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Community-led Initiatives for Water Resource Management in Sumenep Regency, Indonesia

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ABSTRACT

Water scarcity is a global issue affecting human health, well-being, and the environment. Community participation is vital to managing water resources, particularly in addressing water scarcity. In Indonesia, East Java is one of the provinces that frequently experiences water shortages. This research explores how local communities manage water resources and utilize local knowledge to address the vulnerability to clean water crises in Desa Parsanga, Sumenep, and East Java. This study employed a qualitative approach using interviews, observations, and document analysis as data collection methods. The research findings revealed that the local community's initiative is demonstrated through their participation in the construction of drilled wells. This participation is facilitated through an organization formed by the local community in Desa Parsanga called the Association of Drinking Water Users (HIPPAM). HIPPAM constructed five drilled wells that supply clean water to approximately 500 households. This initiative demonstrates that the local community plays a strategic role in water resource management and can promote sustainable practices. This research provides insights into the potential of communities and local knowledge in addressing global water issues.

Introduction

Water scarcity is a pressing global issue with broad implications that affect not only human health and well-being but also the overall balance of ecosystems and the sustainability of our planet [1–3]. As access to clean and safe water has become increasingly limited, many communities in various regions have faced serious challenges beyond mere thirst [4–6]. Water scarcity has various consequences. In areas struggling to obtain water supplies, communities often face challenges in meeting their basic needs, such as drinking, cooking, and maintaining personal hygiene [7]. Limited access to adequate water resources can result in malnutrition, the emergence of disease outbreaks, and even potential fatalities, especially among vulnerable groups, such as children and the elderly. Additionally, the inability to provide adequate sanitation facilities and poor hygiene practices resulting from water scarcity further exacerbates health risks and enables the spread of waterborne diseases [8].

Water scarcity directly affects human health and has far-reaching implications for the environment. Aquatic ecosystems such as rivers, lakes, and wetlands can suffer damage due to reduced water supplies, threatening biodiversity and disrupting ecosystem balance. Decreased water flow and depletion of groundwater reserves can also harm agricultural productivity, impacting food security and the livelihoods of communities dependent on the agricultural sector [9,10]. Moreover, water-dependent industries, such as manufacturing and energy production, face significant challenges during periods of water scarcity. Limited water resources can hinder economic growth, lead to job loss, and decrease productivity across various sectors [11].

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These conditions indicate that communities in some regions are still highly vulnerable to clean water access issues. Research conducted by Mbarep et al. [12] revealed that water scarcity in the Sikka District forces communities to rely on rainwater to meet their daily water needs. In such situations, intervention and other assistance are required to address these problems. It is essential to promote awareness and community empowerment when tackling water crises [1,7]. This is particularly crucial in areas where local governments face financial and infrastructure limitations when providing access to clean water for their communities.

Sumenep Regency, located in East Java Province, is one of the areas in Indonesia that frequently experiences annual clean water crises, especially during the dry season. Research on the spatial distribution of drought in East Java Province conducted by Haryanto and Budiprabowo [13] showed that the Sumenep Regency falls into the category of being very prone to drought throughout the year. One of the factors leading to this area is the geographical location of the Sumenep Regency, which is in a coastal region with a very dry arid climate and low rainfall. Research conducted by Wahyudi [14] found that groundwater can be utilized to address drought in the Sumenep Regency. Furthermore, this study found that the utilization of groundwater by the local population and government through the East Java Groundwater Development Project in Sumenep Regency reached 201,598.21 m^3/day. Amid the crisis threat, Sumenep Regency has water resource potential, both from groundwater and surface water sources. Parsanga Village, Kota Sumenep Sub-District, has the potential to manage water resources to meet household needs.

This research fills an information gap regarding how residents in Sumenep Regency are taking the initiative to address the limited access to clean water by utilizing groundwater resources to meet their daily water needs. Effective solutions require community participation, particularly in areas with deep-rooted human-nature interdependencies. This research focuses on citizen engagement in addressing environmental and water crises within grassroots democracy, known as environmentalism. This bottom-up approach emphasizes community self-reliance and solidarity in ecological conservation and resource crisis mitigation, offering a response to industrialization's environmental pressures [15].

