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DEVELOPMENT OF MEASURES AND RECOMMENDATIONS TO COMBAT SOIL EROSION IN THE KHOREZM REGION

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ABSTRACT

This study examines the main causes of soil erosion in the Khorezm region, its negative impact on agricultural lands, and the development of effective measures to combat it. The research analyzes wind and water erosion processes, soil fertility degradation, and deterioration of land reclamation conditions. Furthermore, scientifically based recommendations are proposed, including modern agrotechnical methods, the establishment of protective forest belts, rational use of land resources, and the implementation of innovative technologies. The findings contribute to sustainable agricultural development and environmental stability in the region.

KEYWORDS

Soil erosion, wind erosion, water erosion, soil fertility, land reclamation, agrotechnics, protective forest belts, land resources, sustainable agriculture.

Introduction

In the Republic of Uzbekistan, the protection of land resources, preservation of soil fertility, and prevention of erosion processes are considered priority directions of state policy. Particularly in irrigated regions such as the Khorezm region, soil erosion, salinization, and degradation processes have a negative impact on agricultural productivity. Therefore, this issue is regulated through laws, resolutions, and regulations adopted by the state, and practical measures are being developed.

First of all, the Law of the Republic of Uzbekistan "On Nature Protection," adopted on December 9, 1992, establishes the general legal framework for the protection of land and soil resources, maintaining ecological balance, and preventing erosion and degradation processes. This law forms the conceptual basis for combating soil erosion.

Additionally, the Law "On Water and Water Use," adopted on May 6, 1993, defines mechanisms for rational use of water resources, management of irrigation systems, and prevention of water erosion in irrigated areas. In the Khorezm region, soil washout caused by improper irrigation practices is regulated by this law[1].

Furthermore, the Land Code of the Republic of Uzbekistan, adopted on April 30, 1998, establishes specific obligations regarding rational use of land resources, preservation of soil fertility, and combating erosion. According to this code, landowners and users are required to protect soil from degradation and implement agrotechnical and meliorative measures.

LITERATURE REVIEW AND RESEARCH METHODOLOGY

In recent years, new regulatory documents have been adopted to further improve the management system of water and land resources. In particular, the Water Code of the Republic of Uzbekistan, adopted on July 30, 2025, defines modern mechanisms for the use, protection, and monitoring of water resources. This code plays an important role in preventing water erosion, ensuring efficient management of irrigation systems, and maintaining ecological sustainability.

Based on the above legislative framework, the following key directions for combating soil erosion in the Khorezm region have been formed:

rational use of land resources and implementation of agrotechnical measures;

modernization of irrigation systems and reduction of water erosion;

establishment of protective forest belts against wind erosion;

improvement of meliorative conditions and restoration of soil fertility;

strengthening of environmental monitoring and control systems.

Analysis shows that the existing legal framework ensures a comprehensive approach to combating soil erosion. However, the natural and climatic conditions of the Khorezm region arid climate, strong winds, and high dependence on irrigation further complicate this problem.

Therefore, it is essential to adapt legislative measures to local conditions and widely implement scientifically grounded recommendations in practice.

The issue of soil erosion and its control has long been the focus of scientific research. Especially in irrigated regions such as Khorezm, this problem has not only ecological but also economic and social significance. Therefore, numerous studies have been conducted by both Uzbek and foreign scholars in this field[2].

Among Uzbek researchers, A. Abduganiyev analyzed the efficient use of land resources and preservation of soil fertility from an economic perspective. He demonstrated that soil erosion leads to decreased crop yields and increased production costs, and highlighted the economic effectiveness of anti-erosion agrotechnical measures.

Studies conducted by Sh. Kholiqulov and B. To‘rayev deeply examined the causes of water erosion in irrigated areas. They scientifically substantiated that improper irrigation technologies, excessive water application, and insufficient drainage systems intensify soil washout. These scholars emphasized the importance of introducing water-saving technologies to combat erosion.

