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Artificial Intelligence Applications for Sustainable Water Management: A Systematic Review of the Literature

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Resumen:

Introducción. La gestión eficiente de los recursos hídricos es crucial ante el cambio climático y la creciente demanda de agua. La inteligencia artificial se perfila como una herramienta clave para optimizar y hacer más sostenible su gestión. Este artículo examina la aplicación de la IA en la gestión del agua, destacando sus beneficios, desafíos e implementación. Trabajo relacionado: Estudios previos han explorado la IA en el modelado predictivo, los sistemas de monitoreo y la toma de decisiones. Sin embargo, su adopción práctica sigue siendo limitada debido a barreras técnicas y socioeconómicas. Metodología: Este estudio realizó una revisión bibliográfica sobre la aplicación de la inteligencia artificial en la gestión del agua, analizando investigaciones teóricas y estudios de caso, y centrándose en tecnologías y contextos de aplicación. Resultados: Los resultados muestran que la IA puede optimizar el uso del agua y mejorar la respuesta ante emergencias, pero enfrenta limitaciones en la disponibilidad de datos y el acceso a la tecnología. Análisis de resultados: A pesar de su potencial, la implementación de la inteligencia artificial enfrenta desafíos, como la calidad de los datos y la accesibilidad a la tecnología. Conclusiones: La inteligencia artificial tiene un gran potencial, pero es necesario superar desafíos como la calidad de los datos y un mejor acceso a la tecnología para maximizar sus beneficios.

Palabras Clave: Gestión sostenible del agua, inteligencia artificial, cambio climático, pronóstico del agua.

Abstract:

Introduction. Efficient management of water resources is crucial in the face of climate change and increasing water demand. Artificial intelligence emerges as a key tool to optimize and make its management more sustainable. This paper examines the application of AI in water management, highlighting benefits, challenges, and implementation. **Related Work:** Previous studies have explored AI in predictive modeling, monitoring systems, and decision-making. However, it is practical adoption remains limited because of technical and socioeconomic barriers. **Methodology**: This study conducted a literature review on the application of AI in water management, analyzing theoretical research and case studies, and focusing on technologies and application contexts. **Results:** The results show AI can optimize water use and improve emergency response but face limitations in data availability and access to technology. **Analysis of Results:** Despite its potential, AI implementation faces challenges, such as data quality and technology accessibility. **Conclusions.** AI has great potential, but challenges such as data quality and improved access to technology need to be overcome to maximize its benefits.

Keywords: Sustainable water management, artificial intelligence, climate change, water forecasting.

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1. Introduction

Sustainable water management is a fundamental pillar in climate change, given that this essential resource is facing increasingly intense pressures in various regions of the planet [1], [2]. Rising global temperatures, changing weather patterns, and the increasing frequency of extreme events such as droughts and floods have significantly altered natural hydrological cycles [3], [4]. As a result, some areas are experiencing severe water shortages, while others are facing water quality problems because of pollution or overuse of water sources [5]. Faced with these challenges, it is imperative to implement management strategies that guarantee the long-term availability of the resource, protect the integrity of aquatic ecosystems, and ensure water supply for human populations [6], [7].

Water management, from a sustainable approach, not only seeks to respond to scarcity but also promotes resilience to the effects of climate change [8], [9]. Through practices such as conservation, water reuse, and ecosystem protection, it is possible to improve water efficiency and ensure that natural and human systems can adapt to changing climatic conditions [10], [11]. In this scenario, incorporating emerging technologies, such as Artificial Intelligence (AI), represents a key tool to transform traditional water management by enabling the development of predictive models, early warning systems, and intelligent platforms for water distribution and monitoring [12], [13].

Likewise, AI is playing an increasingly central role in water management, offering advanced tools for the analysis, modeling, and prediction of complex phenomena related to the water cycle [14], [15]. Using machine learning algorithms, artificial neural networks, fuzzy logic, and knowledge-based systems, among others, AI allows the optimization of processes such as water use planning, early detection of extreme events such as droughts or floods, management of distribution networks, and real-time water quality control [16], [17]. These capabilities are especially relevant in contexts of water scarcity, pressure on ecosystems, and climate change, where data-driven decision-making is essential [18].

