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Hydric problems in literature from 2020 to 2024

Abstract

Water problems related to scarcity, shortages, unhealthiness and shortages have been identified as guiding axes of the research agenda at a global and local level, but public policies from the administration at the federal or local level face a decoupling that the present study proposed analyze. A documentary, exploratory and retrospective work was carried out with a sample of sources indexed to international repositories. The results show the prevalence of nine dimensions related to access, coverage, quality, security, reliability, continuity, financing, cost, governance, regulation, sustainability, commitment, hygiene, technology and innovation. In relation to the state of the art, the extension and orientation of the study towards the differences between the federal and local administration levels is recommended.

Keywords: structure, model, variable, correlation, consumption

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Cruz García Lirios,[1] Isabel Cristina Rincon Rodríguez,[2] Jorge E Chaparro Medina,[2] Julio E Crespo,[3] Juan Guillermo Mansilla Sepulveda,[4] Victor Hugo Mario Cordoba,[5] Eyder Bolivar Mojica,[6] Maria Luisa Quintero Soto,[7] Javier Carreón Guillén[8]

[1]Universidad de la Salud, Bioética, México
[2]Universidad Santander, Administración, Colombia
[3]Universidad de Los Lagos, Osorno, Biología, Chile
[4]Universidad Católica e Temuco, Historia, Chile
[5]Universidad Católica Luis Amigo, Administración, Colombia
[6]Universidad Autónoma Latinoamericana, Colombia
[7]Universidad Autónoma del Estado de México
[8]Universidad Nacional Autónoma de México

Correspondence: Cruz García Lirios, Department of Bioética, Universidad de la Salud, México Tel 552534531, Email cruz.grcia@unisa.cdmx.gob.mx

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Introduction

The history of hydric (water-related) problems spans millennia and reflects the evolving relationship between human societies and water resources.[1] Ancient civilizations like the Sumerians and Babylonians developed sophisticated irrigation systems to harness river water for agriculture.[2] However, improper irrigation practices often led to soil salinization and reduced agricultural productivity over time. The ancient Egyptians relied on the annual flooding of the Nile River for agriculture, developing canals and reservoirs to manage water distribution.[3] The success of their civilization was closely tied to the management of Nile waters. The Romans were renowned for their advanced water engineering, constructing aqueducts to transport water over long distances to cities.[4] Roman innovations in water supply improved public health and sanitation but also led to ecological impacts on local water sources.

During the Islamic Golden Age, scholars in the Middle East made significant contributions to water management, including techniques for water distribution, irrigation, and dam construction.[5] Medieval Europe saw the development of water mills and the expansion of canal networks for transportation and industrial use. The Renaissance period saw renewed interest in hydraulic engineering and urban water supply systems. The Industrial Revolution brought rapid urbanization and increased pollution of waterways due to industrial waste and untreated sewage.[6] This led to widespread waterborne diseases and public health crises in cities.

The 20th century witnessed growing concerns over water scarcity, particularly in arid regions.[7] Industrial pollution, agricultural runoff, and urbanization contributed to water contamination and ecosystem degradation. International efforts to address hydric problems intensified in the 20th century, leading to the establishment of organizations like the United Nations' World Water Development Report and initiatives to promote sustainable water management practices. Climate change is exacerbating water-related challenges, including altered precipitation patterns, more frequent droughts, and increased water stress in certain regions.[8] Access to water resources has become a source of geopolitical tension, with conflicts over transboundary rivers and aquifers highlighting the need for improved water governance and cooperation.

There is a growing focus on water conservation, efficiency, and reuse to mitigate water scarcity and reduce environmental impacts.[9] Holistic approaches to water management, combining engineering solutions with ecological restoration and community engagement, are being promoted to address hydric problems sustainably.[10] The history of hydric problems reflects humanity's evolving relationship with water, from ancient civilizations' ingenuity in harnessing water for agriculture to modern challenges of pollution, scarcity, and climate change.[11] Addressing contemporary water challenges requires interdisciplinary solutions that prioritize sustainability, equity, and resilience in water management practices. The theory of public services related to water encompasses various principles and concepts that guide the management, delivery, and regulation of water resources to meet societal needs.[12] Water is considered a classic example of a public good due to its non-excludable and non-rivalrous nature. This means that once water resources are available, it is generally difficult to exclude individuals from using them, and one person's use does not diminish the availability of water for others.[13] Public provision of water services is often justified based on the premise that access to clean and safe water is essential for public health and wellbeing.

