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POLLUTION OF THE HYDROSPHERE AND LITHOSPHERE AND WAYS TO REDUCE ITS CONSEQUENCES

***Abstract.** On May 24, 2024, the Information and Resource Center for Hazardous Chemicals and Waste began operating in Uzbekistan under the Specialized Analytical Control Center of the Ministry of Ecology, Environmental Protection, and Climate Change. The primary objective of the center is to monitor the implementation of international environmental chemical conventions, raise public awareness, and strengthen the country's institutional capacity in chemical safety management. Through the center and the *ecochem.uz* platform, users can access information on the Basel, Rotterdam, and Stockholm conventions, as well as short online courses and scientific materials. This article examines the major sources of chemical pollution, including industrial emissions, pesticides, and consumer products, and analyzes their impact on water and soil ecosystems. Particular attention is given to pesticide toxicity and its potential effects on environmental and human health. Furthermore, the study highlights sustainable management strategies and preventive measures aimed at reducing chemical contamination and protecting ecological systems.*

***Key words:** hazardous chemicals, environmental pollution, pesticides, chemical contamination, water ecosystems, toxicity, ecological risk, biodiversity, sustainable environmental management.*

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ЗАГРЯЗНЕНИЕ ГИДРОСФЕРЫ И ЛИТОСФЕРЫ И ПУТИ СНИЖЕНИЯ ЕГО ПОСЛЕДСТВИЙ

Аннотация. 24 мая 2024 года в Узбекистане начал функционировать Информационно-ресурсный центр по работе с опасными химическими веществами и отходами при Специализированном аналитическом контрольном центре Министерства экологии, охраны окружающей среды и изменения климата. Основной целью центра является мониторинг выполнения международных экологических химических конвенций, повышение уровня общественной осведомлённости и укрепление институционального потенциала страны в области управления химической безопасностью. Через центр и платформу ecochem.uz пользователи могут получить доступ к информации о Базельской, Роттердамской и Стокгольмской конвенциях, а также к кратким онлайн-курсам и научным материалам. В данной статье рассматриваются основные источники химического загрязнения, включая промышленные выбросы, пестициды и потребительские товары, а также анализируется их влияние на водные и почвенные экосистемы. Особое внимание уделено токсичности пестицидов и их потенциальному воздействию на окружающую среду и здоровье человека. Кроме того, в работе представлены устойчивые стратегии управления и профилактические меры, направленные на снижение химического загрязнения и защиту экологических систем.

Ключевые слова: опасные химические вещества, экологическое загрязнение, пестициды, химическая контаминация, водные экосистемы, токсичность, экологический риск, биоразнообразие, устойчивое экологическое управление.

Introduction. Chemical pollution is one of the most pressing environmental challenges facing modern society. Rapid population growth, industrial expansion, energy production, and intensive agricultural practices have significantly increased the pressure on natural resources, particularly water and soil. These processes contribute to environmental degradation, which negatively affects food security, public health, biodiversity, and economic development. On May 24, 2024,

Uzbekistan launched the Information and Resource Center for Hazardous Chemicals and Waste within the Specialized Analytical Control Center under the Ministry of Ecology, Environmental Protection, and Climate Change. The center aims to enhance the implementation of international environmental conventions related to chemical safety and hazardous waste management. Its activities are designed to improve the awareness of government institutions, businesses, and the general public regarding the obligations and mechanisms associated with international environmental agreements. The center collects, organizes, and disseminates information related to the management of hazardous chemicals and waste. Additionally, it contributes to strengthening the institutional capacity of Uzbekistan in the field of chemical safety and environmental protection. To facilitate interaction with users, the online platform ecochem.uz was launched. The platform provides educational resources and short online courses covering the fundamental principles of three major international chemical conventions: the Basel Convention, the Rotterdam Convention, and the Stockholm Convention. The establishment of the Information and Resource Center was supported through a collaborative project involving the Ministry of Ecology, Environmental Protection and Climate Change, the United Nations Environment Programme (UNEP), and the organization Health and Environment Justice Support e.V. (Germany). The project aims to strengthen Uzbekistan's institutional capacity in implementing the Basel and Stockholm conventions and the Globally Harmonized System (GHS), while also supporting the country's accession to the Rotterdam and Minamata conventions [1].