In this same context, AI contributes to strengthening the sustainability of water systems by integrating with technologies such as remote sensing, geographic information systems (GIS) and the Internet of Things (IoT), facilitating the massive collection of spatial and temporal data [19]. This synergy enables the development of intelligent decision support systems that incorporate robust predictive models, adaptable to different climatic and socioeconomic scenarios. Therefore, AI makes water management more efficient and reliable, and it helps create more open, collaborative, and data-driven decision-making [20], [21].

This research systematically reviews literature on AI applications in sustainable water management, identifying key techniques, application areas, and technological advances. The relevance of the study lies in the need for innovative solutions to address the effects of climate change and pressure on water systems, highlighting the potential of AI to improve decision-making and optimize water management. This review includes only studies published between 2000 and 2025, focusing on AI's practical applications in water management and its integration with emerging technologies like remote sensing, IoT, and GIS.

2. Methodology

This study is based on a systematic literature review conducted according to the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 protocol [22]. This method ensures transparency, reproducibility, and scientific rigor during all phases of the review process, from protocol definition to critical appraisal and synthesis of the selected studies. The researchers applied specific eligibility criteria, structured search strategies, and a detailed analysis of the included articles [23]. Fig. 1 illustrates the complete methodological process of searching, screening, eligibility assessment, and inclusion of relevant studies.

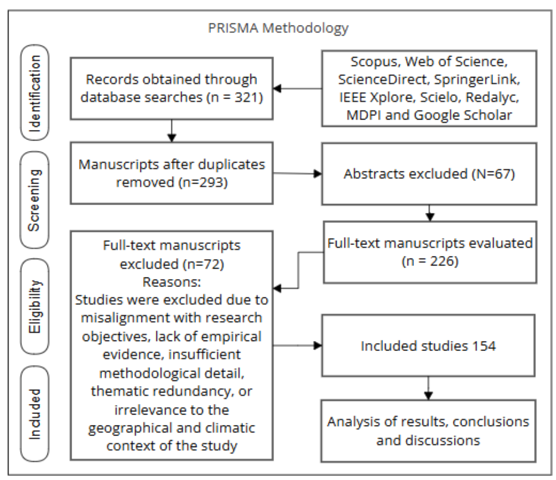

Fig. 1. Methodological outline of the search, selection, screening, eligibility assessment, and inclusion of relevant studies

2.1 Research question and objectives

This review sought to address this fundamental question: How is artificial intelligence being applied in sustainable water management, and what are its benefits, limitations, and emerging areas of application? We set the following specific objectives: (i) identifying the main AI techniques used, (ii) analyzing the most frequent application areas, such as drought prediction, water quality monitoring, and smart irrigation, and (iii) evaluating synergies with emerging technologies such as remote sensing, geographic information systems (GIS), and the Internet of Things (IoT). The overall purpose was to synthesize empirical and conceptual evidence to identify key trends, knowledge gaps, and promising approaches towards more efficient and resilient water management.

2.2 Search strategy

We conducted the systematic search in English and Spanish using highly affected academic databases, including Scopus, Web of Science, IEEE Xplore, ScienceDirect, MDPI, and Google Scholar. We considered peer-reviewed articles, book chapters, and institutional papers published between 2000 and 2025. Search strings included Boolean connectors such as (“artificial intelligence” OR “machine learning” OR “deep learning”) AND (“water management” OR “sustainable water use” OR “hydrological modeling” OR “water quality monitoring”), adapted according to the criteria of each database. This strategy allowed a broad and multidisciplinary coverage of scientific literature on AI applied to the water context.

2.3 Inclusion and exclusion criteria and selection process

Rigorous criteria ensured the quality and relevance of the studies analyzed. We included research that addressed practical applications of AI in water management, such as prediction, monitoring, or optimization processes that presented empirical evidence or applied models and that integrated complementary technologies such as sensors, GIS, or IoT. We excluded purely theoretical studies lacking practical application, non-peer-reviewed papers, and those not explicitly focused on water sustainability. The selection process comprised of four stages: identification, screening, eligibility assessment, and final inclusion. After analyzing titles and abstracts, we removed duplicate records from the initial 321, leaving 226 articles. The complete evaluation of the content finally made it possible to include 154 studies that met the objectives and criteria established for this review.

