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ANALYSIS OF THE STATE OF IRRIGATED LANDS OF THE FERGANA REGION

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Abstract
This article provides an in-depth analysis of the current state of irrigated lands in the Fergana region and scientifically examines their natural-climatic, technical-meliorative, and ecological characteristics. The study revealed an increase in the need for water resources under conditions of the length of the growing season, low precipitation, and high temperatures. It was also noted that the soil cover is prone to salinization, the groundwater level is close to the surface, and the melioration systems are in a faulty state. When analyzing the technical condition of irrigation systems, it was found that most of the main and internal canals are physically obsolete, more than 60% of pumping stations require repair, and up to 30-40% of water is lost. In conditions where traditional irrigation methods prevail, the introduction of water-saving technologies is indicated as a pressing issue. The prevalence of erosion processes was assessed using the RUSLE model, NDVI, BSI indices, and topographic maps. According to the results, water erosion covered up to 20% of the area, and the rate of soil loss was 15-50 tons/ha/year. This led to a decrease in yield by an average of 10-15%. At the end of the study, recommendations were developed for a set of measures to restore the stability and fertility of irrigated lands, including the modernization of infrastructure, the introduction of digital monitoring systems, the expansion of water-saving technologies, and the application of anti-erosion agrotechnical measures.

Keywords: Fergana region, irrigated lands, salinization, land reclamation, irrigation system, erosion, NDVI, technical efficiency, soil loss, yield.

Introduction

The agricultural sector of the Republic of Uzbekistan is one of the leading sectors of the country's economy and plays an important role in ensuring food security of the population, increasing employment, and expanding export potential. Sustainable development of agriculture depends, first of all, on productive and effectively used irrigated land resources. In particular, the Fergana Valley is the most fertile and intensively irrigated region of Uzbekistan. The Fergana region, located in this oasis, is distinguished by its agro-climatic conditions, water supply, and intensive agriculture. However, in recent years, under the influence of natural, man-made, and anthropogenic factors, the state of irrigated lands has changed dramatically, which necessitates their monitoring and in-depth analysis.

In agriculture of the Fergana region, irrigated lands serve as the main factor of production. Such agricultural products as cotton, grain, vegetables, fruit trees, and fodder crops are grown on the basis of irrigation. By 2020, there are more than 260 thousand hectares of irrigated land in the region, a significant part of which is cotton-grain crop rotation. However, the technical and

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reclamation condition of these areas is deteriorating annually under the influence of various factors: salinization, erosion, water scarcity, deterioration of irrigation networks, and poor maintenance.

Assessment of the state of irrigated lands and their monitoring based on modern methods is a matter of not only scientific, but also practical importance. Through a deep analysis of the current state of irrigated lands in the Fergana region, their degradation processes, melioration indicators, the level of water supply, efficiency of use, and other aspects will be resolved. This problem is becoming especially acute against the backdrop of limited water resources and global climate change.

It should be noted that most of the existing irrigation systems, water distribution, and drainage structures in the Fergana region have a 30-50-year history, many of which are technically obsolete and require modernization. This leads to a deterioration in the melioration state of the land, an increase in the level of salinity, and, as a consequence, a decrease in soil fertility. At the same time, as a result of climate change, the decrease in rainfall, the increase in temperature, and the intensification of evaporation processes also negatively affect the condition of irrigated lands.

Territorial analyses show that in some districts of the region (for example, Kuva, Rishtan, Buvayda, Fergana districts) the level of salinity and erosion is high, and special agrotechnical and land reclamation measures are necessary for the restoration of these lands. Moreover, the possibilities of identifying and analyzing these problems are increasing through the use of modern GIS technologies, remote sensing methods, ground monitoring, and satellite imagery [1,2].

From this point of view, the purpose of this article is to comprehensively study the state of irrigated lands in the Fergana region, assess their current technical, agroecological, and melioration state, identify existing problems, and propose scientifically based solutions. At the same time, the solution of the following tasks is envisaged:

- Collection of statistical and geoinformation data assessing the general state of irrigated lands;
- Determination of the natural-climatic and soil-reclamation features of the territory;
- Study of the technical condition of irrigation systems and analysis of their operational efficiency;
- Determination of the prevalence of erosion processes, assessment of their intensity;
- Development of recommendations based on advanced foreign and domestic experience.

