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Community-Based Adaptation Strategies in Response to Clean Water Scarcity in a Peatland Ecosystem: A Case Study of Banyuasin, South Sumatra, Indonesia

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ABSTRACT

Indonesia contains approximately 36% of the world's tropical peatlands, which are crucial for carbon storage, biodiversity conservation, and hydrological regulation. However, in many peatland regions, including Muara Sugihan in Banyuasin Regency, South Sumatra, communities face chronic water quality problems due to peat soils rich in organic matter and high acidity. The local groundwater is bitter, salty, yellowish-brown, and pungent, making it unsuitable for human consumption. This qualitative case study applied cross-generational sampling in 22 villages to capture diverse perspectives on water adaptation. Primary data were collected through semi-structured interviews, participant observation, and field documentation, while secondary data from NGOs were prioritized for contextual relevance. Thematic analysis was used to identify patterns and variations in adaptation strategies. All respondents deemed groundwater unfit for drinking, leading to three main adaptation strategies: (1) simple filtration using sand and charcoal, (2) diversification of water sources via rainwater harvesting and selective swamp water use, and (3) boiling rainwater before consumption. Approximately 70% of younger residents have adopted technological solutions, such as large-capacity rainwater storage, deep-well drilling, and self-managed treatment, although with limited success. Older generations relied more on traditional practices. Adaptive capacity is constrained by limited filtration technology, poor infrastructure, and socio-economic barriers. Critically, 85% of respondents reported no formal water quality monitoring, revealing a governance gap. Strengthening peatland water resilience requires expanding access to effective filtration, improving infrastructure, and instituting regular monitoring. Lessons from Muara Sugihan can inform policies for other peatland communities.

1. INTRODUCTION

Indonesia is home to the largest expanse of tropical peatlands globally, with recent estimates placing this area at approximately 21 million hectares (Mha) [1, 2]. This significant coverage translates to about 36% of the world's tropical peatlands, making Indonesia a focal point for both ecological studies and environmental management initiatives [2, 3]. The distribution of these peatlands is primarily concentrated across three major islands: Sumatra, which accounts for around 35% of the area; Kalimantan (32%); and Papua (30%) [1, 4, 5]. This unique ecosystem plays a crucial role in the global carbon cycle, storing an estimated 57.4 gigatons of carbon [6]. Santoso and serving as a vital buffer for surrounding hydrological systems [4].

Peatland ecosystems play a critical role in global environmental sustainability due to their function in carbon storage, biodiversity conservation, and hydrological regulation. However, in tropical regions such as Indonesia, peatlands are often subject to land conversion, drainage, and exploitation, which significantly alter their ecological functions [7, 8]. One of the most urgent environmental issues arising from peatland degradation is the scarcity of clean water, particularly in areas where local communities depend on groundwater and surface water sources for daily use.

Banyuasin Regency in South Sumatra, Indonesia, serves as a prominent example of this problem. This region, particularly Muara Sugihan District, was developed as part of Indonesia's transmigration program beginning in the 1980s, transforming previously uninhabited peat swamp forests into agricultural and settlement areas [9]. The topography of the region is dominated by wetlands, tidal swamps, and coastal lowlands—conditions that contribute to persistent water stagnation and degradation of water quality due to the presence of humic substances, high acidity, and brackish conditions influenced by tidal intrusion [10, 11].

The scarcity of clean water in these peat-dominated landscapes poses serious challenges to community health and livelihoods. Water sourced from peatlands is often unsuitable for direct consumption without intensive treatment due to high levels of natural organic matter such as humic and fulvic acids, which are associated with long-term health risks including gastrointestinal issues and carcinogenic potential [12, 13].

In facing these challenges, local communities in Banyuasin Regency have developed various adaptation patterns to overcome the clean water crisis. These adaptation patterns are the result of complex interactions between the physical and social environments, and reflect the strong efforts of the community to survive in difficult conditions [14-16]. The way local communities respond to environmental changes and use local knowledge to develop sustainable adaptation strategies [17] is key to addressing the clean water crisis in the region.

