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THE ROLE OF THE GEOGRAPHIC INFORMATION SYSTEMS IN THE WATER SUPPLY SYSTEMS

Bo Libert

retired Regional Advisor

of the United Nations Consultant

Phd. **Sultanov Akmal**

Abdusatorov Saidavzal, master's student of

Jizzakh Polytechnic Institute

Abstract

Geographic Information Systems (GIS) have become indispensable tools in modern water resource management. This article explores the pivotal role of GIS in optimizing water supply systems, discussing its ability to map infrastructure, monitor resources, and facilitate informed decision-making for sustainable water management.

Keywords – gis, data, monitoring, infrastructure, resource, supply, management, mapping, pipelines, vulnerabilities

Introduction

The provision of clean and accessible water is a fundamental pillar of modern society, sustaining life and fostering development. As populations grow and urban areas expand, the management of water resources becomes increasingly complex. Addressing these challenges requires sophisticated tools and technologies, and Geographic Information Systems (GIS) have emerged as invaluable assets in revolutionizing water supply systems.

In the context of burgeoning global populations and environmental changes, ensuring a reliable and sustainable water supply has become increasingly challenging. The integration of GIS in water supply systems has revolutionized the approach to managing this precious resource. GIS technology provides a comprehensive framework for mapping, analyzing, and monitoring various elements crucial for effective water resource management.

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Discussion and Analysis

GIS, a powerful tool that captures, stores, analyzes, and visualizes geographic data, plays a pivotal role in managing water resources effectively. In the realm of water supply systems, GIS facilitates comprehensive mapping and monitoring of various elements crucial to ensuring a reliable water supply.

Geographic Information Systems (GIS) have revolutionized the management of water resources by providing a multifaceted approach to handling complex spatial data. Within water supply systems, GIS serves as a dynamic tool for mapping, analyzing, and monitoring critical elements essential for ensuring a sustainable and reliable water supply.

One of the primary strengths of GIS in water management is its capability to accurately map and visualize water sources, infrastructure, and distribution networks. GIS software enables the precise identification and delineation of diverse water sources such as rivers, lakes, reservoirs, and groundwater aquifers on geographic maps. This comprehensive mapping is further enriched by integrating data on pipelines, treatment facilities, pumping stations, and distribution networks into a unified database.

2-picture. There are two main GIS types: vector data and raster data.

– Vector data includes spatial features (points, lines, and polygons) and attributes about that data (descriptive information).

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– Raster: data are stored electronic images (e.g., pictures taken as an aerial photograph or satellite images).

Analysis: is the process of using spatial data to answer questions. There are many different analysis techniques.

Hardware: GIS software is run on computers. Memory and computing power are important because spatial data includes many attributes making it very large.

Software: Geographic Information Systems require specialized software. The most commonly used GIS software at CDC/ATSDR include ArcGIS and QGIS. These types of programs can be used in conjunction with other types of software such as databases, statistical packages, or programming languages to increase functionality.

The amalgamation of this data within GIS platforms creates a comprehensive and detailed representation of the entire water supply system. It provides a holistic view of the interconnected components, allowing stakeholders to visualize the spatial relationships between water sources, treatment facilities, pipelines, and consumers. By overlaying various layers of information, GIS facilitates the identification of vulnerabilities, potential risks, and inefficiencies within the system.

Identifying vulnerabilities within the infrastructure becomes more intuitive with GIS. By analyzing spatial data, GIS can pinpoint potential weak points, such as aging pipelines or areas prone to water contamination. This insight empowers decision-makers to prioritize maintenance activities, plan infrastructure upgrades, and optimize the placement of new facilities for maximum efficiency.

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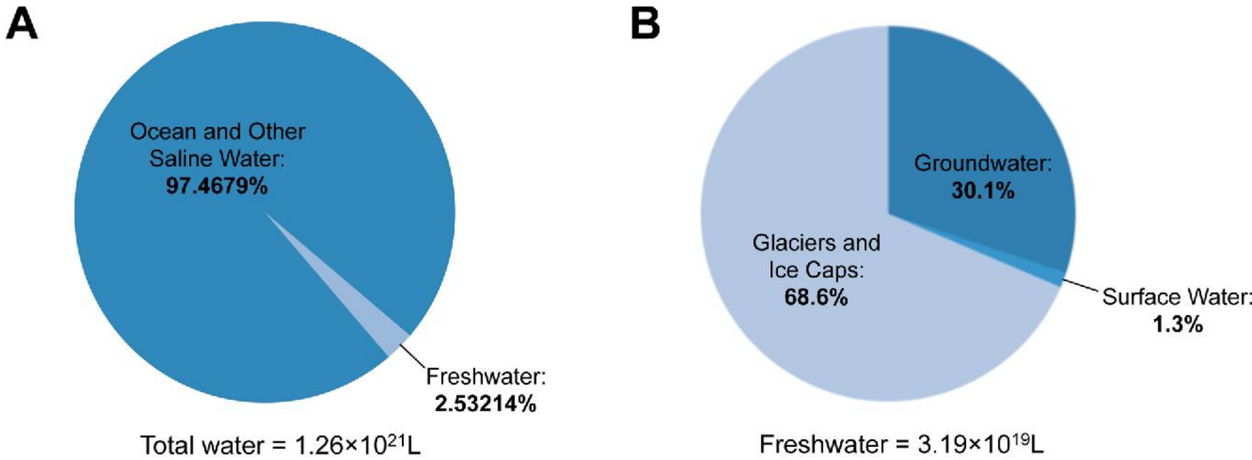

