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ANALYSIS OF THE MAIN DIRECTIONS OF DIGITALIZATION AND SUPPORT OF WATER CONSUMPTION MANAGEMENT IN ECONOMIC SECTORS

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Abstract

This study analyzes the main directions of digitalization of water consumption management in economic sectors and the support provided by the public and private sectors. It highlights the role of information and communication technologies, digital monitoring systems, smart meters, databases, and analytical platforms in ensuring efficient use of water resources. In addition, the organizational and economic mechanisms for implementing digital management, institutional support measures, and their importance in increasing water efficiency across economic sectors are substantiated.

Keywords

water consumption management, digitalization, economic sectors, smart water systems, digital monitoring, water resource efficiency, information technologies, water accounting, organizational and economic mechanisms, government support.

Water resources are considered one of the most important natural resources for the economy of any region. In areas with intensive agricultural and industrial activities, such as the Andijan region, effective management of water consumption plays a crucial role not only in ensuring economic stability but also in maintaining environmental security. Under modern conditions, water resource management is carried out not only through traditional methods but also through digital technologies and management approaches[1]. Therefore, identifying the main directions for the digitalization of water consumption management in the economic sectors of the Andijan region and implementing them systematically is of significant importance.

Table 1. Main directions of digitalization of water consumption in economic sectors of the Andijan region and management opportunities

Main direction	Description	Importance for management	Adaptation to the Andijan region
Digital monitoring and real-time observation	Real-time monitoring of canals, pumping stations, and reservoirs using IoT sensors and digital devices	Continuous control of water flow and volume, reduction of losses, rapid decision-making	Installation of sensors on water canals and pumping stations across all districts of Andijan, real-time monitoring via a centralized system
Centralized management systems	Management of water distribution and consumption across economic sectors through a unified	Accelerating decision-making processes, optimizing interregional distribution, setting	Integration of farmers and enterprise water users in Andijan into a single platform, coordination of inter-

[1] Sriyono, E. (2020). Suv resurslarini boshqarishni raqamlashtirish: Barqarorlikni hal qilish uchun blokcheyn texnologiyalaridan innovatsion foydalanish sari. Cogent Engineering , 7 (1). https://doi.org/10.1080/23311916.2020.1769366

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	platform	priorities	district water resources
Data analysis and forecasting	Analysis of water consumption and demand, and development of forecasts using artificial intelligence and digital platforms	Data-driven management decisions, resource saving, increased economic efficiency	Forecasting water demand in economic sectors (agriculture, industry) of Andijan, planning seasonal distribution
Supporting technologies and services	Mobile and web applications, digital reporting, incentive and restriction systems	Advising farmers and enterprises, monitoring and regulating water consumption	Providing information on water distribution to farmers and entrepreneurs in Andijan via mobile apps, SMS, and Telegram

This table illustrates the main directions of digitalizing water consumption management in the economic sectors of the Andijan region. It presents the description of each direction, its importance for management, and its regional adaptation. The table enables a systematic presentation of key directions for decision-making, resource optimization, and efficiency improvement from a management perspective[2]. Using the Andijan region as an example, these directions are practically adapted to the regional water resource management system.

