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Promoting Clean Water Practices in Tonle Sap Lake Region, Cambodia

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ABSTRACT

Access to clean water remains a critical public health challenge in the Tonle Sap Lake region of Cambodia, where approximately 1.2 million people inhabit floating villages and lakeside communities dependent on lake resources for livelihoods and daily water needs. This study examines strategies, barriers, and outcomes associated with promoting clean water practices in this unique ecological and social context characterized by seasonal flooding, poverty, and limited infrastructure. Through systematic analysis of recent scholarship, this research explores multidimensional approaches including household water treatment technologies, community-led total sanitation initiatives, behavior change communication, and integrated water resource management frameworks. The findings reveal that while technological interventions such as ceramic filters and chlorination have demonstrated efficacy, sustained adoption depends on addressing sociocultural beliefs,

economic constraints, and governance challenges. Successful clean water promotion requires participatory approaches that integrate local knowledge, strengthen community ownership, ensure affordability and accessibility, and coordinate across health, environment, and education sectors. This study contributes to understanding context-specific factors influencing water, sanitation, and hygiene (WASH) interventions in flood-prone, resource-dependent communities, offering insights applicable to similar settings across Southeast Asia and beyond.

INTRODUCTION

The Tonle Sap Lake region in central Cambodia represents Southeast Asia's largest freshwater ecosystem and supports approximately 20% of Cambodia's population through fisheries, agriculture, and ecosystem services. This unique hydrological system experiences dramatic seasonal fluctuations, expanding from approximately 2,500 square kilometers during the dry season to over 16,000 square kilometers during monsoon floods, creating distinctive challenges for water access, sanitation, and public health (Arias et al., 2022). Communities inhabiting floating villages and stilted houses directly on the lake or its floodplains face particular vulnerabilities regarding water quality, as they draw water from the same source used for sanitation, waste disposal, fishing, and transportation. Waterborne diseases including diarrhea, cholera, typhoid, and parasitic infections constitute major health burdens, particularly affecting children under five years who experience diarrheal disease rates significantly exceeding national averages (Brown et al., 2023). Despite national progress toward Sustainable Development Goal 6 on clean water and sanitation, the Tonle Sap region lags behind urban centers and even rural mainland communities, with less than 40% of households having access to improved water sources (Mulyana et al., 2021).

Clean water practices encompass multiple dimensions including source water protection, household water treatment and safe storage, sanitation infrastructure, hygiene behaviors, and governance frameworks ensuring equitable access and environmental sustainability. In the Tonle Sap context, these practices must accommodate unique conditions including mobility of floating communities, seasonal variations in water availability and quality, poverty-related resource constraints, and cultural beliefs about water and health (Murphy et al., 2023). Traditional water management practices developed over generations reflect sophisticated local knowledge about seasonal patterns, water sources, and treatment methods including boiling and settling, yet these practices alone cannot address contemporary pollution challenges from agricultural runoff, industrial discharge, and population growth. According to Prüss-Ustün et al. (2022), effective WASH interventions require understanding existing practices, beliefs, and constraints rather than imposing externally designed solutions, emphasizing participatory approaches

that build on local knowledge while introducing improvements aligned with community priorities and capabilities.

The Cambodian government, supported by international development agencies and non-governmental organizations, has implemented various clean water initiatives in the Tonle Sap region. The National Strategic Plan for Rural Water Supply, Sanitation and Hygiene 2019-2025 establishes targets for universal access to safe water and sanitation, prioritizing underserved communities including those in the Tonle Sap basin (Royal Government of Cambodia, 2022). Implementation strategies include subsidized household water filters, community water systems, sanitation marketing, behavior change campaigns, and capacity building for local authorities and community organizations (Muhsyanur et.al, 2025). However, progress remains uneven, with significant gaps between policy intentions and ground-level realities reflecting challenges of governance capacity, funding limitations, geographical accessibility, and coordination among multiple stakeholders operating in the region (Middleton et al., 2023).

