

Bottom-Up Approaches to Rural Water Security

Evidence from a Community-Based WASH Project in Nigeria

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ABSTRACT

Access to clean water remains a critical challenge in rural Nigeria, with over 60 million people lacking safe drinking water. This study examines a bottom-up, community-based WASH intervention implemented by the Rural Nurture Initiative in rural communities in southwestern Nigeria. Employing a qualitative single case study approach, the research used in-depth interviews with local leaders and focus group discussions with project beneficiaries. Results revealed that community participation in project design, implementation, and monitoring fostered a sense of ownership and contributed to project sustainability. Community preference for well water infrastructure over solar boreholes highlighted the importance of contextually appropriate technology selection. Additionally, WASH education components significantly improved hygiene practices among beneficiaries. The study concludes that participatory approaches to rural water provision are essential for sustainable community development and recommends that policies promoting community ownership and participatory water resource management be advanced to address water challenges in rural Nigeria.

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Introduction

Water is a fundamental human right and essential for achieving the Sustainable Development Goals (SDGs), particularly SDG 6: clean water and sanitation [1]. The United Nations recognizes that "the human right to water entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses" [2]. Despite this recognition, many communities worldwide continue to face significant challenges in accessing clean water, with rural areas being disproportionately affected [1]. As of 2019, Nigeria's Water, Sanitation, and Hygiene (WASH) sector was reportedly in crisis, with more than 60 million people lacking access to safe drinking water, with rural dwellers being particularly affected [3]. The situation has been characterized by failing infrastructure, inadequate government investment, and insufficient community engagement in water-resource management. Inadequate water supply and poor sanitation in Nigeria contribute to high infant mortality rates and reduced productivity, due to water-borne diseases [4],[5]. The inadequate access to clean water not only compromises health and well-being but also undermines economic development and social progress in rural communities. Women and children often bear the greatest burden, spending considerable time and energy fetching water from distant sources, time that could otherwise be spent on education, income-generating activities, or leisure [6]. Furthermore, the lack of clean water exacerbates gender inequalities, as women are typically responsible for household water management in most Nigerian rural contexts.

In response to these challenges, the Rural Nurture Initiative (RNI), as a social impact organisation advancing community-centred rural development across Africa, implemented a safe rural water project in Oyo State, Nigeria, using bottom-up approaches to enhance water infrastructure in rural communities [7]. The importance of such community-led initiatives has been recognized by Fadairo et al., who noted that RNI's participatory approach to WASH intervention in Agele and Mogba communities can create sustainable water solutions in rural settings [8]. This intervention was particularly significant given the increased importance of handwashing and hygiene practices in rural communities, when water access is not only a development issue but also a critical public health concern.

Several studies have documented the importance of community participation in water projects, suggesting that community involvement in planning, implementation, and management leads to more sustainable outcomes [9],[10]. However, there remains a need for context-specific evidence on how participatory approaches function in practice, particularly in rural Nigerian settings.

Understanding the effectiveness of community-based approaches to WASH interventions is crucial for informing sustainable water resource management strategies in rural areas. This study assesses RNI's safe rural water project and identifies key lessons from the organization's implementation approach to contribute to the broader discourse on sustainable WASH interventions in rural Africa. Specifically, the study aims to:

- Examine the process and outcomes of community participation in the RNI water project
- Assess the factors influencing technology selection in rural water interventions
- Explore the relationship between WASH education and hygiene practice changes
- Identify key lessons for sustainable rural water interventions in similar contexts

By addressing these objectives, this study contributes to the growing body of knowledge on participatory approaches to rural development, with specific insights for water resource management in challenging contexts.

Literature Review

A. Community Participation in Water Resource Management

Community participation in development projects has gained increased recognition as essential for sustainable outcomes. Arnstein's seminal "ladder of citizen participation" provided an early framework for understanding different levels of community involvement, ranging from manipulation and tokenism to genuine citizen power [11]. In the context of water resources management, the Dublin Principles of 1992 explicitly recognized that "water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels" [12]. Empirical studies have demonstrated various benefits of community participation in water projects. Community participation contributes to project sustainability by increasing users' sense of ownership, willingness to pay for services, and capacity to manage infrastructure [13]. Similarly, participatory approaches lead to more contextually appropriate technological choices and higher satisfaction with water services [14]. However, critiques of participatory approaches have also emerged. There is a caution against romanticizing community participation, noting that communities are not homogeneous entities and participatory processes may reproduce existing power inequalities [15]. Furthermore, it is observed that participatory projects often face challenges in ensuring inclusive representation, particularly of marginalized groups [16]. In the Nigerian context, several studies have examined community participation in water projects with mixed findings. Akpabio [17] found that cultural beliefs and practices significantly influence community engagement with water interventions in southern Nigeria. Successful community-managed water schemes are documented, but noted challenges related to technical capacity and financial sustainability [18].

