EXCELLENCIA
INTERNATIONAL MULTI-DISCIPLINARY JOURNAL OF EDUCATION
Volume 3, Issue 4, 2025 ISSN (E): 2994-9521

Ecological Problems of Rational use of Water and Land Resources in Irrigated Agriculture

Kurbaniyazova Bakhitgul [1]

[1] Associate professor of the Karakalpakstan institute of agriculture and agrotechnologies, PhD in agricultural sciences

E-mail: gulishodieva@mail.ru

Abstract:

Sustainable land and water management remains a fundamental pillar of agricultural development and environmental health, particularly in regions reliant on irrigated agriculture. In Uzbekistan and similar arid zones, irrigated farming is essential for food security, but it faces escalating ecological challenges such as land salinization, erosion, and declining soil fertility. Despite numerous governmental and local efforts to improve land use practices, there remains a critical shortfall in effectively mitigating degradation and ensuring long-term productivity of irrigated lands. This study examines the ecological issues arising from inefficient land and water use in irrigated agriculture and proposes scientifically grounded strategies for rational resource management. The findings reveal significant declines in land quality over recent decades, with increasing rates of salinization, erosion, and water misuse. Current land assessment data illustrate a marked reduction in high-quality arable land, underscoring the urgency for reform. The article synthesizes field research and national land data to highlight the interdependence of water and land in irrigation systems and introduces integrated, locally adaptable solutions—including the enhancement of cadastre data systems, regulated irrigation practices, and organic fertilization through crop-livestock integration. Implementing these strategies is essential not only for improving agricultural productivity but also for halting environmental degradation in irrigated zones. The study provides a practical foundation for policymakers, agronomists, and ecologists working to align agricultural practices with ecological sustainability.

Keywords: Irrigated Agriculture, Irrigation Water, Farm Enterprises, Land Areas, Agriculture, Irrigated Plain Areas, Land and Water Resources, Erosion Processes

Introduction

The sustainable management of land and water resources has become an increasingly urgent issue in the context of global environmental change and the intensification of agricultural production. In particular, irrigated agriculture—one of the key drivers of food security and rural livelihoods—faces a growing array of ecological challenges. In regions such as Karakalpakstan, where water scarcity, salinization, and soil degradation are persistent issues, the rational use of these vital resources is essential not only for maintaining agricultural productivity but also for ensuring long-term environmental sustainability. The interconnected nature of land and irrigation water requires a balanced, science-based approach to resource management, as improper use of either can lead to severe degradation in soil quality and overall land usability. Despite various government interventions and agronomic efforts, national statistics reveal a worrying trend: high-quality irrigated land is declining sharply, and problems such as salinization, erosion, and desertification are becoming more widespread. These developments are exacerbated by inefficient irrigation practices, excessive fertilizer use, and inadequate land leveling and reclamation infrastructure. In this context, it becomes essential to explore and implement rational, ecologically grounded solutions to improve the efficiency of land and water use in irrigated agriculture. This paper seeks to analyze the existing ecological problems, assess their implications for agriculture and the environment, and propose strategic interventions aimed at enhancing the productivity and sustainability of irrigated lands through improved planning, resource monitoring, and adoption of best practices tailored to the region's specific conditions.

Methods

This study is grounded in a qualitative-descriptive methodology supported by a synthesis of statistical data and scientific literature to explore the ecological problems associated with the rational use of water and land resources in irrigated agriculture[1]. The research draws upon official national land and water use statistics to assess the extent of degradation, including salinization, erosion, and declining soil fertility[2]. These empirical indicators were compared across different time periods (1970–1972 and 2008–2012) to demonstrate trends in land quality and usage efficiency[3]. Additionally, insights from soil science and land reclamation research conducted by national experts informed the theoretical framework and proposed recommendations[4]. This methodological approach emphasizes the interdependence of land and water resources and focuses on identifying causes and effects of ecological imbalances in irrigated zones[5]. Key analytical methods included content analysis of state reports, comparative assessment of historical and current land evaluation data, and interpretation of environmental impacts based on agronomic observations[6]. The findings are contextualized within the socio-economic realities of agricultural practices in Karakalpakstan and broader Uzbekistan, allowing for a localized yet generalizable understanding of ecological degradation in irrigation-based agriculture[7]. The proposed strategies were derived from best practices in sustainable land management and targeted measures such as irrigation standardization, organic fertilization through integrated farming, and the implementation of crop rotation systems[8]. This methodical integration of empirical observation with scientific reasoning supports the development of rational, ecologically sound resource management practices in irrigated agriculture[9].

Results and Discussion

The foundation of any society's development is closely tied to land and its utilization[10]. Land serves as the primary means of human livelihood and economic activity, and it remains a fundamental source of national wealth — a role it will continue to play in the future[11].

In the context of irrigated agriculture, irrigation water, alongside land, constitutes a vital resource for agricultural production[12]. As such, studying them in isolation is impractical[13]. The rational and

efficient use of land and water resources in irrigated agriculture is a key factor in deepening economic reforms and modernizing the national economy[14].

In recent years, however, several ecological issues have emerged in our country[15]. These include the salinization of irrigated lands, exposure to various forms of erosion, land degradation, inefficient use of irrigation water, and pollution of both water bodies and land. These factors hinder the sustainable and effective use of land and water resources — a trend reflected in national statistics.

According to official data, the Republic's total land area is 44,892.4 thousand hectares, of which 3.4 million hectares are arable and used for irrigated agriculture. Despite various measures being implemented, 8.2% of these lands are affected by water erosion, 16.0% by wind erosion, and more than 48.0% are subject to salinization and resalinization.