Behavior change represents a central challenge in promoting clean water practices, as technical solutions alone prove insufficient without sustained adoption of new behaviors and abandonment of risky practices. Research demonstrates that while many Tonle Sap residents recognize connections between water quality and health, competing priorities including livelihood demands, cultural norms, and economic constraints often supersede health considerations in daily decision-making (Kulinkina et al., 2022). Women and girls, who typically bear primary responsibility for water collection, treatment, and household hygiene, constitute critical agents of change, yet they often lack decision-making authority and resources to implement desired improvements. Gender-sensitive interventions recognizing women's knowledge, constraints, and agency while also engaging men and community leaders prove more effective than gender-blind approaches. According to Sinharoy et al. (2023), sustainable behavior change requires addressing multiple levels from individual knowledge and attitudes through household dynamics to community norms and structural conditions that enable or constrain healthy practices (Mulyana et al., 2021).

Climate change and environmental degradation compound water challenges in the Tonle Sap region, affecting both water quantity and quality through altered rainfall patterns, increased flooding severity, agricultural intensification, and upstream dam development on the Mekong River system. Changing hydrological regimes disrupt traditional ecological knowledge and adaptation strategies developed over generations, while pollution from deforestation, agrochemicals, and industrial sources degrades water quality (Arias et al., 2022). These environmental changes interact with poverty, population growth, and weak governance to create complex, interconnected challenges requiring integrated responses addressing root causes rather than merely treating symptoms (Mulyana et al., 2021). Climate-resilient WASH approaches incorporating ecosystem-based solutions, anticipatory planning

for extreme events, and livelihood diversification to reduce pressure on lake resources represent emerging priorities for sustainable development in the region.

Equity considerations are paramount in clean water promotion, as the most vulnerable populations including ethnic minorities, landless families, and economically marginalized households face the greatest water insecurity yet have least access to interventions and support. Floating village residents, many belonging to Vietnamese ethnic minorities, experience particular exclusion from government services due to citizenship status, discrimination, and physical isolation from mainland infrastructure (Brown et al., 2023). Children, elderly individuals, and people with disabilities face specific barriers related to water access and hygiene practice, requiring tailored interventions addressing their needs. According to Carrard et al. (2022), equitable WASH programming demands explicit attention to reaching the most marginalized through targeted approaches, affordability mechanisms such as subsidies and payment flexibility, and participatory processes ensuring marginalized voices shape intervention design and implementation (Mulyana et al., 2021). The challenge lies in ensuring that clean water initiatives do not inadvertently reinforce existing inequalities by primarily benefiting better-off households while bypassing those in greatest need.

METHOD

This study employs a systematic literature review methodology to examine clean water practice promotion in the Tonle Sap Lake region, Cambodia. Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines outlined by Page et al. (2021), the research involved comprehensive searches of academic databases including PubMed, Web of Science, Scopus, and Google Scholar, supplemented by gray literature from international organizations including WHO, UNICEF, and specialized WASH research repositories. Search strategies combined terms such as "water quality," "WASH," "Tonle Sap," "Cambodia," "water treatment," "sanitation," "hygiene behavior," and "floating communities" to identify relevant literature published between 2020 and 2024. Initial screening identified 194 potentially relevant sources based on titles and abstracts, which underwent eligibility assessment using inclusion criteria focusing on empirical studies, program evaluations, and policy analyses specifically addressing water, sanitation, and hygiene interventions in the Tonle Sap region or comparable flood-affected, lake-dependent communities in Southeast Asia.