B. Technology Selection in Rural Water Interventions

The selection of appropriate technology for rural water supply has been a subject of considerable debate in development literature. The "appropriate technology" movement, popularized by Schumacher's [19] "Small is Beautiful," advocated for technologies that are small-scale, decentralized, labor-intensive, and environmentally sound. In the water sector, this has translated into preferences for technologies that match local technical capacities, economic resources, and environmental conditions. Key factors influencing the sustainability of rural water technologies include maintenance requirements, spare parts availability, technical capacity of users, and life-cycle costs [6]. Their study found that technically sophisticated solutions often fail in rural contexts due to maintenance challenges, whereas simpler technologies that can be managed locally tend to have greater longevity.

The debate between "traditional" and "modern" water technologies continues to evolve. While solar-powered systems have gained popularity due to their environmental benefits and potential for reducing operating costs, studies by Practical Action have documented challenges related to technical expertise for maintenance and high upfront costs [20]. In contrast, improved versions of traditional technologies like hand-dug wells with modern protective features have shown resilience in various contexts [21]. In Nigeria specifically, technology choices for rural water supply are often made without adequate consideration of community preferences or maintenance capabilities, contributing to high failure rates of water infrastructure. This highlights the need for more community-driven approaches to technology selection.

C. WASH Education and Behaviour Change

Infrastructure improvements alone are insufficient for achieving health benefits from water interventions. Educational components that promote hygiene awareness and behaviour change are increasingly recognized as essential elements of comprehensive WASH programs [18]. A review found that hygiene education interventions reduced diarrheal disease by an average of 28%, comparable to the impact of water supply interventions (25%). However, the most significant reductions came from combined approaches that addressed both infrastructure and behaviour. Various theories and frameworks have been developed to understand and promote hygiene behaviour change. The RANAS (Risk, Attitudes, Norms, Abilities, and Self-regulation) model developed by Mosler identifies psychological factors that influence hygiene behaviours and has been successfully applied in multiple contexts [24]. Similarly, the Integrated Behavioural Model for Water, Sanitation, and Hygiene (IBM-WASH), which considers contextual, psychosocial, and technological factors in behaviour change, was proposed [25]. In Nigeria, the effectiveness of community-based hygiene education in improving water handling practices and reducing

waterborne diseases [26]. However, sustaining behaviour change over time remains a challenge that requires ongoing engagement and reinforcement.

D. Theoretical Framework

This study is guided by a framework that integrates three interconnected concepts: participatory approaches, community-based water resource management, and rural water sustainability (Fig. 1). This framework recognizes the essential role of multiple stakeholders—including community members, local leaders, government bodies, NGOs, and the private sector—in achieving sustainable water outcomes in rural areas.

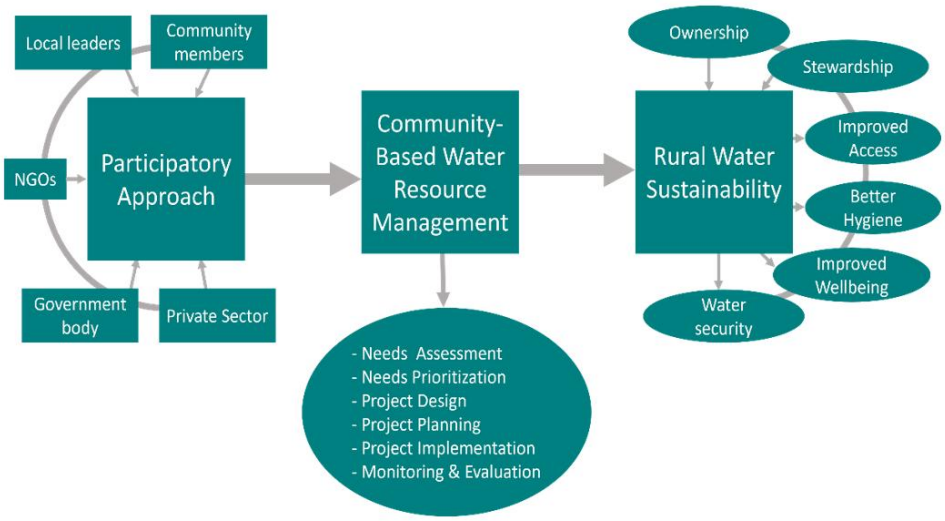


Fig. 1. A framework on participatory approach, community-based water resource management, and rural water sustainability.

