Sustainable Management Model for Springs Water in Remote Areas as an Effort to Fulfill Water Needs

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Abstract – *The Pesiraman Manik Tirta Spring in Timuhun Village can potentially supply clean water. However, the main challenge lies in the lack of infrastructure to distribute water from the source to residents' homes. As a result, those seeking water must traverse steep terrain to reach the spring. To ensure a consistent water supply for Timuhun Village, a comprehensive management plan for the Pesiraman Manik Tirta spring region is essential. Sustaining the current water potential requires the implementation of an effective management approach. This research comprises a descriptive study that incorporates both quantitative and qualitative analyses. Microsoft Excel was utilized to assess quantitative data. A SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was developed to address Timuhun Village's need for sustainable water management. This model has been adopted as the management framework for the village's Pesiraman Manik Tirta Springs model. This model can be successfully implemented by establishing cost-effective infrastructure, such as hydro pumps operating without electricity. Improved accessibility to clean water distribution infrastructure can significantly enhance the quality of life for residents, even in steep and remote areas.*

***Keywords**: Sustainable, Management, Spring Water, Remote Area.*

I. Nomenclature

SWOT : Strengths, Weaknesses, Opportunities, and Threats
IFAS : Internal Factor Analysis Summary
EFAS : External Factor Analysis Summary
TCU : True Color Unit
NTU : Nephelometric Turbidity Unit
PH : Potential Hydrogen
SO : using strength to maximize opportunities
WO : minimizing weaknesses to capitalize on opportunities
ST : using strength to overcome threats
WT : minimizing weaknesses to avoid threats

II. Introduction

Water is essential for all living things, especially human life [1]–[4]. However, until recently, providing clean water for the community has been hampered by several complicated issues that have yet to be fully resolved. The limited availability of clean water for both urban and rural communities is one of the issues still present today [5]–[7]. Water resources include surface, ground, and spring water [8]–[10]. Springs are karst-shaped natural water sources generated when groundwater rises to the surface via fissures in the topography. These gaps or surface springs can generally be found in mountainous or highland environments. Springs are high-quality water resources that can produce raw water [11]–[13]. The potential of springs that exist but have not been managed causes potential that can be wasted in the rivers [14], [15]. However, there are still a few places not reached by clean water distribution facilities that meet the required quality standards [16]–[20].

In Klungkung Regency's Timuhun Village, this occurred. The community has not yet had access to a sufficient amount of drinking water. Society must travel 700 meters to reach water [21]. In contrast, the Pesiraman Manik Tirta spring in Timuhun Village has the potential to discharge water to meet the need for clean water.

This spring's problematic source is a lack of infrastructure to distribute water from the source to locals' residences, requiring residents who want to get water to travel through fairly steep terrain to the spring. Furthermore, Pesiraman Manik Tirta Springs is being developed as a Hindu religious ecotourism destination known as *"melukat"*. For Hindus in Bali, *"melukat"* is a ritual purifying the bodies and minds.

The sustainability of the water potential will be threatened by improper management of water resources [22]–[25]. As a result, a management plan for the Pesiraman Manik Tirta spring region is required to continue providing Timuhun Village's water needs. Establishing a comprehensive management plan for the Pesiraman Manik Tirta spring area is crucial to guarantee a steady water supply for Timuhun Village. Adopting an effective management strategy is imperative to maintain the current water resources.

Manuscript received Mei 2023, revised November 2023

This research encompasses a descriptive study that combines both quantitative and qualitative analyses. Quantitative data was evaluated using Microsoft Excel. SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis was formulated to address Timuhun Village's requirement for sustainable water management. This model is believed to enable the optimal management approach to be adjusted to the site's specific issues. The SWOT (strengths, weaknesses, opportunities, and threats) analysis method will be used to create this management model by considering the strengths, weaknesses, opportunities, and threats [26]–[30]. The SWOT model provides a structured framework for assessing and developing a sustainable management model for spring water in remote areas. It helps make informed decisions, optimize resource allocation, and foster community engagement, all essential for ensuring long-term access to clean and reliable water sources in remote regions. This analysis has been embraced as the management framework for the Pesiraman Manik Tirta Springs in the village. This management model will be implemented as a Sustainable Springs Water Management Model for Remote Areas to Fulfill Water Demands.