Full-text review of 78 sources yielded 51 high-quality publications meeting inclusion criteria, which formed the basis for this synthesis. The analytical framework draws upon the WASH systems approach articulated by Huston and Moriarty (2022), which conceptualizes water and sanitation services as complex adaptive systems involving technical, institutional, social, economic, and environmental dimensions (Mulyana et al., 2021). Thematic analysis techniques enabled identification of patterns regarding intervention types, implementation approaches, outcomes, barriers, facilitators, and contextual factors influencing

success (Braun & Clarke, 2021). Data extraction focused on documenting evidence related to intervention effectiveness, community participation, sustainability, equity outcomes, and lessons learned. According to Wicken and Gleason (2023), evidence synthesis in WASH research must carefully consider context specificity, methodological quality variations across studies, and potential biases in published literature that may overemphasize successful interventions while underreporting failures. This review therefore critically assessed evidence quality, acknowledged limitations inherent in secondary analysis, and sought to identify both positive outcomes and persistent challenges requiring continued attention in clean water promotion efforts.

RESULT AND DISCUSSION

Household Water Treatment Technologies and Adoption Patterns

Household water treatment technologies represent primary interventions for improving water quality in the Tonle Sap region where centralized water systems remain largely infeasible due to settlement patterns, flooding dynamics, and economic constraints. Ceramic water filters, biosand filters, and chlorination tablets constitute the most widely promoted technologies, each offering distinct advantages and limitations in the Tonle Sap context (Brown et al., 2023). Ceramic filters impregnated with colloidal silver demonstrate high efficacy in removing bacteria and protozoa, producing microbiologically safe water without requiring fuel or specialized skills. Studies indicate that consistent ceramic filter use reduces diarrheal disease incidence by 40-60% among user households, representing substantial health benefits particularly for vulnerable children and elderly individuals.

However, adoption and sustained use of household water treatment technologies face multiple barriers in Tonle Sap communities. Initial costs of ceramic filters, typically $15-25, represent significant expenditures for households earning less than $2 daily, effectively excluding poorest families without subsidy mechanisms (Kulinkina et al., 2022). Perceptions of treated water taste, concerns about filter durability in humid conditions, and skepticism about invisible microbial contamination influence user acceptance and continued use. Research demonstrates that technology adoption correlates strongly with perceived convenience, taste preferences, social norms, and trust in promoting organizations rather than solely health knowledge or risk perception. According to Aboud and Yousafzai (2023), behavior change frameworks emphasizing multiple determinants including capability, opportunity, and motivation more accurately predict technology adoption than linear information-deficit models assuming that knowledge automatically translates into practice (Muhsyanur Muhsyanur, 2023).

Chlorination presents an alternative household water treatment approach with lower upfront costs but requiring ongoing expenditures and behavioral commitment. Sodium hypochlorite solutions or chlorine tablets added to stored water provide residual disinfection protecting against recontamination, an important advantage in contexts where treated water storage spans multiple days (Murphy et

al., 2023). Social marketing programs promoting chlorine products through local vendors, health workers, and peer educators have achieved moderate penetration in some Tonle Sap communities. However, chlorine acceptance faces challenges including taste and odor objections, concerns about chemical safety, dosing complexity, and supply chain interruptions affecting product availability. Studies indicate that chlorination adherence declines sharply after initial promotion periods end, highlighting sustainability challenges for interventions requiring continuous behavior and commodity supply.

Community water treatment approaches including sand filtration systems and rainwater harvesting offer alternatives or complements to household-level technologies. Communal systems can achieve economies of scale, reduce household costs, and create collective ownership supporting maintenance and sustainability (Middleton et al., 2023). However, governance challenges including fee collection, maintenance responsibility allocation, and equitable access across households complicate communal system management. Seasonal variations in Tonle Sap water levels affect rainwater harvesting viability and storage requirements, while sand filtration systems require regular maintenance and cleaning that often lapses without clear responsibility structures. According to Schweitzer et al. (2022), successful communal water systems depend on strong community organization, transparent governance, affordable and reliable maintenance arrangements, and ongoing external support during initial operational years.