The structure of this article is as follows: the first part provides an analysis of the literature, highlights advanced theoretical views and practical experience in this area. In the following sections, the natural and climatic conditions, soil and land reclamation characteristics of the Fergana region are analyzed. The state of irrigation systems and the effectiveness of their operation, land degradation, in particular, erosion processes, are also studied. In the final part, conclusions and scientific and practical recommendations are given.

In general, this study will contribute to the more rational and effective use of land resources in the region. The results of this article are important in ensuring the stability of agricultural production, improving the melioration state of lands, and maintaining ecological balance [3,4].

LITERATURE ANALYSIS

The issue of assessing and monitoring the state of irrigated lands is recognized as one of the priority areas for ensuring the stability of the agricultural sector on a global scale. In recent decades, such problems as the degradation of agricultural land, the limitation of water resources, salinization,

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and erosion have become the central theme of scientific research in many countries. In particular, the FAO (2020) report "Status of the World's Soil Resources" emphasizes that the rapid deterioration of land resources poses a serious threat to human food security. In this report, land reclamation measures, water-saving technologies, and landscape monitoring tools are presented as the main solutions.

Classical approaches to determining the agroecological state of irrigated lands were developed by such Russian scientists as A. A. Kovda (1983), L. K. Lebedev (1992), A. I. Kostyakov (1976). In their research, the main criteria for assessing the melioration status are the degree of salinity, groundwater depth, physicochemical analyses, mechanical composition, and erosion properties. In particular, the works of A.I. Kostyakov on hydromelioration created an important theoretical basis for ensuring the stability of the water balance.

In recent years, scientists of Uzbekistan have also been conducting large-scale scientific research on monitoring and assessing the state of irrigated lands. In particular, B. Rakhmonkulov (2017) developed a system of indicators based on agroecological zoning in assessing the melioration state of the Fergana Valley, in which such parameters as the degree of salinity, mechanical composition, humus content, and hydromorphism play an important role. Also, in the work prepared by A. Ismailov and A. Khamidov (2021), land degradation processes, especially cases of secondary salinization caused by malfunctions and improper use of irrigation systems, are noted as problems. Among foreign sources, the research conducted by Turner et al. (2007) and Ziadat et al. (2010) deserves special attention. Their research covers methods of dynamic analysis of the state of lands using remote sensing and geoinformation systems (GIS). In particular, it was shown that it is possible to draw accurate conclusions about soil fertility and moisture using vegetation indices such as NDVI (Normalized Difference Vegetation Index), NDMI (Normalized Difference Moisture Index), SAVI (Soil Adjusted Vegetation Index) using Landsat and Sentinel satellite images.

In determining the processes of salinization and erosion, on the basis of the classification methodology proposed by T. R. Yakubov (2018), land reclamation monitoring was carried out in various natural and climatic zones of Uzbekistan. These approaches are also important in the conditions of the Fergana Valley, especially in the analysis of vertical and horizontal zoning of the level of salinity in lowland and flat valley areas.

In recent years, due to the global shortage of water resources and climate change, the relevance of water-saving technologies has increased. Literature on such methods as drip irrigation, laser leveling, sprinkler irrigation (UNESCO, 2022; IWMI, 2021) as important means of increasing irrigation efficiency, reducing erosion and salinization. In particular, in the experience of India and Israel, as a result of the application of these methods, the yield increased by 25-40%, and water consumption decreased by 30-50%, which is confirmed by scientific statistical data.

In improving the melioration monitoring system, remote monitoring technologies are being widely implemented, in particular, methods that allow assessing the agrotechnical state using GPS, drones, aerial photographs, and satellite imagery. Through open sources in the databases of NASA EarthData, Copernicus, and USGS (United States Geological Survey), it is possible to compile historical (by year) NDVI maps of the Fergana region and conduct dynamic monitoring based on them [5,6].

