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DRINKING WATER AVAILABILITY IN RURAL AREAS UNDER CLIMATE CHANGE: A BIBLIOGRAPHIC REVIEW OF SCIENTIFIC LITERATURE

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ABSTRACT

Access to safe drinking water in rural contexts remains one of the main structural gaps in the global sustainable development agenda, exacerbated by the growing effects of climate change. This article presents a literature review of scientific publications from 2016 to 2025, aiming to identify the main approaches, challenges, and proposed solutions regarding drinking water availability in rural areas affected by climatic variability, institutional fragility, and regulatory fragmentation. A total of 30 academic studies were analyzed, retrieved from databases such as Scopus and DOAJ, covering research conducted in Latin America, Asia, and Africa. The findings were organized into five thematic categories: (1) water safety plans and community-based management, (2) water quality and health risks, (3) climate change impacts on water availability, (4) technological innovations, and (5) public policies and regulatory frameworks. The review shows a predominance of technical-community approaches with weak institutional articulation and limited normative adaptation to rural contexts. It is concluded that ensuring sustainable access to drinking water in rural areas requires the integration of appropriate technologies, active community participation, decentralized planning, and the inclusion of local knowledge. The results offer relevant insights for future research and for the formulation of climate-resilient public policies focused on water equity.

KEYWORDS: Rural Drinking Water, Climate Change, Water Governance, Climate Adaptation, Water Security.

1. INTRODUCTION

According to data from the World Bank (2022), more than 2.2 billion people worldwide live without access to safely managed drinking water services, with a particularly severe impact on low-income rural communities. This situation results in over 485,000 annual child deaths due to diarrheal diseases linked to the consumption of contaminated water. Furthermore, according to the joint WHO and UNICEF report (2023), 29% of the global population lacks access to basic sanitation services, exposing millions of people—especially women and children—to health and protection risks.

Various independent studies confirm that the scarcity of potable water in rural areas is not solely due to technical limitations, but also to social, institutional, and climatic factors (Truelove et al., 2023; Eakin et al., 2022). In regions such as Latin America and Sub-Saharan Africa, the effects of climate change have intensified rainfall irregularities and reduced aquifer recharge capacity, critically impacting community-based water supply systems (Calow et al., 2022). Empirical evidence shows that the lack of investment in rural water infrastructure, combined with weak coordination across levels of government, has perpetuated a historical gap in access in dispersed and hard-to-reach areas (UNICEF, 2024; FAO, 2023).

In the Peruvian case, the Ministry of Agrarian Development and Irrigation (MIDAGRI, 2023) has reported that rural areas face a serious problem of water access, marked by water scarcity, ecosystem degradation, and limited community management capacity. Deforestation in watershed headwaters, soil desertification, and the lack of adequate infrastructure—such as reservoirs, cochas, and catchment systems—affect the availability of water for irrigation, human consumption, and agricultural production. In addition, inadequate agricultural practices and climate change exacerbate the loss of natural water sources. This situation compromises water security, rural productivity, and the sustainability of peasant livelihoods. The National Water Authority (ANA, 2024) has declared over 200 districts under water emergency due to the critical reduction of natural sources. This issue reflects a combination of structural vulnerability, environmental exposure, and institutional limitations that must be analyzed from a comprehensive perspective, with emphasis on the specific conditions of rurality in the context of climate change.

Within this scenario, there is growing concern over the limited availability of drinking water in rural areas exposed to the effects of climate change, where extreme weather events and changes in hydrological patterns have intensified inequalities in access to water resources. Although various strategies have been developed to ensure safe water supply in these settings, their implementation has been insufficient or poorly coordinated in light of the scale of the problem. This situation is further exacerbated by the lack of resilient infrastructure, weak community water management, and poor integration between environmental and social policies tailored to rural contexts. In response, this study aims to analyze, based on a literature review, the main conditions that determine the availability of drinking water in rural contexts affected by climate change, while also identifying the mechanisms, limitations, and factors that influence its sustainability.

2. THEORETICAL FRAMEWORK

According to Li et al. (2022), the intensification of environmental phenomena has given rise to multiple scientific approaches seeking to explain their causes, impacts, and mitigation mechanisms. Additionally, the Climate Change Theory, consolidated by James Hansen in the 1980s, is based on the accumulation of greenhouse gases—mainly carbon dioxide, methane, and nitrogen oxides—as a consequence of industrial and agricultural human activity (Butler, 2024). Subsequently, Dinku et al. (2022) emphasize that this sustained increase in global temperature alters weather patterns, causes the melting of ice masses, and generates extreme events such as droughts, floods, and hurricanes. It has been demonstrated that human action has surpassed the planet's natural resilience thresholds, generating a systemic crisis affecting biodiversity, public health, and food security.

According to Nedeljković et al. (2023), pressure on water resources has led to the emergence of theories that promote integrated management based on ecological, social, and economic criteria. Likewise, the Sustainable Water Management Theory, promoted by Sandra Postel since the 1990s, proposes that water should be managed as a finite, vulnerable, and essential good for life and development (Pulizzi, 2024). According to Franssen (2023), this model proposes rational use strategies that consider resource availability, basic human needs, ecosystem conservation, and intergenerational equity. It also introduces an integrative vision in which the balance between water demand and supply is based on environmental resilience, citizen participation, and adaptation to climate change.

2.1. Climate Change

Sesana et al. (2021) state that climate change is a global phenomenon involving persistent modifications in climate patterns over time, primarily resulting from human activities that intensify the greenhouse effect. Moreover, it is characterized by a sustained rise in the planet's average temperature, alterations in precipitation regimes, increased frequency and intensity of extreme weather events, and the melting of glaciers (Ting & Vasel-Be-Hagh, 2022). Lee et al. (2024) add that this process is not limited to temperature variations but also includes transformations in ecosystems, impacts on biodiversity, species displacement, and changes in agricultural productivity. Climate change has a systemic nature, meaning that its impacts manifest in an interconnected manner across social, economic, ecological, and health dimensions, particularly affecting the most vulnerable populations on the planet.

2.2. Climate Change Scenarios Related To Water

Surendran et al. (2021) explain that one of the most critical scenarios of climate change concerns the availability of freshwater, a resource that has become scarcer and more irregular due to altered hydrological cycles. Variations in global temperature directly affect evaporation and precipitation patterns, generating prolonged droughts in arid regions and intense, unpredictable rains in others (Prosser et al., 2021). Liu et al. (2022) add that glacier retreat and the reduction of seasonal snow significantly diminish the water reserves that feed watersheds and rivers.

In mountainous areas, this melting affects water flow during dry months, altering the supply for human consumption, irrigation, and hydroelectric generation (Surendran et al., 2021). Likewise, the loss of wetlands and the degradation of aquifers further limit the natural recharge of underground sources (Prosser et al., 2021). According to Liu et al. (2022), this scenario shows how climate change compromises the global water balance and demands urgent responses in conservation, adaptation, and water resource planning.

According to Surendran et al. (2021), another key scenario linked to climate change is the increase in water stress in agricultural areas, where rainfall irregularities and groundwater depletion jeopardize food security. In many regions, prolonged drought periods have become more frequent, forcing farmers to rely on artificial irrigation systems that are not always available or entail high energy costs (Prosser et al., 2021). Based on Liu et al. (2022), torrential rains associated with extreme events because soil erosion, nutrient loss, and crop destruction. In coastal regions, rising sea levels and saline intrusion into aquifers affect water quality for irrigation and consumption (Surendran et al., 2021). This instability reduces agricultural productivity and threatens rural livelihoods (Prosser et al., 2021).

