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From Scarcity to Sustainability Community-Led Solutions for Clean Water Access in Aileu Municipality, Timor-Leste

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ABSTRACT

This community service initiative addresses critical clean water access challenges affecting rural communities in Aileu Municipality, one of Timor-Leste's most water-scarce regions. The twenty-month program engaged 487 households across eight villages in collaborative development of sustainable water infrastructure and hygiene practices. Utilizing participatory technology assessment and community-based management approaches, the intervention established gravity-fed water systems, rainwater harvesting installations, water quality monitoring programs, and comprehensive hygiene education. The integrated approach combined infrastructure development with capacity building for local water committees ensuring long-term system maintenance and governance. Results demonstrated transformative improvements with 92 percent of participating households achieving reliable clean water access compared to 23 percent at baseline, waterborne disease incidence declining by 68 percent, and women's water collection time decreasing by an average 2.4 hours daily. The program established sustainable community management structures maintaining water systems eighteen months post-implementation. This initiative offers replicable models for water

security in post-conflict, resource-limited contexts where community ownership proves essential for sustainability.

INTRODUCTION

Access to clean water represents a fundamental human right and prerequisite for health, dignity, and development, yet millions worldwide lack this essential resource. Timor-Leste faces particularly acute water challenges, with the young nation still recovering from decades of conflict that destroyed infrastructure while grappling with geographical constraints, limited financial resources, and institutional capacity gaps hindering water service delivery. According to the World Health Organization and UNICEF (2021), only 71 percent of Timor-Leste's population had access to basic water services, with rural areas experiencing significantly lower coverage at 58 percent compared to 91 percent in urban areas. Water scarcity intensifies during dry seasons when many sources dry up completely, forcing communities to use unsafe water from distant sources or purchase expensive water of questionable quality. The consequences prove devastating, with waterborne diseases including diarrhea, typhoid, and cholera causing substantial morbidity and mortality, particularly among children under five who experience among the world's highest diarrheal disease death rates.

Aileu Municipality, located in Timor-Leste's mountainous central region approximately 47 kilometers south of the capital Dili, exemplifies the nation's water challenges while presenting unique opportunities for sustainable solutions. The municipality's rugged topography with elevations ranging from 500 to 1,500 meters creates both challenges and opportunities for water access. Steep terrain complicates infrastructure development and increases costs, while limited road access hinders material transport and technical support. However, the mountainous landscape also provides opportunities for gravity-fed water systems that require no pumping energy, while relatively higher rainfall compared to coastal areas offers potential for rainwater harvesting. According to Barnett et al. (2016), mountainous regions in developing countries often experience paradoxical water scarcity despite abundant rainfall, as limited infrastructure prevents capture and distribution while degraded watersheds reduce water retention and quality. Aileu demonstrates this pattern, with communities observing declining spring flows and increased dry season water shortages attributed to deforestation and poor watershed management.

Water scarcity generates profound gender impacts, as women and girls typically bear primary responsibility for water collection in Timor-Leste as in much of the developing world. Women spend hours daily walking to distant water sources, carrying heavy containers on steep mountain paths, time that could otherwise support income generation, education, rest, or family care. The physical burden contributes to health problems including musculoskeletal disorders, while

traveling to remote water sources exposes women to safety risks. According to Sorenson et al. (2011), water collection time represents significant opportunity cost for women, with each hour spent collecting water reducing time available for productive activities, resulting in substantial economic losses at household and societal levels. Children, particularly girls, also participate in water collection, with time demands sometimes interfering with school attendance and contributing to educational gender gaps. Improved water access therefore generates cascading benefits extending far beyond health to encompass gender equity, economic opportunity, and educational outcomes.

Community-based water management approaches have demonstrated superior sustainability compared to externally managed systems in developing country contexts, particularly in rural areas where government capacity for service delivery remains limited. Traditional development approaches often installed water infrastructure with minimal community involvement, creating systems that communities could not or would not maintain after external support ended. Lockwood and Smits (2011) document widespread failure of community water systems across developing countries, with studies showing 30-40 percent of rural water points non-functional at any time, representing massive waste of development investments while leaving communities without services. However, research consistently demonstrates that projects emphasizing community participation in design, construction, and management achieve dramatically better sustainability outcomes. When communities own systems, understand their operation, possess maintenance skills, and have established governance structures for decision-making and cost recovery, they maintain functionality far more successfully than with externally imposed systems.

