

## AN IMPORTANCE OF THE EARTH SCIENCES IN FORMING KNOWLEDGE ABOUT THE ENVIRONMENT AND CONDUCTING ECOLOGICAL RESEARCH

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### Annotation

*“A far-reaching ecological program should be adopted in the field of environmental protection. .... Therefore, attention should be paid to this issue.”*

**Ilham Aliyev**

*“In my opinion, the biggest mistake I made was not paying enough attention to the direct impact of the environment.”*

**Charles Darwin**

Providing information about the development history, theoretical and practical importance, and a position in the systems science of the Earth Sciences, their role in the development of natural and social productive forces were evaluated in the research paper. Furthermore, the geological and geographical content of the formation of the environment, the features of the formation of environmental risk in it, and the results of cosmic processes are analyzed. The paper presents the scientific analyses of geographers and geologists about the environment, the place of matter, and energy exchange in creating the environment, and discusses the directions of the aforementioned trend in the conditions of Azerbaijan. In the study of the surrounding environment, the substrate of geology and the constructive importance of geography are interpreted. By assessing the role of both in creating the environment, preference is given to physical geographic regionalization in management. Consequently, the author considers physical-geographical regionalization as one of the fundamental principles in the successful implementation of the COP-29 program, which provides important global significance.

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A system of the Earth sciences has taken an irreplaceable place in enriching the natural science and the philosophical worldview at all stages of development of the society by becoming a fundamental essence as well. Ideas about the historicity of the Earth, its role in the development of society, etc. have been based on the experiences gained in relation to the Earth. It should be taken into account that the foundations of modern dialectical materialism and ideas about the geographical environment are already freed from the political determinism of the recent past that created scientific

limitations. At the present moment, in the era of the application of integrative laws and regularities along with the laws of nature and society, it is accepted that knowledge about natural conditions is the basis of life and the substrate of management. Experiments on the adaptation or contradiction of human activity to the rhythm of the biosphere are expanding. The entire scientific community has already begun to understand that not only natural processes and natural phenomena but also the development stages of society are primarily the result of cosmic processes or having cosmic origin. Nonetheless, the strategy of worldwide management until modern times has focused on taking more from the Earth's natural environment, changing the biosphere, and destroying the environment as well as the natural and social spheres. Starting from the middle of the 20th century, the worldwide demographic explosion, the development of urbanization, the ever-growing demand of the population, and the creation of an inverse proportion between the reproduction of social production and the reproduction of natural conditions have been observed by both specialists and non-specialists.

Although the study of the Earth's history and geological processes throughout the world and in Azerbaijan is ancient, purposeful activity in this field has expanded in an organized manner after the establishment of the Azerbaijan National Academy of Sciences (ANAS) (1945) and the Earth Sciences Department of the Academy (1966). The Earth Sciences Department has a broad profile and specializes in fundamental and applied fields. Contemporaneously, through the Presidium of the ANAS, projects for scientific and organizational activities, regulatory and legal documents were prepared for the management bodies of Azerbaijan, as well as the strategies of scientific research were studied. The participation of scientists has been planned in solving the crucial issues of the country, especially implementing state policy, environmental security, environmental protection, balancing the use and processing of hydrocarbon potential, as well as developing state projects such as geodynamics of the South Caspian basin, seismology of Azerbaijan, earthquake prediction [3]. Scientists and specialists in the Earth sciences managed to turn scientific research into a productive force very early, and in order to increase the practical importance of their activities, they compiled large-scale geological, tectonic, geophysical, geomorphological, climate, landscape, population, and settlement maps.

At the next stage, the Council for the Study of the Productive Forces (CSPF) was created. Scientists and specialists at Institutes of Geology, Geography, and Geophysics worked together in creating science and innovation systems of higher education institutions as well as Baku State University (BSU) in order to pass on their experience to the younger generation and to continue the traditions of scientific inheritance.

With the development of international relations and the division of labour, fields of science have become dynamic and transformed. Particularly, the increase has been experienced in the demand for raw materials, the creation of local and global markets, geographical assessment and zoning, geological exploration, and scientific discoveries. As all sciences tend to integrate gradually, the Earth sciences have been integrated into geophysics, geochemistry, astronomy, astrophysics, cosmology, paleogeography, geopolitics, and anthropography. As a result, Earth sciences have had a wide source of information. The results obtained through these cases have enriched the thinking about the environment. At the same time, the role of the Earth sciences has increased in the formation of information about the natural, social, and interactive content of the environment, as well as in the scientific and practical management of Geographical Information Systems. It is no coincidence that Azerbaijan was one of the first republics to start this field during the period of the flourishing of sciences in the former USSR starting from the 1970s. In those times, along with geology, geography was evaluated as a fundamental field of science.