In the broader context, chemical pollution has become a global environmental issue. Industrial activities, agricultural chemicals, and everyday consumer products release numerous synthetic compounds into the environment. These substances can accumulate in ecosystems and enter food chains, posing significant risks to human health and biodiversity [2].

Recent studies estimate that approximately 350,000 chemical substances are currently registered for production and use worldwide. Many of these substances enter environmental compartments such as air, water, soil, and living organisms. Since the mid-20th century, the global production of synthetic organic chemicals has increased dramatically—from about 5 million tons per year in 1950 to approximately 400–500 million tons annually today [3].

Research Methodology. This study is based on a comprehensive analysis of global and national data related to chemical pollution, pesticide usage, and international environmental conventions. Several research approaches were employed, including quantitative analysis, ecological monitoring and assessment, regulatory and policy analysis, and comparative analytical methods [4].

The research integrates concepts from chemistry, environmental science, toxicology, water resource management, and environmental governance. Scientific literature, international environmental reports, and regulatory frameworks were analyzed to identify key trends and risks associated with chemical pollution. Additionally, methodological tools used in environmental monitoring—such as chemical analysis and ecological risk assessment—were reviewed to evaluate environmental impacts [5].

Toxicity Assessment and Environmental Risk Evaluation. The regulatory approval process for pesticides involves evaluating their potential environmental concentrations under conditions consistent with good agricultural practices [6]. These exposure assessments estimate the concentrations that may occur in different environmental compartments such as surface water and soil. Because new chemical substances may not yet be present in the environment prior to authorization, predictive models are typically used to estimate their potential distribution [7].

Risk assessment also requires determining the concentration levels at which harmful biological effects occur. Laboratory and field experiments are conducted on various biological groups, including aquatic plants, invertebrates, fish,

terrestrial plants, insects, birds, and mammals. These experiments identify the threshold levels at which ecological effects begin to occur [8-10].

To account for uncertainties in experimental data, safety or assessment factors are applied to determine regulatory threshold concentrations below which harmful ecological effects are unlikely to occur. Ultimately, environmental risk assessment is based on a comparison between predicted environmental concentrations and these threshold values. If expected environmental concentrations exceed safe limits, regulatory approval for the substance may be denied [11].

Sources of Chemical Pollution. Industrial activities represent one of the primary sources of chemical contamination. Industries such as metallurgy, petrochemicals, pharmaceuticals, and manufacturing release hazardous substances including heavy metals such as lead, cadmium, and mercury, as well as organic solvents and acidic waste [12].

In addition to industrial sources, numerous chemicals are found in everyday consumer products. These include food packaging materials, textiles, cosmetics, and personal care products. Chemical compounds released from these materials can enter the environment and, in some cases, accumulate in human tissues [13].

Among the most significant environmental pollutants are pesticides, which are widely used in modern agriculture. While pesticides play an important role in crop protection, they are biologically active substances designed to affect living organisms. Consequently, their widespread use may result in unintended impacts on non-target species, including aquatic organisms, birds, insects, and mammals.

Pesticides are typically classified according to their target organisms. Insecticides are used to control insect populations, herbicides eliminate unwanted plants, and fungicides prevent fungal diseases. Although these substances are essential for maintaining agricultural productivity, their misuse or excessive application can lead to ecological imbalances and environmental contamination.

Degradation of Water Ecosystems. Water ecosystem degradation is a critical environmental issue in Uzbekistan and Central Asia. One of the most significant examples is the environmental crisis associated with the Aral Sea. During the Soviet period, large volumes of water from the Amu Darya and Syr Darya rivers were diverted for irrigation purposes. As a result, the Aral Sea experienced a dramatic reduction in its size and water volume.