3. Results

3.1 Bibliometric analysis: temporal, geographical and institutional distribution of studies

The bibliometric analysis conducted on the 154 studies included in this systematic review revealed an increasing trend in scientific production related to AI applications in sustainable water management, especially from 2018 onwards, with a significant peak of publications in 2022 and 2023, coinciding with the increased availability of hydrological data, the advancement in machine learning algorithms, and the growing global concern about water scarcity and climate change.

In terms of geographic distribution, there was a greater concentration of studies in countries such as China, the United States, India, and Australia, followed by European countries such as Spain, Italy, and Germany. These regions stand out for their technological research capabilities and for facing significant challenges in terms of water resources. In Latin America, Brazil and Mexico lead scientific production in this field, with studies focused on intelligent irrigation systems, watershed monitoring and drought prediction.

In terms of institutional affiliation, universities and research centers specialized in environmental engineering, water sciences, and computational technologies were the main generators of knowledge. Institutions such as Tsinghua University (China), the Indian Institute of Technology (India), the University of California (USA) and the Technical University of Munich (Germany) were among the most cited. We also identified a growing trend of interdisciplinary collaboration between engineering, environmental science, and computer science departments. Table 1 presents all the information.

Table 1. Distribution of studies on AI in water resources management (2000–2025)

Year	**No. of Studies**	**Main Region**	**Institutions**
2000	2	North America	University of California, USGS
2001	1	Asia	University of Tokyo
2002	1	Europe	Technical University of Munich
2003	1	North America	MIT
2004	1	Europe	University of Oxford
2005	1	Asia	Indian Institute of Technology
2006	1	North America	Stanford University
2007	1	Europe	University of Barcelona
2008	1	Asia	Tsinghua University
2009	1	North America	University of California
2010	1	Europe	ETH Zurich
2011	2	Asia	Nanyang Technological University, IIT Delhi
2012	2	North America	USGS, University of Texas
2013	2	Europe	University of Cambridge, TU Delft
2014	3	Asia	Tsinghua University, KAIST
2015	4	North America	MIT, University of California, USGS

Year	No. of Studies	Main Region	Institutions
2016	5	Europe	Technical University of Munich, University of Bologna
2017	6	Asia	IIT Bombay, Tsinghua University, Kyoto University
2018	8	North America	Stanford University, USGS, University of California
2019	10	Europe	University of Oxford, Technical University of Munich, ETH Zurich
2020	12	Asia	Tsinghua University, Indian Institute of Technology, University of Tokyo
2021	15	North America	MIT, University of California, USGS, University of Illinois
2022	16	Europe	Technical University of Munich, University of London, Politecnico di Milano
2023	16	Asia	Tsinghua University, KAIST, IIT Madras
2024	21	North America	University of California, USGS, Stanford, Colorado School of Mines
2025	20	Europe	Technical University of Munich, University of Cambridge, Wageningen University
Total	154		

This bibliometric overview evidences a consolidation of AI as a transversal tool in water management studies, highlighting both its global adoption and its relevance in specific regional contexts where pressure on water resources is more critical.

3.2 Sustainable water management: an integrated approach from environmental, social and technological dimensions

Sustainable water management seeks to balance economic, social, and environmental needs, ensuring the availability of water in sufficient quantity and quality for both present and future generations while protecting the environment and ecosystems [24]. This integrating vision is based on three key dimensions: environmental, which promote the conservation of water sources and biodiversity; social, which encourages community participation and fair access to the resource; and technological, which acts as a strategic facilitator for the efficiency and sustainability of the water sector [25].