In the next section, several literature reviews related to the Sustainable Management Model for Springs Water in Remote Areas as an Effort to Fulfill Water Needs will be presented. Then, in the research method section, the required data and the methods used for data analysis and the creation of a SWOT model for strategy selection will be discussed. Following that, in the results and discussion section, the existing conditions of the research location will be presented, and the created SWOT model and the selected management strategy for Sustainable Management Model for Springs Water in Remote Areas as an Effort to Fulfill Water Needs will be explained. With this management strategy, it is hoped that the sustainability of water distribution in remote areas to meet the water needs of the community can be maintained.

III. Literature Review

III.1. Water Supply Challenge in Remote Area

Water scarcity represents a significant global challenge, impacting approximately two-thirds of the world's population [31]. Faisalabad is facing a significant water supply challenge. In 1999, the city needed a substantial daily water supply, but a significant portion (3 million gallons) came from domestic pumps from subsoil water and tube wells. Clean drinking water is primarily found in deep sources and surface water resources in the north of Khyber Pakhtunkhwa, while excessive groundwater is available in the central part, often pumped out using tube wells for daily use. Water quality and quantity issues are particularly prevalent in urban areas due to inadequate treatment and old sanitation systems [32].

Water crisis looms as the paramount risk over the next decade, surpassing climate change, extreme weather events, food crises, and social instability. It is not limited to absolute water scarcity but extends to many issues. In sub-Saharan Africa, challenges encompass the unequal distribution and allocation of water resources, water pollution, weak institutions, ineffective governance, and a lack of political will to address the growing water scarcity problem. The relationship between water availability and population growth has been scrutinized for over a decade, revealing historical challenges predominantly in rural areas [33].

Groundwater emerges as a paramount natural resource with global significance. Within Africa, it takes center stage as the foremost and steadfast water supply solution for catering to the essential daily needs of rural communities. This reliance on groundwater stems from the inherent challenges posed by the remote and rugged terrains where many rural settlements are situated. South Africa, in particular, grapples with these complexities, making providing water services to rural areas costly and arduous. With an estimated two million individuals, primarily residing in these remote communities, still lacking access to fundamental water services [34]

This condition also happened in Timuhun Village. To get water, people had to go to Manik Tirta Temple, approximately 700 meters away.

III.2. The importance of springs water in remote areas

Groundwater stands as a critical natural resource on a global scale, playing a pivotal role in meeting the daily water requirements of communities, particularly in rural areas across Africa. This reliance on groundwater is driven by the geographical challenges posed by remote and rugged terrain, making it costly and challenging for conventional water service providers to reach these communities. South Africa, in particular, grapples with this issue, with an estimated two million people, primarily in rural areas, still lacking access to basic water services [34].

Groundwater is a crucial source of exceptionally high-quality water, yet it remains susceptible to depletion and contamination. Its composition is intricately linked to various factors, including the geological substrate, the duration of residence, initial composition, flow pathways, and the surrounding land use and practices. Karst regions, found globally, are pivotal in supplying drinking water due to their vast water storage capabilities [35].

The issue of inadequate clean water supply is especially pronounced in rural areas, where 11% of the world's population, with 84% residing in rural regions, lacks access to safe water. Tragically, this situation contributes to child mortality rates, particularly in developing rural communities. Additionally, pollution of surface waters remains a significant challenge due to rapid urbanization and insufficient sanitation facilities in many developing nations. Focusing on Nepal as an example, despite its abundant water resources, it faces water scarcity issues, particularly in rural areas where more than 70% of the population resides. Many rural villages lack piped water supplies, relying on sources like springs, which can be susceptible to contamination during collection and storage [36].

Springs are the lifeblood of rural households in the Himalayan region, serving as the primary water source for millions of people. These springs are essential for drinking and support irrigation and livestock, playing a crucial role in the livelihoods of local communities. It is estimated that there are approximately five million springs across India, with a significant concentration of nearly three million in the Indian Himalayan Region [37].

In the mountainous regions of Sikkim, Arunachal Pradesh, Meghalaya, and Nagaland, springs are the primary drinking water and irrigation source, vital in sustaining human communities and the surrounding ecosystems. These natural springs are not merely essential for the well-being of local populations; they also serve as lifelines for wildlife and contribute significantly to the health of broader ecosystems [38].