Surendran et al. (2021) also explain that urban environments face water risk scenarios associated with climate change, especially in contexts of rapid urbanization and poor infrastructure management. Intense rains increase the risk of flooding in cities with inadequate drainage systems, causing material damage, interruptions in basic services, and health hazards (Prosser et al., 2021). According to Liu et al. (2022), these challenges require integrated public policies that combine green infrastructure, water efficiency technologies, environmental education, and participatory governance to mitigate climate impacts on urban water.

2.3. Sustainable Management of Drinking Water

According to Ehsan et al. (2023), sustainable management of drinking water constitutes a comprehensive approach that ensures continuous and safe supply of this essential resource without compromising its availability for future generations. This model integrates environmental, social, and economic criteria to preserve water sources, minimize extraction impacts, ensure efficient distribution, and promote responsible consumption (Srivastav et al., 2021). In the view of Kumar et al. (2023), its core features include long-term planning, participatory governance, the incorporation of clean technologies, and the protection of ecosystems linked to the hydrological cycle.

It also promotes equitable access, waste reduction, and the implementation of monitoring and continuous evaluation mechanisms (Ehsan et al., 2023). As Srivastav et al. (2021) point out, sustainable management goes beyond the rational use of the resource by integrating public policies, environmental education, and institutional cooperation to address challenges such as climate change, population growth, and pollution. As noted by Kumar et al. (2023), this approach establishes a dynamic balance between human needs and nature's regenerative capacity.

2.4. Dimensions of Sustainable Drinking Water Management: Quality, Timeliness, Access

According to Shi et al. (2022), one of the central dimensions of sustainable drinking water management is **quality**, understood as compliance with physical-chemical, microbiological, and organoleptic standards that ensure the safety of the resource for human consumption. This dimension involves strict control from water catchment to final distribution, including processes such as purification, storage, and maintenance of hydraulic networks (Rahman et al., 2023). Likewise, water quality is ensured through regular testing and compliance with national and international regulations, such as WHO guidelines, and through coordination among government agencies, service operators, local communities, and users, thus strengthening transparency and accountability (Rahman et al., 2023).

According to Amankwaa et al. (2024), the **timeliness** dimension in sustainable drinking water management refers to the regular and continuous supply of water in the appropriate quantity and at the right time, according to the population's needs. This requires water planning based on demand analysis, seasonal availability, and demographic projections. Furthermore, timeliness is also related to system resilience in the face of extreme events such as droughts, floods, or operational failures (Pierce et al., 2021).

According to Kim et al. (2021), **access** constitutes a third essential dimension in sustainable drinking water management, focused on ensuring that all people—regardless of geographic, economic, or social conditions—have secure, affordable, and permanent access to this vital resource. This involves overcoming structural barriers that limit service coverage, such as population dispersion in rural areas or lack of basic infrastructure (Oskam et al., 2021).

Achieving this objective also requires equity-focused public policies that prioritize vulnerable populations, reduce historical coverage gaps, and promote fair tariff models (Kim et al., 2021). According to Oskam et al. (2021), access is also linked to community empowerment, participation in decision-making, and awareness of water rights.

2.5. Sustainable Rural Development

According to Yanbo et al. (2021), sustainable rural development is a comprehensive approach aimed at improving the quality of life in rural populations through a balance between economic growth, social inclusion, and environmental protection. This vision promotes structural transformations in rural territories while respecting their cultural and productive diversity. It also ensures the long-term conservation of natural resources through the active participation of local communities (Wang et al., 2021).

According to Harbiankova and Gertsberg (2022), its main features include equitable access to opportunities, diversification of productive activities, efficient land management, and the adoption of appropriate technologies. This model also requires coordination among public, private, and civil society sectors (Yanbo et al., 2021). As Wang et al. (2021) highlight, sustainable rural development is not limited to increasing agricultural income but also integrates educational, health, cultural, and infrastructure aspects. This approach seeks to generate long-lasting, resilient, and context-adapted well-being conditions (Harbiankova & Gertsberg, 2022).

2.6. Dimensions of Sustainable Rural Development

According to Prasetyo and Setyadharma (2022), a key dimension of sustainable rural development is the economic dimension, aimed at strengthening the productive capacities of rural territories through the promotion of inclusive value chains, access to markets and financial services, and income diversification. This dimension enhances sustainable agricultural productivity, local entrepreneurship, and technological innovation. It also includes the reinforcement of physical and logistical infrastructure to improve the competitiveness of rural economies (Soleymani et al., 2021).

According to Li et al. (2021), sustainable rural economic development relies on resilient productive systems that generate decent employment, increase household income, and contribute to food sovereignty. This vision involves combining traditional knowledge with modern practices to reduce dependency on extractive or low-value-added activities. To achieve this, coordinated action among agricultural, commercial, and fiscal policies is essential—policies that consider the heterogeneity of territories and promote economic justice in access to assets and resources (Nugraha et al., 2021).

According to Hu et al. (2021), the social dimension of sustainable rural development focuses on ensuring equity, inclusion, and respect for human rights in rural territories, acknowledging the ethnic, cultural, gender, and generational diversity of these communities. This approach promotes the strengthening of human capital through access to basic services such as healthcare, education, decent housing, and social security. It also fosters civic participation, empowerment of rural women and youth, and social cohesion as a central element of development sustainability (Reyes-Espejo et al., 2025).

Moreover, sustainable rural development requires building just and resilient communities capable of leading their own territorial transformation processes from an inclusive perspective (Prasetyo & Setyadharma, 2022). This process encourages solidarity, collaborative networks, and mechanisms for conflict resolution (Soleymani et al., 2021).

According to Reyes-Espejo et al. (2025), the environmental dimension of sustainable rural development is oriented toward the conservation and responsible use of natural resources in rural territories, recognizing their strategic value for life and community livelihoods. This dimension promotes ecological farming practices, agroforestry systems, and sustainable management of soil and water (Hu et al., 2021). According to Li et al. (2021), environmental management in rural areas requires clear regulatory frameworks, incentives for clean production, and participatory monitoring mechanisms. Ecological balance is considered a necessary condition to ensure long-term economic and social sustainability (Nugraha et al., 2021).

2.7. Background on Drinking Water in Rural Areas Affected By Climate Change

Ishaque et al. (2022) explain that climate change has drastically altered hydrological patterns in rural regions of Pakistan, where extreme rainfall and prolonged droughts impact both the quantity and quality of drinking water. These changes have caused entire communities to face increasing health risks due to exposure to contaminated sources. According to Díaz et al. (2025), intense rainfall and rising temperatures in Ecuador generate urban and agricultural runoff that carries pathogens and chemicals into surface water bodies, deteriorating their quality and potability.

In the same vein, Malima et al. (2022) report that in rural areas of South Africa, such as the Vhembe district, a large part of the population depends on boreholes, many of which are non-operational due to vandalism, lack of maintenance, and shortages of spare parts—forcing reliance on unprotected sources. This dependence on collapsed systems is exacerbated by climate phenomena such as drought, which increase pressure on depleted aquifers. Mishra et al. (2021) emphasize that effective responses to these crises require decentralized, integrated, and resilient governance models capable of managing both the physical and social impacts of climate change on water resources.