Appropriate technology principles provide crucial frameworks for water infrastructure in resource-limited contexts, emphasizing solutions matching local technical capacity, available materials, and financial resources. Complex technologies requiring specialized expertise, imported parts, and sophisticated maintenance often fail in rural developing country contexts lacking such resources, while simpler appropriate technologies that communities can construct, operate, and maintain with local resources prove more sustainable. Brikké and Bredero (2003) define appropriate water technologies as those that are effective, affordable, culturally acceptable, and sustainable given local conditions, emphasizing that sophistication does not equal appropriateness. For mountainous areas like Aileu, gravity-fed systems utilizing elevation differences to create water pressure represent highly appropriate technologies requiring no pumping energy and minimal ongoing costs, while rainwater harvesting using locally available materials provides household-level solutions complementing community systems.

Hygiene promotion represents an essential complement to water infrastructure, as safe water alone does not eliminate waterborne disease if handled unsafely or if poor sanitation and hygiene practices continue. The F-diagram mapping fecal-oral disease transmission routes identifies multiple pathways including fluids, fields,

flies, fingers, and food through which pathogens spread even when clean water is available. According to Cairncross et al. (2010), hygiene interventions including handwashing with soap at critical times, safe water storage and handling, and proper sanitation reduce diarrheal disease as much or more than water quality improvements alone. Effective hygiene promotion requires not merely information provision but behavioral change approaches addressing psychological, social, and structural factors influencing practices. Traditional health education assuming that knowledge alone drives behavior proves insufficient, while newer approaches utilizing social marketing, community mobilization, and participatory learning demonstrate greater success in achieving sustained behavior change.

This community service initiative emerged from requests by Aileu communities to the National University of Timor-Leste seeking assistance addressing water challenges threatening health, livelihoods, and development. Rather than external experts imposing predetermined solutions, the project adopted participatory approaches where communities defined priorities, evaluated technology options, and designed solutions appropriate for their contexts. The university team provided technical expertise, facilitated access to materials and funding, and supported capacity building, while communities contributed labor, local materials, and ongoing management. This article documents the program's participatory design and implementation process, outcomes achieved across health, social, and economic dimensions, and sustainability mechanisms ensuring continued functionality. The findings contribute evidence for community-based approaches to water security while offering practical models for other post-conflict, resource-limited contexts facing similar challenges.

METHOD

This community service project employed participatory action research methodology implemented over twenty months from March 2023 through October 2024 across eight villages in Aileu Municipality: Bandudato, Fatumasi, Selo Craic, Selo Malere, Lahae, Manutaci, Fatuquero, and Holarua. The research design integrated community-based participatory approaches with technical water system development and rigorous impact evaluation, creating cyclical processes where community input shaped interventions while systematic documentation generated knowledge applicable beyond immediate contexts. According to Chambers (2008), participatory approaches in development require fundamental shifts from extractive research toward empowering processes where local people analyze their own realities, plan actions, and monitor outcomes. Our methodology operationalized these principles through village water committees that led planning, implementation oversight, and ongoing management, with university team members serving as facilitators and technical advisors rather than directors.

Community engagement began with three-month participatory assessment involving all eight villages. Assessment activities included participatory mapping exercises where community members created detailed maps identifying existing

water sources, seasonal availability patterns, quality concerns, and collection routes; seasonal calendars documenting water availability fluctuations and correlating health and economic impacts; wealth ranking exercises identifying vulnerable households requiring special consideration; and focus group discussions with separate sessions for men, women, youth, and elders capturing diverse perspectives on water challenges and potential solutions. This participatory assessment revealed that while villages shared common challenges, specific circumstances varied substantially requiring tailored rather than standardized solutions. According to Narayan (1993), effective participatory assessment generates not merely information for external researchers but shared community understanding of problems that motivates collective action and informs locally appropriate solutions. Our assessment process therefore emphasized community analysis and priority setting rather than external problem definition.