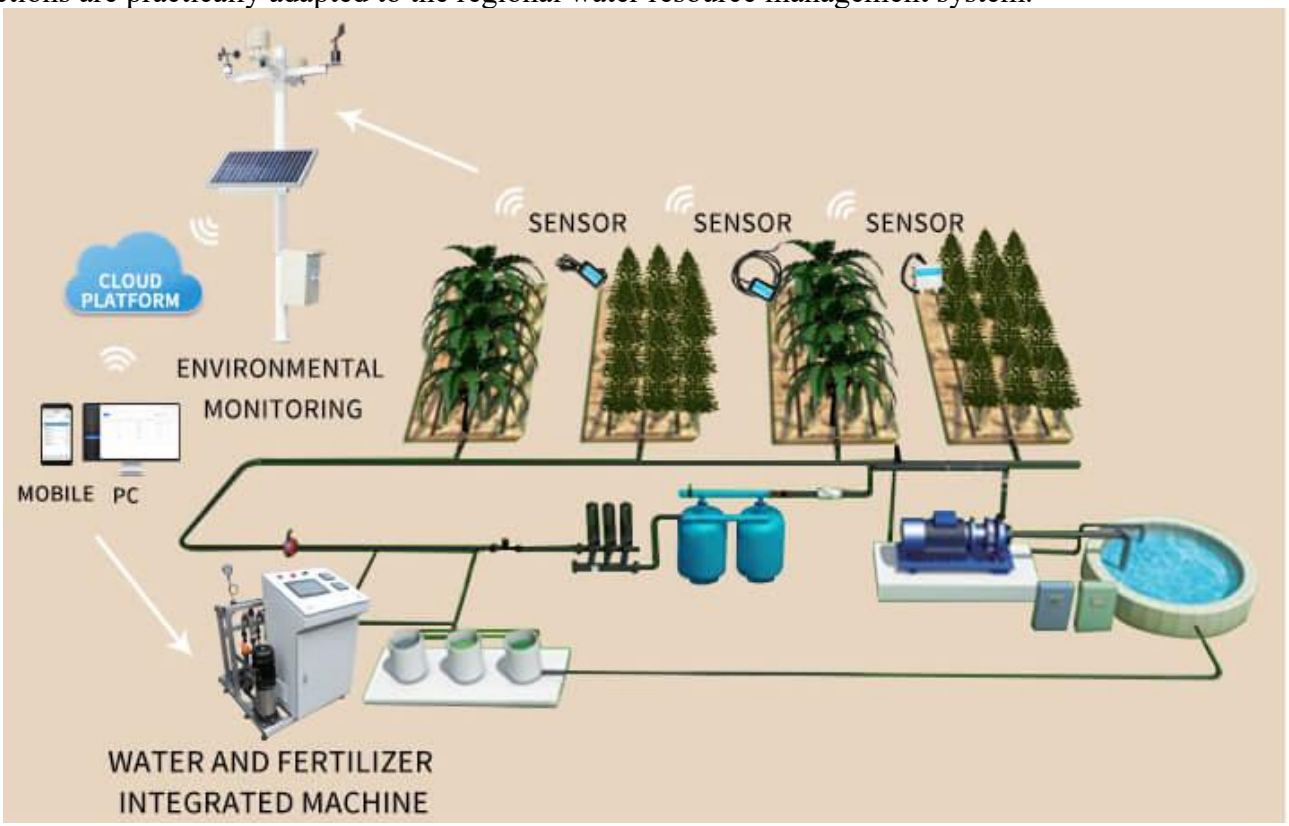


Figure 1. Automated irrigation and monitoring system based on a cloud platform.

[2] SWAMP Project, Yevropa Ittifoqi (swamp-project.org). https://www.swamp-project.org/architecture

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In recent years, problems such as water scarcity, losses, and unfair distribution have intensified in many regions. Therefore, the need for efficient water resource management systems is increasing. Monitoring, control, and analysis of water consumption using digital technologies are significantly more effective than traditional methods[3]. In the Andijan region, this issue is particularly important for agriculture, industry, and urban infrastructure, as the region has an extensive canal network and complex water distribution. To address these problems, a number of decrees and resolutions have been adopted by the national leadership. In particular, the Decree of the President of the Republic of Uzbekistan "On measures to further accelerate the process of digitalization in the water sector and ensure sustainable development" sets key objectives such as ensuring full accounting of water resources used nationwide, digitalizing more than 400 datasets, electronically forming data on over 600,000 water consumers, 4.3 million hectares of irrigated land, and water used for irrigation, reducing the human factor in water accounting, creating databases on water use by users and economic sectors, ensuring sustainable development of the water sector, and widely introducing innovative and advanced technologies.



Figure 2. Main advantages of smart water management based on IoT technologies.