The expansion of spaceflight, the study of the solar system and solar activity, the drifting of the Earth's geographic and geomagnetic poles, and geodynamic processes have begun. Along with the above, the effects on the Earth's spheres and the environment, as well as the information about the non-linear processes that disturb the balance of the Earth and bring it to the bifurcation limit, the information about the strong impact on the environment in anthropogenic processes has increased [10]. Particularly, due to the progress of constructivism in the Earth sciences, interdisciplinary integrations, and scientific and applied research have increased, and innovation processes in personnel training of higher education institutions have begun to expand. During that period, in connection with the appointment of academician Hasan Aliyev as the head of the Institute of Geography of the ANAS, the Nature Protection Department was established at the Institute of Geography (the department was headed by K.A.Alakbarov and Sh.B.Khalilov at different times. A.A.Aliyev heads that institution until the present period). In addition to studying the lands, flora, and fauna, forests of Azerbaijan, radioactivity in the environment, especially the mining industry and other areas, has been studied in the department [2]. Research has not only scientific but also applied importance.

Sustainable development of natural and social productive forces, effective use of natural resources, and attention and demanding approach to all spheres of life have begun in Azerbaijan. Implementation of purposeful activity in that area required expanding the ecological approach. As a result of the very important activity carried out at the same time, the academician paid special attention to reserves and the creation of new reserves in Azerbaijan and for the first time proposed the creation of an entomological reserve in Azerbaijan. The scientist's advice to increase the forest area to 20-25% in order to protect the republic from drought and rainy periods is one of the issues that are relevant even today. In 1976-1980, his ideas were used in the General Scheme of Forestry in Azerbaijan.

Soil erosion and agro-industrial clusters, chemical composition of waste in areas with mining waste, their radioactivity, and recultivation of areas, ecology of landscapes, and geochemical characteristics of heavy metals in landscape components were studied. Starting from that period, the foundation of landscape and ecological evaluation of geocomplexes was laid at the Institute of Geography.

In addition to calculating the water balance of the rivers of Azerbaijan, the employees of the Hydrology Department of the Institute of Geography gave valuable suggestions on protection issues. Projects and maps on the geographical aspects, ecogeographical problems, and efficient use of water reservoirs have been prepared. At the same time, the impact of thermal power plants on the environment was evaluated along with conducting valuable analysis on the environmental impact of the river aquatoriums.

Climatologists have created conditions for the effective use of climate by conducting interesting studies on the climate of the country and regions, the effects of climate zones and types on the living world and the economy, and the conversion of solar energy into heat and balancing. At the same time, regional differences in alternative energy potential have been provided in the maps and atlases. Additionally, the great prospects of conservation arising from solar energy have influenced the study of ecological processes and the further improvement of ecological culture. Generally, starting from the 1970s, interesting studies on the ecological content of climate have been conducted at the Institute of Geography. Due to the natural-climatic conditions of Azerbaijan, relations between complex agro- and bioclimate, climate and forest, climate and recreation have been studied.

The expansion of research on Azerbaijan's natural conditions and resources has not only influenced the development of natural and social productive forces but also is creating new

opportunities. In Azerbaijan, the productive forces and related agro-industrial associations influenced the creation of industrial territorial complexes (Baku-Sumgait, Ganja-Mingachevir, Hajigabul, Shirvan-Neftchala, etc.). In addition to this, production technologies, and the intensification of transport in urbanization centres affected the tension in the ecological conditions of the environment. As a result of increasing the production capacity of industrial hubs, lands suitable for agriculture in the agrarian sector have decreased relatively, and the ecological environment has started to become tense in some areas.

After 1970, measures similar to environmental reforms were implemented in the economic and social life of Azerbaijan. The ecological approach in management has created a need for personnel training in that field. In this regard, on the recommendation of academician H.Aliyev, the Environmental Protection and Efficient Use of Natural Resources Department was established at the Faculty of Geology and Geography of Azerbaijan State University (ASU) (current BSU) in 1980. Most importantly, due to the fact that Heydar Aliyev began to lead Azerbaijan, favorable conditions were created for the formation of the field of education and science innovation in the republic. Purposeful personnel training has started in the first ecology-oriented Environmental Protection Department (EP) of BSU using the material and technical bases of the Institutes of Geography and Botany of the ANAS, the State Nature Protection and Hydrometeorology Committees of the Azerbaijan SSR.

In accordance with the specialization and the curriculum of the department, the complex approach has taken the main place in the scientific and methodological bases, and programs of environmental research. During the first decade, the concept of the environment, its structure, the scientific analysis, and teaching of the nature-population-production fields separately and together in creating a (complex) environment were carried out on the basis of Earth sciences. That beginning was carried out by the leadership of ASU in accordance with the decisions and resolutions of the leadership of Azerbaijan starting from the 1970s. At the next stage, towards the end of the 20th century, it consisted of analyzing the historical stages of scientific research and drawing correct conclusions from the results of the past. The most important thing is that both have a common condition in environmental protection and the use of natural conditions and natural resources. In the following decades, social structures, mainly population, were brought to the fore as an integral part of the material world, and thus ecological associations and as well as geoecology were formed.