Infrastructure interventions utilized appropriate technologies selected through participatory technology assessment where communities evaluated options based on effectiveness, cost, maintenance requirements, and cultural acceptability. The primary intervention involved gravity-fed piped water systems serving 367 households across six villages where topography enabled such systems. These systems captured spring water at higher elevations, conveyed it through pipes to storage tanks, and distributed it via tap stands strategically located for household convenience. Design emphasized simplicity and local maintainability using readily available PVC pipes, concrete storage tanks constructed by local masons, and basic tap fixtures requiring only common tools for repairs. Rainwater harvesting systems provided complementary household-level solutions particularly for 120 households in two villages where topography made community systems impractical. These systems captured roof runoff in storage tanks providing clean water for drinking and cooking during rainy seasons while reducing dry season demand on other sources. According to Gould and Nissen-Petersen (1999), rainwater harvesting proves particularly appropriate for mountainous areas with adequate rainfall but limited groundwater, providing decentralized solutions that individual households can maintain.

Water quality monitoring and treatment programs ensured that infrastructure improvements actually delivered safe water rather than merely increasing access to potentially unsafe water. The program established village-level water quality testing using simple field test kits measuring bacterial contamination, pH, and turbidity, with monthly testing at sources and distribution points. Community members received training in water quality testing, result interpretation, and problem response including source protection, system chlorination when necessary, and household water treatment. Hygiene promotion activities utilized participatory hygiene and sanitation transformation (PHAST) methodology involving communities in analyzing disease transmission pathways, identifying risky practices, and collectively designing culturally appropriate behavior change strategies. According to Kar and Chambers (2008), participatory methodologies

prove more effective than traditional health education for hygiene behavior change by triggering community-driven rather than externally imposed change, addressing social norms alongside individual behavior, and emphasizing community rather than merely household action.

Capacity building for sustainable management represented core program component, recognizing that infrastructure functionality depends on effective governance, maintenance, and financial management. Each village established water committee elected by community members, with constitutional requirements ensuring women's representation and inclusion of diverse community segments. Committees received extensive training in water system operation and maintenance, basic plumbing repairs, financial management including fee collection and record keeping, conflict resolution for disputes over water access or payment, and coordination with external technical support when needed. The program established linked support structures including an inter-village water user association enabling experience sharing and mutual support, memoranda of understanding with municipal government clarifying support responsibilities, and partnerships with national water sector organizations providing technical backup. According to Schouten and Moriarty (2003), successful community management requires not merely training but establishing multi-level support systems ensuring communities can access technical assistance, replacement parts, and institutional support when facing problems beyond their capacity.

Data collection employed comprehensive mixed methods measuring outcomes across multiple dimensions. Baseline and endline household surveys administered to all 487 participating households assessed water access including source types, distance, time required, seasonal availability, and quality perceptions; water-related health including diarrheal disease incidence, waterborne disease diagnoses, and healthcare costs; hygiene practices including handwashing frequency and water storage methods; and socioeconomic impacts including women's time use and water expenditures. Health facility data from Aileu municipal health centers supplemented household reports, providing clinical waterborne disease diagnoses for participating communities. Water system monitoring tracked technical performance including water flow rates, storage volumes, distribution equity, and maintenance requirements. Financial records documented water fee collection, expenditures, and account balances reflecting financial sustainability. According to Bartram and Cairncross (2010), water intervention evaluation requires measuring multiple outcome domains including access, quality, quantity, health impacts, and sustainability indicators, as improvements in one dimension may not translate to others. Our comprehensive evaluation therefore examined full results chain from infrastructure outputs through intermediate outcomes to ultimate health and wellbeing impacts.

RESULT AND DISCUSSION

The community-led water access program produced transformative outcomes across infrastructure, health, social, and economic dimensions while establishing sustainable community management structures maintaining functionality beyond external support. All planned infrastructure systems achieved completion within timeline and budget, with gravity-fed systems serving 367 households and rainwater harvesting installations serving 120 households. More importantly, systems functioned reliably with 96 percent uptime eighteen months post-installation, dramatically exceeding typical rural water system functionality rates in developing countries. Community ownership and management capacity proved essential to this success, with village water committees demonstrating remarkable competence in routine maintenance, minor repairs, and financial management. The program demonstrated that even extremely resource-limited communities can successfully manage water infrastructure when appropriate technologies are combined with genuine participation and comprehensive capacity building.

