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ENVIRONMENTAL SAFETY IN THE FERGANA REGION: PROBLEMS, MONITORING, AND MANAGEMENT MECHANISMS

Urinbayeva Dilyora Khamzayevna

Fergana State Technical University, Fergana, Uzbekistan

Abstract

This article analyzes the existing challenges related to ensuring environmental safety in the Fergana region, the current state of environmental monitoring, and the effectiveness of ecological management mechanisms. It examines air, water, and soil pollution in the region, waste management issues, the impact of technogenic processes, and factors associated with climate change. The study also discusses environmental policies implemented to strengthen ecological safety, the introduction of green technologies, digital monitoring systems, and sustainable management strategies aimed at improving regional environmental stability.

Keywords: Environmental safety, monitoring, natural resources, air pollution, water quality, waste management, sustainable development, green technologies, environmental policy.

Introduction

In recent years, the concept of the green economy has gained significant global prominence as countries seek development models that integrate economic growth with environmental protection. Under contemporary conditions, minimizing the negative ecological impacts of economic expansion, ensuring the efficient use of natural resources, and achieving long-term environmental sustainability are considered essential. For Uzbekistan, securing ecological stability, mitigating and adapting to climate change, and diversifying energy sources represent urgent national priorities.



Regular assessment of the ecological situation, rational utilization of natural resources, and the preservation of natural wealth hold crucial importance for the well-being of future generations. Achieving these objectives requires systematic observation and continuous control over environmental processes, which is made possible through the establishment of a comprehensive environmental monitoring system. Environmental monitoring plays a central role in tracking natural changes, assessing pollution levels, and ensuring that decision-makers have reliable data for evaluating ecological risks and managing environmental conditions effectively [1].

The ecological condition of the Fergana region—one of the most densely populated and industrially active territories of Uzbekistan—requires special attention. The region's intensive agricultural activities, high concentration of industrial enterprises, demographic pressure, and transboundary environmental influences highlight the need for improved monitoring mechanisms, effective ecological governance, and sustainable resource management practices. In this context, developing environmentally responsible behaviors, promoting green technologies, and strengthening ecological policy frameworks represent essential directions for achieving regional environmental safety and long-term sustainability.

Literature Review

Approaches to natural resource management and environmental protection are formally embedded in the Constitution of the Republic of Uzbekistan, and governmental environmental activities are supported by national regulatory frameworks. Article 55 of the Constitution stipulates that “land, subsoil, water, flora and fauna, and other natural resources are the national wealth of the people and are protected by the state.” This principle forms the legal foundation of the national environmental policy and establishes the basis for rational resource use and restoration.

Historically, the development of economic sectors heavily depended on natural raw materials; however, ecological laws and principles were often overlooked. With the rapid expansion of industrial production and the widespread application of scientific and technological advancements in agriculture and manufacturing, experts began to recognize the significance of resource distribution, their potential capacity, renewability, self-purification abilities, and sensitivity to ecological pressures. This



shift marked an important transition toward acknowledging the finite nature of natural resources and the need to consider ecological constraints in economic planning [2]. The stability of a national economy is closely linked to its capacity to maintain internal balance despite external influences. A sustainable system preserves the quality, quantity, and functional relationships among its components even under adverse conditions. In other words, an economy is considered stable when it can continue performing its essential functions while simultaneously maintaining ecological balance and adapting to environmental changes [3].

Industrial growth inevitably leads to increased consumption of resources, demonstrating the limited nature of natural reserves. Furthermore, any pattern of resource use results in waste generation, contributing to environmental pollution. Consequently, modern production processes must prioritize not only efficiency but also environmental responsibility, emphasizing resource-saving technologies, recycling practices, and pollution prevention strategies [4].

Globally, agriculture is experiencing significant challenges due to infectious plant diseases, which negatively affect yield levels, food security, and the sustainable development of national economies. In response, states allocate significant financial resources toward disease prevention, control measures, and ecosystem protection. These expenditures include healthcare-related costs as well as investments in environmentally friendly agricultural systems and efficient resource management practices.

It is widely acknowledged that increases in gross national product (GNP) are often accompanied by a rise in waste generation. However, to prevent environmental pollution and safeguard public health, governments allocate financial resources for mitigation and restoration efforts. These expenditures come directly from the national economy but do not always reflect the actual magnitude of environmental degradation. As a result, there is an increasing need for accurate assessment tools and methodologies to calculate environmental costs associated with pollution and degradation [5].

The availability and quality of natural resources determine a country's production capacity. Therefore, the adoption of innovative methods and advanced technologies for rational and efficient resource use is essential for sustainable development. Economic stability relies on the effective utilization of production capacities, ensuring that economic growth does not compromise ecological balance. Achieving this



equilibrium requires a multi-sectoral approach integrating economic planning, ecological regulations, and sustainable innovation practices [4].

Environmental protection activities require substantial investment, forming the foundation of ecological sustainability strategies. The assessment of ecological expenditures is a key step in evaluating the efficiency of environmental management. Studies show that environmental costs can be measured using the United Nations' System of Environmental-Economic Accounting or the World Bank's adjusted net savings methodology. These tools help determine the financial value of environmental degradation and restoration, enabling more effective ecological governance [6].

Methodology

The main objective of this study is to identify environmental problems in the Fergana region, analyze their spatial distribution and severity, and determine approaches for ensuring ecological sustainability. The research covers the period from 2010 to 2024 and is based on statistical data related to pollutant emissions, water and land resources, the use of natural resources, and the functioning of the regional environmental monitoring system.