As Burgos et al. (2025) warn, the retreat of Andean glaciers in Ecuador is significantly reducing river flow in mountain communities, compromising access to water for human consumption and small-scale agriculture. These transformations in the hydrological cycle are already affecting multiple territories, especially those lacking storage infrastructure and stable distribution networks. Macas et al. (2025) indicate that declining water quality is associated with rising waterborne diseases such as diarrhea, cholera, and dysentery, which disproportionately affect rural populations without basic sanitation or chlorination systems.

Chasi et al. (2025) argue that the lack of territorial planning and absence of local water committees in rural areas hinder timely responses to water emergencies, leading to chronic dependence on mobile sources such as water tank trucks. Faced with this scenario, the authors agree that without comprehensive community adaptation measures and climate-resilient water management, the availability of potable water in rural contexts will continue to decline rapidly.

3. METHODOLOGY

The literature search was conducted in the Scopus and DOAJ databases due to their coverage of open-access scientific literature related to drinking water, climate change, and rural management in Latin American and African contexts. The keywords used included "rural drinking water," "climate change," "community management," "water security," and "decentralized supply models," which resulted in the selection of 30 scientific articles.

To ensure the relevance and quality of the studies selected for this literature review, specific inclusion and exclusion criteria were defined and applied during the screening and analysis process:

3.1. Inclusion Criteria

a) **Publication year**: Only studies published between 2016 and 2025 were considered to ensure up-to-date and contextually relevant evidence.

b) **Type of study**: Quantitative, qualitative, mixed-methods research, and systematic reviews were included, provided they directly addressed the availability of drinking water in rural settings affected by climate change.

c) **Central topic**: Articles had to focus on aspects such as access, quality, management, sustainability, or climate impacts on rural drinking water.

d) **Language and accessibility**: Studies published in English or Spanish with full-text access were included.

3.1.2. Exclusion Criteria

a) **Type of publication**: Editorial letters, opinion columns, abstracts without empirical data, and non-peer-reviewed articles were excluded.

b) **Thematic relevance**: Studies focused exclusively on urban settings or on water for industrial or recreational purposes were disregarded.
c) **Scientific contribution**: Papers with weak methodological development or without relevant findings on rural drinking water were excluded.
d) **Availability**: Publications not available in full text were not considered.

3.2. Search Strings Used

Boolean operators such as AND and OR were employed to combine search terms, resulting in the following search strings: "rural drinking water" AND "climate change"; "water security" AND "rural areas" AND "supply models"; "water quality" OR "water infrastructure" AND "climate adaptation"; "community management" AND "rural water services"; "water safety plans" AND ("climate" OR "vulnerability"). These combinations were iteratively refined to optimize the relevance and specificity of the results.

3.3. Study Selection Process

The study selection process occurred in three phases. In the first phase, publications were identified in Scopus and DOAJ using the defined search strings. The second phase involved an initial screening based on title and abstract review, applying the inclusion and exclusion criteria. In the third phase, full-text articles were reviewed, resulting in the final inclusion of 30 publications. Zotero software was used for reference management, facilitating article organization, duplicate removal, and APA-format export. A flow diagram was developed to illustrate the selection process.

3.4. Data Extraction

Once the relevant studies were selected, data extraction was conducted using a coding sheet specifically designed for this review. The data collected included authors, publication year, country of application, methodology, objective, key concepts, instruments used, intervention strategies, and main findings. Theoretical frameworks, limitations, and conclusions of each study were also identified. This information was organized into a comparative matrix to analyze trends, identify thematic convergence, and group publications by analytical categories such as community management, water quality, climate change, water safety plans, and innovative supply models. This systematization enabled a robust cross-sectional analysis aligned with the research objectives.

3.5. Methodological Quality Assessment

Prior to thematic analysis and documentation of the selection process, the methodological quality of the included studies was assessed using the critical appraisal tool developed by the Joanna Briggs Institute (JBI), adapted to various methodological approaches (quantitative, qualitative, mixed-methods, and modeling studies). The tool evaluates ten criteria: (1) clearly stated objective, (2) methodological coherence, (3) adequacy in data collection, (4) analytical reliability, (5) bias management, (6) ethical review, (7) transparency in reporting, (8) valid interpretation of results, (9) practical applicability, and (10) consistency between findings and conclusions. Each study was scored on a 10-point scale and categorized as high quality (8–10 points), medium (6–7 points), or low (≤5 points). Table 1 presents the scores, study types, and estimated risk of bias for each article.

Table 1: Methodological Quality Assessment of Included Studies According To JBI Criteria.

N	Author(s) and Year	Type of Study	JBI Score (/10)	Overall Quality	Risk of Bias
1	Mehrabani et al. (2023)	Quantitative – Modeling	9/10	High	Low
2	Silva et al. (2023)	Quantitative – Observational	8/10	High	Low
3	Ramos-Parra et al. (2025)	Applied Qualitative	7/10	Moderate	Moderate
4	Pérez-Vidal et al. (2020)	Case Study	8/10	High	Low
5	Baracho et al. (2023)	Case Study – Qualitative	7/10	Moderate	Moderate
6	Pundir et al. (2021)	Quasi-Experimental	8/10	High	Low
7	Ko & Sakai (2022)	Cross-Sectional – Survey and Microbiological Analysis	7/10	Moderate	Moderate
8	Galezzo & Rodríguez (2021)	Cross-Sectional – Water Quality	8/10	High	Low
9	Szopińska et al. (2024)	Technical and Risk Assessment	9/10	High	Low
10	Roman et al. (2021)	Hydrological Modeling	8/10	High	Low
11	Marwaha et al. (2021)	Applied Review	6/10	Moderate	Moderate
12	Murray et al. (2024)	Applied Review	7/10	Moderate	Moderate
13	Silva (2024)	Narrative Review	7/10	Moderate	Moderate
14	Pareja-Pineda (2023)	Legal-Descriptive	6/10	Moderate	Moderate

15	Sapién-Aguilar et al. (2025)	Applied Strategic Design	7/10	Moderate	Moderate
16	Razafindratsima et al. (2019)	Longitudinal Observational	8/10	High	Low
17	Chathuranika et al. (2022)	Climate Modeling	9/10	High	Low
18	Domínguez et al. (2016)	Case Study – Qualitative	7/10	Moderate	Moderate
19	Silva (2022)	Longitudinal Descriptive	8/10	High	Low
20	Leon et al. (2020)	Predictive Modeling	9/10	High	Low
21	Togo et al. (2024)	Survey – Social Analysis	7/10	Moderate	Moderate
22	Angelova et al. (2024)	Economic Evaluation – IWRM	8/10	High	Low
23	Chen (2024)	Institutional Evaluation	7/10	Moderate	Moderate
24	Xu et al. (2023)	Grounded Theory + DEMATEL	9/10	High	Low
25	Sambo et al. (2021)	Multivariable Evaluation	8/10	High	Low
26	Aliabadi et al. (2020)	TPB + HBM – Survey	8/10	High	Low
27	Chew & Ng (2019)	Technical Assessment	8/10	High	Low
28	Sumanasekara et al. (2025)	Technical Diagnosis	8/10	High	Low
29	Richards et al. (2025)	Technical and Economic Study	8/10	High	Low
30	Molinos-Senante et al. (2019)	Descriptive Study	7/10	Moderate	Moderate