III.3. Spring Water Quality

The quality of water is as crucial as its quantity, with its importance varying depending on the specific needs of users. Globally, groundwater quality is deteriorating due to multiple factors, such as agriculture, mining, industrialization, waste disposal, and urbanization, making it unsafe for human consumption. This decline in water quality poses a significant threat to public health. In developing countries like Uganda, the migration of people from rural areas to urban centers has led to informal and unplanned settlements, particularly in places like Kampala. These peri-urban communities often suffer from poor sanitation practices and inadequate solid waste management. As a result, they rely heavily on spring water as their primary source of affordable drinking water. However, the quality of this spring water is not guaranteed and is susceptible to contamination due to unsanitary practices in these settlements [39].

For the sake of human health, it is of utmost importance to establish chemically balanced and medically safe drinking water quality standards and criteria. Water quality assessment primarily relies on monitoring physical, chemical, and biological parameters. In Pakistan, natural springs from hilly areas like Murree and Margalla provide water used by local populations as it flows through residential areas. Given the significant usage of this spring water for daily consumption, assessing its quality is crucial. Samples were collected from various locations and analyzed for specific parameters to evaluate the suitability of spring water for drinking purposes. Physicochemical parameters such as color, temperature, pH, odor, turbidity, hardness, total dissolved solids (TDS), electrical conductivity (EC), alkalinity, dissolved oxygen (DO), chlorides (Cl^-), nitrite ($NO2^-$), nitrate, sulfate, heavy metals, and microbiological parameters including total Coliform, Pseudomonas aeruginosa, Enterococcus, and Staphylococcus aureus were examined. This comprehensive assessment aims to ensure safe and healthy drinking water for the surrounding population, safeguarding their well-being and addressing the region's critical water quality issue [40].

III.4. Spring Water Management

Enhancing spring water availability can be achieved by judiciously excavating around the spring area without disrupting the underground formation. This practice can increase the quantity of water flow, ensuring a more consistent supply for the community it serves. However, it is important to note that spring water often requires treatment due to the limited leachate and runoff control in the surrounding watershed. Despite the need for treatment, the advantage of gravity-based distribution systems is that they eliminate the requirement for storage tanks and pumps at the source, reducing infrastructure complexity and energy consumption. Nonetheless, there may still be a need for storage facilities further downstream, primarily for treatment and to manage fluctuations in daily water flow [41].

III.5. SWOT Analysis

SWOT is derived from Strengths, Weaknesses, Opportunities, and Threats, which signifies its fundamental components. Its development was inspired by management techniques such as Force Field Analysis by K. Lewin and the LCAG model from Harvard Business School. These influences reflect the complexity of change processes and the delicate balance between driving forces for positive change and restraining forces maintaining the status quo [42].

The SWOT analysis, conceived in the 1960s and enduring in popularity today, owes its esteemed reputation to a fundamental philosophical underpinning. This philosophy mandates a dual evaluation approach for an organization's future: an internal assessment, encompassing strengths and weaknesses, and an external assessment, focusing on the opportunities and threats posed by the organization's environment. The model's standout feature is its emphasis on aligning the organization's capabilities with the demands of the external world, marking it as a model of significant merit. This simplicity ensures that individuals can readily comprehend and apply the SWOT analysis across various managerial contexts. Thus, the enduring success of SWOT analysis can be attributed to its philosophy of holistic evaluation and user-friendly nature, making it a cornerstone of strategic decision-making [43].

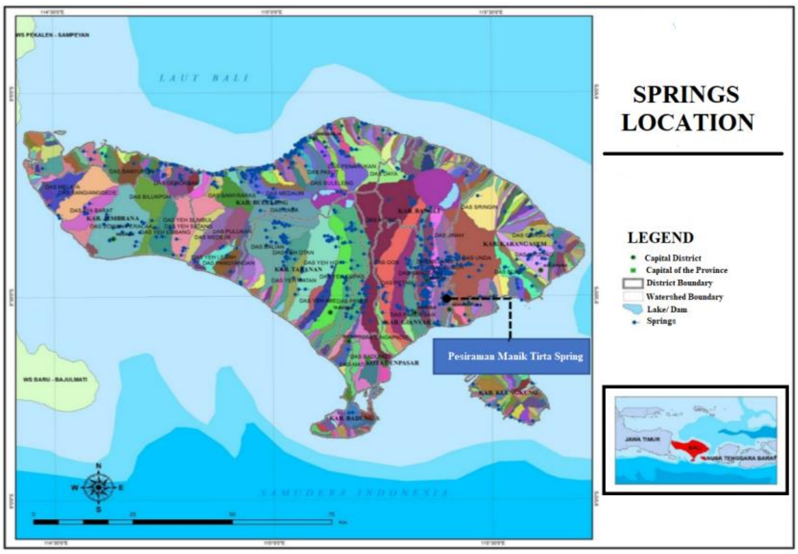
SWOT analysis is a versatile and widely adopted tool in issue management and strategic planning. Its two-dimensional approach delves into internal and external factors, encompassing the positive and negative aspects affecting businesses, organizations, and territorial units. Its enduring popularity can be attributed to its multifaceted and dynamic nature, which allows for various interpretations and applications in theory and practice, as recognized in both the private and public sectors.