In this context, Information and Communication Technologies (ICTs) offer interactive platforms and mobile applications that strengthen community involvement in decision-making and water monitoring. In addition, their application in agriculture and in the conservation of aquatic ecosystems promotes a more efficient and responsible use of water resources. Overall, technology integration is emerging as an essential catalyst for effective, sustainable, and adaptive water management to emerging challenges [26].

3.3 *Artificial Intelligence in Environmental Management*

The speedup advance of digital technologies and the resurgence of artificial intelligence (AI) have led to profound transformations in organizational management, especially in contexts where natural resources, such as water, are under increasing pressure. In Latin America, this process implies particular challenges because of structural inequalities and socioeconomic constraints, which require a re-engineering of management strategies and a contextualized technological adaptation. In this sense, it becomes essential for states to implement public policies aimed at the ethical, transparent, and responsible use of AI, especially in strategic sectors such as water, in order to guarantee fundamental rights and long-term sustainability [27].

AI is also emerging as a key tool for driving human development, with applications already generating tangible benefits in several areas. However, this progress also poses challenges, particularly in terms of labor equity and access to technologies. The fear of job losses, especially in vulnerable sectors, highlights the urgency of fostering specialized technical skills and digital capabilities in the population, which would allow a more fair use of these emerging technologies and their effective integration into water management systems [28].

In the agricultural sector, which represents a crucial component of water management, AI offers enormous potential for optimizing the use of resources. Technologies such as drones, big data analysis, and predictive systems enable more efficient irrigation management, better crop planning, and rational use of water resources. These innovations not only increase productivity but also favor the conservation of ecosystems, contributing to a more balanced environmental management. However, for truly effective implementation of artificial intelligence, we must address the associated ethical, social, and technical aspects, ensuring its responsible, inclusive, and sustainable application [29].

3.4 *Main AI techniques used in water management*

AI has revolutionized the field of water management by introducing automated and predictive methods that enable more efficient, timely, and data-driven decision-making. Among the fundamental techniques used are machine learning and deep learning, which allow modeling time series of rainfall, water flows, and water quality with high accuracy [30]. These models learn patterns from large volumes of historical data, generating predictions useful for anticipating water shortages, managing reservoirs, and optimizing agricultural use of the resource [31].

Another relevant technique is the application of artificial neural networks (ANNs), used to simulate and predict complex phenomena of the hydrological cycle [32], [33]. ANNs are especially useful in contexts where data may be nonlinear or incomplete, as occurs in watersheds that are difficult to monitor [34]. Fuzzy logic systems and genetic algorithms have also found application in irrigation system planning, water stress assessment, and the design of climate change mitigation strategies. These tools allow the integration of socio-environmental and economic variables, improving decision-making from a multidisciplinary approach [35].

AI integrates IoT sensors, satellite image analysis, and predictive algorithms in smart water management platforms for real-time monitoring of distribution networks, leak detection, and drinking water quality management [36]. This technological integration facilitates the transition towards smart, more resilient and sustainable water systems. Experts have incorporated the application of these techniques as an essential component in climate change adaptation plans and in the promotion of sustainable development, particularly in vulnerable regions with infrastructure limitations [37].

3.5 *Classification of AI applications in water management*

Thematic analysis of the included studies allowed us to classify AI applications in water management into four categories, based on their purpose and implementation context. This classification facilitates understanding the current scope of AI technologies and their contribution to the efficient, resilient, and sustainable use of water resources.

a. Prediction of water availability and demand

A considerable number of studies employ AI models, such as artificial neural networks (ANNs), support vector machines (SVMs), and hybrid models, to predict key hydrological variables such as stream flow, precipitation, and reservoir storage levels [30], [38]. These predictions allow expecting short-, medium-, and long-term water supply and demand, which is crucial for water planning and basin management in contexts of scarcity and climate variability [39], [40].

b. Optimization of irrigation in agriculture

AI has been widely used to develop smart irrigation systems that adjust the amount and frequency of water applied according to weather, crop type, and soil condition [41]. Algorithms based on supervised learning and multi-objective optimization models, integrated with sensor data and IoT platforms, stand out, allowing for improved water efficiency and increased agricultural productivity, especially in arid and semi-arid regions [42], [43].