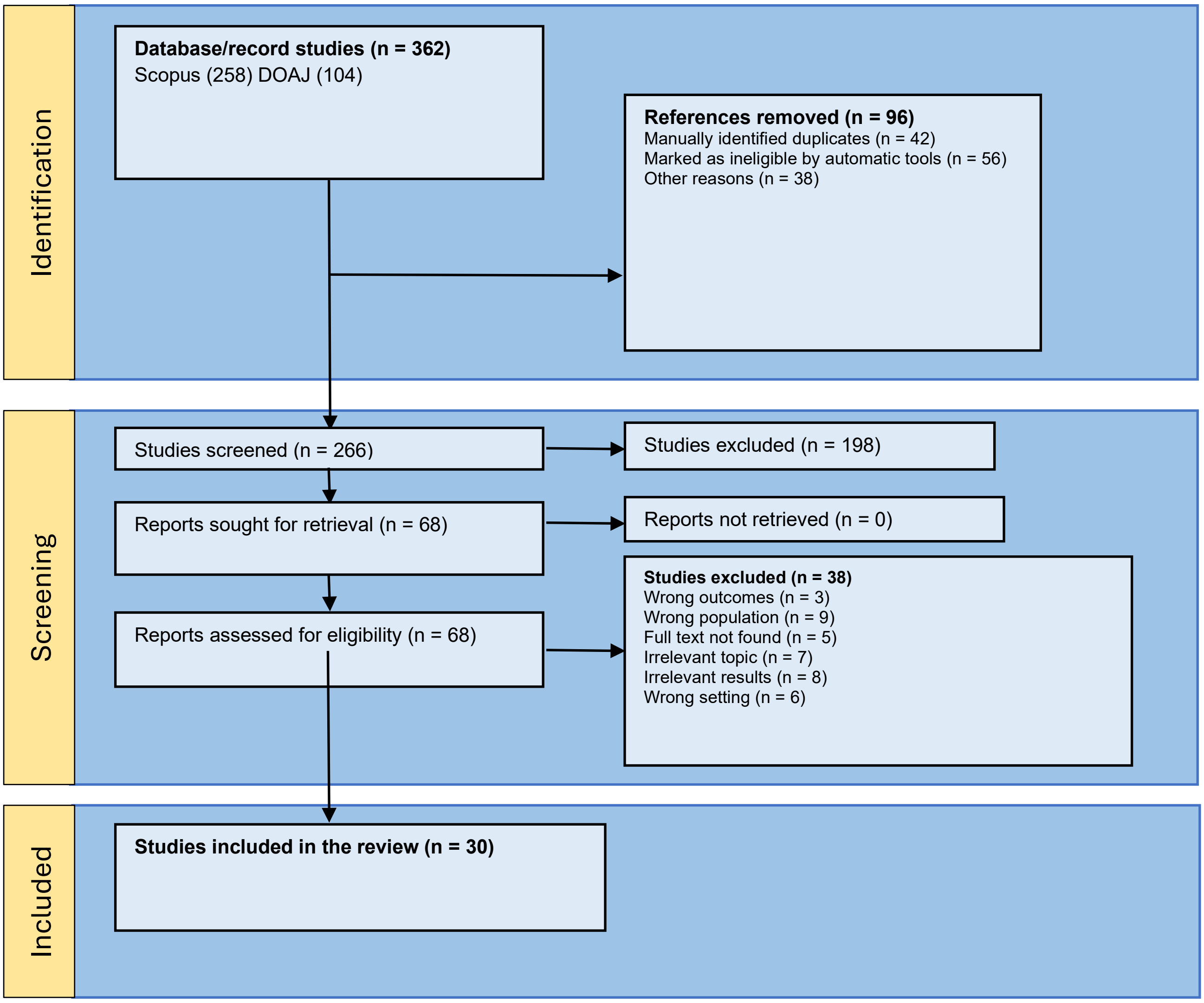

Figure 1: Flowchart of the Study Identification and Selection Process.

After applying the criteria, 30 full-text publications were selected for systematic analysis, as shown in Table 2.

Table 2: Descriptive Data of the Selected Scientific Articles.

N	Author	Article Title	Methodology	Country	Year	Database
1	Mehrabani et al. (2023)	Research on the Factors Affecting Rural Drinking Water Consumption Using Intelligent Hybrid Models	Quantitative	Iran	2022	Scopus
2	Silva et al. (2023)	Climate Extremes in the State of Acre, Southwestern Amazon: Floods, Droughts, Fires, and Water Crises	Systematic Review	Brazil	2023	Scopus
3	Ramos-Parra et al. (2025)	Risk Assessment of the Potable Water Supply and Distribution System in Rural Areas of Boyacá, Colombia, Using Water Safety Plans	Quantitative	Colombia	2025	Scopus
4	Pérez-Vidal et al. (2020)	Development and Implementation of a Water Safety Plan for the Drinking Water Supply System of Cali, Colombia	Quantitative	Colombia	2020	Scopus
5	Baracho et al. (2023)	Factors Impacting the Implementation of Water Safety Plans: A Case Study from Brazil	Qualitative	Brazil	2023	Scopus
6	Pundir et al. (2021)	Risk Assessment and Water Safety Planning for Rural Water Supply in Uttarakhand, India	Quantitative	India	2021	Scopus
7	Ko & Sakai (2022)	Water Sanitation, Hygiene, and the Prevalence of Diarrhea in Rural Areas of the Delta Region of Myanmar	Mixed	Myanmar	2021	Scopus
8	Galezzo & Rodríguez (2021)	The Challenges of Monitoring and Controlling Drinking Water Quality in Dispersed Rural Areas: A Case Study Based on Two Settlements in the Colombian Caribbean	Quantitative	Colombia	2021	Scopus
9	Szopińska et al. (2024)	Drinking Water Safety Evaluation in Selected Sub-Saharan African Countries: A Case Study of Madagascar, Uganda, and Rwanda	Quantitative	Madagascar, Uganda, Rwanda	2024	Scopus
10	Roman et al. (2021)	Optimizing Rural Drinking Water Supply Infrastructure to Account for Spatial Variations in Groundwater Quality and Household Welfare in Coastal Bangladesh	Quantitative	Bangladesh	2021	Scopus
11	Marwaha et al. (2021)	Identifying Agricultural Managed Aquifer Recharge Locations to Benefit Drinking Water Supply in Rural Communities	Quantitative	USA	2021	Scopus
12	Murray et al. (2024)	Innovative Models for Potable Water Supply in Rural Areas Affected by Climate Change	Quantitative	Sub-Saharan Africa and South Asia	2024	Scopus
13	Silva (2024)	Access and Supply of Rural Water in Mexico and Brazil	Systematic Review	Mexico and Brazil	2024	Scopus
14	Pareja-Pineda (2023)	Limits to Articulation, Decentralization, and Participation in Chilean Rural Drinking Water	Qualitative	Chile	2023	Scopus
15	Sapién-Aguilar et al. (2025)	Administrative Strategy for Potable Water Management in Rural Communities in the State of Chihuahua	Mixed	Mexico	2024	Scopus
16	Razafindratsima et al. (2019)	The Impact of Rain on the Quality of Drinking Water in Antananarivo, Madagascar	Quantitative	Madagascar	2019	Scopus
17	Chathuranika et al. (2022)	Evaluation of Future Flow in the Upper Nilwala River Basin (Sri Lanka) Under Climate Change	Quantitative	Sri Lanka	2022	Scopus
18	Domínguez et al. (2016)	Service Provision in Rural Water Systems: Analysis of Four Community Systems in Colombia	Mixed	Colombia	2016	Scopus
19	Silva (2022)	Improvement of Rural Water Supply in Paraguay During COVID-19	Systematic Review	Paraguay	2022	Scopus