Participatory approaches encompass various stages of project development, including needs assessment, needs prioritization, project design, planning, implementation, and monitoring and evaluation. This aligns with Chambers' concept of "putting the last first," which emphasizes the importance of centering marginalized voices in development processes [27]. The framework conceptualizes participation not as a singular event but as a continuous process throughout the project cycle, reflecting Pretty's typology of participation, which distinguishes between passive participation, consultation, functional participation, and self-mobilization [28].

When effectively applied, these participatory approaches facilitate community-based water resource management, which fosters a sense of ownership, stewardship, and sustainable practices among community members. This element of the framework draws on Ostrom's work on governing the commons, which identified design principles for successful community management of shared resources [29]. These principles include clearly defined boundaries, collective-choice arrangements, monitoring, graduated sanctions, and conflict-resolution

mechanisms. The framework posits that the integration of participatory approaches and community-based resource management ultimately contributes to rural water sustainability, characterized by water security, improved access, better hygiene practices, and enhanced overall well-being for rural communities. This reflects the concept of sustainability as multidimensional, encompassing not only environmental sustainability but also social, economic, and institutional dimensions [30].

This study was conducted in Ibarapa East Local Government Area (LGA), Oyo State, Nigeria. Ibarapa East covers approximately 838 square kilometers and had an estimated population of 118,226 according to the 2006 census, with projections suggesting current numbers exceed 150,000 [31]. Ibarapa East is predominantly rural, with agriculture serving as the primary livelihood for most residents. Despite the agrarian nature of the area, basic infrastructure such as electricity, roads, and potable water remains inadequate in many communities. This region is facing severe water access challenges, with most households relying on unimproved sources that pose significant health risks to community members [8].

Before the RNI intervention, many communities in Ibarapa East faced significant challenges relating to water access. A baseline assessment revealed that approximately 70% of households relied on unimproved water sources, including unprotected wells, streams, and ponds. During the dry season, water scarcity becomes particularly acute, with some residents traveling up to 3 kilometers to access water. Three villages, as shown in Fig. 2: Agele, Mogba, and Gaa-Agele, were selected as pilot communities for the project based on a water needs assessment conducted by RNI in collaboration with local leaders.

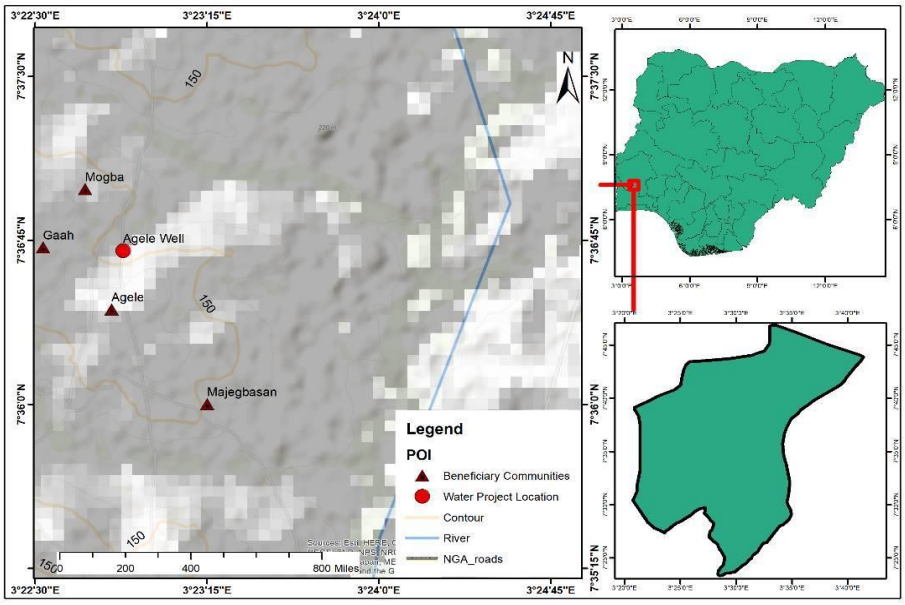


Fig. 2. Study area map showing project location and beneficiary communities

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Methods

A. Research Design

This study employed a qualitative single case study design to provide in-depth insights into the implementation and impact of RNI's water project. The case study focused on the RNI water project as the unit of analysis, with embedded units including the three beneficiary villages where focus groups were conducted.