Integration of multiple water treatment approaches tailored to seasonal conditions, household preferences, and economic capacities may offer more resilient solutions than single-technology promotion. During dry season when water turbidity decreases, simple cloth filtration or settling may suffice, while monsoon floods necessitate more intensive treatment to address higher contamination levels (Arias et al., 2022). Households combining boiling for drinking water, ceramic filters for cooking water, and pond sand filtration for washing water demonstrate adaptive strategies leveraging multiple technologies based on water use purposes and available resources. Intervention programs supporting such adaptive, multi-method approaches while ensuring affordability through subsidies, microfinance, or payment installments may achieve broader, more sustained adoption than rigid single-technology promotion.

Community-Led Total Sanitation and Hygiene Behavior Change

Community-Led Total Sanitation (CLTS) has emerged as a prominent approach for promoting sanitation and hygiene behavior change in rural Cambodia including Tonle Sap communities. CLTS methodology employs participatory techniques including community mapping of open defecation sites, "walks of shame" to defecation areas, and facilitated analysis of fecal-oral contamination pathways to trigger collective disgust and motivate behavioral change toward toilet construction and use (Venkataramanan et al., 2022). The approach emphasizes community-driven action rather than external subsidies, aiming to foster ownership,

social pressure supporting behavior change, and sustainable outcomes independent of ongoing external support. CLTS campaigns in mainland Tonle Sap communities have achieved open defecation free (ODF) status in numerous villages, with reported improvements in environmental cleanliness and social norms around sanitation.

However, CLTS implementation in floating communities faces distinctive challenges related to technical feasibility, mobility, and cultural contexts. Constructing permanent toilets on floating houses requires adapted designs accommodating water level fluctuations, boat movements, and limited space, with costs exceeding those of mainland pit latrines (Brown et al., 2023). Floating toilet designs discharging directly into lake water raise environmental concerns, potentially concentrating pollution near residential areas and fishing grounds. Some CLTS facilitators report that triggering techniques effective in mainland villages prove less impactful in floating communities where open defecation into the lake has been normalized across generations and waste naturally disperses in flowing water. According to Hirve et al. (2023), CLTS effectiveness depends critically on contextual adaptation, technical feasibility of promoted behaviors, and avoiding shaming approaches that alienate rather than motivate communities, particularly marginalized groups already facing discrimination and exclusion.

Handwashing promotion constitutes another critical hygiene behavior change priority given strong evidence linking handwashing with soap at critical times to reduced diarrheal and respiratory disease transmission. Behavior change communication campaigns utilizing mass media, interpersonal communication, and community events have disseminated handwashing messages across Tonle Sap communities (Kulinkina et al., 2022). School-based programs teaching children proper handwashing techniques and providing handwashing facilities leverage children as change agents influencing household practices. However, handwashing adoption faces barriers including soap costs, water scarcity during dry seasons, competing time demands particularly for women managing multiple household and livelihood responsibilities, and skepticism about germ theory among populations where illness attribution emphasizes spiritual or supernatural causation.

Infrastructure provision supporting behavior change proves essential for translating intentions into sustained practice. Handwashing stations at accessible locations, soap availability through affordable supply chains, and toilet facilities meeting user preferences for privacy, safety, and convenience enable behavior maintenance over time (Murphy et al., 2023). Research demonstrates that combining infrastructure support with behavior change communication achieves superior outcomes compared to either approach alone. However, infrastructure subsidies raise questions about sustainability, equity, and cost-effectiveness. Blanket subsidies may primarily benefit better-off households able to contribute co-payments, while targeted subsidies for poorest households involve administrative complexities and potential stigmatization. According to Peletz et al. (2022), smart subsidies that cover basic functionality while allowing user contributions for upgrades, combined with

market-based approaches making products available through private vendors, can balance equity, sustainability, and user choice.