In the department, population settlement, protection, and forecasting of the ecogeography and atmosphere of cities (especially large cities), ecology and restoration of landscapes have enriched geographical ecology as a science. In order to study the problems and take a constructive approach to their solution, activities related to the design of urban and rural regions were performed. That is why the basics of ecological urban planning were created together with the project institutes of the State Committee of Urban Planning and Architecture.

The curriculum and general report created by the efforts of the EP department were listened to and accepted at the meeting of the Methodology Council on Geographical Sciences of the Ministry of Education of the former USSR held in ASU. In addition to personnel training, the department carried out scientific research works on the evaluation and protection of the environment of economic regions. At the same time, upon the order of the State Nature Protection Committee of the Azerbaijan SSR, the Environmental Protection Department participating in the implementation of the Comprehensive Scheme of Nature Protection of Azerbaijan by the Southern Agricultural Industry Project Institute, represented BSU as one of the 17 executive institutions. The staff of the department prepared maps on nature protection and provided pre-project analyses of the results of scientific research. The comprehensive scheme of nature protection was completed in 1988 in four volumes,

being the first comprehensive design. The business traditions created by Heydar Aliyev in the management system of Azerbaijan, with his high position in the country during the former Soviet Union, gave an impetus to the solution of even bigger problems in our republic. Thus, practical activities were carried out with the participation of geographers in the complex design of economic regions, and experts from the Project Institutes of the State Committee of Urban Planning and Architecture of Azerbaijan. A comprehensive project document was prepared with the participation of geologists, geographers, and economists in order to restore the environment and resettle the population in the Guba-Khachmaz region, and to effectively use the Filizchay polymetallic deposits of the Shaki-Zagatala region.

In order to continue activities in the field of environmental protection and efficient use of natural resources on a more scientific basis, on April 17-20, 1990, a conference dedicated to Environment and Ecology was held at ASU. In spite of his health problem, Academician Hasan Aliyev accepted the invitation and came to greet and bless the participants of the conference. At the opening of the conference, Heydar Aliyev's and Academician Hasan Aliyev's services in the field of ecology and environmental protection in Azerbaijan were noted, and that information was welcomed by the participants [22].

The conference was held as an interinstitutional event, attended by 180 representatives from the republics of the former USSR, and more than 150 reports and speeches were listened to. In the adopted resolution, the conference was highly appreciated. Concurrently, the division of labour accepted for the environmental sciences was approved, and landscape restoration was proposed with the aim of effective management of the country and regions. In the resolution of the forum, training of specialists such as geoecologists, engineer ecologists, environmental chemists, and agroecologists was recommended. Moreover, it was recommended to provide a wide place for human ecology in the environmental protection system and to evaluate the local environment of each region in this field.

After the independence of Azerbaijan, in relation with the return to power of the national leader Heydar Aliyev, as in all scientific fields in the country, environmental management and ecology began to flourish again. Regarding the conclusion of the Contract of the Century, the International Operating Company's study of the ecological conditions of the Caspian Sea, and the relations with the Japan International Cooperation Agency in the preparation of the Master Plan for the interactive management of the environment of Baku culminated in the positive results. The indicated project was one of the fundamental projects carried out jointly with foreign agencies in Azerbaijan in the 2000s.

In environmental science and education, applied fields, an interdisciplinary division of labour, regional planning, and constructive tendencies have been expanded. It has been repeated several times since the second half of the last century that the geographical approach has an irreplaceable place in what has been indicated. For example, in the former USSR, due to the dropping level of the Caspian Sea in the 1960s, Flowing the Northern Rivers into the Caspian Sea project was stopped upon the insistence of geographers. At the next stage, many geographers objected to the idea "The Caspian Sea is rising, we must retreat." Ideas such as the relocation of the population from the mountainous areas were also protested with "No". On March 16, 2024, we expressed our position on the idea of "The Caspian Sea is shrinking" on the pages of a newspaper titled "Khalq" (Xalq in Aze.). The Volga River, which supplies up to 80% of the water of the Caspian Sea, has been left out of oceanological influence as a result of anthropogenic impact. Nine reservoirs built on it in the past greatly increased the evaporation of river water and its climate sensitivity.