IV. Research Methods

Primary and secondary data are used in this study. The Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) weights in the SWOT (strengths, weaknesses, opportunities, and threats) analysis, which will be utilized to construct a spring area management model, were determined using information from stakeholder interviews. A SWOT analysis is a strategic planning tool businesses and organizations use to assess their current position and make informed decisions about their future [44]. IFAS evaluates and prioritizes internal factors, primarily strengths and weaknesses, identified in the SWOT analysis. The goal is to assign weighted scores to these factors to determine their relative importance. EFAS, however, focuses on evaluating and prioritizing external factors, mainly opportunities and threats, identified in the SWOT analysis. It helps organizations understand the external environment's impact on their strategic decisions. The secondary data utilized to establish the socio-cultural circumstances in the Pesiraman Manik Tirta Springs area include village profiles. In addition, climatology data from https://power.larc.nasa.gov/data-access-viewer/ is used. The climatological data used in this study range from 1990 to 2021. This information is used to forecast the climatological conditions in the area around the spring. This study also conducted the water quality to know the spring's water quality.

IV.1. Study Area

The Pesiraman Manik Tirta spring is in Timuhun Village, Klungkung Regency, at 8° 28' 34.39" South Latitude and 115° 23' 3.48" East Longitude. The potential of water springs refers to the likelihood of finding and accessing a sustainable source of fresh water from underground aquifers or natural springs in a particular area. Assessing the potential of water springs is essential for various purposes, including water supply planning, agriculture, community water access, and environmental conservation. This spring has the potential to reach 1.6 liters per second. Throughout the year, this spring discharges continuously. The study area location can be seen in Fig. 1.



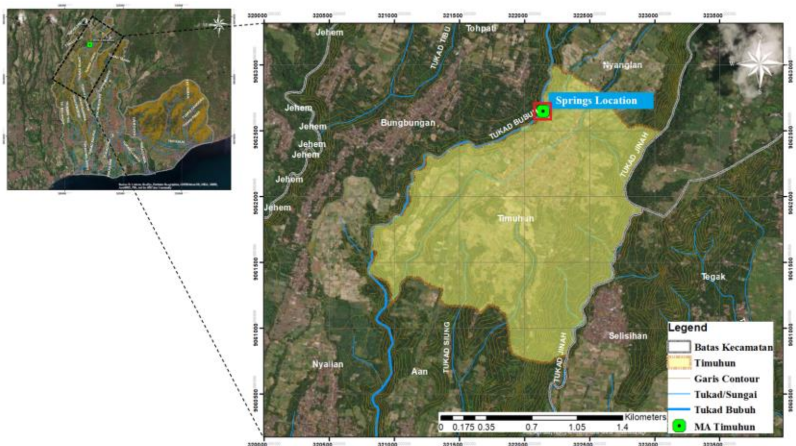


Fig. 1. The Pesiraman Manik Tirta Spring Location

IV.2. Data Analysis Methods

This study is a descriptive study that combines quantitative and qualitative analysis. Microsoft Excel was used to evaluate quantitative data. Regarding the qualitative analysis, questionnaire-based interviews and in-depth discussions with chosen respondents were conducted utilizing survey methods, observations, Literature reviews, and survey methodologies. A Management Model for the Pesiraman Manik Tirta Springs Area was developed from analysis, surveys, and questionnaires to manage the potential of Pesiraman Manik Tirta Springs to meet Timuhun Village's water needs. The flowchart of data analysis can be seen in Fig. 2.