20	Leon et al. (2020)	Forecasting Water Consumption Using Soft Computing: A Case Study in Trinidad and Tobago	Quantitative	Trinidad and Tobago	2020	Scopus
21	Togo et al. (2024)	Water Provision in Rural Municipalities During the COVID-19 Pandemic	Quantitative	South Africa	2024	Scopus
22	Angelova et al. (2024)	Technical and Economic Impact of Water Reuse as an IWRM Measure in Rural Water Supply Systems	Quantitative	Bulgaria	2024	Scopus
23	Chen (2024)	Construction of a Rural Water Environment Management System from the Perspective of Ecological Civilization	Quantitative	China	2024	Scopus
24	Xu et al. (2023)	Identification and Analysis of Factors Influencing Construction Quality Management in Rural Drinking Water Safety Projects	Qualitative	China	2023	Scopus
25	Sambo et al. (2021)	Systems Analysis: Complex Factor Interactions Affecting the Sustainability of Access to Improved Water Services in a Rural Municipality in South Africa	Mixed	South Africa	2021	Scopus
26	Aliabadi et al. (2020)	Rural People's Intention to Adopt Sustainable Water Management Through Rainwater Harvesting Practices: Application of the TPB and HBM Models	Quantitative	Iran	2020	Scopus
27	Chew & Ng (2019)	Feasibility of Solar-Powered Ultrafiltration Water Treatment Systems for Rural Water Supply in Malaysia	Quantitative	Malaysia	2019	Scopus
28	Sumanasekara et al. (2025)	Perspectives on the Irrigation Efficiency of Three Canal Systems to Improve Agricultural Sustainability in Sri Lanka	Quantitative	Sri Lanka	2025	Scopus
29	Richards et al. (2025)	Water Reuse Options for Decentralized MBR Effluents: A Case Study in South Africa	Mixed	South Africa	2025	Scopus
30	Molinos-Senante et al. (2019)	Service Quality Assessment for Potable Water Supply in Rural Settings: A Synthetic Index Approach	Mixed	Chile	2022	Scopus

3.6. Countries of Origin of the Studies

The reviewed articles encompass research conducted in 17 different countries, with a clear predominance of Latin America and Africa. Colombia has the highest number of studies, with six publications, followed by Chile, Peru, and South Africa, each with three. Brazil, Iran, Mexico, and Sri Lanka are represented in two studies each. Additional countries include India, China, Myanmar, Paraguay, Trinidad and Tobago, Bulgaria, Malaysia, Madagascar, Uganda, and Rwanda. Some studies are multinational, involving comparative analyses between two or three countries. This geographic diversity reflects a shared concern for access to and sustainability of rural drinking water in the face of climate change, particularly in vulnerable regions of the Global South.

3.7. Theoretical Frameworks Used In the Studies

Although many studies do not explicitly adopt theoretical models, several incorporate recognizable conceptual frameworks. The Water Safety Plan (WSP) is used as a structural approach in at least nine studies. The Theory of Planned Behavior (TPB) and the Health Belief Model (HBM) are applied jointly in an Iranian study on water harvesting. Another article uses Grounded Theory alongside DEMATEL-ISM to model quality factors in water projects. In some cases, Integrated Water Resources Management (IWRM) is employed as a methodological approach. While the formulations differ, the conceptual foundations converge in prioritizing preventive, participatory, and adaptive management of water resources in rural settings.

3.8. Research Objectives

The objectives of the studies show a strong focus on risk evaluation, sustainability, and quality of rural drinking water supply. At least eight articles analyze the implementation or effectiveness of the Water Safety Plan. Five aim to propose or validate predictive or administrative models. Six focus on assessing the impact of climate change on water availability. Additional objectives include systematic reviews, legislative explorations, and evaluations of perception and adoption of sustainable practices. Despite the variation in formulations, all objectives converge on improving access, quality, or sustainability of rural drinking water.

3.9. Types of Methodologies Employed

The methodologies used are diverse, although quantitative and mixed-method approaches predominate. Twelve studies use quantitative methods, mainly through surveys, laboratory analyses, hydrological modeling, or risk index calculations. Ten employ mixed methods, combining quantitative data with interviews or qualitative analysis. Six are based on systematic or documentary reviews, and only two rely solely on qualitative approaches. This methodological diversity reflects the complexity of the topic, though there is a clear preference for empirical analysis of objective data in rural contexts.

3.10. Population and Sample

The most frequently studied populations are rural communities (18 articles), followed by water systems managed by local committees or entities (7). Other studies focus on the perceptions of public officials, service providers, or technical experts (4). Some examine entire regions or specific cities affected by climate events (3), while others use hydrological models without a direct population sample (2). Most samples focus on households, community leaders, or rural aqueducts, reflecting a concern for the structural and social conditions of water management.

3.11. Instruments Used

The most common instruments are structured surveys, used in at least 10 studies. Nine employ water quality analysis through microbiological or physicochemical testing. Seven use semi-structured interviews or focus groups. Hydrological modeling systems, risk indices (such as IRCA or WQI), advanced statistical analyses, and georeferencing tools (GIS) are also frequently used. Three studies utilize software for climate modeling or hydrological simulation. The selection of instruments reflects the need to combine objective data with community perceptions and territorial analysis.

3.12. Variables Addressed

Among the most frequently studied variables are water quality (14 articles), health or environmental risks (9), service sustainability (8), and community perception or attitudes towards water management (7). Other variables include citizen participation, governance, operational efficiency, climate vulnerability, and type of water source. In some cases, variables such as "water resilience," "organizational capacity," or "economic efficiency" appear as composite factors or indicators. While terminology varies, most studies converge on themes of quality, access, management, and sustainability of rural water.

3.13. Mitigation and Adaptation Strategies

The most common strategies include the implementation of the Water Safety Plan (10 articles), followed by community training actions (7), institutional strengthening (5), and improvements in water capture and treatment infrastructure (9). Four studies highlight water reuse, rainwater harvesting, or source diversification. Others propose continuous monitoring systems, educational campaigns, or multisectoral partnerships. Despite varying terminology, most studies promote anticipatory adaptation based on community management, technical improvements, and social participation in response to the impacts of climate change.

3.14. Innovative Supply Models In The Face Of Climate Change

The most cited models include hybrid systems for rainwater harvesting and wastewater reuse (6 studies), solar ultrafiltration (2), decentralized supply networks (3), and predictive models based on artificial intelligence or hydrological modeling (5). Other works propose integrated approaches combining local knowledge with climate simulations. Adaptive community water management systems and co-production regulatory frameworks are also identified. While the degree of technological innovation varies, nearly all models aim to ensure sustainable access in rural areas with high climate vulnerability.

Table 3: Overlaps between Narrative Findings and the Reviewed Articles.