After the 90s, in the years of independence, a new view of the environment was required. That is why a new approach to the efficient use of natural resources was put forward to the methodological

foundations of environmental studies [9; 11]. That field and similar approaches can be evaluated as an achievement in the stages of transition to “Great Ecology”. Therefore, experience shows that the causes and consequences of many complex processes taking place in the environment required to be assessed primarily by cosmic, geological, and eco-geographical factors. The geographical approaches in the scientific methodological directions of environmental research have proven themselves in many fields: in the systematization of paleoecological conditions; in the modeling of nature and social systems; in conducting complex examination of environmental projects; in the environmental restoration and optimization; in the forecasting of ecological processes, etc. What has been shown is mainly connected with achievements of the Earth sciences.

Geographical aspects of ecological analysis of the environment have created a very fruitful transformation in the Earth sciences in general. Most importantly, in the last 2 centuries, a big mistake was made by separating geography into physical and economic geography: the former was included in the natural sciences, the latter in the social sciences. The activities of scientists and specialists for the sake of unified geography during that period did not conclude with the expected result. However, starting from the 70s of the last century, as a result of the ideas put forward by the national leader Heydar Aliyev in management, the flourishing of geography and the geographicalization of ecology gave interesting results [12]. Ecologically synthesizing the environment, and its natural and social function has had an effective role in the transformation of geography. It was observed that the indicated process created progress in the interdisciplinary content of geography, as well as information about the synthesis of natural and social-ecological processes in the philosophical content of the sciences. That process has enriched the terms in the field of ecology and EP and renewed scientific ideas and concepts, ecological language and culture, and finally ecological thinking. In addition to this, it should be noted that for several years the Science, Education, and Innovation Union was established in the educational system of EP on the basis of the Seacoast Monitoring Department of the Ministry of Ecology and Natural Resources, and the Institutes of Geography and Botany of the ANAS. First of all, scientific research on the ecology of natural zones and landscapes, assessment of natural conditions and natural resources, studying, forecasting, and monitoring of the population of the cities in Azerbaijan, effective use of land, and recultivation have been expanded in the relevant faculties of BSU, and then the other universities. That is why information on natural and social-economic structures, and territorial associations has been enriched, and scientific and practical information on the synthesis of objects and processes in methodological approaches has been obtained. The information about cosmic formations has enriched the knowledge about Sun-Earth relations (Table).

The formation of the synthesis of the Earth sciences and other related sciences, the development of geochemistry, geophysics, cosmology, astrophysics, and planetary geology have also created favourable conditions for the development of EP and ecological geography, and have a positive effect on the study of ecology in relation to cosmic foundations. Analyzing multilateral information about the environment, the provision of the following global model of the environment in the system of Sun-Earth relations is of international importance.

Undoubtedly, corrections and additions can be made to the presented structural model of the environment. The most important thing is that the cosmic, geodynamic, and physical-geographical processes in the environment have affected the world culture and the way of life. At the same time, the ecological content and interdisciplinary connection of the general geography are becoming increasingly ecological. It is noteworthy that in science and practice, geographic ecology is accepted as “the mechanism and architecture of environmental protection”.

Table. The structure of the environment

<b><i>The structure of the environment</i></b>		
<b><i>The division of the environment</i></b>	<b><i>Scope</i></b>	<b><i>Interactions and effects</i></b>
<b>Cosmic systems</b>	Cosmos-Sun-Earth	Cosmos-Sun-Earth relations
<b>Planetary system</b>	Earth's layer – biosphere, geostructures	Interaction and effects of spheres of the Earth, formation of geological environment
<b>Macrosystems</b>	Interconnections between continents and oceans	Interactions and effects of continents, parts of the world ocean
<b>Mesosystems</b>	Integrative parts of continents and world ocean	Interior of continents, oceans, and unity of organisms
<b>Regional systems</b>	Union in regions	Geographical units of regions (physical, ecological, economic)
<b>Local systems</b>	Intra-regional structures (physical-geographical regions)	Interactions of natural landscape complexes, urbanized areas
<b>Microsystems</b>	Natural economic areas	Facies and formations in different landscape structures
<b>Nanostructures</b>	Primitive genetic stages of parts of landscapes	Interactions of the smallest particles

The successful implementation of reforms in our country, the adoption of laws in the fields of environmental protection and ecology, especially the Decree of national leader Heydar Aliyev dated January 22, 2003, on Education and Enlightenment of the People on Ecology was of great importance. Regarding the above, the following textbooks, materials, and monographs were written for the preparation of various qualified personnel in that field: "Basics of Ecology", "General Ecology", "Environmental Protection", "Environment and Human", "Geography and Problems of Geographical Ecology", "Landscape Ecology", "Global Ecology", "Applied Ecology". Those books had an impact on the interdisciplinary structuring of ecology, the expansion of the scope of application of EP, and at the same time, the creation of methodological clarifications. Structuring from the space environment to the nanoenvironment distinguishes the environment as having a complex structure. This has influenced the more efficient use of the material resources of the environment and a more constructive approach to the restoration of nature.