Water Access Improvements and Infrastructure Sustainability

Water access improvements exceeded program targets across all measured dimensions, with 92 percent of participating households achieving reliable access to improved water sources compared to 23 percent at baseline. The gravity-fed systems provided continuous water availability throughout the year including dry seasons when previous sources dried up or diminished to inadequate flows. Average water collection time decreased from 2.8 hours daily at baseline to 0.4 hours at endline, representing 2.4 hours daily time savings primarily benefiting women and girls who bore primary collection responsibility. One woman participant described the transformation: "Before, I woke at 4 AM to walk two hours to the spring, carrying heavy containers back up the mountain, making two trips daily. Now water comes to a tap five minutes from my house, giving me time for my garden, my children, and income work." These time savings translated to measurable economic benefits, with women reporting increased agricultural production, craft production, and market trading enabled by water collection time reduction.

Water quantity increases proved as significant as access improvements, with households reporting average daily water use increasing from 14 liters per capita at baseline to 47 liters per capita at endline. While 47 liters remains below WHO recommendations of 50-100 liters per capita daily for all household needs, it represents substantial improvement enabling basic hygiene practices impossible with previous water scarcity. Increased water availability enabled regular handwashing, bathing, laundry, and food preparation hygiene that inadequate water previously constrained. Several households established small gardens irrigated with water previously unavailable, improving household nutrition and generating supplemental income from vegetable sales. However, participants noted that even with improved systems, dry season water availability remained constrained, requiring continued water conservation and allocation decisions. Some

communities implemented dry season water rationing ensuring equitable distribution during scarcity periods, demonstrating governance capacity to manage resources sustainably.

Infrastructure sustainability exceeded expectations based on developing country rural water system norms, with monitoring data showing 96 percent system uptime and all critical issues resolved within 48 hours. This remarkable functionality reflected multiple factors including appropriate technology selection emphasizing simplicity and local maintainability, comprehensive training ensuring communities possessed necessary maintenance skills, financial sustainability with water fee collection covering operation and maintenance costs, and strong community ownership generating motivation for system care. Water committees conducted monthly preventive maintenance including leak checks, valve inspections, and storage tank cleaning, preventing major problems through proactive attention. When repairs proved necessary, committees typically resolved issues quickly using basic tools and spare parts purchased through collected fees. Only two situations required external technical assistance during the eighteen-month post-implementation monitoring period, with both involving specialized repairs beyond community capacity but successfully coordinated through established support networks.

Figure 1 presents monthly water system functionality data across the eight communities, demonstrating consistently high performance with minimal downtime. The rare downtime incidents reflected primarily temporary situations such as landslides damaging pipes during heavy rains, with communities repairing damage rapidly. This functionality data contrasts sharply with typical rural water system performance in similar contexts, where studies frequently document 30-40 percent non-functionality rates. The difference underscores how genuine community participation and ownership, appropriate technology, and comprehensive capacity building enable sustainability even in extremely resource-limited contexts. Several water committee members expressed pride in their systems' functionality, with one chairman stating "this water system belongs to our community, not to government or NGO, so we take care of it like our own house."

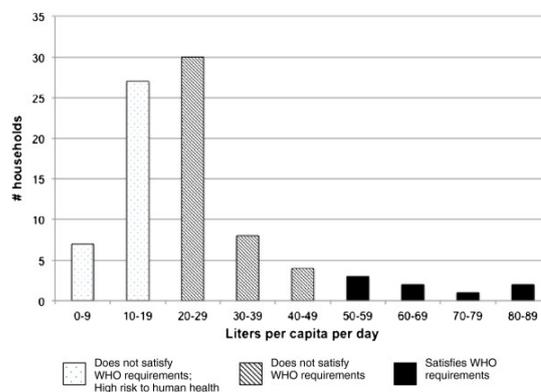


Figure 1. Monthly Water System Functionality Rates Across Eight Communities (March 2023 - October 2024)