Category	Observed Overlaps	Key Authors

Country of Origin	Colombian articles predominate (6), followed by Chile, Peru, and South Africa (3 each). Brazil, Iran, Mexico, and Sri Lanka appear in two studies each. Other countries represented include India, China, Myanmar, Paraguay, Trinidad and Tobago, Bulgaria, Malaysia, Madagascar, Uganda, and Rwanda.	Ramos-Parra et al. (2025); Pareja-Pineda (2023); Silva (2024)
Theories Addressed	Theoretical frameworks include the Water Safety Plan (9), the Theory of Planned Behavior (TPB), the Health Belief Model (HBM), Grounded Theory combined with DEMATEL-ISM, and Integrated Water Resources Management (IWRM) approaches.	Aliabadi et al. (2020); Xu et al. (2023); Baracho et al. (2023)
Research Objectives	Research objectives focus on risk assessment, sustainability, and water quality in rural areas. Eight studies address WSP implementation, five propose or validate models, and six explore climate change impacts.	Ramos-Parra et al. (2025); Chathuranika et al. (2022); Ko & Sakai (2022)
Methodology Employed	Quantitative approaches predominate (12), followed by mixed methods (10), systematic reviews (6), and qualitative designs (2).	Galezzo & Rodríguez (2021); Pundir et al. (2021); Richards et al. (2025)
Population and Sample	The main populations studied are rural communities (18 studies), water committees or local managers (7), government officials or technicians (4), and hydrological models without direct human populations (2).	Domínguez Rivera et al. (2016); Togo et al. (2024); Silva (2022)
Instruments Used	Instruments used include structured surveys (10), laboratory analysis (9), semi-structured interviews (7), hydrological modeling, risk indices, and GIS systems.	Higuera-Rodríguez et al. (2020); Mehrabani Bashar et al. (2023); Szopińska et al. (2024)
Variables Addressed	Most frequent variables include water quality (14), health or environmental risks (9), service sustainability (8), and community perceptions or attitudes (7). Governance, participation, and operational efficiency also appear.	Leon et al. (2020); Pérez-Vidal et al. (2020); Angelova et al. (2024)
Mitigation and Adaptation Strategies	Key mitigation and adaptation strategies include the Water Safety Plan (10), community training (7), institutional strengthening (5), water infrastructure development (9), and rainwater harvesting or reuse (4).	Ko & Sakai (2022); Pundir et al. (2021); Baracho et al. (2023)
Innovative Supply Models in Response to Climate Change	Innovative supply models feature rainwater collection and reuse (6), solar-powered ultrafiltration systems (2), decentralized networks (3), AI and hydrological modeling (5), and adaptive community-based management systems.	Chew & Ng (2019); Angelova et al. (2024); Murray et al. (2024).

4. DISCUSSION

Con el fin de identificar patrones conceptuales y metodológicos, los estudios incluidos se organizaron en cinco categorías temáticas: (1) planes de seguridad del agua y gestión comunitaria; (2) calidad del agua y riesgos sanitarios; (3) impactos del cambio climático en la disponibilidad; (4) innovaciones tecnológicas y modelos predictivos; y (5) enfoques integradores y políticas públicas. Esta reagrupación permite comparar enfoques, detectar vacíos y derivar implicancias para la gobernanza del agua en zonas rurales afectadas por el cambio climático.

Table 4: Emerging Thematic Axes in the Study of Rural Drinking Water In The Face Of Climate Change: Analysis of 30 Scientific Articles.

Thematic Category	Included Authors	Main Focus
1. Water Safety Plans (WSP), governance, and community-based management	Ramos-Parra et al. (2025), Pérez-Vidal et al. (2020), Baracho et al. (2023), Pundir et al. (2021), Galezzo & Rodríguez (2021), Pareja-Pineda (2023), Sapién-Aguilar et al. (2025), Domínguez et al. (2016), Marwaha et al. (2021), Murray et al. (2024), Silva (2024), Xu et al. (2023), Chen (2024), Molinos-Senante et al. (2019)	Risk assessment, institutional and community strengthening, regulatory framework, WSP, decentralization
2. Water quality and health-related risks	Ko & Sakai (2022), Szopińska et al. (2024), Galezzo & Rodríguez (2021), Razafindratsima et al. (2019), Richards et al. (2025), Chew & Ng (2019), Pundir et al. (2021), Xu et al. (2023), Murray et al. (2024)	Microbiological contamination, risks from metals and chemicals, quality monitoring, treatment technologies
3. Climate change, water availability, and extreme events	Silva et al. (2023), Roman et al. (2021), Chathuranika et al. (2022), Leon et al. (2020), Sumanasekara et al. (2025), Silva (2022), Togo et al. (2024), Razafindratsima et al. (2019), Angelova et al. (2024), Richards et al. (2025)	Droughts, increased water flow, climate risks, rural vulnerability, COVID-19 impacts on water access
4. Predictive models, technological solutions, and operational sustainability	Mehrabani et al. (2023), Leon et al. (2020), Aliabadi et al. (2020), Angelova et al. (2024), Chew & Ng (2019), Xu et al. (2023), Sumanasekara et al. (2025), Richards et al. (2025), Chen (2024)	Intelligent models (SVMeSA, GEP), rainwater harvesting, water reuse, ultrafiltration, operational efficiency, automation

5. Public policies, legal frameworks, and community participation	Murray et al. (2024), Silva (2024), Pareja-Pineda (2023), Sapién-Aguilar et al. (2025), Domínguez et al. (2016), Molinos-Senante et al. (2019), Xu et al. (2023), Togo et al. (2024), Baracho et al. (2023)	Rural legal framework, access typologies, local–state coordination, participation, national regulation and planning

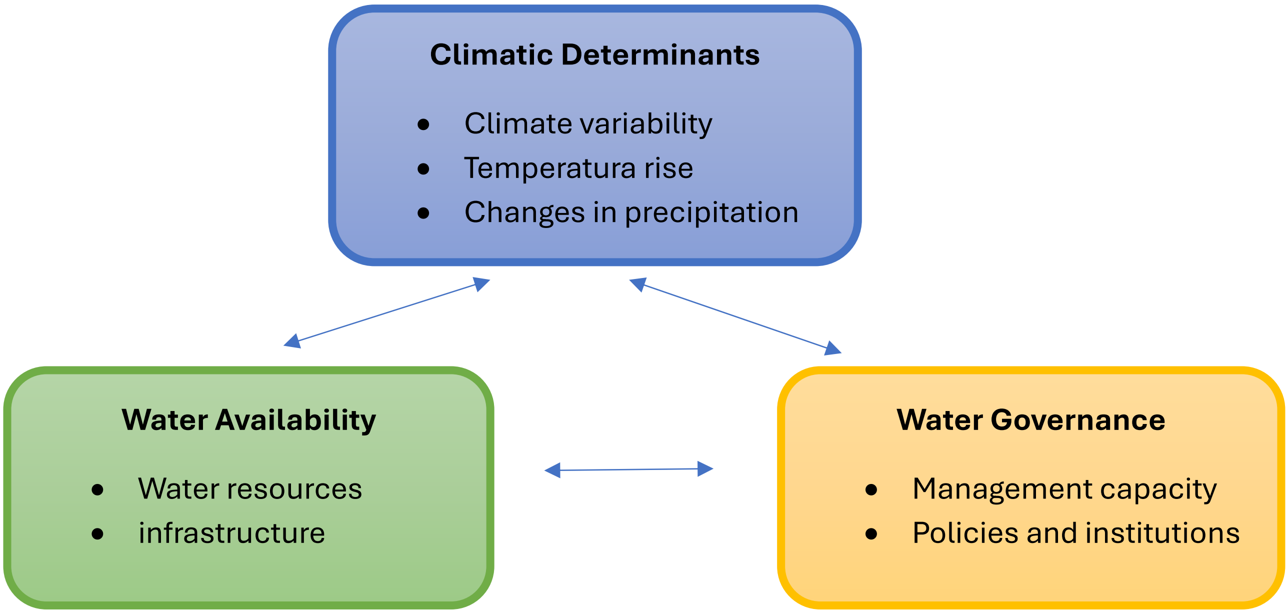

Figure 2: Interpretive Model of the Factors Conditioning the Availability of Drinking Water in Rural Areas Vulnerable To Climate Change.