To further accelerate digitalization in the water sector, it is proposed to establish a Water Sector Digitalization and Monitoring Center as a state institution based on the Central Dispatching and Water Balance Service within the water management structure. From a management perspective, the main benefits of digital management include real-time monitoring of resources, faster decision-making processes, and enhanced control[4]. This, in turn, enables water savings, increased production efficiency, and higher economic returns.

[3] Carlos Parra-López, Saker Ben Abdallah, Guillermo Garcia-Garcia, Abdo Hassoun, Hana Trollman, Sandeep Jagtap, Sumit Gupta, Abderrahmane Aït-Kaddour, Sureerat Makmuang, Carmen Carmona-Torres, Digital technologies for water use and management in agriculture: Recent applications and future outlook, Agricultural Water Management, Volume 309, 2025, 109347,

[4] Article: Analysis of Regional Water and Energy Consumption Considering Economic Development Authors: by Jing Liu,Nimin Xie andZhongbo Yu Link: https://www.mdpi.com/2073-4441/13/24/3582

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Blockchain-based water management ensures data immutability, speed, and simplicity, allowing stakeholders to become part of a continuous process rather than relying on post-analysis and audits. New designs of certain distributed ledger layers can provide robust yet lightweight frameworks with centralized features, such as easy interoperability across systems, reliable data isolation for industrial-grade security, and flexible replication across authorized centers.