It should be taken into account that the properties of the structures, as well as the environmental properties of the planetary systems, have not been sufficiently studied. In some cases, known scientific ideas are not reflected in practice. For example, as the role of substances and energy exchange in the creation of the environment or their impact on the environment is studied, geographical-ecological processes in nature are clearly understood. Azerbaijani geographers, especially the founders and followers of the school of landscape studies have conducted interesting studies on the exchange and flow of substances and energy in landscapes. It has been observed that the concentration of Pb, As, Zn, B, V, Cu, and Hg in the mountain-meadow soils of the Greater Caucasus is high, and the amount of Ba, Zr, Sr, and Co is low. The concentration of Pb, As, Cu, Zn, Hg, B, and V in the soils of the middle parts of the mountain-forest zone exceeds the optimal level, while the amount of Co, Ni, Be, and Sr is relatively less than the optimal level, etc. Generally, researchers have shown

that elements change from north to south and from west to east on the southern slope [18]. Conducting such research has created new perspectives for the study of geochemical properties of landscapes and the preparation of geochemical landscape maps, as well as landscape melioration problems. Furthermore, the ecogeochemical characteristics of the modern landscapes of the Absheron Peninsula were studied on a large scale, and the effects of microelements on living organisms and landscape biogeochemical provinces were distinguished [16]. These are of great importance in landscape restoration, ecomelioration measures, and regional planning.

During the period when a human becomes a geological force, ecological tensions increase because the degrees of impact of anthropogenic processes on the Earth and its spheres are not sufficiently studied and constructive measures are not taken. At the same time, it was determined that as a result of solar activity and anthropogenic effects [14], the thermal balance of the atmosphere and the interior of the Earth is disturbed. Geodynamic processes have a strong influence on physical-geographical conditions, especially climate change.

From the structural divisions of the environment, it becomes clear that the entire planet Earth and its parts are under the influence of space, and in many cases, negative effects on the Sun and space on the Earth occur periodically. The anthropogenic effects occurring on the Earth are gradually becoming globalized and turning into an opposite force to the Earth. Naturally, as the properties, functions, and scopes of the environment on the Earth have been well studied, ecological processes have also been well understood and vice versa. Since the end of the last century, as geoecology was formed, the geological environment has begun to be studied more widely [5]. That period can be called the stage of geoecology and the formation of the geological environment.

It should be noted that numerous achievements have been gained in the field of Earth sciences and ecology, and interesting scientific research was conducted in the fields of environmental geology and geoecological monitoring under the leadership of Academician Vasif Babazadeh at the Mineral Resources Department of the Faculty of Geology of BSU.

In their textbooks and monographs, our geologist colleagues and geochemists describe the relationship between the components of the environment and the geological environment [4]. It is shown that the components of the environment – atmosphere, surface water, and hydrogeological environment (groundwater, rocks, relief, natural and anthropogenic processes, etc.) are the constituent parts of the geoecological structure. At the same time, referring to V.I.Vernadsky, it is stated that the natural environment is the environment in which living substances of the planet are located. It is shown that all elements of the lithosphere – rocks, morphological features, groundwater, in general, geological processes actively and strongly affect practically all elements of the biosphere [6]. The lithosphere and its parts are separated under the name **“geological environment”**. That environment is also the dynamic synthesis environment of many components. In our opinion, the described **geological environment** can be evaluated as an achievement brought to the ecological field in Earth science. Those processes should be evaluated as a process that periodically creates risks to all spheres and the biosphere as well [8].

The geologists' book “Geoecological Monitoring” provides a very interesting analysis of the scientific and practical importance of monitoring, the function and systems of the environment. By connecting the Earth's ecological functions with the Solar system, the authors bring the notion of the environment to a generally understandable logic by describing the endogenous (geological), and exogenous (geographical) systems in geosystems, and then transferring them to biogeosystems and biosystems (subsystems). In our opinion, an important stage in the direction of both natural area

complexes (landscape-soil), as well as studies on geomorphology, geography, and medical geochemistry begins.

In the analysis of monitoring, interesting ideas have been expressed about the design and problems of ecogeological maps (in the e-maps). Scientific and methodological approaches related to maps enrich the base of geographic and geological information systems and increase the importance of using road maps.

The main advantage of the analysis of geoecological monitoring is that the textbook gives ample space for scientific analysis of monitoring and the environment. Probably, the authors mention extensively about the environment, taking into account that little space has been given to the scientific and methodological directions of the geological environment. Providing interesting (logical, graphical, mathematical) models of monitoring in the environment makes it easier to understand the topics in the book. We believe that after the geoecological phase, a good basis has been created to collaborate with geologists, geographers, ecogeographers, sociologists, etc.