Community-based adaptation (CBA) has gained recognition as an effective approach to addressing environmental stressors in vulnerable regions. CBA emphasizes the role of local knowledge, participation, and institutions in formulating responses that are socially acceptable, ecologically sound, and economically feasible [18, 19]. This approach is particularly relevant in marginalized peatland areas, where top-down technological interventions may be economically unsustainable or culturally incompatible.

Despite its potential, empirical studies on CBA in Indonesian peatland regions remain scarce. Much of the existing literature focuses on the biophysical degradation of peatlands and the technical dimensions of restoration [8, 20-31]. There remains a significant gap in understanding how communities adapt socially and culturally to environmental challenges, especially in relation to water scarcity.

This study aims to fill that gap by investigating the vulnerability and adaptive strategies of transmigrant communities in Muara Sugihan, Banyuasin Regency. It explores how local knowledge interacts with environmental pressures to shape adaptive behaviors in the context of clean water scarcity.

Grounded in this objective, the research is guided by the hypothesis that: "Local knowledge demonstrates greater efficacy than technological interventions in fostering sustainable water adaptation in peatland environments". Through this lens, the study seeks to contribute to theoretical and practical discussions on sustainable adaptation in wetland regions and inform integrated, community-centered policy strategies for peatland water governance.

2. METHODS AND PROCEDURES

This study examines how the community in a peatland setting has adapted to the clean water crisis using a qualitative methodology and a case study design. The qualitative approach was chosen for its suitability in capturing complex socio-environmental phenomena through participants' perspectives [32]. The case study design enabled an in-depth exploration of community adaptation in Muara Sugihan, revealing various strategies, local practices, and factors influencing community responses to limited clean water resources [33].

Both primary and secondary data were utilised. Primary data included adaptation narratives, perceived challenges, the role of community institutions, water collection techniques, and the condition of water infrastructure in Muara Sugihan—secondary data comprised village reports, NGO publications, and local news related to the water crisis. Primary data were obtained from in-depth interviews and participant observations conducted within the Muara Janji community. Secondary data were sourced from village reports, NGO documents, and local news archives.

NGO reports were prioritised over government datasets because they provide more context-specific, participatory, and up-to-date information, often capturing micro-level environmental changes and community practices that aggregated government statistics tend to overlook. In remote peatland settlements, such as Muara Sugihan, NGO-led monitoring often involves direct community engagement, ensuring higher relevance to local realities and providing timely updates on environmental and infrastructural conditions. This rationale aligns with participatory research principles that value local knowledge as an essential complement to official data.

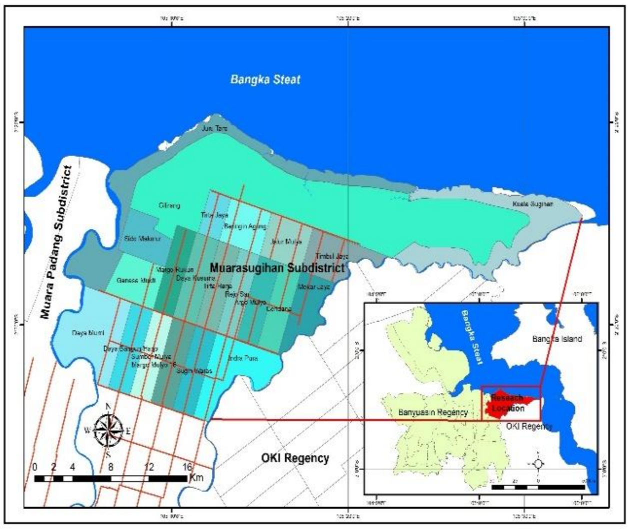

Figure 1. Location of the study area

This research was conducted in Muara Sugihan District, Banyuasin Regency, with a population of approximately 36,000 people spread across 22 villages. The 22 villages are listed in Table 1, and their respective locations are shown in Figure 1.