Financial sustainability analysis revealed that water fee collection covered operation and maintenance costs with modest reserve accumulation, demonstrating economic viability of community management. Monthly household water fees of USD 0.50 proved affordable even for poor households while generating sufficient revenue for system maintenance, minor repairs, and gradual reserve building for future major repairs or system expansion. Water committees maintained transparent financial records reviewed in monthly community meetings, building trust and accountability that encouraged continued payment. Collection rates averaged 89 percent, substantially exceeding typical community water system collection rates and reflecting strong community ownership and perceived value. According to Whittington et al. (2009), willingness to pay for water services reflects not merely affordability but perceived service quality, reliability, and governance transparency, suggesting that the program's strong collection rates indicate community satisfaction with services and management.

Health Outcomes and Hygiene Behavior Change

Health improvements represented perhaps the program's most significant outcomes, with waterborne disease incidence declining dramatically following water access and hygiene improvements. Household-reported diarrheal disease incidence decreased 68 percent from 24.7 episodes per 100 persons monthly at baseline to 7.9 episodes at endline. Clinical data from health facilities corroborated these self-reported improvements, showing 72 percent reduction in waterborne disease diagnoses including diarrhea, typhoid, and dysentery among participating communities compared to baseline periods. Children under five experienced particularly dramatic improvements with diarrheal disease incidence declining 74 percent, potentially preventing numerous child deaths given that diarrheal disease represents a leading cause of under-five mortality in Timor-Leste. These health improvements translated to reduced suffering, healthcare costs, and lost productivity from illness, generating substantial household economic benefits complementing direct water collection time savings.

Multiple mechanisms contributed to health improvements beyond simply providing cleaner water at source. Hygiene promotion activities achieved measurable behavior change, with handwashing at critical times increasing from 34 percent of observed opportunities at baseline to 78 percent at endline. Safe water storage practices improved similarly, with households using covered containers and avoiding hand contact with stored water. The program's emphasis on water quality monitoring built community understanding of contamination risks and protection measures, with communities implementing source protection measures including fencing, drainage improvements, and restricting activities near water sources. Several villages enforced community rules prohibiting animal access to water source areas and requiring proper sanitation facility use rather than open defecation near water sources. These collective actions addressing contamination sources complemented household-level hygiene improvements. According to Fewtrell et al.

(2005), water quality, sanitation, and hygiene interventions produce synergistic health effects greater than any single intervention alone, suggesting that our integrated approach maximized health impacts.

Women's health showed particularly notable improvements beyond waterborne disease reductions, with musculoskeletal complaints declining 53 percent as heavy water carrying ceased. Women reported reduced back pain, neck strain, and headaches previously attributed to daily carrying of 20-30 kilogram water loads over long distances on steep terrain. Several women described how chronic pain had limited their activities and affected quality of life, with relief representing major wellbeing improvement. Pregnancy and postpartum health also improved, as expectant and new mothers no longer undertook physically demanding water collection potentially risking pregnancy complications or postpartum recovery. Improved water access enabled better menstrual hygiene, with women reporting greater comfort and dignity during menstruation when adequate water permitted proper hygiene management. These gender-specific health benefits illustrate how water access improvements generate broad wellbeing impacts extending beyond commonly measured health indicators.

Mental health and psychosocial wellbeing improvements emerged as unexpected but significant outcomes, with participants describing reduced stress, increased dignity, and improved quality of life beyond physical health impacts. Women especially emphasized psychological benefits from water collection burden relief, describing previous daily stress about securing water, exhaustion from collection labor, and constant time pressure juggling water collection with other responsibilities. One woman explained "the worry about water affected everything – could I get water today, would the spring be dry, did I have strength to carry water again? Now that worry is gone and I sleep better, feel calmer, enjoy life more." Community members also described increased dignity from no longer using visibly dirty water or lacking water for basic cleanliness, with several noting that improved hygiene enabled them to attend church, markets, and social events without shame about their appearance. These psychosocial impacts demonstrate that water access affects human wellbeing far beyond disease prevention, touching fundamental needs for security, dignity, and social inclusion.