In addition to the general description of the geological environment, the department's employees enriched the information on the ecological environment of the Caspian Sea by providing a large-scale geochemical analysis of the Middle Caspian shelf zone [5; 15]. Shelf zones are one of the regions that have historically stimulated the emergence and evolution of life. Until now, the shelf zones have been studied mainly for the purpose of using natural resources and developing maritime transport. In the monograph, the authors identified the ecological and geochemical conditions polluted by heavy metals and various substances, and creating anomalies in the areas exposed/not exposed to the wave. The study also reflects the ecological and geochemical properties of the lithosphere, maintaining stability in the biosphere, and preventing environmental stresses. In this direction, new perspectives of environmental research appear.

By calling the shelf zone a complex natural geochemical system, it is shown that physical and chemical, biochemical, hydrodynamic pollution, repeated pollution occur, and some conditions are created for an anomalous environment here as a result of strong anthropogenic effects, especially oil and gas production, infrastructure, etc.

In the monograph, bottom sediments of abrasion-accumulative areas and geochemical properties of accumulative plains were studied, including some islands in Makhachkala to the southern Absheron. By dividing the coastal shelf zone into the Samur-Davachi and the Absheron coastal regions, the geochemical properties of the territories of cities and towns, correlative properties of chemical elements, and microelements were described.

As the authors were able to determine the natural ecogeochemical background of the area, which differs in its complexity, they could also evaluate the ecogeochemical course of the environment along with the anthropogenic impact of the area. Thus, they provided certain valuable information on the study of the regularity of other shelf zones of the entire Caspian Sea. It is shown that the indicated natural and anthropogenic processes are connected with global and regional natural disasters [5].

We can agree with the authors that the history of the Earth's geological stages and civilizations has provided us with a lot of information. The stages of evolution that have passed through several millions and billions of years, from the creation of the Earth in the Archean Eon, and the green water plants in the Cenozoic Era to the development of the Homo Era, have given us valuable information about our future development. As the authors of that article, I state that we have yet to draw very few conclusions from that information for today and our future. The geological history of the planet is a continuous change of ecological conditions over time, from countless alternations of physical and geographical conditions – the merging continents, the creation of oceans and seas, the occurrence of

transgressions and regressions, the emergence and spread of organisms, and their death [5]. Currently, historical geoecology, which is a special direction with the analysis of their restoration (reconstruction) and development, is being discussed. These processes are important as a source of paleoecology. At the same time, it should be taken into account that it will not be possible to carry out a general environmental assessment without conducting a geographical, especially a physical-geographical assessment. It should not be forgotten that ***we, humans, are first and foremost born and raised by physical-geographical conditions.***

It should be noted that the Faculty of Ecology was established at BSU regarding the President of the Republic of Azerbaijan, Ilham Aliyev called 2010 the “Year of Ecology”. In this regard, a textbook on the basics of geographic ecology was written at the Department of Environmental Protection (now Geographical Ecology). The content of the textbook was written on the basis of Earth sciences and analyzed in relation to the system of general sciences. The book describes the development stages, object, and subject (ecosystems) of research of geographic ecology, the ecological content of the Earth’s planetary properties, especially the Sun-Earth, Sun-biosphere relations, the ecological characteristics of the noosphere, and systematic analysis in geographic ecology.

Geological processes in different ways, especially geotectonic processes – volcanoes, earthquakes, etc. play a pivotal role in the formation of the ecological environment. At the same time, we must take into account that the structures of natural conditions (physical-geographical regions, landscapes) and natural resources are formed by a common environment. The indicated environment is called the geological environment by geologists. Since that environment consists of components necessary for the development of life, it can be called a “geoecological environment”. Scientific and methodological analyses in geological ecology are very interesting. Geoecosystems are common research objects for Earth sciences. Most importantly, the authors consider ecology as a research aspect of all Earth sciences, as well as an object of research in other sciences (medical, social, etc.).

In their views, interesting ideas are expressed about the optimality of the global ecological state of the atmosphere, and it is shown that in historical geological periods, CO<sub>2</sub> was important in the formation of life on Earth. Today, along with other gases, CO<sub>2</sub> has a special place in the optimization of the atmosphere – environment. At the same time, historical increases and decreases of CO<sub>2</sub> have been observed. In the last 3 centuries, carbon dioxide has been increasing more strongly as a result of anthropogenic effects. In fact, the danger is that the background level, which has remained unchanged for millions of years, is changing in modern times [7]. We have no doubt that according to the COP29 program, the gradual reduction of the greenhouse effect will be implemented.

The geographical environment has been formed on geosystems of the environment and has been characterized by the processes taking place in the structure of landscapes. After the geoecological system, ecogeographical systems are formed as a continuation of geosystems together with social ecological systems – anthropogenic landscapes. These include the structure together with the geosphere-biosphere-technosphere from geological ecology to socioecology. As a result, together with Earth sciences and other sciences (geochemistry, geophysics, etc.), geoecological, and ecogeographical conditions (landscape ecology) cover the natural and social environment. The environment actually forms the continuation of the matter that started with the geological environment – the geographical environment.