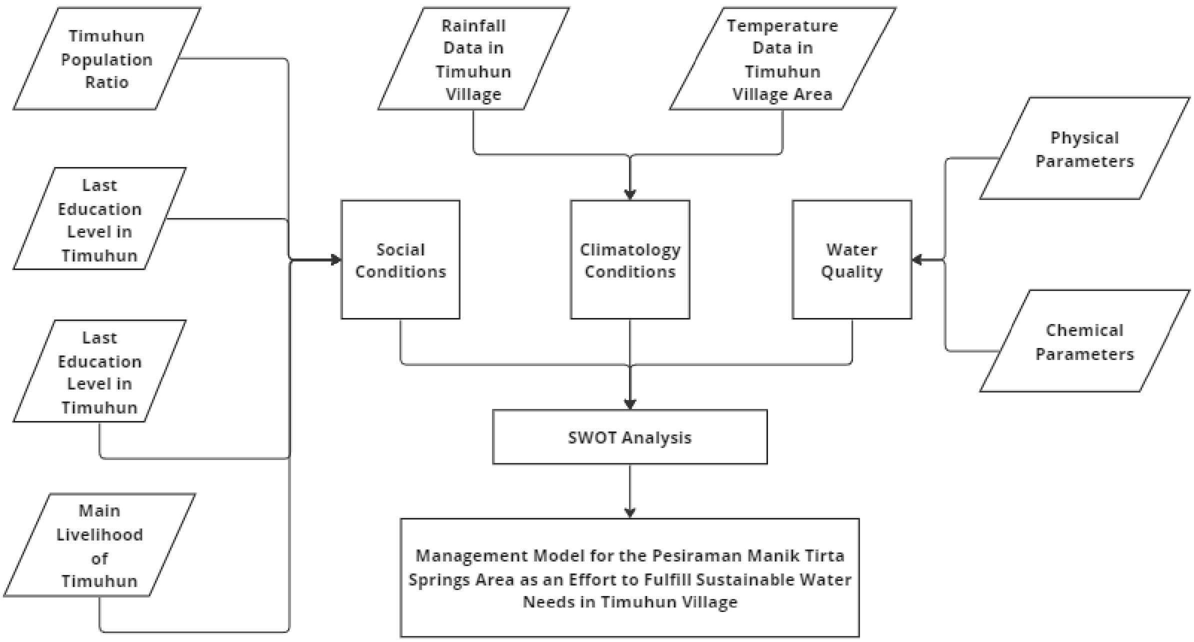


Fig. 2. The Flowchart of Data Analysis

V. Result

V.1. Social Conditions in the Pesiraman Manik Tirta Springs Area

The population of Timuhun Village is 3314 people, consisting of 1644 males and 1670 females, or a ratio of roughly 50/50. Residents, particularly women, find it difficult to obtain water sources due to the distance from the springs and the steep terrain of the water access. The population ratio of Timuhun Village can be seen in Fig. 3.

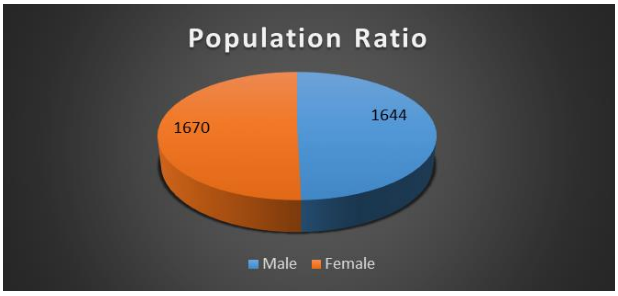


Fig. 3. Timuhun Population Ratio

Varied levels of education will result in different attitudes about addressing the water demands problems. Elementary is the most common level of education in Timuhun Village. The inability to create a sustainable area management pattern is due to the poor level of education in the local community. The last education level in Timuhun Village can be seen in Fig. 4.

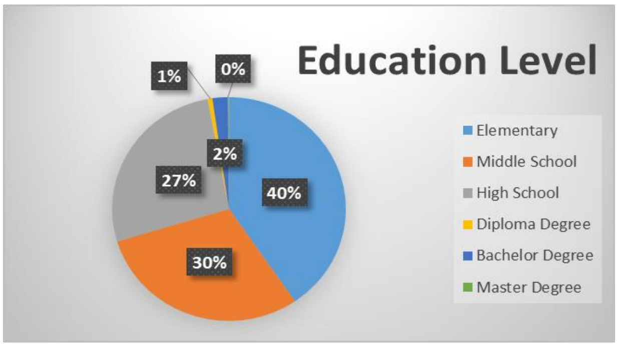


Fig. 4. Education Level in Timuhun Village

Most Timuhun Village residents are housewives or students. Because of the poor level of residents' livelihoods, residents cannot employ electric pumps to lift water from the source to the residential zones. This condition is due to the community's inability to cover the operational costs of the pumps. The main livelihood in Timuhun Village can be seen in Fig. 5.