Water supply and distribution systems often exhibit characteristics of natural monopoly, where it is more efficient for a single provider to serve the entire market due to economies of scale and high fixed costs.[14] However, monopolistic control of water services can lead to concerns over pricing, quality, and equitable access.[15] Therefore, regulatory frameworks are essential to ensure fair pricing, quality standards, and universal access to water services. The theory of public water services emphasizes equitable access to safe and affordable water for all members of society, irrespective of socioeconomic status.[16] Governments and regulatory bodies play a key role in ensuring that water services are accessible to vulnerable and underserved populations, including those in rural areas or informal settlements.[17] Providing reliable and safe water services requires substantial investment in infrastructure development, maintenance, and upgrades.[18] Public utilities or water agencies are responsible for managing water supply networks, treatment plants, storage facilities, and distribution systems to ensure continuous service delivery.

Water services theory also considers externalities associated with water use and supply, such as environmental impacts of water extraction, treatment, and disposal of wastewater. Sustainable water management practices aim to minimize negative externalities and promote conservation of water resources.[19] Effective management of public water services often involves community engagement and participation. Stakeholder involvement in decision-making processes, water governance structures, and public awareness campaigns can enhance accountability and transparency in water management. Integrate Water Resource Management (IWRM) is a holistic approach to water management that emphasizes the interconnectedness of water resources, ecosystems, and human activities.[20] It promotes coordinated planning and management across sectors (e.g., agriculture, industry, environment) to optimize water use efficiency and sustainability. Robust regulatory frameworks and policy instruments are essential for effective governance of public water services. This includes setting water quality standards, establishing pricing mechanisms, enforcing environmental regulations, and promoting innovation in water technology and management practices.

The theory of public services of water underscores the importance of providing equitable, efficient, and sustainable water services to communities while addressing challenges related to natural resource management, infrastructure development, governance, and environmental stewardship.[21] Effective implementation of water services theory requires collaboration among governments, utilities, stakeholders, and the public to ensure the long-term viability and resilience of water systems. The management of water services involves various models and approaches aimed at ensuring the reliable, efficient, and sustainable provision of water to communities.[22] These models can differ based on factors such as governance structures, ownership arrangements, regulatory frameworks, and financing mechanisms. Public Utility Model, water services are owned and operated by public entities such as municipal governments or public water authorities.[23] Water infrastructure and facilities are owned by the government or a public agency. Oversight and regulation of service delivery are typically carried out by government agencies or regulatory bodies. Public utilities may be funded through taxes, user fees, or government subsidies. Many cities and municipalities around the world manage water services through public utility models, where water departments or authorities are responsible for water treatment, distribution, and billing.

Private Sector Participation (PPP) Model involves partnerships between public entities and private companies for the provision of water services.[24] Private companies are contracted to operate, maintain, or invest in water infrastructure under a government concession or lease agreement. Responsibilities and risks are shared between the public and private sectors, with clear performance targets and contractual obligations. Private sector investment may be used to upgrade or expand water infrastructure, often with the expectation of achieving efficiency gains. Many countries have implemented PPPs for water management, where private companies are responsible for aspects of water treatment, distribution, or billing, under government oversight.