It is probably worth repeating the quote “Geographic ecology is the mechanism and architecture of environmental protection”. This expression consists of two parts: Physical (natural) geography and economic geography. There is a great need to determine the degree of optimality of physical and economic geographic processes with ecological norms.

Although they create the fundamental foundations of Earth sciences together with geology and geography, sometimes geologists rarely refer to geographical points when talking about the environment and ecology. It should be taken into account that geological processes and synthesized through the geographical environment in the geological layer after the geological environment. As shown above, historically, the geographical (physico-economic) environment changes from time to time under the influence of the geological environment and processes. In the 20th century, it was clear from V.I.Vernadsky's ideas about the noosphere teaching that the natural spheres, after the most extreme processes, mostly reconcile with each other and tend to stability. As the noosphere (technosphere) develops, environmental risks increase and degrade the geological environment. In this case, the geographical environment begins to fail. In various regions of the world, as well as in Azerbaijan, we observe the destruction of natural conditions due to the exploitation of natural resources. Therefore, the resources that have been depleted in the geological environment have been destroyed in the natural environment as they have been exploited. Even if there are certain payments commensurate with the value of the resources, the destruction of natural conditions causes enormous damage. In our opinion, in the assessment of the environment and resources, we suggest the assessment of ecological resources in the calculation of so far depleted and non-depletable resources. Thus, after COP29, we will probably move from the stage of modern management to ecological management. There is no doubt that cooperation with representatives of other sciences along with Earth sciences in that field will bring positive results. The most important thing is that the natural conditions are related to the climate factor along with the environment. We have to consider that climate variability as well as CO<sub>2</sub> variability are more clearly reflected in physical-geographic distributions, especially geochemical distributions of landscapes.

In many cases, as a result of anthropogenic processes and volcanic eruptions, aerosols rise in the troposphere and up, disrupting the balance. Even in the presence of winds and precipitation when pollution is high in the troposphere, natural cleanup is poor. When the composition of precipitation changes, the ingredients rise again into the atmosphere through wind and evaporation processes. As a result of the mixing of radiation, heat, and steam, very strong processes take place in the environment. As the source of the above is mainly solar radiation, the composition and movement of air become complicated due to the influence of the shape of the Earth, the atmosphere, and the world's oceans, and it also affects global circulation. Radiation entering the atmosphere, water vapour, carbonic acids, and aerosols loaded there is absorbed by ozone. They become molecular by fluctuating under the influence of heat in the changing state of the atmosphere. Thus, the radiation of the Sun turns into diffuse radiation and the process of ionization takes place. According to experts, all of the above together change the radiation balance in the atmosphere. Thus, the vertical and horizontal movement of heat in the atmosphere – air in the form of different gases – creates different warm and cold currents. Therefore, snow is observed in areas where it never snows, and intense heat is observed in areas where there is no intense heat.

The environment has been widely studied. Geologists and geophysicists, astrophysicists, physical geographers and climatologists, oceanographers, biologists, and chemists have conducted fascinating research on the environment. Complex environmental processes have influenced climate formation. Although the secrets of climate are not yet fully understood, it is an undeniable fact that life is also the result of climate. The processes of adaptation and protection occupy a special place in climate science. Climate should be effectively used in daily activities. In the very recent past, people had the experience of creating a favourable environment in households and farms without using refrigerators and heaters, people turned deserts into forest deserts and created oases and reserves in

semi-deserts and deserts. By carrying out nature restoration works according to the potential and distribution of physical and geographical conditions, they were able to have an important impact on the restoration of landscapes, biodiversity, and the biosphere.

The role of forests and greenery is irreplaceable in the restoration of the biosphere and in the relations between natural spheres in general, in the formation of people's worldviews, and in the optimization of their environment. Academician Hasan Aliyev, the guardian of our nature, wrote: "Being surrounded by greenery, people are filled with bright thoughts, good mood, and the love of building and creating is strengthened. It is a well-known fact that if we do not imagine the forest – this green belt of the Earth for a single moment, then humanity will not exist" [1]. We must take into account that the importance of forests in the regulation of Sun-Earth relations and the optimization of the human environment has not yet been sufficiently studied. In modern times, regarding the implementation of the COP29 program, along with the area and number of forests, nature reserves, and national parks, their resilience should also be increased. In Azerbaijan, a method of increasing the resistance of reserves has been developed [16].

