



STUDY AND FORECASTING OF THE GLOBAL PROBLEM OF SOIL DEVELOPMENT IN THE ARAL RIVER REGIONS AND ITS SIGNIFICANCE IN THE WORLD WITH THE HELP OF MODERN COMPUTER TECHNOLOGIES

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ABSTRACT

The Aral Sea lands are in the spotlight of the world today. Where once blue waves played, and the most unique aquatic creatures were crowded, now white salts are dazzling. Nature seems to be silently crying out for our help. Salinization is intensifying day by day, not only from day to day, but also from second to second, and is covering many places. This is worrying not only the Aral Sea area, but the whole world. Therefore, scientists are studying this process with the help of modern computer technologies and trying to predict what will happen in the future. Because the fate of the Aral Sea is the fate of humanity. People who are indifferent to this problem are indifferent to their own fate. The Aral Sea, which once fed and fed people, now needs the help of people who have fed them a little. Where there was once a sea, now we have turned it into a white desert due to the droughts. It may have turned into a white desert, but now this white desert can cause great harm to human life. Thousands of tons of salt are being spread far and wide by the wind from this white desert island every year. The island problem has already become a global problem. The process of salinization is reducing soil fertility all over the world, especially in the Aral Sea regions, which has become a very big problem. Dusty salt particles, which negatively affect people's health, are spreading for thousands of kilometers and are covering thousands of new patients. The Aral Sea is a symbol of awareness for humanity today. Therefore, scientists are currently studying this situation in depth using computer technologies. Through geoinformation, satellites and forecasting, it is possible to anticipate problems that may occur in these regions in the future and

take practical measures to prevent these problems. Studying the Aral Sea problem is not just a scientific study, but also a re-understanding of the relationship between man and nature, and at the same time, thinking about how much harm each of humanity's actions can cause to nature. Every problem may have a limit, but the Aral Sea problem is an exception, because the dust on the Aral Sea knows no limits.

Introduction

The Aral Sea is a painful point of ecology not only for Uzbekistan, but also for the whole world. The Aral Sea, once teeming with life and the constant passage of huge ships, is now a ship graveyard. This process is changing not only the regions around the Aral Sea, but also the climate of the entire Central Asia and even the global ecological system. In the second half of the 20th century, as a result of the large-scale diversion of the waters of the Amu Darya and Syr Darya rivers to irrigation systems, the amount of water flowing into the Aral Sea sharply decreased and the level of the Aral Sea significantly dropped. At the same time, billions of tons of salts, sand and minerals from the seabed were exposed to the surface and began to spread under the influence of winds. Today, a large part of the Aral Sea lands is saline, making it difficult to grow crops, and the area of land unsuitable for agriculture is increasing. Due to salinization, the quality of water resources has deteriorated, and the harmful effects on human health are increasing. The Aral Sea is a region around the Aral Sea, that is, the territories of Uzbekistan and Kazakhstan. Water flows into the Aral Sea mainly through two large rivers, the Amu Darya and the Syr Darya. At one time, the Aral Sea was considered the fourth largest lake in the world, with an area of 68,000 km² at that time.

But unfortunately, since the 1960s, due to the large-scale exploitation of the waters of the Amu Darya and Syr Darya for agriculture, it has begun to dry up. The exposure of the Aral Sea and the drying up of coastal areas, as well as a sharp drop in water levels, have led to an ecological and social disaster in Central Asia. The problem of salinization of soil and groundwater in these regions is very serious. Salinization is a violation of the physical, chemical and biological properties of the soil as a result of an increase in the amount of dissolved salts in the soil, which negatively affects agriculture. The problem of salinization may be simple to hear and may not attract people's attention, but at its core is the fate of humanity, many global problems, a sharp decline in productivity, and most importantly, its rapid spread and lack of boundaries. If we talk about the factors accelerating the salinization process, these are: high evaporation, improper irrigation methods, and limited water resources. Many experiments have been conducted to study the extent and main causes of salinization in the Aral Sea regions. Computer technology plays a very important role in conducting these experiments. These computer technology research methods include: remote sensing, artificial intelligence and machine learning, GIS technologies, and digital analysis of soil data.