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In general, the analysis of the available literature shows that the following priority approaches have been formed in the assessment of irrigated lands of the Fergana region:

1. **Assessment based on classical agro-meliorative indicators** - Based on salinity, groundwater depth, mechanical composition, pH, and humus content.
2. **Modern assessment based on GIS and RS technologies** - analysis of vegetation and moisture dynamics based on NDVI, NDMI, SAVI, and other indices.
3. **Based monitoring results on territorial zoning** - Development of separate assessment criteria for each agroclimatic zone.
4. **Application of adapted technologies from international experience** - Water-saving methods, digital land monitoring systems, and integrated agro-melioration strategies.

Thus, based on the analysis of the literature, the application of not only traditional methods, but also modern remote sensing technologies, index-based assessment, and statistical and cartographic modeling systems for a comprehensive assessment of the condition of irrigated lands in the Fergana region is considered the most optimal approach. Throughout this article, analyses will be conducted based on these scientific and methodological approaches.

RESULT AND DISCUSSION

Natural-climatic and soil-reclamation conditions of the territory

Fergana region is the most densely populated and agricultural region of Uzbekistan, and its natural-climatic and soil-reclamation conditions occupy a special place in the entire agro-climatic system of the republic. This region, encompassing the central and eastern parts of the Fergana Valley, is located near the lower reaches of the Syr Darya River. The geosystem of this region, formed by natural and anthropogenic factors, distinguishes it from other regions of Uzbekistan. In particular, annual precipitation, temperature, distribution of water resources, soil composition, and hydrogeological state are the main determining factors in the monitoring and assessment of irrigated lands.

The region is located in a continental climate zone, characterized by the main features of the climate - sharp temperature differences, extremely hot and dry summers, short and relatively warm winters. The vegetation period lasts an average of 210-230 days. The warmth of the spring months and the relatively high amount of precipitation (average 25-40 mm in April-May) create favorable conditions for crops. Summer temperatures are around 35-42°C, and due to intensive evaporation, especially in July-August, moisture in the soil is quickly lost, which increases the need for irrigation. The average annual precipitation is 100-200 mm, which does not fully cover the natural needs of agricultural crops. As a result, irrigation becomes the main factor. Precisely for this reason, irrigation systems have always been and still remain a priority in agriculture in this region.

The relief of the Fergana region is predominantly valley-plain, gradually descending towards the southwest from the foothills of the Karategin Range and the Kyrgyz mountain range. This relief configuration corresponds to the natural orientation of irrigation and drainage systems. However, in the lowlands, the groundwater level is relatively high (1-2 meters), which intensifies salinization processes. In some places, groundwater is located at a depth of 3-5 meters, but due to its high mineralization, it negatively affects soil fertility. The main water sources in the region are the Syr Darya and its tributaries, however, the availability of water resources is directly related to their seasonal distribution and technical provision. Currently, due to imbalances in the water distribution

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system, obsolescence of irrigation structures, and insufficient mechanization, there is a shortage of water in some areas [7].

In terms of soil-meliorative conditions, the Fergana region is more complex and at the same time more intensive than other regions of Uzbekistan. Gray soils, light gray soils, and in some places sandy solonchaks and hydromorphic soils are widespread in the territory. These soils have a physicochemical composition ranging from sandy loam to medium-heavy mechanical composition. Their water permeability is relatively low, and salinization processes have intensified due to prolonged malfunction of irrigation and drainage systems. In a number of districts (for example, Kuva, Dangara, Besharyk, Tashlak), the level of secondary salinity reaches 35-40%, which sharply reduces yields and complicates agrotechnical measures.

The humus content in the soil is in the range of 1.5-2.5%, which is lower than in other regions of Uzbekistan. This creates the need for feeding with organic matter and increasing the microbiological activity of the soil. Due to the high rate of decomposition and slow recovery, the regular implementation of fertilization and agromeliorative measures in these areas is of great importance. In particular, biological activity, the number of enzymes, microflora, and microfauna are relatively poorly developed, showing sensitivity to any intensity associated with agricultural technologies.