2-picture. The information about total water capacity according to GIS

In accordance with scientific research findings, the Earth possesses a voluminous water reserve totaling $1.26 \times 10^{21}L$, with an overwhelming majority of 97.4679% constituting salt water. Conversely, a mere 2.53214% of this extensive reserve is classified as fresh water. Within the fresh water category, the total reserves amount to $3.19 \times 10^{19}L$, with glaciers and groundwater accounting for 68.6% and 30.1%, respectively. These statistics underscore the critical importance of discerning between salt water and limited fresh water resources on our planet.

Furthermore, GIS plays a pivotal role in optimizing infrastructure placement. By leveraging spatial analysis tools, GIS aids in identifying suitable locations for new reservoirs, treatment plants, or distribution centers. Factors such as proximity to water sources, topography, population density, and environmental considerations can be systematically evaluated to make informed decisions about the optimal placement of infrastructure, thereby improving operational efficiency and reducing costs.

Additionally, GIS supports the planning and management of maintenance activities. By integrating data on the age, material, and condition of pipelines, GIS facilitates predictive maintenance strategies. This proactive approach allows utilities to schedule maintenance interventions before potential failures occur, thereby reducing service disruptions and minimizing water losses.

Moreover, GIS doesn’t just serve as a static repository of information; it enables real-time monitoring and analysis. Through the integration of sensors and

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telemetry systems, GIS platforms can collect live data on water flow rates, pressure variations, and water quality parameters. This real-time monitoring capability aids in early detection of anomalies, such as leaks or contamination events, enabling prompt responses to mitigate risks and ensure water quality and supply reliability.

In essence, GIS acts as a central hub, collating, analyzing, and visualizing spatial data critical for effective water resource management. Its ability to create detailed maps, identify vulnerabilities, optimize infrastructure, and facilitate real-time monitoring makes it an indispensable tool in ensuring the sustainability and resilience of water supply systems. As technology advances and data collection methods improve, the role of GIS in water management will continue to evolve, enabling more efficient and informed decision-making processes in safeguarding this vital resource.

One primary application of GIS in water management is its ability to map water sources, infrastructure, and distribution networks. GIS software enables the precise delineation of water sources such as rivers, lakes, reservoirs, and groundwater aquifers. By integrating data on pipelines, treatment plants, and distribution networks, GIS provides a holistic view of the entire water supply system. This comprehensive mapping aids in identifying vulnerabilities, optimizing infrastructure placement, and planning for maintenance and upgrades.

Moreover, GIS facilitates real-time monitoring and analysis of water quality and quantity. By incorporating data from sensors and monitoring stations, GIS can generate dynamic maps illustrating changes in water levels, quality parameters, and flow rates. This capability is crucial in detecting anomalies, such as leaks or contamination events, allowing for swift responses to mitigate risks to public health and the environment.

Predictive modeling is another area where GIS excels. By employing historical data and advanced algorithms, GIS can forecast water demand patterns, anticipate potential supply shortages, and simulate scenarios to guide decision-making. This predictive capability assists in designing resilient water supply systems capable of adapting to changing conditions, such as population growth or climate variability.

Furthermore, GIS facilitates informed decision-making and stakeholder engagement. By visualizing complex spatial data in easily understandable maps and graphs, GIS aids policymakers, water utility managers, and communities in making informed choices regarding water allocation, infrastructure investments, and

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conservation measures. This transparency fosters collaboration among stakeholders, enhancing the effectiveness of water management strategies. The integration of GIS with other technologies, such as remote sensing and Internet of Things (IoT) devices, further amplifies its capabilities. Remote sensing data, including satellite imagery, can provide valuable information on land use changes, vegetation cover, and hydrological patterns, enriching GIS databases for better decision-making. Meanwhile, IoT devices like smart meters can continuously collect data on water consumption, enabling precise monitoring and efficient management of water distribution.

Despite its numerous advantages, implementing and maintaining a GIS for water supply systems requires investment in skilled personnel, infrastructure, and data management. Additionally, ensuring data accuracy, interoperability, and cybersecurity are ongoing challenges that demand constant attention.

The integration of GIS information systems in water supply systems has led to significant advancements in water resource management. These systems have enhanced the efficiency of infrastructure planning, maintenance, and monitoring, resulting in improved reliability and sustainability of water supply networks.

Conclusion

The role of GIS in water supply systems cannot be overstated. Its capacity to integrate, analyze, and visualize spatial data empowers stakeholders to make informed decisions, optimize resource allocation, and ensure the resilience of water infrastructure. As technology continues to evolve, harnessing the full potential of GIS will be pivotal in addressing the complexities of managing water resources and securing a sustainable future for generations to come.

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