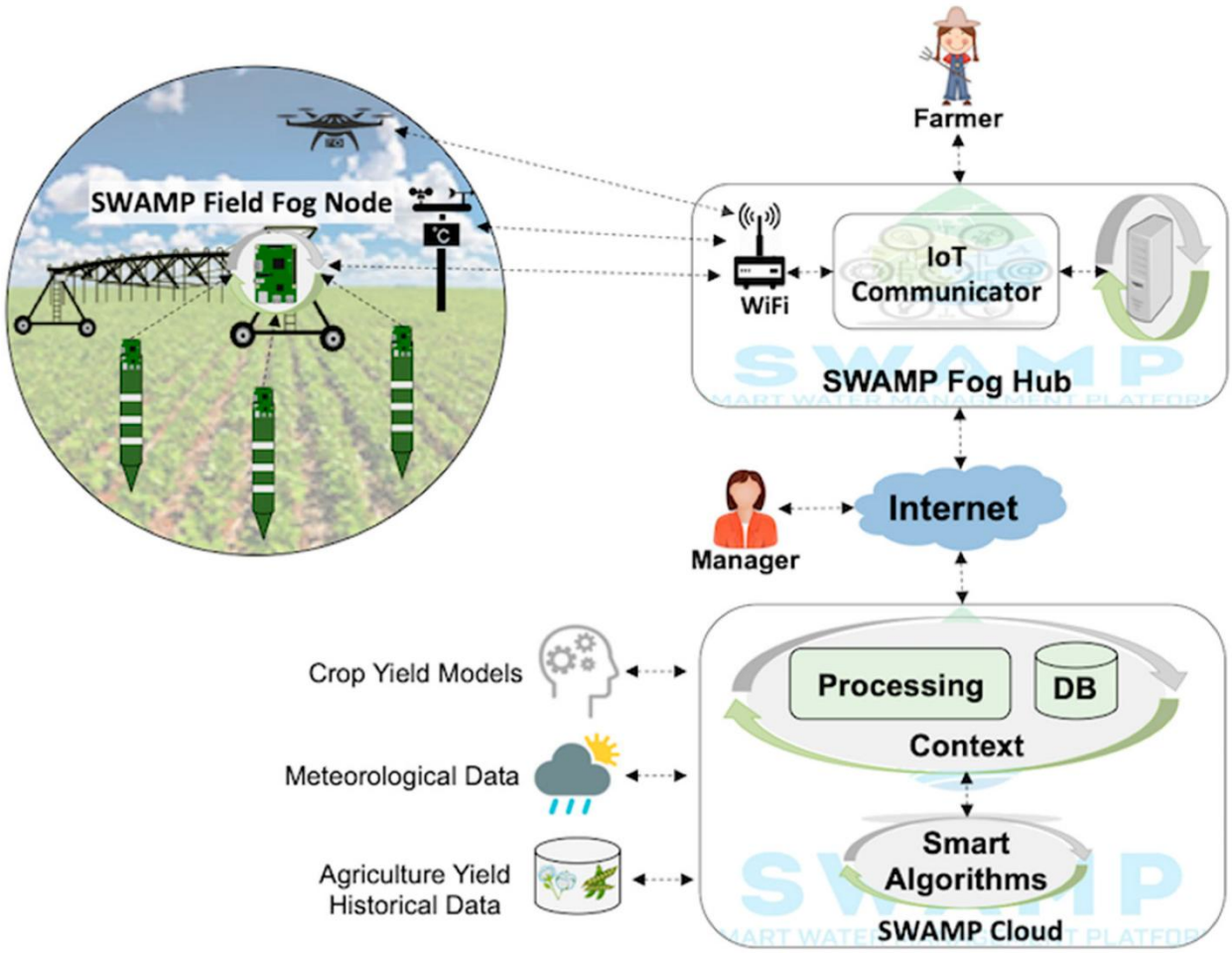


Figure 3. Smart water management architecture based on IoT, Fog, and Cloud technologies in agriculture (SWAMP platform).

Digital devices installed in canals, pumping stations, and irrigation systems of the Andijan region enable real-time monitoring of water flow, pressure, quality, and level. These technologies allow increasing the efficiency of water distribution across the region and automating irrigation processes[5]. From a management perspective, such systems provide leaders with accurate data for decision-making.

Through centralized management platforms, water distribution across all economic sectors of the Andijan region is monitored[6]. These systems help identify where and in which sector

[5] https://blog.se.com/industry/water-and-wastewater/2024/05/29/smart-water-management-strategies-for-high-consumption-industries/

[6] Ochilov Ilhom Saitqulovich, Turgunbayev Utkir Begimovich, Yashil Iqtisodiyot va Taraqqiyot jurnali; “Raqamli iqtisodiyot sharoitida suv resurslaridan samarali foydalanish yo’llari” 2024-yil, dekabr,. 12-son.

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water shortages or excessive consumption occur. For management, these platforms enable optimal resource allocation and prioritization.



Figure 4. Innovative water technologies in agriculture.

Using digital platforms and artificial intelligence, water consumption forecasts are developed. This approach is crucial for identifying water needs in different areas of the region, optimizing water distribution among economic sectors, and eliminating unfair allocation. In management processes, these tools accelerate decision-making and reduce errors[7].

The Andijan region has extensive agricultural areas, and irrigation systems require efficient water use. Digital management helps optimize irrigation regimes, monitor water consumption, and increase productivity[8]. From a management perspective, digital platforms enable real-time advisory services for farmers, water conservation, and improved production efficiency.

[7] Carlos Parra-López, Saker Ben Abdallah, Guillermo Garcia-Garcia, Abdo Hassoun, Hana Trollman, Sandeep Jagtap, Sumit Gupta, Abderrahmane Aït-Kaddour, Sureerat Makmuang, Carmen Carmona-Torres, Digital technologies for water use and management in agriculture: Recent applications and future outlook, Agricultural Water Management, Volume 309, 2025, 109347,

[8] Ingrao, C., Strippoli, R., Lagioia, G., Huisingh, D., 2023. Water scarcity in agriculture: an overview of causes, impacts and approaches for reducing the risks. Heliyon. https:// doi.org/10.1016/j.heliyon.

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Figure 5. Smart agriculture and digital irrigation system.

In industrial enterprises, water consumption is controlled through digital monitoring, preventing excessive use and ensuring compliance with environmental requirements. The management approach enables decisions focused on water conservation and cost reduction.