It is necessary to take into account that, unlike the general gravity of the Solar system, physical and geographical conditions have formed and repeatedly changed on Earth through the forge of gravity. The geosphere (geological sphere) forms the basis of the lithosphere by creating the biosphere through the hydrosphere and atmosphere and constituting the substrate of the latter. Since the geographic layer is more dynamic within the existing spheres, and occupies an intermediate position between the cosmosphere and geosphere, synthetic and at the same time, dynamic processes occur between the living world and society. Therefore, the geographic layer plays the role of a barometer in ecological processes, and geographic ecology studies the laws of information synthesis. We cannot study ecological processes and draw practical conclusions about the environment if we do not consistently distinguish the show in the environment. It is in the era of modern climate change that the differentiation of the structure of the environment (ecogeography) is of great importance [19]. That is why the information on the global biosphere, natural zones, provinces, geographical regions, landscapes (ecosystems), their dynamics, boundaries, functional analysis, and conservation problems will be of great importance in the implementation of the COP29 program [21].

In modern times, the geoecological environment creates conditions for understanding the mechanism of global climate change and its consequences, and the problems of nature restoration [20]. The UN's Intergovernmental Panel on Climate Change (IPCC) has determined that the air temperature has exceeded the norm by 0.8-1.2°C every decade during the period since 1850. It is estimated that in the 21st century, the increase in temperature will be a minimum of 0.3-1.7°C and, a maximum of 2.6-4.8°C [13; 24]. In the information on global climate change, it is shown that the level of the world's oceans and seas will rise, the amount of precipitation in the regions will change, deserts will expand, and ecosystems will change irreversibly.

In the 4th evaluation report of the members of the IPCC, 90% of the participants decided that the increase in temperature is due to the effect of greenhouse gases (2007). In the 5th session of the IPCC, the increase of CO<sub>2</sub> by humans was confirmed in the world [7], at the same time, it was reported that the global hydrological cycle and the permanent snow and glacier cover are changing. In the 6th meeting (2021-2022), global warming has been confirmed to be 1.5°C [23].

Local differences of global climate change affect vegetation processes, ionization process in the organic and inorganic world, metabolism, activity, and growth of microorganisms. The difference in physical geographical regions in Azerbaijan is greater. The analyses conducted by Trend Independent Broadcasting Agency show that in the last century, the average air temperature has increased by 1.8°C;

for regions in Zagatala by 0.7°C, in Nakhchivan by 0.9°C, in Guba by 1.8°C, in Shamakhi by 1.1°C, in Salyan by 0.7°C; in Tbilisi by 0.8°C, and in Kazbek by 0.6°C. During the years 1960-1999, the indicator of warming in all territories of Azerbaijan was 0.03-0.6°C, and the amount of precipitation decreased by 18% [13].

In the winter season, there was significant warming in the territory of the country, in the months of December and January, the warming was on average 0.4<sup>0</sup>-1.2<sup>0</sup>C higher than the norm, in the spring season, there was significant cooling, compared to other months, the coldest month was May. The average value of the decrease was 0.9<sup>0</sup>C, and the maximum cooling was observed in Altiaghaj – 3.33<sup>0</sup>C. The temperature difference increased in the summer and was 0.60-2.19<sup>0</sup>C in June and July; warming occurred again in the fall, it was 0.11<sup>0</sup>C in the highlands and 2.19<sup>0</sup>C in the plains. The abovementioned indicators reflect general and regional patterns of climate change [13]. In that process, the issue that is out of regularity – the dropping level of the Caspian Sea, contrary to the oceanological regularity in modern times, was explained by us. The inclusion of geoengineering (geological and geographical engineering) in the framework convention of the United Nations on climate change is of great importance.

As a result of the successful implementation of the COP29 program in 2024, carbon dioxide (CO<sub>2</sub>) emissions are expected to decrease by 1.5%. In addition, there is a need to study the local differences of carbon gases depending on the geographical environment through the solar activity, the drift of the geographic and geomagnetic poles of the Earth, the agricultural sector, etc. Relevant analyses were conducted in the textbook “Research Methods of Atmospheric Pollution” related to that field [13]. The book was written in collaboration with AAA scientists and covers the following: the atmosphere and its main parameters; radiation processes in the atmosphere and studying them through satellite systems; the nature of atmospheric pollution and their assessment methods; modern methods of atmospheric pollution control; the main problems caused by atmospheric pollution.

Observing climate change requires the implementation of a complex action plan in accordance with the physical-geographical condition. Adaptation to climate change takes place first of all through the application of nature restoration and conservation practices.

Regarding the priority of the geographical approach in the study of the environment and adaptation to the environment, more scientific and practical issues are touched upon in the book “Basics of Environmental Problems and their Solution in Azerbaijan” [17], and what is mentioned is mainly of innovative importance.

Earth sciences took a fundamental place in the system of sciences with its emergence and contributed to the economic development of the Republic of Azerbaijan. In modern times, the high development of science and technology and the increase in the demand for personnel training in environmental research and management create the need to structure Earth sciences according to modern requirements and to teach them on an innovative basis.

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