Table 1. List of village names in Muara Sugihan District

No.	Village	No.	Village
1	Desa Indrapura	12	Tirta Harjo
2	Daya Bangun Harjo	13	Daya Kesuma
3	Sumber Mulyo	14	Margo Rukun
4	Margo Mulyo 16	15	Ganesa Mukti
5	Sugih Waras	16	Timbul Jaya
6	Indrapura	17	Jalur Mulya
7	Mekar Jaya	18	Beringin Agung
8	Cendana	19	Tirta Mulyo
9	Argo Mulyo	20	Sido Makmur
10	Rejo Sari	21	Juru Taro
11	Gilirang	22	Kuala Sugihan

The data collection combined three qualitative techniques—semi-structured interviews [34], participant observation, and document analysis (Table 2)—to obtain rich, in-depth, and complementary information. Semi-structured interviews were guided by flexible interview protocols, allowing for deeper probing based on informants' responses. The interviews explored community perceptions of groundwater quality, adaptation measures to meet water needs, and clean water governance (Table 3). All interviews were conducted with representatives from the first, second, and third generations, as well as key village-level figures (Table 4). They were recorded with participants' consent and transcribed verbatim for analysis.

Table 2. Research data collection techniques

Technique	Data Collected
Semi Structured Interview	1. Public Perception of the Physical Condition of Groundwater 2. Forms of Community Adaptation 3. Clean Water Management
Participatory Observation	Observing real behavior and practices of adaptation
Documentation Study	Completing and confirming primary data

Table 3. Community adaptation parameter indicators

No.	Parameter	Indicators	Ref.
1	Public Perception of Groundwater Physical Characteristics	Taste Color Odor	[35]
2	Forms of Community Adaptation	Community Adaptation Strategies Challenges Encountered Opportunities for Sustained Livelihood	[36, 37]
3	Clean Water Governance	Collaboration Between Groups Expectations for Clean Water Management	[38]

Table 4. Research informants

Age Range (years)	Percentage of Respondents (%)	Information
20–40	51%	Third Generation (The majority of respondents are of young productive age)
40–60	33%	Second Generation (Middle aged respondents)
60–90	16%	First Generation (Elderly Respondents)

Participant observation enabled direct empirical observation of community access to and use of water sources, adaptation infrastructure and technology (such as wells, rainwater harvesting systems, and simple filters), daily activities related to water provision, and peatland environmental conditions that affect water availability. Observations were documented in detailed field notes.

Document analysis complemented the primary data, providing a broader socio-environmental context. Reviewed documents included village and sub-district records on water availability, NGO reports on community-based water adaptation programmes, and local news or archival records documenting water crisis events.

All qualitative data were analysed using thematic analysis [39] to identify recurring patterns in the respondents' accounts, with findings presented in a narrative format. The analysis referred to prior research on adaptation to water crises in peatland areas and theoretical frameworks relevant to community-based resource management.

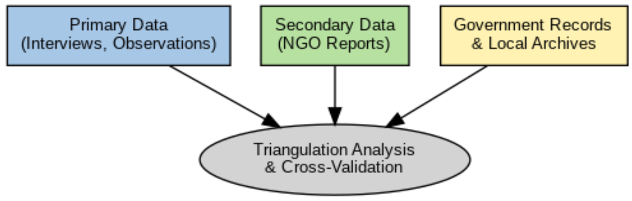

Figure 2. A schematic representation of triangulation process

To ensure methodological transparency and strengthen the validity of findings, a data triangulation framework was applied by integrating:

1. Primary data (interviews, participant observation),
2. Secondary data from NGOs, and
3. Government records/local archives.

A schematic representation of this triangulation process is provided in Figure 2, illustrating how multiple data sources were systematically cross-verified to enhance accuracy, reliability, and contextual relevance.