c. Monitoring and improving water quality

Another significant line of research focuses on the use of AI for real-time analysis of water quality parameters, such as pH, turbidity, dissolved oxygen, and contaminants [44], [45]. These applications use classification and predictive analytics techniques to detect anomalies, identify sources of contamination, and support decision-making in urban water supply systems and aquatic ecosystem conservation [46], [47].

d. Risk management: droughts, floods, and leaks

Currently, several studies apply AI models for the early detection and management of extreme water-related events [30] Classification algorithms and predictive models are used to expect droughts and floods, as well as to locate and quantify leaks in distribution networks [48], [49. These tools improve the resilience of water infrastructures and enable faster responses to emergency scenarios [48].

3.6 Technologies and platforms supporting AI

Technological platforms and tools empower AI in water management by amplifying its impact, improving the accuracy, automation and efficiency of water management systems [49], [50]. The main technologies and their application in water resources optimization are presented below.

a. IoT Sensors and Connected Devices

The Internet of Things (IoT) is critical for collecting real-time data, which feeds AI algorithms for informed decision-making in water management [51], [52]. IoT sensors collect key data on water quality and quantity, soil moisture, and flow in irrigation and distribution systems [53], [54]]. These include water quality sensors that monitor parameters such as pH and contaminants, flow and water level sensors that measure flow in reservoirs and rivers, and meteorological sensors that detect variables such as precipitation and temperature, helping to predict weather events and optimize the use of water resources [55], [56].

b. Data Analysis and Visualization Platforms

Data analytics and visualization platforms enable AI algorithms to process large volumes of information, extracting patterns and making accurate predictions [57], [58]. Examples of these platforms include Google Earth Engine, which uses satellite imagery and geospatial data to train AI models that analyze water behavior [59], [60]; Esri ArcGIS, which integrates spatial data on water resources and geography, facilitating the creation of predictive models [61];; and Microsoft Azure AI, which offers advanced machine learning tools for water demand prediction, leak detection, and water resource optimization [62], [63].

c. AI-Based Hydrological Models

AI-based hydrological models are essential for simulating and predicting the behavior of water systems, improving water management. They use machine learning algorithms to predict water flows, aquifer levels, and ecosystem response to climate change [64], [65]. Examples of these models include artificial neural networks (ANNs), which predict water resource behavior from historical data [66]; drought prediction models, which help expect dry periods and optimize water use [67], [68]; and hydrodynamic models, which simulate water flow in rivers and reservoirs, improving water distribution and flood protection [30], [69].

d. Intelligent Monitoring and Control Platforms

Smart monitoring and control platforms integrate AI and IoT to automate water management in real-time, optimizing distribution and detecting problems such as leaks, waste, or imbalance in irrigation systems [70]. Examples of these platforms include Smart Water Networks (SWNs), which use connected sensors and AI analytics to improve efficiency and reduce losses in water distribution systems [71]; smart irrigation management platforms, which automatically adjust irrigation systems based on data on humidity, weather, and plant needs, reducing water consumption [72]; and water quality management platforms, which employ IoT sensors and AI to detect contaminants and generate early warnings, avoiding public health problems [73].

e. Climate and Water Prediction Platforms

Integrating of climate prediction platforms with AI makes it possible to expect extreme weather events such as droughts and floods, facilitating the planning and management of water resources [30], [68]. These platforms use predictive models that process large volumes of climate data to forecast affects on water availability, improving decision-making [74]. Examples include ClimateAI, which uses AI to predict future weather patterns and their impact on water resources, enabling anticipatory management of water reserves [75]; and HydroPredict, which combines AI with weather and climate data to predict river and reservoir flows, contributing to basin management and flood prevention [76]. Integrating these platforms with real-time monitoring systems offers the ability to make dynamic adjustments to water distribution, optimizing its use and minimizing risks [77].

f. Cloud Computing and Big Data

Using cloud computing and Big Data technologies facilitates the processing and storage of large volumes of data related to water management, allowing AI systems to access data in real-time, perform complex analysis and generate accurate predictions [78]. Examples of these technologies include AWS (Amazon Web Services), which offers a robust infrastructure to support AI models in sustainable water management, allowing the processing of large volumes of data in real-time [79], and Google Cloud AI [80], which provides machine learning tools that can be integrated with water management systems, optimizing the distribution and use of the resource through advanced analysis and cloud processing. These resources contribute to more agile and accurate decision-making, improving efficiency in water resources management [81].