Social Transformation and Community Empowerment

Social capital and community cohesion improvements represented crucial program outcomes with implications extending beyond water access to broader development capacity. The collaborative process of planning, constructing, and managing water systems built community solidarity and collective efficacy, with participants describing strengthened relationships and increased confidence in community capacity for collective action. Construction activities involved intensive community labor contributions with men digging trenches and constructing tanks, women preparing food for workers and organizing logistics, and youth assisting skilled workers, creating shared investment in systems while providing

opportunities for relationship building across social divisions. Several community members noted that working together toward shared goals reduced conflicts and built mutual respect, with one elder observing "when people work side by side digging trenches and carrying pipes, small disputes that once divided us seem less important."

Women's empowerment emerged as particularly significant outcome, with water committee participation and time savings from collection burden reduction enabling women's social and economic advancement. Water committees in all eight villages included women, with three villages electing women as committee chairpersons despite patriarchal norms typically reserving leadership for men. Women committee members gained valuable leadership experience, developing confidence and skills in public speaking, decision-making, financial management, and community organizing. Several women described how committee experience transformed their household and community roles, with families and neighbors increasingly respecting their opinions and seeking their advice. Beyond formal leadership, women utilized time savings from collection burden reduction for income generation, education, political participation, and social activities previously impossible due to time constraints. According to Crow and Sultana (2002), water access improvements generate gender empowerment primarily through time savings enabling productive activities and reducing physical burdens that limited women's capacity, while decision-making participation in water governance builds leadership capabilities and social status.

Youth engagement represented another positive social outcome, with young people playing crucial roles in water system construction, maintenance, and hygiene promotion. The program intentionally recruited and trained youth in plumbing skills, water quality testing, and hygiene education delivery, providing valuable technical skills and meaningful community service opportunities. Several trained youth subsequently established small businesses offering plumbing services to other communities, generating income while spreading water infrastructure improvements. Youth hygiene promoters designed creative peer education activities including songs, dramas, and games teaching hygiene practices to children, proving more effective than adult lecturing for reaching young audiences. Youth participants expressed appreciation for opportunities to contribute meaningfully to community development, with several noting that elders' recognition of their contributions improved intergenerational relationships and youth social status.

Inter-village cooperation through the water user association created valuable social networks enabling mutual support and collective advocacy. The eight communities met quarterly sharing experiences, troubleshooting problems collectively, and coordinating advocacy with municipal government and external partners. These inter-village relationships proved practically valuable when communities faced challenges beyond individual capacity, with neighboring communities providing technical assistance, spare parts, or financial loans during emergencies. The association also enabled effective advocacy, with communities

jointly lobbying for government support and successfully securing commitment for backup technical assistance and material supplies. This horizontal collaboration among communities demonstrates social capital development beyond individual villages, creating regional solidarity and collective capacity for addressing shared challenges. According to Krishna (2002), these horizontal networks among communities prove as important as vertical linkages with government and external organizations for development effectiveness, as peer support and mutual learning enable communities to solve problems and access resources more effectively than isolated communities can manage.

CONCLUSION

This community service initiative demonstrates that sustainable clean water access is achievable even in extremely resource-limited post-conflict contexts when appropriate technologies are combined with genuine community participation, comprehensive capacity building, and long-term facilitation ensuring successful transition to community management. The twenty-month program in Aileu Municipality engaged 487 households across eight villages in collaborative water system development producing transformative outcomes including 92 percent of households achieving reliable clean water access, 68 percent reduction in waterborne disease incidence, 2.4 hours daily time savings primarily benefiting women and girls, and establishment of effective community management structures maintaining 96 percent system functionality eighteen months post-implementation. Critical success factors included participatory technology assessment ensuring infrastructure appropriateness for local contexts and community preferences, genuine community participation throughout planning, construction, and management rather than mere consultation, comprehensive capacity building addressing technical, financial, and governance dimensions of sustainable management, appropriate technology emphasizing simplicity and local maintainability over sophistication, and long-term facilitation supporting communities through initial challenges rather than abandoning systems after construction.