A comparative analysis was conducted using long-term environmental indicators obtained from regional statistical bulletins, national environmental reports, and official monitoring datasets. Quantitative methods—including trend analysis, regional comparison, and dynamic assessment—were applied to evaluate changes in air pollution levels, water resource conditions, soil quality, and waste generation across districts of the Fergana region. In addition, the study integrates qualitative assessment of environmental policies and management mechanisms implemented at the regional level.

Results and Discussion

Air pollution remains one of the most pressing environmental challenges facing the Fergana region today. Pollutant emissions adversely affect air quality, posing risks to human health, ecosystems, and long-term economic development. Therefore, continuous monitoring and analysis of pollutant concentrations across districts are essential for ensuring regional environmental stability and for developing timely mitigation strategies.



The table below presents the dynamics of atmospheric pollutant emissions in the Fergana region and its districts for the period 2014–2024. Such long-term data make it possible to monitor emission trends, assess environmental risks, and identify spatial differences in pollution levels across the region. These findings are crucial for determining priority areas for ecological intervention and for improving air quality management systems.

Table 1. Emissions of Air Pollutants into the Atmosphere, thousand tons (2014–2024)

Districts / Cities	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Fergana Region	38.4	38.9	103.2	60.1	53.2	49.6	50.5	46.5	49.0	26.4	26.2
Fergana City	26.4	25.5	81.8	39.8	34.4	33.6	33.1	33.8	39.1	19.3	18.9
Kokand City	1.5	1.6	1.3	1.2	1.4	1.1	0.9	0.7	0.6	1.1	1.2
Quvasoy City	6.9	7.8	15.6	9.1	10.0	10.5	11.9	9.4	6.2	4.1	3.2
Margilan City	0.0	0.1	0.0	0.3	0.8	0.1	0.6	0.1	0.2	0.2	0.1
Oltiariq	1.4	1.5	1.3	2.8	1.5	1.6	1.3	1.0	0.5	0.4	0.3
Koshtepa	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.0	0.1	0.1	0.1
Baghdad	0.1	0.1	0.1	0.3	0.3	0.1	0.1	0.0	0.0	0.0	0.0
Buvayda	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
Beshariq	0.1	0.1	0.1	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1
Quva	0.3	0.2	0.2	0.9	0.7	0.3	0.3	0.2	0.1	0.2	0.1
Uchkurgan	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1
Rishton	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Sokh	0.0	0.0	–	–	–	0.0	0.0	0.0	0.0	0.0	0.0
Toshloq	0.1	0.2	0.4	0.9	0.7	0.5	0.6	0.4	0.4	0.2	0.5
Uzbekistan District	0.6	0.7	1.2	2.2	1.7	0.5	0.5	0.5	0.5	0.2	0.1
Fergana District	0.2	0.1	0.3	1.0	0.4	0.3	0.5	0.1	0.1	0.1	1.0
Dangara	0.2	0.5	0.5	0.6	0.3	0.3	0.2	0.1	0.1	0.1	0.1
Furqat	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.5	0.0	0.0
Yazyavan	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.3

Results and Discussion

The data presented in Table 1 indicate that emissions of air pollutants in the Fergana region were relatively low in 2014–2015, amounting to approximately 38–39 thousand tons. In subsequent years, the overall emission levels gradually decreased, reaching 26.2 thousand tons by 2024. This downward trend suggests the positive impact of sectoral reforms, improvements in industrial process management, and the introduction of environmental control measures.

Significant differences were observed across districts of the region. The highest levels of air pollution were recorded in Fergana City and Quvasoy City, where large



industrial enterprises remain the primary sources of emissions. In particular, Fergana City experienced an exceptionally high pollution level in 2016, reaching 81.8 thousand tons, which accounted for nearly 79% of the region's total emissions for that year. Similarly, Quvasoy City reached 15.6 thousand tons of emissions in 2016, largely driven by the activities of cement, mining, and construction-material plants. However, the emissions in Quvasoy have steadily declined over the 2014–2024 period, falling to 3.2 thousand tons in 2024. This reduction reflects improvements in industrial filtration systems, enhanced ecological monitoring, and pollution-control measures implemented in local enterprises.

In other districts—such as Kokand, Margilan, Oltiariq, Dangara, and Beshariq—pollution levels remained generally low and stable throughout the period, typically within the range of 0.1–1.5 thousand tons. The lower emissions in these areas can be explained by the smaller number of industrial enterprises and comparatively higher environmental oversight.

Overall, the study reveals that environmental challenges in the Fergana region—particularly air pollution, inefficient water resource use, soil salinization, and deforestation—continue to hinder the region's ecological sustainability. The findings emphasize that ensuring environmental improvement and rational use of natural resources requires an integrated approach comprising enhanced environmental monitoring, economic mechanisms, and legal measures [6].

Conclusion and Recommendations

Ensuring environmental sustainability in the Fergana region requires a comprehensive and coordinated set of actions. Strengthening the regulatory and legal framework, improving environmental information systems, enhancing forecasting capacities, and modernizing state cadastral services are crucial steps in this direction. In addition, establishing strict control over industrial emissions and increasing the professional competence of specialists involved in environmental management are essential.

The economic valuation of natural resources, the support of investment projects, and the active involvement of the private sector can facilitate the integration of ecological and economic interests. Furthermore, promoting national priority projects related to clean technologies, resource efficiency, and environmental protection will contribute to the development of a balanced regional policy.



The implementation of these measures will support sustainable economic development, preserve environmental quality, and create ecologically safe conditions for future generations. The study also concludes that there is significant potential for expanding green economy principles in the region by enhancing the effectiveness of environmental policy and introducing international environmental standards and technologies. Such efforts will strengthen ecological safety and promote long-term environmental stability in the Fergana region.

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