Agricultural runoff containing fertilizers and pesticides has further contributed to the pollution of water bodies in the region. These processes have led to the loss of biodiversity and the decline of ecosystem stability, particularly within the Aral Sea basin.

Uzbekistan's arid climate further complicates water resource management. Limited water availability, combined with inefficient irrigation systems, increases pressure on aquatic ecosystems. Therefore, effective water management strategies are essential for ensuring sustainable development and environmental protection.

Sustainable Solutions and Preventive Measures. Several strategies can be implemented to reduce the degradation of water ecosystems and mitigate chemical pollution. One important approach is the modernization of irrigation systems through the adoption of water-efficient technologies such as drip irrigation and improved canal infrastructure.

Improved water resource planning and monitoring systems are also essential for maintaining ecological balance in rivers and lakes. Reducing chemical contamination requires more effective regulation of agricultural fertilizers and pesticides, as well as improved waste management and recycling systems.

Ecological restoration initiatives can play a significant role in environmental recovery. These initiatives may include restoring wetlands, reintroducing aquatic vegetation, and developing green infrastructure that enhances ecosystem resilience.

Strengthening environmental legislation and regulatory frameworks is another key component of sustainable environmental governance. Establishing

ecological protection zones around water bodies and limiting harmful industrial and agricultural activities can help prevent further degradation.

International cooperation is particularly important when managing transboundary water resources. Collaborative agreements between neighboring countries are necessary to ensure sustainable water use and equitable resource distribution.

Finally, scientific research and technological innovation are essential for developing new approaches to environmental monitoring, pollution control, and ecosystem restoration.

Impacts on Human Health. The degradation and contamination of water ecosystems can have serious consequences for human health. Polluted water sources may contain hazardous chemicals, heavy metals, pesticides, and pathogenic microorganisms that can enter the human body through drinking water or food consumption.

Exposure to contaminated water may cause gastrointestinal disorders, skin diseases, and chronic health conditions such as kidney and liver damage. Furthermore, toxic substances can accumulate in crops grown in contaminated soils, entering the food chain and posing long-term health risks.

Environmental degradation may also increase the prevalence of vector-borne diseases. For example, the loss of natural wetlands and ecosystem imbalance can create favorable conditions for mosquito populations, potentially increasing the risk of diseases such as malaria.

Scientific studies have also linked exposure to certain chemical contaminants with cancer, endocrine system disorders, and neurological damage. These risks highlight the importance of monitoring environmental pollution and implementing preventive measures.

Environmental Monitoring and Treatment Technologies. Environmental monitoring relies on a range of physical and chemical analytical techniques. Key indicators include pH levels, electrical conductivity, and oxidation-reduction

potential. Advanced laboratory methods such as spectrometry are used to detect heavy metals, while chromatographic techniques help identify organic pollutants.

Several treatment technologies are available for removing contaminants from water systems. These include membrane filtration, adsorption using activated carbon or zeolites, biological treatment processes, and photocatalytic oxidation methods. Among these technologies, integrated treatment systems combining multiple processes often provide the most effective results.

Conclusion. Chemical pollution and the degradation of water and soil ecosystems represent major environmental challenges for Uzbekistan. The establishment of the Information and Resource Center for Hazardous Chemicals and Waste is an important step toward improving chemical management, strengthening environmental monitoring, and increasing public awareness.

Addressing these challenges requires a comprehensive and integrated approach. Sustainable solutions include the modernization of irrigation systems, improved waste management practices, ecological restoration projects, stronger regulatory frameworks, and enhanced international cooperation.

Since chemical pollution has ecological, economic, and social dimensions, effective management must involve coordinated efforts across multiple sectors. The adoption of sustainable technologies, improved chemical management systems, enhanced environmental monitoring, and increased environmental literacy among the population can significantly reduce pollution levels and contribute to long-term environmental sustainability.

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