It is essential to deeply explore the participation and initiatives of the local community in water resource management. This is based on two considerations: first, water is a vital resource needed by humans for their survival; second, the availability of water resources has economic and political significance [1]. This research aims to analyze the local community's participation in water resource management and the local knowledge applied to water management to address vulnerability to the clean water crisis in Parsanga Village. This can be an effort to ensure justice in access to clean water for all, safeguard public health, protect ecosystems, and promote sustainable development for present and future generations.

Materials and Methods

This study was conducted in 2021 in Parsanga Village, Kota Sumenep Sub-District, and Sumenep Regency. This study adopts a qualitative approach that focuses on exploring and understanding the complexity and nuances of a specific phenomenon or topic. Subjective assessment, context, and social construction of reality are emphasized in qualitative research. By focusing on depth rather than breadth, researchers using this method strive to capture the complex and profound aspects of their research topic. The strengths of qualitative research include its ability to generate in-depth and contextually rich data, uncover new ideas, and provide a comprehensive understanding of research issues [16].

This study used primary and secondary data collected from various sources. Primary data were collected through interviews and field observations, whereas secondary data were obtained through media searches, policy documents, and relevant scholarly publications. All collected data were then analyzed using pattern-matching analysis, which compares the observed patterns with the conceptual framework used. The analysis began by formulating initial propositions or ideas about expected patterns based on prior knowledge, theories, or predictions. The collected data were then compared with the initial propositions to determine the degree of fit or deviation from the expected patterns [17].

Bouncken's qualitative research approach that employs flexible pattern matching involves a five-step process [17]. Initially, theoretical concepts were pinpointed for use as foundational theoretical templates. Subsequently, data were gathered from diverse sources, such as interviews, observations, and documents. The third step involved scrutinizing the data about the initial theoretical template, noting both commonalities and disparities. The fourth step involves refining the theoretical template based on the identified overlaps and discrepancies. The fifth step encompasses an iterative cycle of data collection and analysis until a satisfactory level of theoretical saturation is attained.

Results and Discussion

Water Resources Vs Water Crisis Problems

The water crisis is one of the main issues in the Sumenep Regency, including in Parsanga Village. Water scarcity occurs primarily during the dry season. People in the village face difficulties meeting their drinking water, household, and sanitation needs. Moreover, productive economic sectors, such as agriculture, plantations, and animal husbandry, are also affected. The ongoing water crisis, which has become an annual problem in Parsanga Village, significantly impacts the quality of life of village residents.

Seeking external assistance is generally the approach the community takes to address the water crisis. When a water crisis occurs, the community often requests water assistance from external parties, especially the government and non-governmental organizations. The government usually provides help by dropping water into tanks to be distributed to areas highly affected by the water crisis. This situation typically arises when the dry season persists, exacerbating the water crisis at the village level, and no water sources are available to meet residents' water needs (interview with MA, 18 September 2021).

Relying on external assistance at some point creates a dependency on external parties to address the water crisis that can continue every year. The water crisis at the village level rarely receives adequate attention, as interventions tend to focus on the consequences rather than causes. Such mechanisms provide temporary solutions to this problem. Issues related to the sustainable provision of clean water, as one of the basic needs of the village community, seldom receive sufficient attention or proper handling [18].

A water crisis is related to the availability of water resources in a particular area. Water crises are increasing in line with climate change [19]. In summary regency, there are limitations in the water resources required to meet the basic needs of the community. In the Kota Sumenep Sub-District, potential water resources, particularly springs, can be considered limited. There are only seven concentrated springs in Pajagalan, Kacongan, and Paberasan Villages. Pajagalan Village has five springs, while Kacongan and Paberasan Villages each have only one spring. The springs listed in Table 1 refer to natural springs that flow from the rocks or soil to the surface.

Table 1. List of springs in Kota Sumenep Sub-District [20].

No	Name of Spring	Location (Village)	Condition	Used for		Issue
				Daily needs	Irrigation	
1	Kacongan	Kacongan	Moderate	V	-	Small water discharge
2	Banding	Pajagalan	Moderate	V	V	
3	Kampung Arab	Pajagalan	Good	V	-	Small water discharge
4	Keraton	Pajagalan	Moderate	V	-	Operationalized by *Perusahaan Daerah Air Minum* (PDAM)
5	Taman Lake	Pajagalan	Good	V	V	
6	Pajagalan	Pajagalan	Good	V	-	
7	Sumber Kali Masjid	Paberasan	Good	V	V	

