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DIGITAL TECHNOLOGIES AND ENVIRONMENTAL MONITORING: THE NEED FOR LEGAL REGULATION

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Abstract: The integration of digital technologies such as remote sensing, geographic information systems (GIS), drones, and real-time data platforms has significantly enhanced environmental monitoring capabilities worldwide. However, the rapid expansion of these technologies has outpaced the development of adequate legal frameworks to regulate their use, ensure data integrity, and protect privacy. This article explores the benefits and risks associated with digital environmental monitoring and examines the need for robust legal regulation to guide responsible and effective implementation. The paper provides a comparative overview of international practices and outlines key recommendations for national legislators.

Keywords: Environmental monitoring, digital technology, legal regulation, GIS, drones, data protection, environmental law, smart governance.

Digital technologies are revolutionizing how governments, scientists, and citizens monitor and respond to environmental changes. Tools such as satellite imaging, automated air and water sensors, artificial intelligence (AI)-driven analytics, and citizen science platforms have made environmental data more accessible, timely, and actionable. These tools are critical for tracking climate change, pollution, deforestation, water scarcity, and biodiversity loss.

However, the legal regulation of digital environmental monitoring remains underdeveloped in many countries. Challenges include data ownership, privacy, liability, standardization, and the admissibility of digital data in legal and regulatory processes. Without a comprehensive legal framework, the potential of digital tools may be undermined by ethical, legal, and operational uncertainties. This article addresses the urgent need for legal regulation in the deployment and use of digital environmental technologies.

This study uses a combination of:

- **Doctrinal legal analysis**: Review of existing national and international legal instruments related to environmental monitoring and digital data;
- **Comparative study**: Evaluation of legal approaches in countries such as the European Union, the United States, China, and Uzbekistan;
- **Case analysis**: Assessment of recent environmental incidents where digital technologies played a role in monitoring or litigation;
- **Policy review**: Examination of government strategies, environmental reports, and regulatory guidelines on environmental digitalization.

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Digital tools have improved environmental oversight by providing faster, more accurate, and broader data collection capabilities. Satellite-based remote sensing helps detect illegal logging and land use changes. Drones are used to monitor emissions from industrial facilities. AI and machine learning allow for predictive environmental modeling, while open data platforms enable transparency and public participation.

Despite these advancements, the lack of clear legal regulation has created several problems. In many jurisdictions, environmental data collected through digital means is not always recognized in court due to authenticity concerns or unclear chain-of-custody procedures. Privacy regulations often lag behind technology, especially regarding drone surveillance or sensor networks operating in residential areas.

There is also a gap in defining the responsibility for data accuracy, maintenance, and security. If flawed digital data leads to erroneous environmental assessments or regulatory decisions, it is often unclear who is legally liable—technology providers, state agencies, or data users. Moreover, developing countries face challenges in accessing high-quality environmental data due to technological or legal barriers.

At the international level, frameworks such as the **Aarhus Convention** promote access to environmental information, but do not yet fully address the complexities of digital monitoring. The **European Union's General Data Protection Regulation (GDPR)** provides safeguards for personal data but requires adaptation when applied to environmental technologies that collect both personal and environmental data.

There is an urgent need to establish a comprehensive legal framework that supports innovation in environmental monitoring while protecting legal and ethical rights. This includes:

- Defining the legal status and admissibility of data collected through digital technologies in court and administrative proceedings;
- Creating standards for data quality, interoperability, and security across digital platforms;
- Addressing data ownership and intellectual property rights of environmental data;
- Developing privacy regulations that are tailored to digital environmental surveillance, including drone and sensor usage;
- Establishing accountability mechanisms in case of data misuse, falsification, or system failures.

Countries such as Estonia, Germany, and South Korea have begun integrating legal and technological strategies, using **"digital-by-default"** principles in environmental governance. These include real-time pollution dashboards, AI-enabled regulatory compliance monitoring, and blockchain-based environmental data storage.

For countries like Uzbekistan, which are actively modernizing their environmental governance, it is critical to adopt laws that regulate the acquisition, use, and protection of digital environmental data. This would not only improve regulatory enforcement but also promote transparency, public trust, and international cooperation.

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Digital technologies present a transformative opportunity for environmental monitoring and management. However, their effectiveness depends on a strong legal foundation that ensures reliability, accountability, and respect for rights. Without such regulation, the use of digital tools may be challenged in courts or misused in practice, ultimately undermining environmental protection goals.

- Enact national legislation defining standards for digital environmental data collection, sharing, and use;
- Align environmental monitoring policies with international data protection and access-to-information frameworks;
- Develop certification and licensing systems for environmental technology providers;
- Promote inter-agency and cross-border cooperation on digital environmental governance;
- Train legal professionals, regulators, and technology developers on digital environmental law and ethics.

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