The model synthesizes the main factors identified in the reviewed literature, organized into three key dimensions: climatic determinants, water availability, and resource governance. The bidirectional relationships indicate interdependence between these elements, where climate variability directly affects water supply and strains local management capacities. The diagram summarizes the central findings of this review and can serve as a conceptual basis for future comparative research or adapted public policy design.

4.1. Community Management in Rural Water Systems

In the reviewed studies, community-based water management in rural areas articulates technical, social, and organizational dimensions, facing multiple structural tensions. Ramos et al. (2025) demonstrated that water safety plans are only effective when communities actively participate in identifying risks and solutions. Furthermore, access to water in rural Chilean areas has been shown to be highly heterogeneous, requiring decentralized and flexible responses (Molinos et al., 2019). Likewise, Domínguez et al. (2016) identified that community systems with limited technical support and no institutional continuity tend to weaken in their operation. It has also been suggested that the absence of adapted support models affects operational sustainability in dispersed territories (Baracho et al., 2023).

Moreover, Pareja (2023) warned that Chilean legislation, although recognizing participation and decentralization, does not establish clear mechanisms for intersectoral coordination. Similarly, the lack of differentiated policies based on territorial vulnerability hinders equitable access to water resources (Silva, 2024). Domínguez et al. (2016) also showed that systems serving small populations require specific technical and financial support strategies. It has been noted that the effectiveness of water safety plans is directly linked to the existence of flexible and adaptive governance networks (Baracho et al., 2023).

Methodological gaps have also been identified, limiting the possibility of building replicable patterns of efficient management. For this reason, studies that combine participatory instruments with technical evaluation have been proposed as more territorially applicable (Ramos et al., 2025). In contrast, it has been noted that normative approaches, though useful for institutional design, do not guarantee feasibility in rural operational contexts (Pareja, 2023). Moreover, Molinos et al. (2019) stressed that policies must be based on territorial realities rather than standardized models. Therefore, a strengthening route is proposed based on community indicators sensitive to local diversity and situated governance (Silva, 2024).

4.2. Climate Change Impacts on Supply

The impacts of climate change on rural water supply manifest in reduced availability, increased variability, and weakened operational resilience. Silva et al. (2023) documented a significant rise in extreme events in the Brazilian Amazon, where floods and droughts recurrently alter local hydrological balance. Furthermore, the frequency of climate emergencies puts pressure on existing water infrastructure, especially in highly vulnerable municipalities (Angelova et al., 2024). Similarly, Chathuranika et al. (2022) showed that streamflows in Sri Lanka are expected to increase significantly under RCP scenarios, raising the risk of both scarcity and excess water. It has also been shown that rural communities are often excluded from state hydrological mitigation strategies (Marwaha et al., 2021).

In addition, Mehrabani et al. (2023) demonstrated through hybrid models that drinking water demand in Iran is highly sensitive to changes in population and precipitation. It has also been found that temperature has less impact than social variables such as the number of subscribers (Silva et al., 2023). Moreover, Chathuranika et al. (2022) concluded that projected increases in rainfall will severely alter the seasonal behavior of basins. It has also been suggested that groundwater availability in high Andean regions will decline unless infiltration and soil conservation plans are applied (Roman et al., 2021).

Angelova et al. (2024) further pointed out that combining greywater reuse and rainwater harvesting could reduce potable water use by up to 60 % in small systems. It has also been proposed to integrate climate modeling tools with community approaches to ensure technical and economic sustainability (Mehrabani et al., 2023). Thus, decentralized solutions have been reinforced as more adaptable to climate variability (Silva et al., 2023). Finally, Marwaha et al. (2021) emphasized that integrated intervention frameworks must be built through articulation between local knowledge and scientific evidence.

4.3. Implemented Water Safety Plans

Water safety plans (WSPs) have been consolidated as key tools to address water vulnerability in rural settings, although their effectiveness depends on technical, institutional, and social factors. Ramos et al. (2025) applied phases two and three of the WSP in Colombia, showing that the highest concentration of risks is found in uncontrolled intake zones. It has also been determined that the success of WSPs in urban contexts, such as Cali, depends on methodological flexibility and the integration of all system actors (Pérez et al., 2020). Additionally, Baracho et al. (2023) concluded that administrative discontinuities and low institutional priority hinder implementation in Brazil. Permanent technical support has also been noted as crucial for long-term sustainability (Domínguez et al., 2016).

Moreover, Xu et al. (2023) used the DEMATEL-ISM model to show that quality control and leadership are central factors in managing WSPs in rural areas of China. It has also been indicated that the absence of clear operational structures compromises systematic execution of plans (Baracho et al., 2023). Ramos et al. (2025) also emphasized that differences in operation and maintenance among rural aqueducts influence the outcomes of WSPs. Community participation from the design stage has been observed to improve risk identification and preventive planning (Pérez et al., 2020).

Furthermore, Pundir et al. (2021) showed in India significant statistical improvements in water quality after implementing WSP measures in four rural systems. Sanitary monitoring and technical inspection have also been found to strengthen adaptive system capacity (Xu et al., 2023). The importance of adapting WSPs to local conditions—beyond the original WHO methodology—has been reinforced (Baracho et al., 2023). Finally, Domínguez et al. (2016) warned that without post-implementation technical support, initial results tend to fade over time.

4.4. Microbiological and Physicochemical Water Quality

Water quality in rural areas continues to be marked by multiple microbiological and physicochemical deficiencies, which directly affect public health and resource sustainability. Ko and Sakai (2022) found that all sources evaluated in Myanmar were contaminated with fecal coliforms, associated with a high prevalence of diarrhea. In addition, it has been documented that in the Colombian Caribbean, all household samples showed Escherichia coli and high turbidity levels (Galezzo & Rodríguez, 2021). Similarly, Szopińska et al. (2024) found concerning levels of nitrates and organic pollutants in Africa, posing a significant non-carcinogenic risk to consumers. It has also been indicated that household storage systems tend to degrade water quality, especially in areas with precarious infrastructure (Razafindratsima et al., 2019).

On the other hand, León et al. (2020) applied computational models in the Caribbean to forecast consumption peaks that coincide with greater microbiological risks. Moreover, climate variability has been shown to cause interruptions in seasonal quality patterns, affecting conventional treatment (Ko & Sakai, 2022). It has been determined that prolonged storage without proper treatment increases the presence of coliform bacteria (Szopińska et al., 2024). Deficient infrastructure and rural topography also make sustained sanitary surveillance interventions more difficult (Galezzo & Rodríguez, 2021).