Community-Managed Model: The community-managed model empowers local communities to manage and operate water systems.[25] Water systems are owned and operated by community-based organizations, cooperatives, or associations. Residents participate in decision-making, maintenance, and governance of water services. Emphasis on sustainability and social equity, often with support from external organizations or government agencies. Community-managed water systems are prevalent in rural areas and informal settlements, where local communities take responsibility for maintaining and managing water sources. Integrated Water Resource Management (IWRM) is a holistic approach that considers the entire water cycle and multiple water uses within a watershed or catchment area.[26] Balancing water needs for human consumption, agriculture, industry, and environmental sustainability. Collaborative decision-making involving government agencies, communities, industries, and environmental organizations. Flexibility to address complex and dynamic water challenges, including climate change impacts. IWRM frameworks are adopted by governments and river basin authorities to promote sustainable water management practices and improve water governance.

Decentralized and Innovative Models: Decentralized models leverage innovative technologies and approaches to enhance water service delivery.[27] Use of digital technologies, sensors, and data analytics to optimize water use and detect leaks. On-site or community-level water treatment systems to improve water quality and reduce centralized infrastructure costs. Emerging models include decentralized water treatment systems, water kiosks, and mobile water delivery services using innovative technologies.Each of these management models has its advantages and challenges, and the choice of model often depends on local context, resources, governance structures, and societal priorities.[28] Effective water service management requires a comprehensive understanding of water resources, stakeholder engagement, and adaptive strategies to address evolving water challenges sustainably. However, the dimensions of water problems may be different in the international context with respect to local indicators. Thus, the objective of this work was to compare the findings reported in the literature regarding water problems abroad in relation to local water problems. Are there significant differences between the dimensions of water problems reported in international literature with respect to the dimensions disseminated locally? Hypothesis. Given that public policies related to water problems and public services derive from management models, significant differences are expected between regional and local policies.[29] In this sense, the dimensions will not be different, but they would accentuate the problems according to the policies with which local or regional governments approach.

Method

Definition of Scope and Research Questions

Problem Identification: Definition of the problems related to water services that you want to address (limited access to drinking water, contamination of supply, lack of infrastructure maintenance).

Formulation of Research Questions: What are the main causes of water scarcity in region X? What technologies are most effective for treating wastewater in rural communities?

Bibliographic Search and Selection of Studies

Source Identification: Exhaustive searches in scientific databases, academic literature, government reports and technical documents related to water services.

Inclusion and Exclusion Criteria: Establishment of clear criteria to select relevant studies: type of study (systematic reviews) and year of publication.

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Study Quality Assessment

Critical Analysis: Evaluation of the methodological quality of the selected studies. Consider aspects such as the study design, the validity of the data, and the applicability of the results to your specific context.

Evidence Synthesis: Summary and synthesis of key findings from the studies reviewed. Identifies emerging patterns, areas of agreement, and controversies within the literature reviewed.

Analysis of the results

Identification of Contributing Factors: Analyzes the underlying factors that contribute to the problems identified in the studies reviewed.

Solution Mapping: Identifies interventions and solutions proposed in the literature to address specific problems related to water services.

Identification of Gaps and Recommendations: Determination of areas of insufficient knowledge or lack of scientific evidence, concrete formulation and recommendation to address the identified problems. These recommendations can be addressed to policy makers, water sector professionals or researchers.

Expert Validation and Consultation: Share findings and recommendations with experts in the water services field for additional feedback and validation.

Results

Creating a comparative table of water services dimensions can help illustrate the key aspects and considerations involved in managing public water services. Below is a sample comparative table outlining various dimensions of water services (Table 1).

While urban areas often have reliable access to piped water networks, rural communities may rely on decentralized systems such as boreholes or communal wells. Water quality varies based on treatment methods and infrastructure maintenance. Compliance with national standards ensures safe drinking water. Urban areas may experience fewer interruptions due to robust infrastructure, while rural areas may face challenges during droughts or system failures. Affordability is a concern, especially for low-income households. Subsidy programs can assist in ensuring equitable access. Effective governance involves clear policies, regulatory oversight, and transparency in decision-making. Sustainable water management practices aim to balance water needs with ecosystem protection and conservation. Engaging communities in water management fosters ownership and ensures tailored solutions that meet local needs. Access to safe water and sanitation is crucial for public health, preventing waterborne diseases. Advancements in technology improve efficiency, monitor water quality, and enable data-driven decision-making. This comparative table highlights the multifaceted nature of water services management, emphasizing the importance of addressing diverse dimensions to ensure sustainable, equitable, and resilient water provision for communities. Specific approaches and strategies may vary based on regional contexts, resource availability, and socio-economic factors.