In urban drinking water supply, sewerage, and drainage systems, digital monitoring and automated control systems are applied. This not only optimizes water consumption but also ensures high-quality water supply and sustainable services for the urban population[9]. From a management perspective, these systems support efficient resource planning and error reduction.

Mobile and web applications: Provide farmers and enterprises with irrigation schedules, advice on water use, and reports.

Databases and analytical platforms: Enable centralized monitoring of water resources across the region.

Incentive and restriction systems: Regulate water consumption based on established limits, allowing fair resource distribution from a management standpoint.

International experience demonstrates the effectiveness of digital management systems. For example, smart irrigation systems and the use of IoT and AI ensure efficient water resource management. These innovative solutions can also be implemented in the Andijan region, contributing to sustainable regional economic development. From a management perspective, these trends provide leaders with digital decision-making tools.

Regional characteristics of the Andijan region (canal networks, pumping stations, farmers, and industrial enterprises) must be considered when implementing digital management systems. Integration with regional strategies enables effective water resource management and increased

[9] Pixley, K.V., Cairns, J.E., Lopez-Ridaura, S., Ojiewo, C.O., Dawud, M.A., Drabo, I., Mindaye, T., Nebie, B., Asea, G., Das, B., Daudi, H., Desmae, H., Batieno, B.J.,Boukar, O., Mukankusi, C.T.M., Nkalubo, S.T., Hearne, S.J., Dhugga, K.S.,Gandhi, H., Snapp, S., Zepeda-Villarreal, E.A., 2023. Redesigning crop varieties towin the race between climate change and food security. Mol. Plant 16, 1590–1611.https://doi.org/10.1016/j.molp.2023.09.003.

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economic efficiency. This approach supports water conservation, productivity growth, and fair resource distribution in the region.

Digital technologies and management tools are essential for effective water consumption management across economic sectors. Implementing these technologies in the Andijan region, considering regional conditions and management approaches, ensures efficient use of water resources, economic benefits, and environmental sustainability[10]. At the same time, providing accurate real-time data to leaders and managers optimizes decision-making processes and promotes fair resource allocation. Digital management can serve as a key tool for the long-term sustainable management of water resources in the Andijan region.

To reliably supply economic sectors, including agriculture, with water and improve the reclamation status of lands, a unique water management system has been established nationwide. The system includes 28.4 thousand km of irrigation networks with 54,432 hydraulic structures, as well as 70 reservoirs and flood-control reservoirs with a total capacity of 19.4 billion cubic meters. Due to uneven distribution of water resources and complex relief of irrigated lands, nearly 60% of irrigated areas receive water through 1,687 pumping stations, whose annual electricity consumption amounts to 8 billion kWh. In addition, water user associations, farms, and clusters operate a total of 155.2 thousand km of irrigation networks and more than 10,280 pumping units. For irrigation needs, a total of 12.4 thousand wells are used, including 4,153 wells within the water management system. To improve the reclamation status of irrigated lands, a drainage system with a total length of 142.9 thousand km is in operation, including 106.2 thousand km of open and 36.7 thousand km of closed horizontal collector-drainage networks, as well as 172 reclamation pumping stations and 3,897 vertical drainage wells. It should be emphasized that international experience is of great importance in matters related to the digitalization of water management.

An overview is provided of the main strategies for improving water use and management in agriculture, highlighting their advantages and applicability to various water-related challenges. Identified strategies, associated techniques and practices, and their main benefits are briefly presented in Table 1.

Water scarcity is a major and increasingly growing problem arising from imbalances between freshwater demand and availability in specific regions and periods. In agriculture, this scarcity poses a serious threat to food security due to population growth and competition for water with non-agricultural users.

Agriculture must adapt to climate change and mitigate its impacts. Accordingly, ensuring adaptation and mitigation is a key objective of agricultural strategies.