Furthermore, Chen (2024) indicated that implementing ecological management models significantly improves physicochemical and microbiological quality levels in rural Chinese communities. It has also been suggested that intense rainfall increases sedimentation and alters the organic composition of water in tropical regions (Razafindratsima et al., 2019). Similarly, studies agree that open sources show higher concentrations of iron, lead, and turbidity (Galezzo & Rodríguez, 2021). Szopińska et al. (2024) also recommended using standardized quality indices to detect specific threats and guide effective technical interventions.

4.5. Water Adaptation and Mitigation Strategies

Water adaptation and mitigation strategies in rural contexts show uneven progress in the face of increasing extreme events and water stress. Silva et al. (2023) highlighted that the governmental response to droughts and floods in Brazil is limited to emergency decrees, lacking sustainable structural plans. In addition, the implementation of water safety plans has been shown to reduce microbiological risks and improve water quality in rural areas of India (Pundir et al., 2021). Likewise, Togo et al. (2024) indicated that rainwater harvesting and household treatment have been effective responses during the pandemic in southern African communities. Community education on hygiene and water conservation has also been identified as key to sustaining advances in local resilience (Murray et al., 2024).

Sapién et al. (2025) developed an administrative strategy that strengthens the operational management of rural committees in Mexico, improving maintenance and infrastructure. Furthermore, it has been demonstrated that the active participation of women in water management allows for more equitable and sustainable allocation (Togo et al., 2024). Murray et al. (2024) also observed that diversifying water sources reduces dependency on systems vulnerable to climate change. It has also been suggested that access to appropriate decentralized purification technologies increases community autonomy (Aliabadi et al., 2020).

Aliabadi et al. (2020) showed that the adoption of rainwater harvesting practices is determined by risk perceptions and perceived health benefits. Social norms and community identity also influence the willingness to implement sustainable technologies (Togo et al., 2024). It has been observed that locally focused educational campaigns reinforce mitigation practices and rational water use (Pundir et al., 2021). Finally, Murray et al. (2024) emphasized that any effective strategy requires integration between technical knowledge and territorial wisdom.

4.6. Innovative Models for Decentralized Water Supply

Innovative models for decentralized water supply are emerging as viable alternatives in response to limited state coverage and climate pressure in rural areas. Mehrabani et al. (2023) developed a hybrid model using artificial intelligence to predict drinking water demand based on demographic and climate variables. The use of hydrological simulation has also been shown to anticipate groundwater recharge scenarios in high Andean regions (Roman et al., 2021). Chew and Ng (2019) designed a solar-powered ultrafiltration system that improves water quality in off-grid rural communities in Malaysia. It has also been determined that automating water monitoring increases operational efficiency and reduces distribution errors (Richards et al., 2025).

Angelova et al. (2024) assessed the technical and economic feasibility of combining rainwater harvesting with greywater reuse in rural household systems. These models have been shown to reduce treated drinking water demand by up to 60%, easing pressure on central treatment plants (Murray et al., 2024). Decentralized design has thus been proposed as not only more flexible but also more resilient to climate variability (Mehrabani et al., 2023). Community-led implementation of these solutions has also been observed to enable greater territorial adaptability and financial sustainability (Angelova et al., 2024).

Richards et al. (2025) proposed direct and indirect reuse systems through reverse osmosis and aquifer recharge as strategies to expand water availability. Decentralized models have also been argued to reduce operating costs and improve local self-sufficiency (Chew & Ng, 2019). Integration of technical and traditional knowledge has been shown to strengthen community ownership of these technologies (Murray et al., 2024). However, Roman et al. (2021) warned that without adequate maintenance plans, even innovative models lose effectiveness over time.

4.7. Comparison with Recent Literature and Transferability of Findings

Although the studies included in this review are concentrated in Global South contexts, the findings identify patterns and challenges that transcend these regions. For example, the effectiveness of Water Safety Plans (WSPs) as tools for mitigating health risks and adapting to climate change remains consistent across Latin America, Asia, and Africa, suggesting their applicability in other rural settings worldwide. Likewise, strategies such as rainwater harvesting, community governance, or operational decentralization have proven effective under budgetary, climatic, and regulatory constraints. These insights offer valuable input for rural regions in developed countries facing aging infrastructure, water stress, or institutional disengagement. The evidence gathered in this review strengthens the argument that solutions based on local participation, source diversification, and capacity-building are transferable and scalable, as long as they are adapted to the sociocultural conditions of each territory.

Consequently, the results contribute not only to water planning in vulnerable areas of Latin America and Africa, but also align with global agendas such as SDG 6 and the Sendai Framework for Disaster Risk Reduction, by highlighting resilient, participatory, and sustainable approaches. This review, therefore, expands the analytical horizon for the formulation of integrated public policies on rural drinking water, both in developing countries and in those facing emerging sustainability challenges.

5. ARTICLE CONTRIBUTION

This article provides a structured overview of the main lines of research on drinking water availability in rural areas impacted by climate change, integrating empirical evidence and critical analysis across six key dimensions. Common patterns were identified in the implementation of community management models, highlighting that their effectiveness is conditioned by technical support, local leadership, and institutional coordination. It was evidenced that the impacts of climate change on rural supply manifest in multiple forms, from hydrological changes to structural crises in infrastructure. The analysis of water safety plans showed that their success depends on methodological adaptation to context and on strengthening local capacities. The review also documented widespread deficiencies in the physicochemical and microbiological quality of water, especially in regions with precarious storage systems or contaminated natural sources. Adaptation and mitigation strategies, when integrating appropriate technologies, social participation, and health education, demonstrated greater effectiveness and sustainability. Finally, innovative models of decentralized water supply—particularly those based on renewable energy and reuse—offer viable alternatives to expand coverage and improve resilience to adverse climate scenarios.

6. LIMITATIONS AND RECOMMENDATIONS

One of the main limitations of this literature review lies in its focus on sources in Spanish, English, and Portuguese, meaning that research published in other languages may have provided alternative perspectives or complementary evidence. Another limitation relates to the limited availability of comparative studies between regions, which hindered a more in-depth analysis of contextual differences. Based on these aspects, it is recommended that future research address rural drinking water availability through systematic reviews with broader multilingual and multicriteria coverage. It is also suggested to explore knowledge co-production mechanisms among communities, academia, and policymakers, in order to strengthen sustainable and culturally relevant strategies in response to the rural water crisis.

7. CONCLUSION

This review demonstrates that improving access to drinking water in rural areas depends on both climatic factors and institutional, social, and technological conditions. The most effective solutions are those that integrate participatory governance, technical monitoring, and regulatory flexibility. Climate change intensifies existing vulnerabilities and demands adaptive responses based on local knowledge and scientific evidence. Decentralized models and low-cost technologies represent strategic opportunities to expand coverage and resilience, provided they are supported by institutional backing and community training. Public policies must recognize territorial diversity and design regulatory frameworks that enable collaborative water management under climate uncertainty.

8. DECLARATION OF CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to this research.

9. DECLARATION ON THE USE OF ARTIFICIAL INTELLIGENCE

The authors declare that artificial intelligence tools were used solely as support resources during the development of this article and did not replace human reflective or intellectual processes at any point. After carrying out a thorough review process using various specialized platforms, it was confirmed that the content presents no evidence of plagiarism, as properly documented. The authors also affirm that this work is the result of original and autonomous intellectual effort and has not been previously published or generated by automated systems or digital writing platforms.

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