3. RESULTS AND DISCUSSION

3.1 Public perception of groundwater physical characteristics

The characteristics and types of soil greatly influence the condition of groundwater in a given region. In peatland areas such as Muara Sugihan, the acidic nature and high organic content of the soil significantly affect the quality of groundwater sources. As a result, the residents of Muara Sugihan face a severe clean water crisis. Based on community feedback and researchers' field observations, the groundwater in this region cannot be classified as clean water when assessed from its physical and chemical properties. Observational interviews revealed that the groundwater in this area exhibits unusual taste, color, and odor. The observed taste in the study area is a combination of salty, bitter, and sour flavors, clearly indicating contamination and high levels of dissolved substances and organic compounds. The salty taste is typically caused by dissolved sodium ions related to water salinity, while the bitter taste may result from alkaloid compounds or other chemicals. Peat water is generally highly acidic (low pH); the sour taste is associated with the accumulation of hydrogen ions, which may be caused by high concentrations of humic and fulvic acids [40, 41].

Field observations also showed that the groundwater used by residents in Muara Sugihan appears reddish-brown with a pungent odor. This coloration indicates a high concentration of dissolved organic matter, typically resulting from the decomposition of vegetation in peat soils. Additionally, the distinct metallic odor—especially resembling iron—suggests a significant presence of iron (Fe) in the water. This condition generally results from chemical reactions between groundwater and the minerals in peat soils, which are rich in heavy metals and organic compounds. The color and condition of the groundwater are illustrated in Figures 3(a) and 3(b).

The presence of iron (Fe) in groundwater can significantly reduce water quality, not only by altering its taste and odor but also by changing its color to a reddish-brown hue. This discoloration often causes staining on clothes and household appliances, making the water less suitable for domestic use. The phenomenon results from the oxidation of iron in aquatic environments. According to Cornell and Schwertmann [42], the fundamental reaction involved is: $Fe^{3+}+3H_2O \rightarrow Fe(OH)_3(s)+3H^+$, which produces an orange-brown precipitate of $Fe(OH)_3$ and hydrogen ions (H^+) that increase the acidity of the water. These precipitates are commonly observed as iron rust in wells or natural water bodies. In peatland areas, land drainage accelerates iron oxidation processes, thereby increasing the formation of such deposits and further degrading groundwater quality.

(a)

(b)

Figure 3. (a) Physical condition of groundwater (b) Physical condition of groundwater

Furthermore, water in peatland areas generally possesses characteristics that render it unsuitable as a source of clean water [43, 44]. The use of contaminated water poses potential health risks. The presence of pollutants or pathogenic microorganisms in such water can cause skin irritation and digestive problems, especially with prolonged exposure over time.

This combination of physical and chemical properties makes peat water unsuitable for direct consumption or household use without adequate treatment. The quality of the peat water in Muara Sugihan also presents similar, or potentially greater, health risks compared to conventional groundwater. Based on these findings, there is an urgent need for a simple and sustainable water treatment system for communities living in peatland areas such as Muara Sugihan.

These field observation findings are supported by interview results with residents of Muara Sugihan, who consistently expressed concerns about the quality of groundwater in the area. All informants (100%) reported that the groundwater in their homes tastes salty, sour, and bitter, and therefore is not used as a source of drinking water. Although 80% of respondents have attempted to treat their groundwater using manual filtration methods, the filtered water still exhibits a yellowish hue. It retains a bitter-sour taste, indicating that chemical contamination—particularly organic acids such as humic and fulvic acids—remains a dominant issue. Therefore, the groundwater is still considered unfit for consumption.

The filtered water is only used for domestic purposes such as bathing, washing, and sanitation. However, even for these purposes, its use is limited, particularly for laundry activities. Many respondents reported that the groundwater causes yellow stains on clothing, especially white garments, due to the high concentration of natural colorants from the peat soil dissolved in the water. Furthermore, 60% of respondents also attempted to boil the filtered water in an additional effort to make it drinkable. However, even after boiling, the bitter and sour taste remained, leading them to completely abandon the use of groundwater for drinking purposes.