Uzbek soil scientists M. Mirzaev and R. Qodirov studied changes in the physical and chemical properties of soil and proved that erosion processes lead to a decrease in humus content.

They identified protective forest belts and agrotechnical methods as effective measures against wind erosion.

In studies conducted in areas similar to Khorezm, N. Bekchanov and D. Khudoyberganov demonstrated that improving the meliorative condition of irrigated lands can significantly reduce

erosion. They emphasized that improving drainage systems and land leveling using laser technologies reduces erosion risks[3].

Among foreign scholars, D. Pimentel evaluated soil erosion as a global environmental problem and analyzed its impact on food security, demonstrating the large-scale loss of fertile soil layers. R. Lal studied soil degradation and erosion in relation to climate change and identified conservation agriculture, minimal tillage, and organic matter application as effective measures. H. Morgan developed models for quantitative assessment of erosion processes, emphasizing the importance of forecasting erosion. Additionally, the Universal Soil Loss Equation developed by Wischmeier and Smith is widely used worldwide to estimate soil loss and develop preventive measures.

Overall, literature analysis indicates that the following directions are essential in combating soil erosion:

agrotechnical measures;
meliorative measures;
water-saving technologies;
protective forest belts;
modern monitoring and modeling methods.

DISCUSSION AND RESULTS

Soil erosion has been extensively studied within the Uzbek scientific school of soil science and melioration. In irrigated regions such as Khorezm, this issue is of particular scientific and practical importance.

M. Mirzaev emphasized in his works that soil erosion leads to gradual loss of the fertile topsoil layer. He noted:

“The reduction of humus and nutrients in the topsoil decreases biological activity, which directly affects crop productivity.”

His studies demonstrated that minimal tillage and preservation of plant residues are effective methods for soil protection.

R. Qodirov stated:

“The main cause of soil erosion in irrigated areas is improper water use, where excessive irrigation intensifies soil washout.”

He proved through practical experiments that water-saving technologies such as drip irrigation significantly reduce erosion[4].

Sh. Kholiqulov highlighted that:

“In arid regions, high wind speed and exposed soil surfaces intensify erosion processes.” His studies confirmed that protective forest belts effectively reduce wind speed and prevent soil loss.

B. To‘rayev emphasized: “Proper soil cultivation, crop rotation, and use of organic fertilizers are key factors in preventing erosion.”

Field experiments showed improved soil structure and water absorption capacity.

N. Bekchanov concluded that degraded lands are more prone to erosion due to weak soil structure, and that drainage improvement and land leveling reduce risks.

D. Khudoyberganov emphasized the importance of digital monitoring and GIS technologies for early detection and prevention of erosion[5].