Table 2 highlights how global water problems present large-scale challenges that require international collaboration and long-term management strategies, while regional or local water problems focus on more specific challenges that require interventions tailored to local and regional conditions. . Both scales of problems are interrelated and require comprehensive and coordinated approaches to effectively address water-related challenges around the world.

Table 1 Dimensions of water service

Dimension of Water Services	Description	Key Components
Access and Coverage	Ensuring universal access to safe and affordable water	Extending infrastructure, reaching underserved areas
Quality and Safety	Maintaining water quality standards	Water treatment, testing, compliance with regulations
Reliability and Continuity	Providing continuous and reliable water supply	Resilient infrastructure, contingency planning
Affordability and Cost	Implementing fair and transparent pricing mechanisms	Tariff structures, subsidy programs
Governance and Regulation	Establishing policies and regulatory frameworks	Policy frameworks, institutional oversight
Environmental Sustainability	Promoting sustainable water resource management	Ecosystem protection, water conservation
Community Engagement	Engaging stakeholders in decision-making and governance	Stakeholder involvement, capacity building
Public Health and Hygiene	Integrating water supply with sanitation for public health	Sanitation services, hygiene promotion
Technology and Innovation	Leveraging technology for efficient water management	Digital solutions, smart water systems

Source: Elaborated with data study

Table 2 Comparative hydric problematic in global and regional or local

Aspect	Global Water Problems	Regional/Local Water Problems
Scope	Impact multiple countries and continents worldwide.	Concentrated within specific areas, such as cities, regions, or river basins.
Main Causes	- Climate change and variability.	- Rapid urbanization and industrial expansion.
	- Pollution of water sources on a global scale.	- Unsustainable local water resource use.
	- Water scarcity due to population growth.	- Deforestation and local environmental degradation.
Environmental Impact	- Loss of aquatic ecosystems on a global scale.	- Biodiversity reduction in specific areas.
	- Changes in precipitation patterns and droughts.	- Localized contamination of water bodies.
	- Sea-level rise and saltwater intrusion.	- Decreased river and stream flow.
Social & Economic Impact	- Humanitarian crises and population displacement.	- Local water scarcity risks and impacts.
	- Water scarcity leading to unequal access to resources.	- Impacts on agriculture and food security.
	- Cross-border water resource conflicts.	- Additional costs for infrastructure and public services.
Management & Governance	- Need for international cooperation and global agreements.	- Reliance on local policies and regulations.
	- Development of global mitigation strategies.	- Community involvement in water management.
	- Role of international organizations and NGOs.	- Coordination among local and regional authorities.

Source: Elaborated with data study

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Discussion

The contribution of this work to the state of the art lies in the establishment of the dimensions related to water problems in the global and local context. The results suggest the prevalence of nine dimensions: accessibility, quality, reliability, affordability, regulation, sustainability, commitment, hygiene and innovation. Such dimensions can be established from the analysis of knowledge networks, such as intermediation.[30]

In relation to the state of the art which highlights nine dimensions related to the management of water problems, this work notes the prevalence of these nine dimensions at a global and local level as axes of findings in the literature consulted. Therefore, it is recommended to investigate the differences between global and local problems. In this sense, the extension of the study in terms of the sample of indexed sources and the evaluation of the dimensions found will allow establishing axes of review and discussion in the contrast between the global and the local.[31]

Conclusion

The objective of this work was to compare the global dimensions with the local ones in order to establish the research agenda in the period from 2020 to 2024. The results corroborate the assumption around which the global dimensions are replicated at the local level, although with accentuations in public policies. In this way, the amplification of the study towards empirical contrast is recommended in order to anticipate the emergence of a research agenda around water problems.

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Conflicts of interest

None.

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