Recent annual observations on the assessment of the melioration state (based on Uzhydromet reports for 2020-2024) show that more than 50 thousand hectares of irrigated land in the region are moderately saline, and 20 thousand hectares are highly saline. The main reasons for this are the malfunction of drainage systems, violation of irrigation norms, and improper agrotechnical measures. Although the total length of drainage systems exceeds 3,000 kilometers, more than 40% of them are in need of repair. This leads to an increase in the level of groundwater, an increase in the concentration of salts in the soil, and an increased risk of erosion.

Problems related to climate change have also intensified in recent years. The general increase in temperature, increased evaporation, uneven distribution of atmospheric precipitation, strong winds, and frequent drought episodes - all this creates a negative dynamic in the agroclimatic conditions of the Fergana region. These circumstances necessitate a new approach to irrigation regimes, the introduction of water-saving technologies, and the development of monitoring systems based on vegetation indices [8].

It should be noted that not all regions of the Fergana region have the same conditions. For example, the Baghdad, Uchkuprik, Altyaryk, and Uzbekistan districts are relatively drained areas, where salinity is relatively low and annual yields are high. On the contrary, in districts such as Rishtan, Kuva, and Buvayda, free water flow is limited, drainage is inefficient, and as a result, secondary salinization is high. This requires the development of an individual system of land reclamation measures for each district.

The above-mentioned natural-climatic and soil-reclamation factors indicate the need for a comprehensive assessment of the current state of irrigated lands in the Fergana region, the development of a strategy for rational land use, the introduction of modern technologies, and the territorial differentiation of crop types. Therefore, the use of remote sensing data (NDVI, NDMI, SAVI) along with traditional methods in monitoring work, the identification of risk areas based on agroclimatic zoning, and the development of agrotechnical recommendations remain a requirement of the times.

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Technical condition and operational efficiency of irrigation systems

Irrigated lands in the Fergana region are among the most intensively used and productive lands in the country. This situation is based on the complex system of water facilities and irrigation infrastructure put forward in the region over the years. However, today the technical condition of existing irrigation systems and the effectiveness of their operation face many problems. Factors such as climate change, limited water resources, technical obsolescence, and improper management have a direct negative impact on the efficiency of irrigation systems. This section provides an in-depth analysis of the irrigation infrastructure of the Fergana region, the levels of water distribution and losses, existing technical problems, as well as the applied irrigation methods and their effectiveness.

The existing irrigation infrastructure in the Fergana region mainly consists of open canals, main canals, water intake structures, pumping stations, water distribution devices, and drainage systems. The main sources of irrigation in the region are the Syr Darya River and its tributaries, through which water is supplied to the region through the mountain rivers Shakhimardansay, Isfayramsay, Sokhsay, and Isfara. The main part of the water is supplied through large main canals - the South Fergana Canal, the Kuva-Kuvasay Canal, the Chimgan-Usmat Canal, the Margilan-Yangyaryk Canal, and the Shakhimardansay Canal. The total length of these canals is more than 2,300 km, through which more than 260 thousand hectares of irrigated land are provided with water.

Unfortunately, most of the irrigation networks were built in the 60s and 80s of the last century, and today they are technically obsolete. Many main canals are open, and concrete pavements are unusable or non-existent. This leads to the loss of a significant portion of water. According to calculations, up to 30-40% of water losses occur during the water supply chain. These losses occur due to evaporation, infiltration, and technical malfunctions. Currently, most of the canal embankments, gates, and distribution structures are faulty, leading to water leaks, uncertainty in management, and improper distribution [9].

In addition, many in-farm canals and irrigation networks are built on a soil base, which leads to a high degree of loss of water permeability. Despite the fact that thousands of kilometers of canals are cleaned and repaired annually, the situation does not fundamentally improve due to outdated infrastructure, insufficient financial support, and systemic problems in maintenance. This reduces the economic efficiency of water use, especially during periods of water scarcity, when crops are not fully irrigated.