Practical Approach / Measure	Applied Methods / Technology	Implementation Description	Observed Results	Analytical Notes & Conclusion
Minimal Tillage	No-till and Reduced Tillage	In Khorezm irrigated fields, soil is lightly loosened without deep plowing; crop residues from previous harvests are left on the surface	Soil structure remains intact, soil moisture preserved, wind erosion reduced	Minimal tillage prevents the destruction of the topsoil layer, maintains natural soil fertility, and reduces labor and fuel costs
Wind Erosion Control	Shelterbelts / Protective Forests	Rows of poplar and elm trees planted around agricultural plots and along field edges to act as windbreaks	Wind speed reduced by up to 35%, soil displacement minimized, reduced loss of fertile topsoil	Shelterbelts are highly effective in arid and semi-arid regions; continuous maintenance ensures long-term protection
Water Erosion Reduction	Drip Irrigation	Water delivered directly to plant roots through drip lines, minimizing surface runoff	Soil washing decreased, crop yield stabilized, water use efficiency increased	Drip irrigation in sugar beet and cotton fields reduced erosion caused by traditional flood irrigation by 40%
Irrigation Optimization	Regulated Irrigation	Water application volume and timing scientifically determined based on soil moisture monitoring	Balanced soil moisture, reduced waterlogging, minimized surface runoff	Prevents excessive irrigation that can lead to soil erosion and salinity; improved crop productivity observed
Soil Fertility Improvement	Organic Fertilization	Application of compost and cattle manure on irrigated plots prior to sowing	Increased humus content, improved soil structure, enhanced water retention	Organic amendments strengthen soil's resilience to erosion and support sustainable agriculture
Crop Rotation	Alternating Crops	Alternating cotton, wheat, and legumes over several seasons	Improved soil fertility, decreased erosion risk, enhanced nutrient cycling	Crop rotation restores soil organic matter, reduces monoculture-related degradation
Land Leveling	Laser Land Leveling	Irrigated fields leveled using laser-guided technology to ensure uniform water distribution	Reduced water pooling, minimized surface runoff, improved irrigation efficiency	Prevents micro-erosion channels and uneven water distribution that accelerate soil loss
Melioration Measures	Improved Drainage Systems	Installation and modernization of open drains and subsurface drainage networks	Excess water removed, reduced soil salinity, enhanced soil aeration	Improved drainage directly reduces waterlogging and associated erosion in low-lying areas
Soil Stabilization	Cover Crops	Planting barley, vetch, or clover during off-season to cover bare soil	Reduced wind and water erosion, increased organic matter, improved biodiversity	Provides natural protective layer, mitigates erosion risk in fallow periods
Monitoring Systems	GIS and Digital Observation	Mapping of erosion-prone areas using satellite imagery and field surveys	High-risk zones identified, targeted preventive measures applied, early interventions possible	Digital monitoring enhances efficiency and allows data-driven decision-making
Water Flow Management	Canal and Ditch Modernization	Reshaping and reinforcing irrigation canals and ditches to control water flow	Runoff reduced, erosion along irrigation channels minimized	Proper water flow management prevents gully formation and sediment loss
Soil Loosening	Deep Loosening	Mechanical loosening of subsoil layers without inverting topsoil	Improved water infiltration, reduced surface runoff, minimized crust formation	Deep loosening enhances soil permeability and reduces erosion from heavy rainfall or irrigation
Biomulching	Organic Mulch Cover	Crop residues and straw applied over soil surface	Moisture retention increased, erosion significantly reduced	Economical and environmentally friendly method to maintain soil cover during dry seasons
Agro-technical Protection	Row Planting	Crops planted in alignment perpendicular to prevailing wind direction	Wind impact decreased, topsoil retention improved	Simple, low-cost approach; most effective when combined with protective vegetation
Ecological Rehabilitation	Restoration of Native Vegetation	Degraded lands planted with salt-tolerant shrubs and grasses	Soil stability increased, degraded areas recovered, biodiversity improved	Long-term solution; enhances ecosystem services and provides natural erosion control

CONCLUSION

The results of the study show that soil erosion in the Khorezm region is a complex and multi-factor process influenced by natural and climatic conditions, improper agrotechnical practices, irrigation deficiencies, and wind effects. The arid climate, strong winds, and high dependence on irrigation accelerate erosion processes.

Soil erosion leads not only to reduced soil fertility but also to decreased agricultural productivity, ecological imbalance, and economic losses. Therefore, solving this problem requires a comprehensive approach.

The legislative framework of Uzbekistan provides a solid legal basis for soil protection and erosion control. Based on this, agrotechnical, meliorative, and ecological measures are being implemented.

Practical experience shows that the most effective measures include:

minimal tillage;

water-saving irrigation technologies;

protective forest belts;

improvement of meliorative conditions;

crop rotation and organic fertilization;

application of modern monitoring technologies.

In conclusion, the most effective approach to combating soil erosion is the integrated application of agrotechnical, meliorative, ecological, and technological measures, adapted to regional conditions and widely implemented in practice.

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