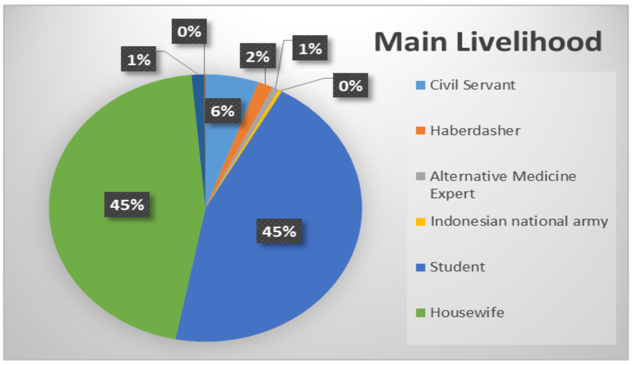


Fig. 5. Main Livelihood of Timuhun Resident

V.2. *Climatology Conditions in the Pesiraman Manik Tirta Springs Area*

Timuhun Village has 1630.3 mm of precipitation on average every year. The annual maximum rainfall is 2606.55 mm, and the annual minimum rainfall is 1075 mm. Fig. 6 shows that rainfall in Timuhun is relatively high.

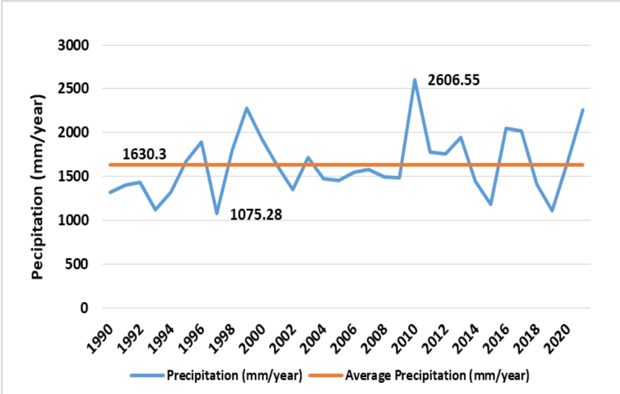


Fig. 6. Rainfall Data in Timuhun Village Area

Because of the heavy rainfall will impact the Pesiraman Manik Tirta Spring's flow. This condition demonstrates that the possibility of spring water in Timuhun Village, now confined by distance and without proper drinking water distribution infrastructure that matches the standards, might be considered to meet the village's water demands.

The average temperature in Timuhun Village is 26.56°C. The maximum temperature is 27.43°C. Temperature changes in Timuhun Village are depicted in Fig. 7. The rate of evaporation increases with increasing temperature. Fig. 7 shows that temperature changes in Timuhun Village are not very significant.

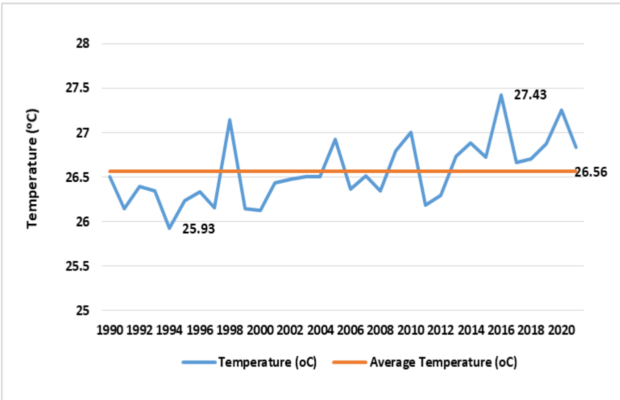


Fig. 7. Rainfall Data in Timuhun Village Area

V.3. *Water Quality of the Pesiraman Manik Tirta Springs Area*

Several physical and chemical water quality experiments were conducted to ascertain the springs' water quality at Pesiraman Manik Tirta. Table 1 displays the outcomes of the spring quality test. Table 1 demonstrates that the spring in Timuhun Village satisfies the criteria for drinking water from a physical and chemical standpoint. Because it satisfies the requirements for both quantity and quality, this spring is ideal for use as a drinking water supply for the residents of Timuhun Village.