B. Data Collection

Data were collected through in-depth interviews (IDIs) with eight key informants, including village heads, water committee chairpersons, and community development association representatives, and focus group discussions (FGDs) with project beneficiaries. The FGDs comprised six groups, three male groups and three female groups, across the three villages, with approximately 8–10 participants per group. In total, 58 participants participated in the focus group discussions. Semi-structured interviews and discussion guides explored key themes, including community water challenges, engagement in planning and implementation, decision-making processes for technology selection, changes in water access and hygiene practices, challenges encountered, and suggestions for sustainability.

All interviews and discussions were conducted in the local Yoruba language and subsequently translated into English for analysis. The data collection was carried out between April and June 2021, approximately six months after the completion of the water project.

C. Data Analysis

The qualitative data were analyzed using thematic content analysis, following Braun and Clarke's approach [32]. This involved familiarization with the data, initial coding, theme development, theme review, definition and naming, and report production. To enhance trustworthiness, the analysis involved multiple researchers who independently coded the data and then compared their interpretations. Member checking was also conducted by sharing preliminary findings with selected participants.

D. Ethical Considerations

Informed consent was secured from all participants after explaining the purpose of the study, voluntary participation, and confidentiality measures were ensured.

Results

A. Addressing the Community Water Crisis

Key informant interviews established the significance of the water project in addressing the water crisis in the beneficiary communities. All eight local leaders acknowledged that before the

intervention, their communities faced severe challenges in accessing clean water, particularly during the dry season.

As one local leader stated:

"Before this project, our people sometimes had to walk for more than an hour to get water, especially during the dry season. Now, with the well in our village, everyone can access clean water within minutes. This has been a great relief, especially for our women and children who used to bear the burden of water collection."

Community members also reported improvements in water quality. Before the intervention, many relied on surface water sources that were visibly contaminated and frequently caused waterborne illnesses. As illustrated in Fig. 3 and 4, a male focus group participant noted:

"The difference in water quality is clear to see. Before, our water often had visible particles and sometimes strange colors, especially during the rainy season. The water from the new well is much clearer, and we have noticed fewer stomach problems in our children."



Fig. 3. Water source before intervention



Fig. 4. Water source after intervention

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B. Timeliness of Intervention

Seven out of eight local leaders specifically mentioned that the intervention was timely, given the aftermath of the COVID-19 pandemic. The provision of clean water facilitated improved hygiene practices, which were particularly important during the pandemic when handwashing was emphasized as a preventive measure.

A community leader noted:

> *"The project came at a critical time when we needed clean water to practice handwashing to protect ourselves from COVID-19. It made a significant difference in our ability to follow health guidelines."*

Several participants observed that the water project had wider implications for community resilience during the pandemic. By ensuring a reliable water source within the community, residents were less dependent on traveling to neighboring areas, which reduced potential exposure to the virus.

C. Community Participation and Ownership

Focus group discussions revealed that community contribution to the project design, implementation, and monitoring gave them a strong sense of ownership. Participants reported being actively involved in decision-making processes, including site selection for the water infrastructure and the establishment of community-led management committees.

As expressed by a female participant:

> *"Unlike other projects where outsiders come and tell us what we need, RNI asked for our input and valued our opinions. This is why we believe this water project belongs to us and that we must maintain it. They involved us from the beginning when they were assessing our needs, and throughout the construction, we contributed labour and local materials."*

The participatory approach was extended to project governance, with each community establishing a water management committee with clearly defined roles and responsibilities. A male committee member explained:

> *"Our committee has representatives from different sections of the village, including women and youth. We developed rules for water use and maintenance together, and everyone understands and respects these rules because they participated in creating them."*

The sense of ownership has translated into ongoing maintenance practices. Regular cleaning schedules, minor repairs, and water quality monitoring are carried out by community members without external prompting. RNI's community-centred approach represents a model for sustainable rural WASH interventions that prioritizes local knowledge, builds community capacity, and creates lasting infrastructure improvements.

D. Infrastructure Preference and Sustainability

Participants expressed satisfaction that their preference for a well water infrastructure was prioritized over the NGO's initial solar borehole proposal. This decision was influenced by

community concerns about maintenance costs and the long-term sustainability of solar technology in their context.