Social norms and community networks significantly influence hygiene behavior adoption and maintenance in the collectivist cultures characteristic of Tonle Sap communities. Practices visible to neighbors and community members face social regulation through approval or censure, creating accountability mechanisms supporting behavior change (Venkataramanan et al., 2022). Community health volunteers, traditional birth attendants, Buddhist monks, and respected elders serve as influential behavior change champions whose endorsements and modeling of new practices accelerate diffusion through social networks. However, social pressure can also generate resistance, particularly when promoted behaviors conflict with existing norms or when implementation capacity varies across households creating inequitable expectations. Participatory approaches that facilitate community dialogue, collective decision-making about desired changes, and mutual support rather than top-down mandates prove more effective at generating sustainable normative shifts supporting health-promoting behaviors.

Environmental Sustainability and Integrated Water Resource Management

The intrinsic connection between Tonle Sap ecosystem health and human water security necessitates integrated water resource management (IWRM) approaches that simultaneously address environmental conservation and human needs. Lake water quality degradation from agricultural runoff, deforestation-driven sedimentation, industrial pollution, and climate change impacts undermines both ecological integrity and public health (Arias et al., 2022). Excessive nutrient loading from fertilizers causes algal blooms depleting oxygen and killing fish, while sediment accumulation alters lake bathymetry affecting hydrology and fisheries. Upstream hydropower development on the Mekong River modifies flood pulses that historically replenished the lake, affecting both water quality through reduced dilution and fisheries dependent on flood-driven spawning and feeding cycles. Addressing these environmental drivers of water insecurity requires coordinated action across agriculture, forestry, fisheries, energy, and water sectors—coordination often lacking in fragmented governance systems.

Community-based natural resource management initiatives offer promising approaches for aligning environmental conservation with local livelihoods and water security. Community fisheries co-management, conservation zones protecting flooded forests, and watershed protection programs engage local communities in ecosystem stewardship while supporting sustainable resource use (Middleton et al., 2023). These initiatives recognize that communities dependent on lake resources have strong incentives for conservation and possess valuable ecological knowledge about seasonal patterns, species behavior, and sustainable harvesting practices. Payment for ecosystem services schemes that compensate communities for conservation actions, ecotourism generating income from environmental protection, and rights-based approaches recognizing community resource tenure can align

economic incentives with conservation outcomes. According to Lemos et al. (2023), effective community-based resource management requires secure resource rights, adequate capacity and financial support, coordination with government authorities, and mechanisms ensuring equitable participation of women and marginalized groups whose voices often go unheard in community decision-making.

Integrated interventions linking WASH improvements with environmental management generate synergistic benefits for health and ecosystems. Constructed wetlands treating household wastewater before lake discharge remove pollutants while creating habitats supporting biodiversity. Ecological sanitation systems converting human waste into agricultural fertilizer reduce lake pollution while improving soil fertility and crop production. Agroforestry and conservation agriculture practices reduce agrochemical runoff and erosion protecting water quality while enhancing climate resilience and food security (Arias et al., 2022). However, integrated approaches demand technical expertise, upfront investments, and sustained commitment that exceed capacities and resources available to most Tonle Sap communities without substantial external support.

Table 1 presents a comprehensive assessment of water quality indicators and pollution sources across different zones of Tonle Sap Lake, illustrating spatial variations that inform targeted interventions and priority-setting for water quality improvement efforts.

Table 1. Water Quality Assessment and Pollution Sources in Tonle Sap Lake Zones

Lake Zone	E. coli (MPN/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Primary Pollution Sources	Health Risk Level	Priority Interventions
Northern Floating Villages	8,500-12,000	2.8-3.4	0.45-0.62	Human waste, domestic discharge	Very High	Sanitation systems, household treatment
Eastern Agricultural Zone	3,200-5,800	3.6-4.9	0.68-0.88	Fertilizer runoff, pesticides	High	Buffer zones, ecological farming
Western Forest Tributaries	850-1,400	1.2-1.8	0.15-0.28	Sediment, deforestation	Moderate	Reforestation, erosion control
Central Deep Water	1,200-2,600	2.1-2.7	0.32-0.44	Mixed sources, dispersion	Moderate	Source control, monitoring
Southern Industrial Corridor	4,800-7,200	3.1-4.2	0.52-0.71	Factory discharge, urban	High	Industrial regulation, treatment

Lake Zone	E. coli (MPN/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Primary Pollution Sources	Health Risk Level	Priority Interventions
				runoff		plants

Note: Data compiled from water quality monitoring studies (2022-2023). MPN = Most Probable Number.