Since 1991, research on selected digital technologies for agricultural water use and management has increased significantly. Digital technologies lead in the number of publications, reflecting their critical role in resource monitoring. Notably, artificial intelligence has experienced rapid growth, especially since 2019, indicating its increasing importance in decision-making processes. In addition, in line with the transition to data-driven agricultural practices, the Internet of Things and big data have also developed rapidly. Although the number of publications on robotics, smart sensors, and blockchain is relatively lower, their steady growth indicates their role in agriculture.

[10] Carlos Parra-López, Saker Ben Abdallah, Guillermo Garcia-Garcia, Abdo Hassoun, Hana Trollman, Sandeep Jagtap, Sumit Gupta, Abderrahmane Aït-Kaddour, Sureerat Makmuang, Carmen Carmona-Torres, Digital technologies for water use and management in agriculture: Recent applications and future outlook, Agricultural Water Management, Volume 309, 2025, 109347, ISSN 0378-3774, https://doi.org/10.1016/j.agwat.2025.109347.

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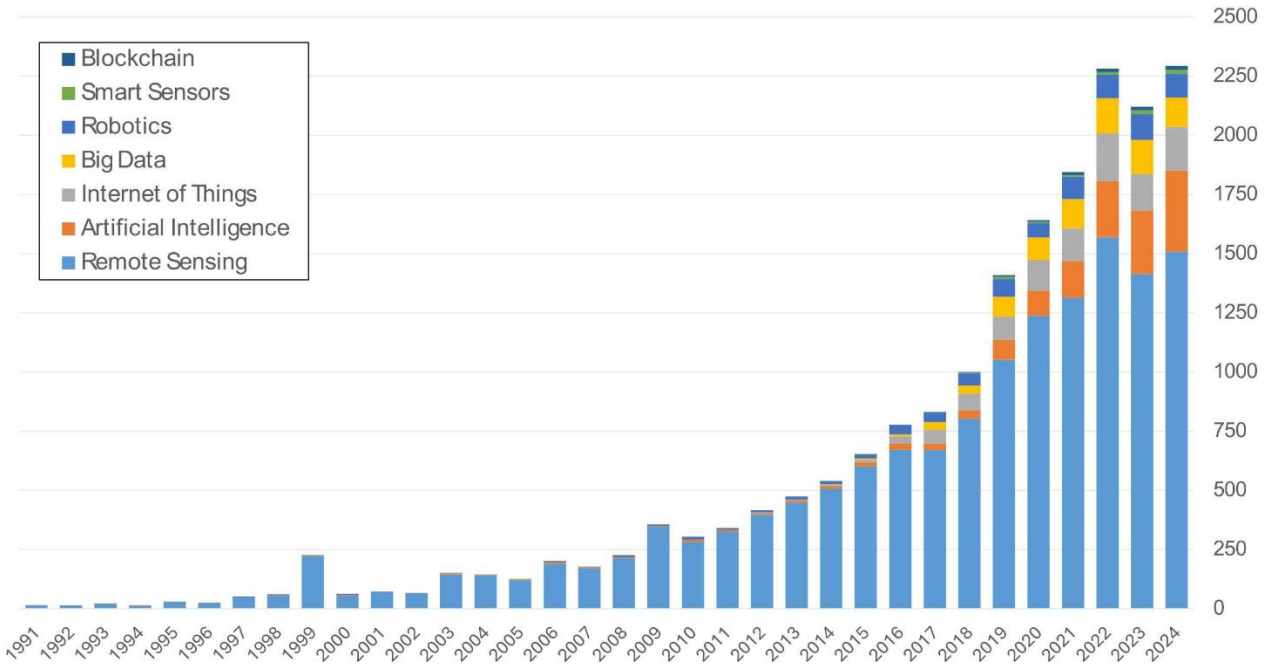


Figure 6. Annual publication trends on selected digital technologies in agricultural water management (from 1991 to present). Source: based on Web of Science data.

An overall perspective is provided based on the results of the review conducted, showing digital technologies, their main applications and contributions, along with relevant references. Furthermore, key water-related challenges and strategies adopted to improve water use and management are identified for each application.

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