One male participant explained:

"We chose the well because we know how to maintain it ourselves. With the solar borehole, if something breaks, we would need experts from outside to fix it, and it would be expensive. Our community has experience with wells, and we have local artisans who can handle repairs."

The technology choice reflects a balance between innovation and tradition. While the wells employ traditional water-lifting principles familiar to the community, they incorporate modern improvements, including reinforced concrete linings, protective covers, drainage systems, and improved pulley mechanisms.

The decision also considered economic sustainability factors. A community leader explained:

"We calculated the long-term costs, not just the initial construction. The solar borehole would have been more convenient with piped water, but when we considered replacement parts and specialized maintenance over 5 to 10 years, we realized it would be difficult for us to sustain."

E. Impact of WASH Sensitization

Participants mentioned that the WASH sensitization conducted before project implementation was instrumental in improving their hygiene practices. The educational component increased awareness about the connection between clean water, proper sanitation, and health outcomes.

A female beneficiary shared:

"The training we received changed how we handle water at home. Now, we treat water before drinking and store it properly. Our children have been falling sick less often since we started these practices."

The education sessions were conducted using participatory methods that encouraged community engagement and knowledge sharing. The WASH education also addressed local beliefs and practices that potentially compromised water safety.

Evidence of behaviour change was visible during community observations. Handwashing stations were present outside many homes, water storage containers were typically covered, and many households reported using water treatment methods before consumption.

E. Challenges and Adaptations

Despite the overall positive outcomes, participants also discussed challenges encountered during the project and adaptations made to address them. Seasonal variations in water availability remained a concern in one community where the water table drops significantly during the driest months. A water committee member explained:

"During January and February, the well water level decreases, and sometimes we have to restrict usage to ensure everyone gets some. We have developed a schedule where households can collect specific amounts at designated times."

Initial resistance from some community members was another challenge. The COVID-19 pandemic necessitated adaptations to the implementation process. Group activities were modified to comply with safety guidelines, and construction timelines had to be adjusted due to movement restrictions and supply chain disruptions.

Competition for leadership roles in water management presented another challenge in one community. A female participant explained:

> *"There was initially some tension about who would serve on the water committee, with certain families or individuals wanting to control the resource. RNI facilitated a transparent selection process where different segments of the community nominated representatives."*

Discussion

A. Community Participation and Sustainability

The strong emphasis on community participation throughout the project cycle corresponds with research suggesting that community involvement enhances the sustainability of development interventions [9]. By actively engaging community members in various stages, RNI fostered a sense of ownership that is likely to contribute to the long-term maintenance and sustainability of the water infrastructure.

This approach addresses one of the primary challenges facing rural water projects globally: the high rate of infrastructure failure due to limited community buy-in and inadequate maintenance arrangements [6,10]. The findings suggest that meaningful participation goes beyond mere consultation to include substantive influence over key decisions and tangible contributions to implementation. This aligns with Pretty's distinction between passive, consultative, and interactive participation, with the latter being most strongly associated with sustainable outcomes [28]. Furthermore, the establishment of representative water committees with clear governance structures and maintenance protocols reflects Ostrom's (1990) design principles for successful common-pool resource management [29].

B. Contextual Appropriateness of Technology

The choice of water infrastructure based on community preferences rather than external technical recommendations underscores the importance of contextually appropriate technology in rural development. While solar boreholes might represent a more advanced technical solution, the community's concern about maintenance costs and technical expertise reflects practical considerations that influence technology adoption and sustainability in resource-constrained settings [33]. This finding aligns with research suggesting that technically sophisticated water solutions often fail in rural contexts due to maintenance challenges, whereas simpler technologies that can be managed locally tend to have greater longevity [34]. The improved well design selected by the communities represents a hybrid approach that combines traditional knowledge

with modern improvements. The technology selection process also highlights the importance of transparent information sharing about different options. By presenting various possibilities with their respective advantages, disadvantages, and maintenance requirements, RNI enabled informed community decision-making rather than prescribing solutions.

C. Integration of Infrastructure and Education

The integration of physical infrastructure development with WASH education exemplifies a holistic approach to water interventions. The reported improvements in hygiene practices following sensitization activities highlight the importance of addressing both supply and demand aspects of water access [35]. This integrated approach is consistent with evidence suggesting that WASH interventions are most effective when they combine infrastructure improvements with educational components [36]. The participatory methods used in the education sessions reflect best practices in adult education and community behavior change communication.