This situation reflects the limited access to clean and potable water in the Muara Sugihan area, driving the community to seek alternative sources to fulfill their drinking water needs.

3.2 Community adaptation strategies

The clean water crisis experienced by the community in Muara Sugihan has driven them to seek and develop alternative solutions to meet their daily needs. The multiple intersecting crises faced by humanity compel individuals to find new ways to address economic, livelihood, and life-related challenges. In this context, the crisis encourages people to adapt and adjust autonomously. Such adaptation efforts are essential to reduce vulnerability and enhance community resilience [21, 45, 46].

The community of Muara Sugihan has developed various forms of adaptation strategies that are locally grounded and based on specific needs. The Muara Sugihan community employs four dominant adaptation strategies in their efforts to meet clean water needs:

1.) Filtration Innovation

The simple filtration innovation used by the Muara Sugihan community is the result of self-engineered efforts developed by residents, particularly the first generation who settled in the area since the 1980s. This filtration system is assembled independently using readily available materials found in their surroundings, such as sand and charcoal, which serve to filter out large particles and reduce unpleasant odors in the water. The adoption of basic filtration techniques—utilizing sand to remove large particles and charcoal to mitigate odor and contamination—is also supported by studies showing that effective water treatment and filtration can be achieved independently using locally accessible materials [47]. Therefore, the recommended filtration system does not solely rely on advanced technology but also reflects simple practices accessible to individuals in resource-limited areas, demonstrating that innovation can emerge from the integration of local knowledge and natural materials.

Although the filtration devices used remain relatively simple and are based on general knowledge, their presence has provided a temporary yet helpful solution in improving water quality for daily use (Figure 4). However, most of these filtration systems have not yet fully met the standards for potable water as outlined in the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023. One key indicator is the physical quality of the water, which, to be considered safe for drinking, must be clear and colorless, odorless, and tasteless. Therefore, further efforts are needed to enhance the effectiveness of these filtration systems through scientifically-based and technologically adequate support to ensure that the resulting water quality is truly safe for consumption.

Figure 4. The water filter sketch was created based on the community's descriptions

Research conducted by Huang et al. [48] demonstrates that filtration systems can utilize simple materials, such as cotton or damp cloth, in the water purification process. They also proposed a basic pond system that applies the principle of gravity filtration to separate suspended particles. Similarly, Hata et al. [49] emphasize that low-cost and effective filtration methods can be developed for emergency use in areas with limited access to clean water. These findings suggest that simple technologies, when applied effectively, can serve as viable alternatives to alleviate pressure on existing water resources.

2.) Source Diversification

The filtration innovations developed by the community have not yet fully ensured the potability of water, particularly in terms of taste, even though color and odor can be reduced through the filtration process. Consequently, the community has adopted a source diversification strategy as a critical initial step to obtain clean water suitable for use, especially for drinking purposes.

(a) The storage tanks used by the first generation were made of cement

(b) The latest rainwater storage tanks are made of plastic

Figure 5. Rainwater storage tank

Various water sources are utilized selectively based on their specific functions. Swamp water, for instance, is still used for limited domestic purposes, while rainwater is collected in containers such as drums or storage tanks during the rainy season (Figures 5(a) and 5(b)) and used for cooking and household consumption. Meanwhile, well water continues to be used for non-consumptive needs such as bathing, washing, and other household activities. This strategy reflects the community's adaptive approach to independently managing water resources amidst limited access to clean water that meets health standards.

3.) Behavioral Adjustment

Behavioral adjustment is a key component of the community's adaptive response to the clean water crisis, particularly in peatland areas such as Muara Sugihan. One tangible form of this adjustment is the community's practice of treating rainwater before consumption. Rainwater collected in storage tanks or closed containers during the rainy season is not used directly but is first processed to ensure its suitability for use.