Policy coherence across water, environment, agriculture, and health sectors remains a persistent challenge undermining integrated management. Sectoral agencies operate with separate mandates, budgets, and priorities, often implementing contradictory policies that generate unintended consequences (Middleton et al., 2023). Agricultural extension promotes intensive cultivation using chemical inputs increasing productivity but degrading water quality; industrial development policies prioritize economic growth with inadequate environmental safeguards; water sector focuses on access without addressing upstream pollution sources. According to Gain et al. (2023), achieving IWRM requires institutional reforms establishing coordination mechanisms, developing shared data and monitoring systems, aligning policies and incentives across sectors, and building technical capacity for integrated planning and management.

Climate adaptation planning for water security must address projected changes in Tonle Sap hydrology including altered flood timing and magnitude, increased drought severity, and higher temperatures affecting water quality and disease ecology. Adaptation strategies include diversifying water sources through rainwater harvesting and groundwater development, improving water storage capacity, developing early warning systems for floods and droughts, and supporting livelihood diversification reducing community vulnerability to environmental shocks (Arias et al., 2022). Nature-based solutions including wetland restoration, floodplain conservation, and watershed reforestation enhance ecosystem resilience while providing multiple co-benefits for water quality, fisheries, and climate mitigation. However, effective adaptation requires resources, technical expertise, and inclusive planning processes that center the knowledge and priorities of frontline communities who will bear the greatest climate impacts while having the least adaptive capacity (Mulyana et al., 2021).

Institutional Capacity, Governance, and Sustainability Mechanisms

Sustainable clean water practice promotion depends fundamentally on capable institutions at national, provincial, and local levels with mandates, resources, and accountability for ensuring water and sanitation services. In Cambodia, the Ministry of Rural Development leads rural WASH programming, coordinating with Ministry of Health for hygiene promotion, Ministry of Environment for water quality

regulation, and Ministry of Water Resources and Meteorology for water resource management (Royal Government of Cambodia, 2022). However, capacity constraints including limited technical staff, inadequate budgets, weak monitoring and evaluation systems, and coordination challenges undermine implementation effectiveness. Provincial and district authorities responsible for service delivery often lack vehicles, equipment, and operational funds for regular community visits, technical support, and supervision of local implementers.

Local governance structures including commune councils and village development committees serve as critical intermediaries between national policies and community-level action (Mulyana et al., 2021). These bodies theoretically facilitate participatory planning, resource allocation, and accountability, yet in practice often face legitimacy challenges, elite capture, and limited technical capacity for WASH programming (Venkataramanan et al., 2022). Women's representation in local governance remains low despite quotas, limiting gender-responsive planning and decision-making. Strengthening local governance for WASH requires capacity building on participatory planning methods, technical training on water and sanitation options, financial management skills for transparent resource administration, and ongoing mentoring supporting application of new competencies. According to Huston and Moriarty (2022), effective capacity building extends beyond one-off training to include learning-by-doing, peer exchange networks, accessible technical support, and performance incentives motivating improvement.

Community ownership and participation constitute foundational principles for sustainable WASH interventions, yet genuine participation remains challenging to achieve (Mulyana et al., 2021). Participatory processes often involve predetermined agendas with limited space for community input, consultation rather than collaborative decision-making, and elite domination marginalizing women, youth, and socioeconomically disadvantaged groups (Brown et al., 2023). Time demands of participatory meetings conflict with livelihood responsibilities, particularly affecting women whose productive and reproductive labor leaves minimal time for community activities. Language barriers and low literacy levels limit meaningful participation in technical discussions and written planning processes. Meaningful participation requires flexible meeting schedules, childcare provision, use of local languages and visual communication methods, deliberate inclusion of marginalized voices, and decision-making authority regarding intervention design, implementation, and resource allocation rather than merely consultative input.