As shown in Table 1, only three villages in the Kota Sumenep Sub-District have access to spring water, while the other villages do not have any potential spring water sources. This situation significantly impacts the availability of water for the entire community in the Kota Sumenep Sub-district and is also a significant cause of drought in the sub-district areas. In addition to spring water, groundwater is another water source that can be used to meet the water requirements of the Kabupaten Sumenep Regency. In the Kota Sumenep Sub-District, the community is aware of the existence of groundwater, but its utilization is still minimal because the groundwater is in deep soil layers. In addition to the significant costs of extracting groundwater from the surface, challenges related to the expertise required to manage groundwater sources also hinder the optimal utilization of groundwater.

Parsanga Village in Kota Sumenep Sub-District is one of the villages that has made efforts to utilize groundwater sources. This step is taken because the village faces limitations in spring water sources. The only existing spring water source is located far from residential areas and beneath the village, requiring significant effort to access water from those sources. To fetch water, villagers must spend 15 to 30 min descending through a steep footpath to the lower area where the spring water source is located (interview with AR and

MA, 18 September 2021). Accessing the spring water source located in the steep valley, as shown in Figure 1 and 2, is difficult. Additional caution is required to reach the location of the spring. This difficulty has been one of the triggers for the community to seek alternative water sources to meet their needs. Considering the challenging access to water sources and the safety risks faced by the community, several community leaders in Parsanga Village began discussing this issue. Ideas and initiatives emerged from these discussions, including the proposal to construct a drilled well in Timur Lekke Hamlet, Parsanga Village. The leading proponents of this idea and initiative were AR, MA and EG. This initiative arose as a form of community adaptation to arid environmental conditions to sustain livelihoods by meeting household and agricultural water needs [6,18,21].

The ideas and initiatives of these three individuals were later brought to a wider forum. In the Village Forum (*Musyawarah Desa*/Mudes), these individuals had the opportunity to communicate their ideas to the entire community and authorities at the village level. The ideas received positive responses during the village forum, and the next step was to submit a proposal to the Government of Sumenep Regency for the construction of a drilled well. At that time, the Sub-District Development Program (*Program Pembangunan Kecamatan*/PPK) was ongoing in the Sumenep Regency, providing an appropriate opportunity to construct a drilled well in Parsanga Village. The village endeavored to apply for funding assistance through the PPK programme to complete the drilled well.

The proposal from the residents of Parsanga Village for the drilled well received a positive response and was accommodated in the PPK program of the Sumenep Regency. After waiting approximately four years, Parsanga Village received financial support from the PPK program. The allocated funds for constructing the drilled well in Parsanga Village amounted to IDR 145,000,000. Funds were received in 2003 (interview with AR, 18 September 2021). With allocated funds of IDR 145 million, the residents of Parsanga Village utilized the funds to build the drilled well, install a generator house, and implement piped water distribution to connect water to the households. However, it is essential to note that the community, especially the residents of Timur Lekke Hamlet, also participated in the drilled well program. Community participation primarily involved contributing additional costs to installing pipes that connect the water obtained from the drilled well to households in Timur Lekke Hamlet. Funding from the PPK program catalyzed community participation in the water supply program for the people of Parsanga Village.

A community-based management mechanism was employed to manage the drilled well, which utilizes groundwater to meet the community's needs. In Parsanga Village, the management of the drilled well is regulated through an institution called the Association of Drinking Water Users (*Himpunan Penduduk Pemakai Air Minum*/HIPPAM). The decision to adopt a community-based management structure with HIPPAM was chosen because the initiative originated from the community of Parsanga Village and is in line with government regulations that provide flexibility for the community to utilize water resources to meet primary drinking water needs.

In the initial stage, drilling activities in Parsanga Village were managed and implemented by a group of administrators consisting of the following: chairperson, HS; secretary, AR; treasurer, HA; and technical teams, SA and HT. The main activities carried out by the management team initially focused on completing the infrastructure construction of the drilled well and piped water distribution. In this initial phase, the piped water distribution process covered approximately 40 households, and the water from the drilled well was primarily used for clean water needs and daily household purposes (interview with AR and MA, 18 September 2021). The first well drilled in Parsanga Village, which was used to pump clean water to the surrounding residents, is shown in Figure 3. The HIPPAM of Parsanga Village then expanded and increased available water discharge and extended access to water for unserved households. In 2005, HIPPAM management in Parsanga Village initiated constructing a second phase of drilled wells. This second-phase drilled well was built on the east side of the first-phase drilled well.