One of the important technical problems in irrigation systems is related to the energy efficiency and stability of pumping stations. There are more than 200 pumping stations in the region, most of which are physically obsolete. Due to interruptions in the electricity supply, a shortage of spare parts, and delays in troubleshooting, irrigation is not carried out on schedule. This negatively affects the harvest, especially during the intensive growing season. In some districts (Kuva, Buvayda, Toshloq), irrigation periods are carried out irrationally, not meeting the established norms, which accelerates soil salinization processes.

Another major source of water loss is a technical malfunction of drainage systems. More than 40% of the existing open and closed drainage systems in the region are in need of repair. In some cases, as a result of the sinking of drainage pipes, the accumulation of sand and clay, or their complete failure, the groundwater level rises, increasing the risk of salinization and flooding. Failure of these systems not only reduces irrigation efficiency, but also leads to land degradation.

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The irrigation methods currently used in the region are mainly based on traditional methods. In particular, irrigation through open ditches using the "shipon" or "nav" method is widespread. With this method, water consumption is excessively high, and excessive irrigation of crops negatively affects the physical condition of the soil. This method loses its effectiveness, especially in sandy and saline soils. For this reason, the introduction of water-saving methods, in particular, drip irrigation, sprinkler irrigation, or micro-irrigation technologies, remains one of the pressing issues. Although drip irrigation has been introduced in some farms in recent years, this practice has not yet become widespread. One of the reasons is the high cost of technology, the shortage of specialists, the need for constant maintenance of the system, and limitations in the credit and financial system. Nevertheless, according to the data obtained from existing experiments, with drip irrigation, water consumption decreased by 35-50%, and yields in some cases increased by 25-40%. This proves the economic and ecological advantages of this method [10].

Sprinkler irrigation is partially used only in the foothills or uneven terrain of the Fergana region. This technology is mainly used for irrigating orchards, vineyards, forage crops, and meadows. However, this method is also not widespread because it requires large investments and high energy consumption. At the same time, the practice of increasing irrigation efficiency using laser leveling technologies is also yielding positive results. Such methods ensure even distribution of irrigation water and reduce the risk of soil leaching and salinization.

In general, the current technical condition of irrigation systems in the Fergana region is unsatisfactory. High water losses during irrigation through open canals, malfunctioning pumps and drainage systems, reliance on traditional, water-intensive irrigation methods not only reduce economic efficiency, but also increase environmental risks. Therefore, the phased modernization of existing infrastructure, the introduction of water-saving technologies, the creation of digital monitoring systems, and the development of effective management mechanisms have become necessary.

The effectiveness of irrigation systems depends not only on technical upgrades, but also on coordinated management in the system, agrotechnical culture, financial support, and strengthening the activities of water user associations. The future agrarian stability of the Fergana region will directly depend on how these systems are modernized and the quality of management.

Prevalence and intensity of erosion processes

Erosion processes are a degradation phenomenon that occurs due to the erosion of the soil layer under the influence of natural and anthropogenic factors, wind erosion, displacement, or erosion. In the Fergana region, erosion is a very serious ecological and agronomic problem, especially for irrigated lands. The features of the relief of this region, the movement of water and wind, uneven irrigation systems, agricultural lands located in the foothills, and in some cases, the weakness of agricultural practices are factors that increase the risk of erosion. In some districts of the Fergana region, especially in Kuva, Rishtan, Buvayda, Altyaryk, and Uchkuprik, erosion processes are quite active, which have a direct negative impact on yields.

