressed from the sides, with a very thick hard shell. Fruiting is irregular, fruitful years alternate with 2-3 lean years. The harvest is collected in August-September.

**Fig. 4. Flowering and fruits of the bear nut**

Reproduction occurs by seeds, grafting, layering, cuttings. Rooting of cuttings is 26% when treated with a rooting agent for 16 hours. Seeds require winter stratification at +1+5°C for 2-6 months. Sowing is carried out in the spring. To collect seeds, take intact fruitlets at the stage of milky-wax ripeness. Classic winter grafting and cambium-to-cambium grafting on a rootstock with an active root system are used.

When propagating with planting, the optimal age of the seedling is 2 years. It is better to plant in the fall. The size of the planting hole is 50x60 cm.

10-15 kg of humus, 200 g of superphosphate, 50 g of potassium salt are poured into the hole and mixed with the top layer of fertile soil. Before planting, seedlings should be cut to 20-25 cm, and the roots are dipped in a slurry of clay and manure. The distance between plants is 4-5 m from each other, in a hedge a little denser.

In plantings with the participation of bear walnut, care consists of loosening the trunk circles, but not deep, mulching (for example, with mown grass). In dry periods, watering is recommended. Pruning should be done in early spring before the sap begins to flow. It only needs sanitary pruning.

Pests and diseases of bear walnut include hazel leaf beetle, nut weevil, hazel wave, bud mite, rodents. Anthracnose, gray and fruit rot.

Usage - for street and alley plantings. Also looks spectacular in solitaires and group plantings. The nuts, despite the thick hard shell, are eaten fresh and dried and have high taste qualities. As a food plant, this species has been cultivated since the times of Ancient Greece and Rome. The wood has a beautiful pinkish pattern, is hard and durable, used for the production of furniture and joinery. The wood is well processed and finished. Dries well, without cracking. Can be used in selection.

## Conclusions

The following can be noted from the work carried out:

It has been established that in the forest communities of the Kelbajar region, over the past 30 years, due to the occupation, a huge change has occurred due to cutting, burning, and other types of interventions in forests, disruption of the entire ecosystem.

It has been discovered that in the area of distribution of the bear nut, most trees have been cut down, the recovery process has almost stopped, and diseases in the form of fungal infections have spread.

## References

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