3.7 Practical applications of artificial intelligence in water management

3.7.1 AI based system for drought prediction in hydrological basins

In a research conducted by Y. Wang and S. Y. Wang and S. Razmjooy created an innovative predictive model combining advanced neural networks and optimization algorithms to forecast drought and water scarcity in hydrological basins. This model aims to improve water resource management by providing more accurate and efficient predictions, promoting more appropriate planning and sustainable use of water, a key resource in the face of climate change challenges [82].

The model uses technologies such as Capsule Neural Networks (CapsNN), which capture spatial and hierarchical relationships in the data, improving the robustness of predictions to variations, and Intelligent Algorithm Optimization (IAO), which dynamically adjusts model parameters to optimize its accuracy and efficiency in complex situations. This technological approach allows for more accurate predictions of drought conditions in watersheds.

Researchers trained and validated the model with historical data on precipitation, soil moisture, temperature, and drought indices from various watersheds. This allowed the model to learn temporal and spatial patterns related to drought events, making it a valuable tool for water resource management, the development of public policies for climate change adaptation, and implementing early warning systems.

This advance in artificial intelligence has great potential to improve the resilience of watersheds to the effects of climate change.

3.7.2 Using AI and IoT for precision irrigation in Dryland agriculture

Daniela Pérez, Katerine Marceles, Eleonora Palta, and Gabriel Elías Chanchi designed the Smart Drip System in their study; it's an automated IoT-based irrigation system for arid zones. This system, oriented towards precision agriculture, seeks to optimize water use and improve agricultural productivity through intelligent irrigation monitoring and control. The architecture used is based on IoT sensors capable of measuring key environmental variables such as soil moisture, temperature, pH, salinity and other climatic factors [83].

For its operation, the system integrates a NodeMCU platform with an ESP8266 chip that enables Wi-Fi connectivity and local data processing, an SD card module for data storage, DHT11 sensors for measuring temperature and humidity, and irrigation motors that activate automatically based on the data received. Through a web platform, farmers can monitor and control irrigation in real time, choosing between manual or timed mode. While the project does not implement an artificial intelligence model as such, the real-time collection and analysis of data lays the groundwork for intelligent decision-making and the future development of predictive models.

The system's results have showed an efficiency improvement of over 80% in blackberry crops, with tangible benefits in arid regions. These include precise irrigation regulation in highly saline soils, a reduction in unnecessary water consumption, lower operating costs because of reduced labor usage, and a significant increase in agricultural sustainability and productivity in water-scarce areas. This type of technological innovation represents a key step toward smarter and more resilient water management.

3.7.3 Real-time water quality monitoring with deep neural networks

A study by the Huangyang Reservoir in Gansu Province, China, implemented a water quality monitoring and prediction system based on deep learning techniques. This reservoir is a vital source of water for irrigation, flood control and human consumption in the region, but faces increasing pressures because of urban pollution and climate change. Researchers developed a predictive model using deep neural networks, specifically the LTSF Linear model, an efficient architecture for multivariate time series [85], to expect critical variations in water quality and enhance resource management.

The system operated with real-time data collected by sensors installed in the reservoir, including parameters such as pH, turbidity, and dissolved oxygen. The system recorded these data at hourly intervals from 2017 to 2023, allowing the model to identify spatial and temporal patterns associated with water quality degradation. Unlike traditional approaches such as ARIMA or LSTM, the LTSF-Linear model reduced the mean square error by 8.55% and the mean absolute error by 10.51%, reflecting a significant improvement in prediction accuracy. This performance makes it a valuable tool for decision-makers and water system operators.