TABLE I
RESULTS OF WATER QUALITY TESTS

No	Parameter	Unit	Result	Quality Standards	Method Specification	Description
	Physical					
1	Smell	-	Odorless	Odorless	Organoleptic	Meet the quality standard
2	Color	TCU	0.51	15	Spectrophotometry	Meet the quality standard
3	Total Dissolved Solids	mg/L	177.4	500	Electrometric	Meet the quality standard
4	Turbidity	NTU	0.56	5	Spectrophotometry	Meet the quality standard
5	Flavor	-	Tasteless	Tasteless	Organoleptic	Meet the quality standard
6	Temperature	˚C	25	Air temperature ± 3˚C	SNI.06.6989.23.2005	Meet the quality standard
	Chemical					
7	Fluoride	mg/L	0.302	1.5	Spectrophotometry	Meet the quality standard
8	Nitrite	mg/L	<0.001	3	Spectrophotometry	Meet the quality standard
9	Nitrate	mg/L	5.33	50	Spectrophotometry	Meet the quality standard
10	Cyanide	mg/L	<0.002	0.07	Spectrophotometry	Meet the quality standard
11	Iron	mg/L	0.089	0.3	Spectrophotometry	Meet the quality standard
12	Hardness	mg/L	101.2	500	Titrimetric	Meet the quality standard
13	Chloride	mg/L	12.84	250	Titrimetric	Meet the quality standard
14	Manganese	mg/L	<0.01	0.4	Spectrophotometry	Meet the quality standard
15	PH	-	7.28	6.5 – 8.5	SNI 6989.11:2019	Meet the quality standard
16	Sulfate	mg/L	21.462	250	Spectrophotometry	Meet the quality standard
17	Ammonia	mg/L	<0.001	1.5	Spectrophotometry	Meet the quality standard
18	Zinc (Zn)	mg/L	0.0134	3	AAS	Meet the quality standard
19	Copper (Cu)	mg/L	<0.0153	2	AAS	Meet the quality standard
20	Lead (Pb)	mg/L	<0.0036	0.01	AAS	Meet the quality standard
21	Total chrome	mg/L	<0.003	0.05	AAS	Meet the quality standard
22	Cadmium (Cd)	mg/L	<0.001	0.003	AAS	Meet the quality standard
23	Aluminum (Al)	mg/L	<0.01	0.2	AAS	Meet the quality standard
24	Nickel (Ni)	mg/L	<0.003	0.07	AAS	Meet the quality standard
25	Selenium (Se)	mg/L	<0.0006	0.01	AAS	Meet the quality standard
26	Arsenic	mg/L	<0.0003	0.01	AAS	Meet the quality standard

V.4. SWOT MODEL

Timuhun Village has 1630.3 mm of precipitation on average every year. The annual maximum rainfall is

2606.55 mm, and the annual minimum rainfall is 1075 mm. Fig. 6 shows that rainfall in Timuhun is relatively high.

Pesiraman Manik Tirta Spring is one of the springs with high potential and a year-round flow. Despite its immense potential, the neighboring population cannot fully utilize it due to a lack of suitable water distribution infrastructure. Based on the outcomes of interviews with critical stakeholders, a SWOT model was developed to get a spring area management model to address the clean water needs of the Timuhun Village community, as shown in Fig. 8.

Fig. 8. SWOT Matrix Management Model for the Pesiraman Manik Tirta Springs Area as an Effort to Fulfill Sustainable Water Needs in Timuhun Village

Strength

- Spring water flows continuously throughout the year, with a discharge rate of up to 1.6 liters per second.
- Based on water quality tests, the water quality satisfies drinking water regulations.
- Forest area habitat with massive vegetation that is still well kept.
- The ease with which the location can be reached
- There is strong community support to conserve the region.

Weakness

- Because there are insufficient water supply facilities, the Pesiraman Manik Tirta spring's potential is wasted.
- The terrain is steep, making it challenging to build water supply infrastructure.
- *The people's income is still relatively poor, and cannot afford the electricity charges even using an electric pump*.
- The water source does not have an area arrangement.
- The inability to create a sustainable area management pattern is due to the poor level of education in the local community.

Opportunity

- The potential for large springs can meet the water needs of the surrounding community.
- The community's economy can increase if clean water distribution infrastructure is available.
- The ease of accessing the location of the springs can be used as *"melukat"* religious ecotourism.
- The maintenance of forest areas as recharge areas can maintain a sustainable spring discharge
- A good community can manage the spring area and can utilize the spring to meet sustainable water needs.