People generally process water by boiling it until it reaches a temperature of 100 degrees Celsius. This process aims to kill pathogenic microorganisms that can cause disease, as well as reduce the risk of transmitting diseases originating from water, such as diarrhoea and digestive tract infections. This practice is carried out almost universally by residents because it is considered the safest, cheapest, and most appropriate method, given the limited water treatment technology available. This behavioral adjustment shows the level of public awareness of the importance of maintaining the quality of drinking water and demonstrates adaptive capacity in overcoming the limitations of clean water infrastructure independently.

3.3 Challenges encountered

Communities residing in the Muara Sugihan peatland region face substantial technical challenges in meeting their daily clean water needs due to limited access to adequate and affordable water filtration technologies. Commonly employed rudimentary filtration systems are insufficient to remove critical contaminants, including heavy metals, pathogenic bacteria, and harmful chemical compounds that are prevalent in peat water. This poses a significant health risk to local populations, especially in the absence of alternative water sources.

Moreover, the absence of centralized water treatment facilities, partly due to minimal governmental investment in infrastructure, remains a fundamental barrier to ensuring safe water access. The complex geographical characteristics of peatland ecosystems—characterized by their waterlogged, unstable, and highly acidic soils—present significant obstacles to the installation of piped water distribution systems. These geographical constraints not only complicate the development of infrastructure but also geographically isolate many communities from cleaner and more reliable water sources, resulting in a high dependency on low-quality peat water for drinking and domestic purposes (Figures 6(a) and 6(b)).

(a) Access to Muara Sugihan subdistrict

(b) The road access is available in Muara Sugihan

Figure 6. Access to Muara Sugihan

These findings are consistent with previous research. Wösten et al. [13] reported that transportation infrastructure in Central Kalimantan's peatland regions is frequently damaged and becomes inaccessible during the rainy season due to unstable soil conditions, which are not easily managed using conventional engineering techniques. Similarly, Sumarga and Hein [50] emphasized that infrastructure development in peat ecosystems is often hindered by technical difficulties and disproportionately high construction and maintenance costs, thereby limiting the provision of essential public services, including access to clean water.

In addition to physical and infrastructural limitations, the problem is exacerbated by a lack of access to information regarding safe drinking water standards. Most residents remain unaware of the potential health risks associated with consuming untreated or inadequately treated water. This situation is further compounded by the absence of local institutions or regulatory bodies tasked with regularly monitoring water quality, leaving the community with little to no assurance regarding the safety of the water they consume.

It is important to note that such challenges are not unique to Muara Sugihan. Several other remote peatland regions across Indonesia experience similar constraints, particularly in areas where environmental conditions hinder infrastructure development and where institutional support remains limited. As such, the case of Muara Sugihan underscores a broader need for context-specific, adaptive, and low-cost technological solutions, as well as robust policy interventions aimed at ensuring equitable access to clean water in peatland ecosystems.

3.4 Opportunities for sustained livelihood

Despite facing serious challenges in accessing clean water, the Muara Sugihan community demonstrates a strong adaptive capacity, which serves as the foundation for long-term livelihood opportunities. This capacity is reflected in the community's ability to mobilize local resources, apply traditional knowledge, and foster social solidarity to develop community-based solutions.

The key opportunities for sustaining livelihoods in peatland areas include:

1) Utilization of Local Knowledge and Social Innovation

The integration of local knowledge and simple technology, such as filtration systems and rainwater collection, illustrates the capacity of communities in peatland regions to innovate sustainably. Communities have demonstrated effectiveness in leveraging their traditional knowledge on water management, which can be further enhanced through collaborations with academic institutions and NGOs. Such partnerships bolster local tech capabilities for water treatment and foster the adoption of culturally appropriate technologies [51, 52]. Zulkarnaini et al. [51] emphasized that peatlands, if managed sustainably, hold tremendous potential for socio-economic improvement, thus establishing a foundation for community-led initiatives in managing water resources while ensuring environmental integrity.

2) The Strength of Social Capital and Collectivity

Community participation is pivotal for effective management and conservation efforts in peatland areas. Initiatives such as constructing water storage facilities often arise from collective action, reinforcing social capital [29, 52]. The establishment of community-based water resilience programs can build upon this social fabric, facilitating the development of adaptive governance frameworks necessary to address environmental challenges in peatland ecosystems [29].