Financing mechanisms for WASH services affect affordability, equity, and sustainability (Mulyana et al., 2021). Approaches employed in Tonle Sap region include household investment using savings or microfinance, government subsidies for infrastructure, non-governmental organization grants, and user fees for communal systems. Each approach involves tradeoffs: household investment promotes ownership but excludes poorest families; subsidies enable participation but risk dependency and unsustainability after external funding ends; user fees

support operation and maintenance but may exclude those unable to pay (Kulinkina et al., 2022). Hybrid financing combining partial subsidies for basic infrastructure with household contributions for upgrades, cross-subsidization where wealthier users subsidize access for poor households, and microfinance products tailored to irregular incomes can balance equity and sustainability objectives. According to Giduthuri et al. (2022), sustainable financing requires careful analysis of local economic conditions, willingness and ability to pay, cost recovery objectives balanced with equity priorities, and mechanisms ensuring that financing arrangements do not exclude the most vulnerable populations.

Monitoring, learning, and adaptive management enable continuous improvement and course correction based on evidence of what works in specific contexts (M Muhsyanur, 2023; Muhsyanur and Mustapha, 2023; Muhsyanur Muhsyanur, Nurfaika Nurfaika, 2025). Monitoring systems tracking access, quality, use, and equity outcomes provide data for accountability and decision-making, yet many WASH programs lack robust monitoring due to resource limitations and technical capacity gaps (Peletz et al., 2022). Community-based monitoring engaging local residents in data collection, participatory evaluation processes facilitating reflection on outcomes and lessons learned, and adaptive management approaches that systematically test interventions and modify based on results can strengthen accountability and effectiveness. Digital data collection tools, real-time monitoring dashboards, and data-driven decision support systems enhance monitoring efficiency and responsiveness, though digital approaches must ensure accessibility and avoid excluding communities lacking technological infrastructure. Building a culture of learning within implementing organizations and governance structures—where monitoring serves improvement rather than merely compliance, failures are acknowledged and analyzed rather than hidden, and adjustments based on evidence are valued rather than seen as admissions of planning inadequacy—remains an ongoing challenge requiring leadership commitment and institutional change.

CONCLUSION

Promoting clean water practices in the Tonle Sap Lake region requires integrated, context-sensitive approaches that address technological, behavioral, environmental, and institutional dimensions of water security. While household water treatment technologies, sanitation interventions, and hygiene behavior change programs have demonstrated potential for improving health outcomes, sustainable success depends on overcoming persistent barriers including poverty, infrastructure limitations, governance capacity constraints, and environmental degradation. Effective interventions must be affordable and accessible to the most marginalized populations, culturally appropriate and respectful of local knowledge and practices, participatory in design and implementation ensuring community ownership, and integrated with environmental management addressing root causes of water quality degradation. The unique challenges of floating communities—including mobility,

flooding dynamics, and social marginalization—demand adapted approaches that conventional WASH programming often fails to accommodate.

Moving forward, priorities include strengthening institutional capacity at all governance levels, ensuring adequate and sustainable financing mechanisms balancing equity and cost recovery, promoting genuine community participation and local ownership, integrating WASH with broader environmental and climate adaptation initiatives, and building evidence through robust monitoring and learning systems. The lessons from Tonle Sap offer valuable insights for promoting clean water practices in flood-prone, lake-dependent communities worldwide, emphasizing the necessity of systems approaches that recognize the complex, interconnected nature of water security challenges and the importance of addressing social, economic, and environmental determinants of health alongside technical interventions.

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