GIS, or geographic information systems, are technologies that allow us to create digital maps of salinity levels, monitor the dynamics of salinity changes over time, and determine which areas need reclamation measures. We can also analyze soil data digitally using

computer technology. Soil moisture, electrical conductivity, and the amount of salt ions can be measured using a digital sensor. This makes the salinity map more accurate. The results of the research show that in 2024, a study aimed at determining the level of salinity in various soil types in Karakalpakstan revealed a large amount of salt in areas where the anthropogenic factor is strong. This means that humans are the main cause of salinity. Salinization is mainly divided into two types: "primary" and "secondary".

The "main" one occurs naturally, the "second" one occurs due to human activity.

The relationship between salinization and global warming. Salinization and global warming are mutually reinforcing processes. Dry and white salt-covered surfaces reflect sunlight differently than dry and water-covered surfaces. This leads to an increase in air temperature. The increase in air temperature, i.e. global warming, has a very significant effect on salinization. In other words, due to the increase in air temperature, water evaporates faster, and after evaporation, the amount of salts in the soil increases, which leads to salinization. As a result of increasing air temperature, the amount of precipitation in some regions decreases, which leads to a decrease in the level of groundwater, while the soil is not washed away and the amount of salt in the soil increases. As the amount of salinization increases, it accelerates the process of global warming. The reason for this is that green plants cannot grow in saline soils, vegetation decreases, and global warming occurs as a result of the increase in the amount of carbon dioxide in the atmosphere. As a result of soil degeneration, the decomposition of organic matter in the soil increases, and greenhouse gases are released. Global warming increases salinization, which reduces the coverage of wetlands and increases greenhouse gases, which leads to deforestation.

The Aral Sea is being degraded due to the lowering of the water level, salinization, wind erosion and climate change. The level of the Aral Sea has now decreased by 10 times compared to the sea level in 1960. The dried-up seabed has now turned into a desert. Today, this place is called the "Aralkum Desert", the area of which is more than 60 thousand km². The soil contains a large amount of salt and pesticides. The Aral Sea desert is causing great harm not only to nature, but also to human life. Its ecological damage includes the following: thousands of tons of salt and sand particles are scattered from there for thousands of kilometers. These particles reach not only the Aral Sea area, but also the whole world, even Antarctica, but these sand and salt particles are carried by the winds, causing the melting of glaciers, which are the largest reserve of drinking water on our planet. The Aral Sea is causing these glaciers to melt in two ways. The first reason is that climate change, i.e., the melting of glaciers due to salinization, is causing them to melt due to increased temperatures. The second reason is that salt particles have the property of melting ice. Salt particles do not melt ice quickly, but slowly, and with the effect of large amounts of salt, this can cause significant damage.

The drying up of the Aral Sea and the resulting water shortage remain one of the most serious environmental and social problems in Central Asia. Since most of the river water is diverted to irrigation systems rather than to the sea, the need for drinking and irrigation water has increased in the downstream regions, such as Kazakhstan, Khorezm, Aral Sea, and Karakalpakstan, and water shortages have occurred. Currently, various measures are being taken to eliminate these problems. In order for the measures to be beneficial, humanity must

also make a small contribution to the restoration of the ecosystem. Examples of measures to reduce water shortage include the following. Water-saving technologies include: drip irrigation, groundwater harvesting. Many pipelines are being laid and drinking water supply systems are being built.

Soil degeneration is the decline in soil fertility, structure, water retention capacity, and biological function under the influence of various natural and human factors, that is, anthropogenic factors.

The increase in the amount of salts in the soil has a negative effect on the soil, the soil becomes denser and aeration worsens, the ability to retain moisture decreases, the soil dries out, the soil surface hardens and forms a hard crust, the pH balance in the soil is out of whack, the amount of elements such as potassium and phosphorus necessary for plant growth and development decreases, and ion exchange is disrupted, the amount of sodium in the soil increases. As the amount of salinity in the soil increases, beneficial microorganisms begin to die. In such saline soil, plant roots are damaged or may even die completely. The amount of humus, that is, humus, also decreases. Due to soil degeneration, the aging process accelerates, the soil turns into dead land. Ecosystems are destroyed, and unfavorable living conditions are created for plants and animals. Agriculture decreases, agro-ecosystems are greatly damaged, productivity decreases, and migration increases. The negative impact of salinization on human health is also very great. For example, the Aral Sea region has a higher aging rate than other regions. Respiratory diseases are also widespread in those regions. This is because salt and pesticide particles flying in the air enter the bronchi and lungs, which leads to lung damage and causes diseases such as bronchitis, asthma, allergies, and chronic cough in people. In some regions, lung diseases in children have increased 3-4 times.