3) Environmental Awareness and Positive Behavioral Change

The ecological understanding exhibited by communities, such as boiling rainwater and avoiding reliance on well water due to health risks, signifies a proactive approach toward environmental conservation [25, 53]. This behavioral shift, understood through the lens of environmental health education, demonstrates the community's commitment to safeguarding their health and the environment. Such awareness can be nurtured through educational programs that enhance knowledge about sustainable practices and the ecological functions of peatlands [25, 52].

4) Potential for External Support

Emerging generations, particularly transmigrants who adapt readily to technology, bring new opportunities for partnerships and resources that can be harnessed to improve community livelihoods [29, 54]. These partnerships, involving governments, NGOs, and the private sector, can help facilitate the implementation of technological, educational, and infrastructural improvements that align with local needs. Moreover, external support can provide the necessary frameworks to engage local communities in peatland restoration, thereby enhancing their ability to manage resources sustainably [29].

By optimizing internal strengths and leveraging external opportunities, the Muara Sugihan community holds promising prospects for sustained livelihoods amid the ecological challenges of peatland environments. The adaptation strategies already in place are not merely reactive but can be transformed into proactive efforts to build community-based clean water resilience.

3.5 Intergroup community collaboration

One of the most prominent forms of community adaptation in the Muara Sugihan area is the strong intergenerational collaboration in managing and fulfilling clean water needs. The first generation, consisting of early transmigrant groups, initiated collective efforts to make groundwater usable by constructing simple, self-built filtration systems. Together, they learned how to filter water using locally available materials such as sand, charcoal, and gravel to reduce the high levels of contaminants in well water. Additionally, the community explored alternative water sources, such as harvesting swamp runoff during the rainy season for basic needs. A notable form of social solidarity is the willingness of residents to share clean water with neighbours facing shortages, reflecting strong social cohesion and enduring communal values.

This spirit of togetherness has continued into the second generation, which has begun to develop innovations on a larger scale, particularly in water storage. Aware of the limitations of small household containers, this generation has constructed large-capacity rainwater storage tanks made of cement. This innovation allows for more effective collection of rainwater, especially during the rainy season, ensuring longer-lasting availability of clean water and enabling equitable distribution among residents.

Meanwhile, the third generation—comprising young people with better access to education and information technology—has sought to develop institutional approaches and external networks. They have established local water management groups and initiated communication with various external parties, including non-governmental organizations (NGOs), government agencies, and private donors, to advocate for more systematic and sustainable access to clean water. However, these efforts continue to face significant challenges, particularly due to the complex topography of the peatland environment and inadequate infrastructure access to the Muara Sugihan Subdistrict. Nevertheless, the shift from household-based manual solutions to organized institutional approaches reflects a progressive evolution of community adaptation, deeply rooted in a spirit of solidarity and intergenerational resilience.

Overall, a growing body of empirical evidence supports the assertion that strong social bonds are essential for emotional and psychological support during times of hardship. Social support interactions within both personal and professional environments underscore the importance of fostering these connections as protective factors against mental health crises and for enhancing individual resilience. Strong social relationships play a crucial role in providing necessary support during difficult times. Various studies emphasize the critical role of social ties in shaping resilience and emotional well-being during adverse conditions. For instance, Gordon et al. highlight the link between social support and well-being, noting that a strong sense of community can significantly improve overall health outcomes, especially during transitions that challenge individual resilience [55].

The importance of social networks extends beyond professional environments to include personal relationships as well. White et al. [56] emphasized that connections with friends and family contribute positively to well-being, aligning with Maslow's hierarchy of needs, where a sense of belonging is a crucial element for psychological health during stressful times. Effective communication within these networks has been highlighted as essential for optimizing support, thereby enabling individuals to better cope with their circumstances. This is consistent with findings by Dyregrov et al. [57], who demonstrate that strong relationships can facilitate adaptive coping through optimized support from family and community networks.