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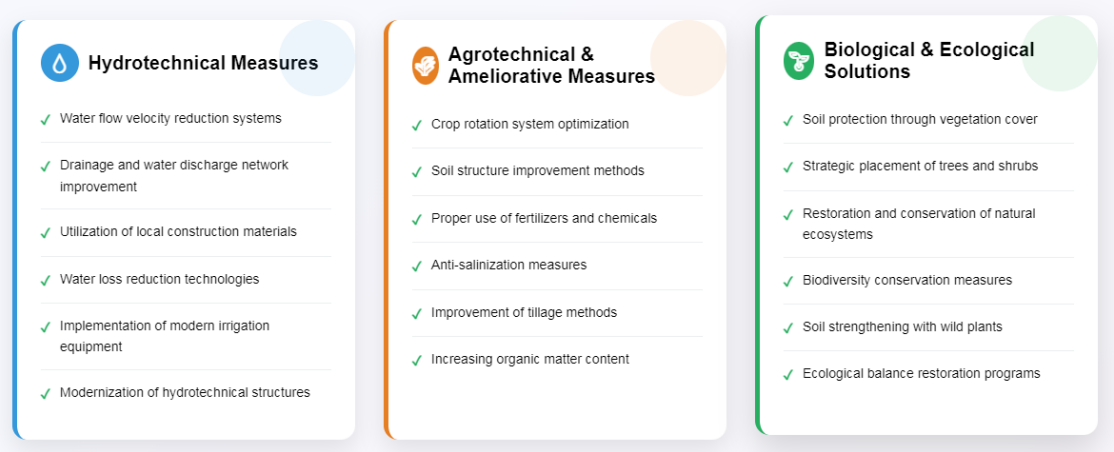

Figure 1. Anti-erosion measures

Among the types of erosion in the region, mainly **water erosion** and **wind erosion**are observed. Water erosion often occurs at the foot of mountains, on flat slopes, when irrigation water is distributed incorrectly, or in fields left without ventilation. Wind erosion intensifies in clear, treeless areas, especially during strong winds in spring. The results of monitoring conducted by region show that lands affected by water erosion account for 18-22 percent of the total irrigated area, and areas prone to wind erosion - 8-10 percent. In some years, these figures may increase sharply against the backdrop of drought and heavy rainfall [11].

The mapping and classification of erosion zones play an important role in maintaining the ecological stability of the region, managing the land fund, and restoring the agroecological balance. In this regard, the rapid development of remote sensing technologies, especially based on satellite images such as Landsat, Sentinel-2, MODIS, NDVI (Vegetation Difference Index), BSI (Bare Soil Index), RUSLE (Based on the Universal Soil Loss Model), topographic slope models, and geomorphic maps, made it possible to identify eroded areas. High-precision analyses are carried out using geoinformation technologies. Based on maps of the Fergana region at a scale of 1:25,000 or 1:10,000, erosion zones are classified as high-risk, medium-risk, and relatively safe zones. They are assessed based on their location, slope angle, soil composition, irrigation system characteristics, and the degree of anthropogenic load on the landscape [12].

According to the analysis conducted, water erosion occurs at the highest rates in areas with a slope of 5-12°. These areas are often poorly leveled, with sharp water currents and insufficient drainage. Especially in sown areas at the foothills, the combination of natural rainwater with irrigation water increases the rate of erosion. Wind erosion occurs more frequently in spring, during months of strong winds, when the ground surface is bare. In such cases, the most fertile topsoil (0-5 cm) completely disappears within a few days.

The volume and rate of soil loss depend on various factors, and in the conditions of the Fergana region, these indicators differ significantly. As a result of water erosion, soil erosion reaches 15-30 tons/ha per year, and in some slopes exceeds 50 tons/ha. This has a direct negative impact on yields, since productivity decreases by 5-10% due to the loss of 10 tons/ha of soil. According to long-term observations, in the sloping areas of the Kuva and Rishtan districts, a decrease in the average annual yield of cotton and grain crops by 12-15% was observed. This directly indicates a

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decrease in the amount of humus, nutrients, and water retention capacity of the soil as a result of erosion.

The influence of soil erosion on yield has not only a physiological basis, but also an economic one. According to international assessment criteria, the annual loss of 10 tons of soil per hectare of irrigated land is approximately equal to a decrease in yield of 3-5 centners. This, in turn, leads to a decrease in annual crop yields, a decrease in the income of farms, and a decrease in overall economic efficiency. In addition, a decrease in soil fertility creates ecological problems that are difficult to restore. Under erosion conditions, the microbiological activity of the soil decreases, its physicochemical properties are disturbed, the degree of water retention decreases, and as a result, the need for additional agromeliorative measures arises.