Interestingly, the community funded the construction of the second-phase drilled well entirely. Collectively, the residents of Parsanga Village raised funds to finance the construction of drilled wells. The community's enthusiasm to collectively finance the construction of the second-phase drilled well is remarkable because, despite limited resources, they were committed to allocating a portion of their funds for well construction (interview with SA, 19 September 2021). Meeting residents' water needs has become a primary focus of HIPPAM management. Important considerations for HIPPAM management include increasing market demand and the potential for significant benefits for the institution. This encouraged HIPPAM management to focus on water supply efforts. As of the end of 2021, when this research was conducted, five drilled wells were built in Parsanga Village, which was able to meet the water needs of more than 500 households in the village.

Figure 1. The road from the residential area in Timur Lekke Hamlet, Parsanga Village, to the spring water source.

Figure 2. Spring water source in Timur Lekke Hamlet, Parsanga Village.

Figure 3. The first drilled well in Timur Lekke Hamlet, Parsanga Village.

With the existence of the community-managed HIPPAM institution and an increasing number of Parsanga Village residents relying on water from HIPPAM, the water crisis in the village could be better addressed. This was evident in 2016 when the Sumenep Regency experienced a drought and water crisis, and Parsanga Village was not severely affected by drought. Data collected by the government of Sumenep Regency indicated that Parsanga Village in the Kota Sumenep Sub-District was not included in the list of drought-affected villages in 2016. This demonstrates the significant contribution of HIPPAM in Parsanga Village in enhancing its ability to address water crisis issues independently.

Community Participation in Water Resource Management

Community participation is crucial to enhancing service delivery and maintaining administrative accountability. Community participation has become essential in the realm of water management [22–26]. In addition, community participation is important for overcoming the water crisis in places prone to drought. Active community involvement in water management is essential in drought-prone areas, enabling users to engage in decision-making and ongoing system management. This participation empowers communities to address imbalances in decision-making and control their water systems. Community-led management of rural water services, including maintaining points such as handpumps, has been the standard for decades. Various studies have confirmed the effectiveness of community participation in managing water resources in drought-prone areas, providing an effective approach for addressing drought through water management [27–30]. The involvement of the community in Parsanga Village's water resource management, facilitated by the HIPPAM organization, aligns with the concept of "citizen control" as defined by Arnstein in the context of participation ladder [31]. This is because the community itself is fully controlled without any intervention from the local village government.

The local community autonomously manages water governance. Every month, water users are charged a water fee of IDR 3,000. This monthly fee is relatively affordable; however, the installation cost for each household is high, reaching IDR 1,200,000 (interview with AR, 18 September 2021). Community participation can be observed through involvement in a program, which can be emotional or material [32]. Across numerous cities globally, according to Kotus and Sowada [33], it has become increasingly evident over the years that citizen's involvement in urban management and physical planning has grown significantly. The purpose of community involvement is to support and facilitate the achievement of group goals and to be responsible for the group [32,34]. Community involvement, working in conjunction with other stakeholders, is a guaranteed effort to secure sustainable management of natural resources [35]. In Parsanga Village, community participation in the management of water resources can be seen in their involvement when it was first initiated by AR and MA in 2003. AR and MA were the initiators of building a drilled well to provide clean water for the community's daily needs.

Local community participation was evident during project implementation. According to AR, who serves as the coordinator of the water infrastructure, the local community made significant contributions to the construction of the drilled well. These contributions include emotional support and labor. The evidence is that the workers involved in the project are residents who voluntarily accept payments that are not entirely equivalent to their working hours to ensure that the budget provided by the local government is sufficient. For example, workers are paid only for four working days, even though they work for seven days. In other words, their remuneration is only approximately 60% of their total work. In addition to contributing to their labor, the community provides input and suggestions regarding water resource management. Community participation in water management in Parsanga Village continued until the fifth drilled well and pipeline installation was completed in 2015 (interview with AR, 18 September 2021).

HIPPAM, a leadership change, occurred in 2007. AR initially led it, but later, SA took over the leadership position. This change in leadership reflects the contestation of power in managing water resources in the village. In addition, community participation has also changed. After the completion of the construction, the level of community participation declined. Said [36], in his research, highlighted that the balance of rights among each actor in the collaboration for water resource management needs to be a crucial focus to avoid potential conflicts in the future. It is important to note that, as Hamel [37] stated in his research, water is a life-giving entity and embodies the essence of justice.