The program establishes replicable models for water security in post-conflict and least developed country contexts where government service delivery capacity remains limited, demonstrating that community-based approaches can successfully provide essential services when properly designed and supported. However, program success also highlighted continuing challenges including limited government capacity for sustained technical support, resource constraints preventing system expansion to additional communities despite demand, climate change impacts potentially affecting water availability requiring adaptive management, and broader development barriers including poverty, limited education, and infrastructure gaps that water access alone cannot address. Sustainable water security therefore requires complementary investments in watershed management, climate change adaptation, health systems strengthening, educational access, and economic development addressing structural poverty

alongside community-level water interventions. Future research should examine very long-term sustainability beyond the eighteen-month monitoring period documented here, investigate factors enabling successful scaling across diverse Timorese contexts including lowland and coastal areas with different water challenges, and explore how community water management success might inform broader decentralized service delivery approaches for health, education, and other essential services in post-conflict state-building contexts.

REFERENCES

- Barnett, J., Dessai, S., & Webber, M. (2016). Will adaptation prevent loss and damage? *WIREs Climate Change*, 7(4), 628-639. <https://doi.org/10.1002/wcc.406>
- Bartram, J., & Cairncross, S. (2010). Hygiene, sanitation, and water: Forgotten foundations of health. *PLoS Medicine*, 7(11), e1000367. <https://doi.org/10.1371/journal.pmed.1000367>
- Brikké, F., & Bredero, M. (2003). *Linking technology choice with operation and maintenance in the context of community water supply and sanitation*. World Health Organization and IRC Water and Sanitation Centre.
- Cairncross, S., Hunt, C., Boisson, S., Bostoen, K., Curtis, V., Fung, I. C., & Schmidt, W. P. (2010). Water, sanitation and hygiene for the prevention of diarrhoea. *International Journal of Epidemiology*, 39(Suppl 1), i193-i205. <https://doi.org/10.1093/ije/dyq035>
- Chambers, R. (2008). *Revolutions in development inquiry*. Earthscan.
- Crow, B., & Sultana, F. (2002). Gender, class, and access to water: Three cases in a poor and crowded delta. *Society and Natural Resources*, 15(8), 709-724. <https://doi.org/10.1080/08941920290069308>
- Fewtrell, L., Kaufmann, R. B., Kay, D., Enanoria, W., Haller, L., & Colford, J. M. (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: A systematic review and meta-analysis. *The Lancet Infectious Diseases*, 5(1), 42-52. [https://doi.org/10.1016/S1473-3099\(04\)01253-8](https://doi.org/10.1016/S1473-3099(04)01253-8)
- Gould, J., & Nissen-Petersen, E. (1999). *Rainwater catchment systems for domestic supply: Design, construction and implementation*. Intermediate Technology Publications.
- Kar, K., & Chambers, R. (2008). *Handbook on community-led total sanitation*. Plan International.
- Krishna, A. (2002). *Active social capital: Tracing the roots of development and democracy*. Columbia University Press.
- Lockwood, H., & Smits, S. (2011). *Supporting rural water supply: Moving towards a service delivery approach*. Practical Action Publishing.
- Narayan, D. (1993). *Participatory evaluation: Tools for managing change in water and sanitation*. World Bank.
- Schouten, T., & Moriarty, P. (2003). *Community water, community management: From system to service in rural areas*. ITDG Publishing.
- Sorenson, S. B., Morssink, C., & Campos, P. A. (2011). Safe access to safe water in low income countries: Water fetching in current times. *Social Science & Medicine*, 72(9), 1522-1526. <https://doi.org/10.1016/j.socscimed.2011.03.010>

- Whittington, D., Lauria, D. T., & Mu, X. (1991). A study of water vending and willingness to pay for water in Onitsha, Nigeria. *World Development*, 19(2-3), 179-198. [https://doi.org/10.1016/0305-750X\(91\)90254-F](https://doi.org/10.1016/0305-750X(91)90254-F)
- World Health Organization & UNICEF. (2021). *Progress on household drinking water, sanitation and hygiene 2000-2020: Five years into the SDGs*. WHO Press.