The findings also highlight the importance of culturally sensitive education that addresses local beliefs and practices without dismissing traditional knowledge [35]. By acknowledging existing perspectives on water and building scientific explanations that respect local cultural contexts, the project avoided resistance that might have emerged from a more didactic approach.

D. Timing and Context of Intervention

The implementation of the water project during the COVID-19 pandemic demonstrates the importance of responsive timing in development interventions. The provision of clean water at a time when handwashing was emphasized as a preventive measure against COVID-19 likely enhanced the perceived value and impact of the intervention.

The adaptations made to implementation processes in response to COVID-19 restrictions also highlight the importance of flexibility and responsiveness in project management. By modifying group activities, adjusting timelines, and implementing safety measures, RNI and the communities demonstrated resilience that enabled the project to continue despite challenging circumstances.

E. Gender Considerations in Water Management

Gender considerations emerged throughout the findings, particularly in discussions of water collection responsibilities, participation in decision-making, and the composition of water management committees. The finding that women and children previously bore the primary burden of water collection aligns with broader literature on gender and water access in rural Africa [37]. The reduction in water collection time and effort, therefore, had particular significance for female community members. The inclusion of women in water management committees represents an important step toward gender equity in resource governance.

Traditional decision-making structures in rural Nigerian communities often marginalize women's voices, yet water management directly impacts women's daily responsibilities [38].

Conclusion

This study concludes that the RNI water intervention was instrumental in meeting the felt needs of the community and providing better water access in rural Oyo State, Nigeria. The bottom-up approaches employed were pivotal to promoting local participation and ownership of community projects. The case study demonstrates how participatory approaches to rural water provision can enhance sustainability and effectiveness, particularly when communities exercise genuine influence over key decisions such as technology selection. The findings highlight the value of integrating infrastructure development with educational components to achieve behavioral changes in water handling and hygiene practices. The implementation of the project during the COVID-19 pandemic further illustrates the importance of adaptability and contextual responsiveness in development interventions. Based on the findings, the following recommendations are proposed:

Recommendations

A. Recommendations for Policy

1. Government agencies should develop policy frameworks that institutionalize community participation throughout the project cycle, specifying minimum standards for community engagement and mechanisms for ensuring representation of diverse community segments.
2. Water policymakers should incorporate clear guidelines for appropriate technology selection that balance technical considerations with community preferences, maintenance capacities, and local resource constraints.
3. Government and development partners should integrate water infrastructure development with WASH education and behaviour change initiatives to ensure long-term sustainability of water interventions.
4. Water resource management authorities should explicitly address gender equity in policies and ensure women’s meaningful participation in water governance and decision-making structures.

B. Recommendations for Practice

1. Development organizations should present communities with comprehensive information about different technological options, enabling informed decision-making that reflects local priorities and capacities.

2. Water projects should include robust training components focused on infrastructure maintenance and repair using locally available materials and skills.
3. Project implementers should build flexibility into their plans to accommodate changing circumstances and external shocks.
4. WASH education should be delivered through culturally appropriate methods that respect existing beliefs while promoting evidence-based practices.
5. Beyond nominal representation, water projects should address structural barriers to women's participation and ensure that their perspectives influence substantive decisions.

C. Recommendations for Research

1. Future research should employ longitudinal designs to track the sustainability of community-managed water infrastructure over extended periods.
2. Comparative research on different water technologies in similar contexts could provide valuable evidence on their relative sustainability and effectiveness.
3. In-depth analysis of how improved water access affects gender relations, women's time use, and economic opportunities would contribute to understanding the broader social impacts of water interventions.
4. More research is needed on implementing development projects during emergencies, exploring synergies between immediate response and long-term development objectives.
5. Research is needed on effective strategies for scaling up participatory water management approaches while maintaining meaningful community engagement.

Final Reflections

The RNI water project demonstrates that effective rural water interventions require more than technical solutions; they necessitate thoughtful engagement with social, cultural, and economic dimensions of community life. By centering community voices in decision-making processes, integrating education with infrastructure, and responding adaptively to contextual factors, the project achieved outcomes that extend beyond physical water access to include enhanced community capacity, behaviour change, and collective resource governance. As global challenges intensify pressures on rural water resources, the participatory approaches documented in this case study offer valuable insights for creating water interventions that are not only technically sound but also socially sustainable.

Conflict of Interest

The authors declare no conflict of interest.

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