Furthermore, the concept of resilience as an adaptive capacity reinforced by social connections is supported by James [58] who explores the relationship between resilience and social ties among specific demographic groups, emphasizing that community support mechanisms can strengthen psychological well-being in the face of adversity [59] also provide evidence that when community members perceive their contributions as valuable, there is a greater likelihood that collaborative efforts will lead to lasting, positive outcomes.

Overall, a substantial body of empirical evidence strongly supports the assertion that strong social bonds are crucial for emotional and psychological support during difficult periods in life. Social support interactions within both personal and professional environments underscore the need to cultivate these connections as protective factors against mental health crises and as a means of enhancing individual resilience.

3.6 Community expectations in clean water management

The people of Muara Sugihan, who have adapted to the challenging conditions of peatland environments, hold strong hopes for the development of a cleaner water management system that is more equitable, sustainable, and affordable.

Based on interviews and field observations, the majority of residents express a desire for a water management system that goes beyond emergency or individual responses—one that is institutionalized and collectively managed by the community with external support [60, 61].

One of the community's main expectations is the establishment of a centralized clean water treatment infrastructure, such as simple water treatment plants (WTPs) capable of processing peat water, which is known for its complex physical and chemical characteristics. They hope that local governments and relevant agencies will initiate clean water provision projects that take into account the region's geographic constraints, including remoteness and limited transportation access [62, 63].

Additionally, the community seeks ongoing technical assistance and educational support from NGOs, academics, and public health institutions regarding safe, efficient, and appropriate water treatment technologies [64, 65]. They recognize that local knowledge needs to be strengthened through scientific approaches to ensure that treated water meets public health standards [66].

Strengthening local institutional capacity is also a key component of the community's aspirations. Several young leaders and village officials have proposed the establishment of a village-level clean water management unit with legal authority to manage water resources in a transparent, inclusive, and participatory manner. Through such institutions, the community hopes to access clean water aid programs in a more organized fashion and to ensure the sustainability of water management efforts after external projects conclude [67].

Finally, the people of Muara Sugihan express a strong desire for inter-regional collaboration and affirmative policy support from the government to bridge the gap in clean water access in remote areas. This support is expected to include peatland-based spatial planning, incentives for local innovations, and the integration of clean water programs into broader village development agendas.

Thus, the community's expectations extend beyond the basic fulfilment of clean water needs; they also encompass structural transformation in water governance—aimed at ensuring ecological sustainability and social justice for vulnerable communities.

4. CONCLUSIONS

This study reveals that the Muara Sugihan community, living in a peatland environment characterized by highly acidic and polluted groundwater, has developed unique adaptation strategies to meet their clean water needs. The poor physical quality of the water—marked by an unpleasant taste, reddish-brown colouration, and a strong odour—has driven residents to adopt alternative approaches to ensure water safety and availability.

Three primary adaptation strategies identified in this study are: (1) local filtration innovations using readily available materials such as sand and charcoal; (2) diversification of water sources, including selective use of swamp water, rainwater harvesting, and limited use of groundwater for non-consumptive purposes; and (3) behavioral adjustments, particularly the practice of boiling rainwater before consumption. These practices reflect community resilience and contextual knowledge in responding to environmental challenges.

The study also found generational differences in adaptation patterns, with younger generations being more receptive to technology and actively engaged in community-based initiatives. In comparison, older generations tend to rely on traditional methods. Nonetheless, the community continues to face serious challenges, such as limited access to effective filtration technologies, inadequate clean water infrastructure, and the absence of routine water quality monitoring.

Thus, the community's adaptive responses to clean water scarcity in peatland areas are shaped by environmental constraints, social capital, and intergenerational knowledge transfer. These findings underscore the importance of integrated support from both governmental and non-governmental actors to enhance the sustainability, safety, and equity of clean water access in ecologically vulnerable regions.

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