Although many measures have been taken in the Fergana region to mitigate and eliminate erosion processes, most of them have a short-term impact. The main reasons for the problems are incorrect agrotechnical measures, low technological culture, inefficient water use, uneven contours on the slopes, poor operation of the crop rotation system, imbalance in water distribution, and insufficient agroecological monitoring. One of the most effective anti-erosion measures is the sowing of crops along the contour of the plain, laser leveling of the land, layered plowing, the use of green spaces between crops (green mulching), the application of organic fertilizers, soil moisture-retaining agricultural techniques, updating drainage systems, and, of course, accurate mapping of erosion-prone zones based on digital monitoring.

Also, international experience shows that agroforestry methods - that is, planting forests in parallel with agricultural crops - can reduce the rate of erosion by 20-30%. In some regions of the Fergana region, in particular, in the foothills, experimental plots have been organized using this method, and positive results have been noted. However, for the widespread popularization of these methods, a scientifically based approach, comprehensive monitoring, financing, and ensuring the participation of the local population are necessary.

Erosion processes in the Fergana region today remain the main cause of land degradation, decreased yields, reduced efficiency of water resource use, and environmental instability. To curb this situation, modern geotechnologies, index remote monitoring, landscape-appropriate agricultural techniques, technical prevention, and an ecological approach adapted to local conditions are necessary. Otherwise, erosion processes will lead to large-scale degradation and sharply reduce the potential of agriculture [13].

Figure 2. Expected results

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CONCLUSION

Scientific analysis of irrigated lands of the Fergana region clearly showed the complexity of the agro-climatic, technical-meliorative, and ecological state of the region. In terms of natural and climatic conditions, the vegetation period of the region is long, the temperature is high, precipitation is low, which sharply increases the need for water for growing agricultural crops. The soil cover consists mainly of sierozem, light sierozem, and saline soils, and due to the high degree of salinity and low humus content, soil fertility in many areas remains at risk. The high groundwater level and malfunctioning reclamation systems further exacerbate salinization processes.

The results of the technical condition of irrigation systems showed that 60-70% of the existing infrastructure is physically and morally obsolete, and significant losses are occurring in water distribution and management. Due to the open condition of main and internal canals, the destruction of concrete pavements, and malfunctions of pumping stations and drainage networks, 30-40% of water is lost before reaching the consumer. Traditional irrigation methods (canal irrigation) are widely used, which reduces the efficiency of water use, salinizes the soil, and intensifies erosion. Modern drip and sprinkler irrigation technologies have been implemented only on a limited scale, and it has been proven in practical experiments that the widespread introduction of these technologies can reduce water consumption by 35-50% and increase yields by 20-40%.

Analysis of the prevalence and intensity of erosion processes also showed a serious threat to the agrarian situation of the region. Water erosion occupies 18-22 percent of the total area, and wind erosion occupies 8-10 percent. Erosion processes are especially strong in areas located on slopes and at the foot of mountains. The rate of soil loss, determined using the RUSLE model, averages 15-50 tons/ha per year. As a result, plant nutrition is deteriorating, vegetation is weakening, and annual yields are decreasing by an average of 10-15%. Insufficient anti-erosion measures, poor agricultural practices, and weak monitoring are exacerbating this problem.

Based on all the above analyses, it can be concluded that a comprehensive, scientifically based, and modern approach is necessary to improve the current state of irrigated lands in the Fergana region. In particular, the following strategic directions are of great importance:

- phased modernization, concreting, automation and accurate water accounting of irrigation systems;
- Wide implementation of water-saving technologies and their financial support;
- mapping of zones with a high risk of salinization and erosion, introduction of territorial management based on agroecological zoning;
- Establishment of a digital monitoring system using remote sensing (NDVI, NDMI) and GIS technologies;
- radical reorganization of the system of land reclamation services and maintenance;
- Implementation of biohumus, green manure, organic agricultural techniques, and agroforestry systems to restore soil fertility.

Also, in these areas, it is necessary to expand scientific and practical projects integrated with the land resources and water management policy of the Republic of Uzbekistan, adapt international experience to local conditions, and transform farms and water user associations into active participating entities. Only in this way will the possibility of sustainable and efficient use of irrigated lands of the Fergana region be achieved.

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