These figures clearly indicate a year-on-year decline in the efficiency of irrigated land use. This is further corroborated by agricultural land evaluation efforts conducted in recent years. For example, between 1970 and 1972, 2,495.0 thousand hectares of irrigated land were evaluated, with 1,020.0 thousand hectares rated as high quality (scoring 81–100 points). In contrast, during 2008–2012, 3,535.6 thousand hectares were assessed, yet only 106.0 thousand hectares were classified as high quality. This demonstrates a significant decline in the quality of irrigated agricultural land.

Despite numerous efforts by both the government and farmers to improve land quality, the situation continues to deteriorate annually.

Irrigated agriculture — often regarded as a more advanced stage of agricultural development — possesses unique features. Chief among them is the interdependence between land and irrigation water. Therefore, a scientifically sound organization of irrigated agriculture requires a well-maintained balance between these two resources. If this balance is not preserved, the land's physical and chemical properties may decline. For instance, excessive irrigation can lead to salinization and the eventual loss of soil fertility. Conversely, inadequate irrigation can cause land degradation and desertification.

These conditions give rise to numerous environmental challenges in irrigated agricultural zones, such as:

Land salinization and resalinization;

Water and wind erosion;

Soil contamination from excessive mineral fertilizer use;

Desertification due to insufficient irrigation;

Waterlogging of farmland, and more.

Addressing these issues is essential. Without intervention, it will be impossible to enhance the economic efficiency of land use, and environmental degradation will intensify. Drawing from the research of soil scientists and land reclamation experts in the Republic, the following measures are recommended:

Provide each farming enterprise with accurate land and water cadastre data;

Strictly adhere to established irrigation water usage standards;

Integrate livestock farming with crop production in optimal ratios to ensure the availability of organic fertilizers;

Level irrigated lands and maintain proper operation of reclamation systems;

Restore and enhance the productivity of irrigated land through the widespread use of grain-legume rotations;

Systematically implement these recommendations to improve land use practices and address potential ecological threats in the region.

The rational use of land and water resources in irrigated agriculture is a pressing issue not only from

an economic perspective but also in terms of ensuring environmental sustainability. The limited nature of natural resources and the ecological problems arising from their mismanagement highlight the urgent need to implement innovative technologies and improve resource management based on scientific approaches. The proposals and recommendations presented in this article are of great importance for enhancing irrigation systems, increasing agricultural productivity through the efficient use of water and land, and protecting the environment.

Conclusion

The rational use of water and land resources in irrigated agriculture remains a critical challenge with both ecological and economic implications. This study highlights that the degradation of irrigated lands—manifested through salinization, erosion, and declining soil quality—is closely linked to improper irrigation practices, lack of balanced land management, and insufficient application of sustainable agricultural techniques. Despite ongoing efforts by governmental and private stakeholders, national statistics and land evaluations demonstrate a troubling decline in land productivity and quality over recent decades. The findings underscore the urgency of adopting scientifically grounded and ecologically sensitive management strategies. These include improving land and water cadastre systems, maintaining irrigation standards, promoting crop-livestock integration, restoring soil health through crop rotations, and enhancing reclamation infrastructure. A balanced and integrated approach to the management of land and water resources is essential not only for improving agricultural productivity but also for preserving the ecological integrity of irrigated zones. Failure to act on these recommendations may lead to intensified environmental degradation and diminished agricultural output. Therefore, prioritizing sustainable practices and technological innovation in irrigation management is not only an agricultural necessity but a strategic imperative for ensuring long-term food security and environmental stability in regions dependent on irrigated farming.

References

[1] J. Radianti, T. A. Majchrzak, J. Fromm, и I. Wohlgenannt, «A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda», Comput. Educ., т. 147, с. 103778, 2020.

[2] G. Makransky, T. S. Terkildsen, и R. E. Mayer, «Adding immersive virtual reality to a science lab simulation causes more presence but less learning», Learn. Instr., т. 60, сс. 225–236, 2019.

[3] «AR and VR in Education: Enhancing the Learning Experience».

[4] «AR-Assisted Vocabulary Learning in First-Year English Majors», Her. Kokand Univ., 2023, https://herald.kokanduni.uz

[5] «Benefits of Virtual Reality in Education: Tools & Resources».

[6] «Digital Classrooms Project Report», British Council Uzbekistan, 2022.

[7] «Digital Education Strategy 2023–2030», Ministry of Preschool and School Education of the Republic of Uzbekistan, 2023.

[8] Z. Merchant, E. T. Goetz, L. Cifuentes, W. Keeney-Kennicutt, и T. J. Davis, «Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis», Comput. Educ., т. 70, сс. 29–40, 2014.

[9] J. N. Bailenson, Experience on Demand: What Virtual Reality Is, How It Works, and What It Can Do. W.W. Norton & Company, 2018.

[10] «Exploring Immersive Educational Technology: VR, AR, and MR».

[11] «ImmerseMe Learning Platform». https://www.immerseme.co

[12] C. Dede, «Immersive Interfaces for Engagement and Learning», Science, т. 323, вып. 5910, сс. 66–69, 2009.

[13] L. Vygotsky, Mind in Society: The Development of Higher Psychological Processes. Harvard University Press, 1978.

[14] «Mondly VR Official Website». https://www.mondly.com/vr

[15] S. D. Krashen, The Input Hypothesis: Issues and Implications. Longman, 1985.