The study found that using deep learning to predict water quality assists in better water resource management, especially in situations where conditions change rapidly and quick action is necessary. The system's ability to expect the evolution of key indicators allows for implementing preventive actions in the event of pollution or resource deterioration, improving the reservoir's resilience. This case successfully shows how artificial intelligence integrates into water management, promoting environmental sustainability and ensuring water security in vulnerable regions.

4. Analysis of Results

Implementing AI in water management offers several key benefits that are critical to improving the efficiency of water use. Predictive models and machine learning algorithms have proven to be effective tools for optimizing water distribution and use, allowing for more accurate demand forecasting and management. According to the reviewed studies, real-time monitoring of water quality and quantity is another significant contribution of AI, enabling rapid responses to incidents such as contamination or infrastructure leaks. This approach not only improves operational efficiency but also promotes long-term sustainability by reducing water waste and ensuring a consistent supply.

Analysis of the bibliometric results also reveals a significant increase in the number of studies since 2000, with a surge in publications beginning in 2015. This growth reflects a growing demand for innovative solutions in water management because of global scarcity issues and the climate crisis. The lack of quality data remains one of the principal obstacles, as AI relies heavily on large volumes of accurate data to train prediction models. In many regions, especially in developing countries, water resources data are incomplete or of inferior quality, making it difficult to build reliable models [84].

The interpretability of AI models remains a significant challenge. Many of the algorithms employed operate as "black boxes," meaning that the decision-making of these systems is not completely transparent. This limits the understanding of the processes involved and generates distrust in their implementation, especially in large-scale applications. The studies reviewed show that, although the developed models are promising, their practical adoption still faces economic, technical, and social barriers. Many times, the studies presented are theoretical, making their translation into applied and scalable solutions limited.

The geographical analysis of the studies shows that the most advanced regions, such as North America and Europe, have led the way in using AI for water management, while in Asia, Africa, and Latin America, implementation remains more limited. In these locations, differences in infrastructure and technological resources pose a significant challenge to implementing solutions developed in urban or technologically advanced contexts. This highlights the importance of contextualizing technological solutions according to local realities and developing adaptive implementation strategies, especially in regions with fewer resources.

5. Conclusions

The review shows that the application of artificial intelligence (AI) in water management has significant potential to improve the efficiency and sustainability of water resources. Through implementing predictive models and machine learning algorithms, it is possible to optimize water use, improve decision-making, and strengthen emergency response capacity. Key benefits of AI include improved efficient water distribution and real-time monitoring of water quality, resulting in more effective management and the prevention of environmental problems. However, effective global adoption requires addressing significant challenges. These challenges include the availability of quality data, model interpretation, and fair access to the technology. Overcoming these obstacles is critical, especially to make the benefits of AI accessible in the most vulnerable regions, which often face technological limitations.

Despite the great potential that AI holds for improving water management, there are persistent challenges related to data quality and a lack of adequate infrastructure in many regions. AI models rely heavily on large volumes of accurate data, and in regions with inadequate infrastructure, such as many developing countries, this is a significant limitation. Model interpretability remains a major issue; many models operate in an opaque manner, hindering user confidence in their use. Progress in this area is critical because transparent AI-based decision-making is essential for acceptance and effective implementation.

Researchers should continue developing more interpretable and accessible AI models. Creating more transparent models will improve confidence in their practical application and facilitate their implementation in diverse contexts. At the public policy level, it is crucial that policymakers promote initiatives that foster fair access to advanced technologies, especially in developing countries. This will prevent the technological gap from exacerbating inequalities in water management, ensuring that technological solutions benefit all communities, regardless of their level of development.

Regarding future lines of research, it is essential to focus efforts on improving the quality of water data, especially in regions that lack adequate infrastructure for its collection. Research should advance the creation of AI models that are more inclusive, accessible, and transparent, ensuring their usefulness in both urban and rural settings. Researchers should also delve into real-life case studies in rural contexts and developing countries to better understand the effective implementation of these technologies in diverse socioeconomic contexts. Finally, researchers should conduct more research on how AI affects equity in water access, ensuring technological solutions are both innovative and accessible to all communities.

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