Due to salt, not only lung diseases, but also cardiovascular diseases are widespread. The reason for this is that salt dust and chemicals increase blood pressure and at the same time disrupt the functioning of the heart. The rate of cardiovascular diseases in the Aral Sea regions is much higher than in other regions of Central Asia. In these regions, not only respiratory and cardiovascular diseases, but also several other dangerous and life-threatening diseases are widespread. Examples of these diseases include: Skin diseases, diseases of the digestive system, nervous system disorders, and mental and physical development disorders in children. Due to the consumption of large amounts of salt water in humans, diseases of the renal system, such as kidney stones, pyelonephritis and glomerulonephritis, occur. In addition, salinity also has a significant effect on the nervous system. Prolonged exposure to salt dust can cause irritability, insomnia, and fatigue. At the same time, children living in areas where salt is abundant can experience growth retardation, immune deficiency, and vitamin deficiencies.

The global scale of the problem.

Soil salinization remains one of the most pressing problems in the world today. According to the UN Food and Agriculture Organization:

More than 65 million hectares of irrigated land on Earth are saline.

Every year, 1.5 million hectares of fertile land become unusable due to salinization. This leads to a sharp decrease in agricultural productivity.

These conditions are observed not only in the Aral Sea regions, but also in more than 90 countries, including: Uzbekistan, Kazakhstan, India, Pakistan, Australia and the USA.

As a result of salinization, the fertility of fertile soils decreases significantly and productivity decreases by 20-25%. A decrease in the percentage of productivity leads to a decrease in the amount of annual production, which in turn leads to a sharp decrease in annual income. As a result of salinization, the soil undergoes physical and chemical changes, which leads to the degeneration of the ecosystem.

Various measures are being taken against salinization not only in Uzbekistan but also all over the world. We will go into the most important of the countries taking measures.

China: "Green Wall" has developed and is implementing the ideas of green vegetation cover and plantation of salinity-resistant plants. This is one of the effective methods. In China, under the "Green Wall" project to combat desertification and salinity, salinity-resistant plants such as saxaul, tamarisk, and quinoa are planted on more than 30 million hectares of land. The level of salinity is monitored using satellites throughout the year and the results of restoration are evaluated.

Australia: Salt-binding "bioengineering" technology. In Australia, the technology of chemically binding salt using microbes is being tested in order to restore saline lands. These organisms absorb sodium ions present in the soil, maintaining the salt balance and helping the soil return to its natural state.

Egypt: To prevent salinization, water recycling and drip irrigation have been introduced. In the Nile Valley areas, drip irrigation systems, salt water re-filtration stations and the widespread use of bio-fertilizers have been widely implemented. The benefits of this are that water consumption is reduced by 40%.

India: Remote sensing and soil cartography. India has created a salinity map of each of its fields thanks to the "Figural Soi Health Card" project. Through remote sensing, it automatically identifies areas with high salinity and selects suitable plants for soil restoration there.

In the USA: Salt-tolerant plants and a digital prehygrometry system.

In the USA, the Canada Degradation Early Warning System program was developed as a result of cooperation between NASA and the USA. This program can be used to early detect soil salinity levels and predict future risk zones based on remote sensing and artificial intelligence data.

International initiatives.

The UN has adopted a strategy for "Development without Soil Degradation" for 2015-2030.

Every year on December 5, as part of the International Soil Day, FAO presents its innovative idea to combat salinity to the public.

As part of the Global Sustainable Partnership (GSP) project, an international database has been created for special monitoring and reclamation for high-risk areas such as the Aral Sea.

Conclusion.

The Aral Sea problem is not an issue that can be ignored. It is one of the problems that determine the fate of global humanity. If the Aral Sea problem is not addressed and left

indifferent, it will cause great harm to humanity and nature. The salinization of the Aral Sea is not only a global problem, but also creates other new global problems, for example, global warming. Therefore, preventing salinization will also lead to a decrease in several other global problems, albeit to a certain extent. Humanity should not be indifferent to such problems.

World experience shows that the elimination of the problem of salinization can be solved not only by land reclamation, but also by a scientific and technological approach, digital monitoring, international cooperation and increasing the ecological literacy of the population.

Applying similar best practices in the Aral Sea region—for example, creating satellite-based salinity mapping, establishing salt-tolerant vegetation zones, and introducing biofilter systems—would greatly contribute to the ecological restoration of the region.

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