In the end, the community's contributions are only seen in their routines, such as monthly payments for water usage or lodging complaints if there are issues with the generator or pipes. Furthermore, the community is no longer actively involved in decision-making regarding water management in HIPPAM. The increasing number of HIPPAM water users has led to a decrease in community participation in water management. Initially 2003, 40 households were using water, but currently, this number exceeds 500 families. As a result, HIPPAM has become an organization exclusively responsible for water management in Parsanga Village. Based on the concept of participation, the form of local community participation in Parsanga Village is considered active despite experiencing a decline over time. However, a sense of ownership of the infrastructure still exists through building and developing a water infrastructure that actively involves the local community.

Local Wisdom in Water Resource Management

Local communities have long been developing ways to interact with nature, including managing water resources, as part of their tradition. This tradition reflects the unique local wisdom that has been adapted to community [38]. In Indonesia, practices and knowledge of interacting with nature are typically transmitted to the next generation through cultural references at the village level. Local communities in many places have effectively utilized their local knowledge and mindsets to maintain environmental sustainability over time [39,40]. The narration of traditions and local knowledge often utilizes narratives such as myths, legends, and stories [41,42]. This model was chosen by cultural authorities within the community and used to understand the community's knowledge and resource management practices, framed in the form of myths, legends, and stories [43]. Local wisdom in water resource management in Parsanga Village is demonstrated by the presence of a sacred place called summer terbing. According to the myth told by the community, summer terbing spring has a unique background. A large stone was purportedly used as a prayer spot by *ulama* (Islamic scholars). According to the legend, if the stone is moved, Kabupaten Sumenep will be flooded by the overflowing water from spring (interview with SA, 19 September 2021).

Furthermore, an ancient legend speaks of a great flood that could reach Pabrasan Village, located next to Parsanga Village. During that time, the righteous servants of Allah knew about the existence of a spring in Parsanga Village covered by a gong. The community used local knowledge to locate the spring and sought assistance from the traditional figures. One of the traditional figures, AR, who later became the chairman of HIPPAM from 2003 to 2007, used a "dream" as a guide to find the spring's location for well drilling. The inspiration for drilling was based on his vision of a spring in his dream at night. The action was to drill and build a reservoir to store water and then distribute it to the households (interview with AR, 18 September 2021). Another aspect of local wisdom is reflected in a community's interaction with nature, particularly its relationship with water sources. The people of Parsanga Village believe that water is a life-giving resource that needs to be respected; therefore, they perform special rituals to request the smooth flow of water. One of the ceremonies conducted by the community was the monthly Thanksgiving ceremony. This ceremony involves collective prayers to maintain availability and smooth water flow in the village (interview with AR, 18 September 2021). According to Hidayati [44], in some places in Indonesia, local wisdom is beginning to fade, which has implications for environmentally unfriendly water-resource management practices.

Conclusions

The community's participation in water resource management in Parsanga Village through the HIPPAM organization exemplifies a form of participation that can be categorized as citizen control, as conceptualized by Arnstein. In its management, the community takes responsibility entirely, without intervention from the local village government. In this case, water management was conducted voluntarily by the local community. The process of community participation can be observed through their involvement in various programs, which can involve emotional and material contributions. In Parsanga Village, community participation in water resource management was evident when the initiative to construct drilled wells was first proposed by AR and MA in 2003. Through the construction of drilled wells, communities can easily access clean water for their daily needs.

The people of Parsanga Village practice local wisdom in water resource management, which is reflected in oral traditions and narratives, such as myths, legends, and stories. They understand the importance of harmonious interactions with nature and treat water as a source of revered life. This local wisdom is also evident in respect given to water as a life-giving resource through regular thanksgiving ceremonies. The sacred place of the summer terbing spring holds significance in myths and legends that influence how the community manages water. During the construction of the well, local knowledge and night dreams were utilized to locate the spring, which was then developed into a source of clean water for the people of Parsanga Village.

Author Contributions

IK: Conceptualization, Methodology, Writing – original draft; **DPS:** Methodology, Writing – review and editing; **CY:** Writing – review and editing, Supervision.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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