Threaten

- Water scarcity caused by climate change
- Land conversion causes damage to nature and the recharge area.
- Water pollution caused by human activities
- Excessive use of water resources
- Damage to the spring area results from inadequate area management.

TABLE 2
MATRIX IFAS AND EFAS

Questionnaire	Total	Rating	Score
Strength (IFAS)			

Spring water flows continuously throughout the year, with a discharge rate of up to 1.6 liters per second.	106	3.53	1.38
Based on water quality tests, the water quality satisfies drinking water regulations.	101	3.37	1.18
Forest area habitat with massive vegetation that is still well kept.	95	3.17	1.10
The ease with which the location can be reached	83	2.77	0.83
There is strong community support to conserve the area	107	3.57	1.09
	279	**9.30**	**3.12**
Weakness (IFAS)			
Because there are insufficient water supply facilities, the Pesiraman Manik Tirta spring's potential is wasted.	113	3.77	0.75
The terrain is quite steep, which makes it challenging to build water supply infrastructure	111	3.70	0.72
The inability to create a sustainable area management pattern is due to the poor level of education in the local community.	83	2.77	0.55
The water source does not have an area arrangement.	94	3.13	0.62
The people's income is still relatively poor, and cannot afford the electricity charges even using an electric pump.	116	3.87	0.81
	517	**-17.23**	**-3.45**
Opportunity (EFAS)			
The maintenance of forest areas as recharge areas can maintain a sustainable spring discharge	104	3.47	0.70
The maintenance of forest areas as recharge areas can maintain a sustainable spring discharge	86	2.87	0.56
The community's economy can increase if there is clean water distribution infrastructure available	87	2.90	0.56
The ease of accessing the location of the springs can be used as *"melukat"* religious ecotourism.	88	2.93	0.54
A good community can manage the spring area and can utilize the spring to meet sustainable water needs	98	3.27	0.74
	463	**15.43**	**3.10**
Threaten (EFAS)			
Water pollution caused by human activities	83	2.77	0.63
Damage to the spring area results from inadequate area management.	93	3.10	0.42
Excessive use of water resources	100	3.33	0.57
Land conversion causes damage to nature and the recharge area.	110	3.67	0.79
Water scarcity caused by climate change	113	3.77	0.95
	499	**-16.63**	**-3.35**

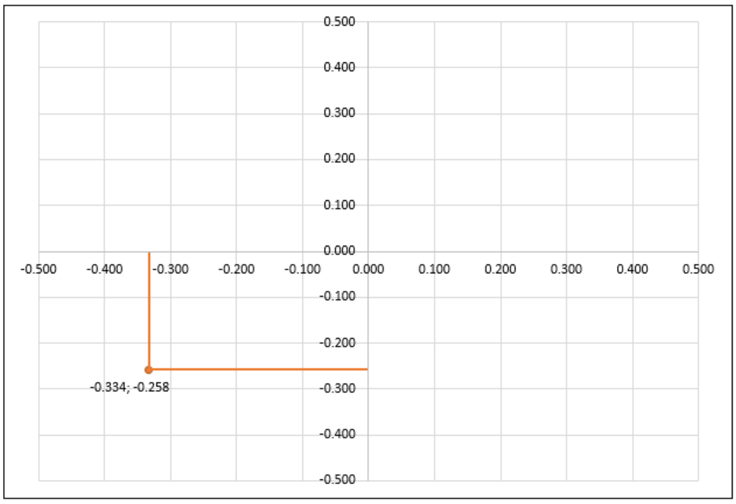


Fig. 9. SWOT Analysis Position Diagram

VI. Discussion

The SWOT matrix, as depicted in Fig. 8, will explain the external opportunities and threats encountered by the strengths and weaknesses it possesses. Several strategies are possible based on the SWOT matrix, as shown below.

- The SO strategy (using strength to maximize opportunities) can be used to manage the potential of the springs by arranging the area around the springs, particularly in recharge zones. Furthermore, the existing water quality must be preserved so that the existing water potential can be used to meet Timuhun Village's clean water needs in the future.
- The WO strategy (minimizing weaknesses to capitalize on opportunities) can be used to create and implement water usage rules to ensure the existing water potential is sustainable in quantity and quality. In Bali, these regulations can be created in *"awig-awig"* (traditional law source in Bali) and engage the traditional villages. In addition to establishing laws, this spring region has the potential to be developed as a place for *"melukat"* (cleansing our body and spirit), which might raise the area's economic condition.
- The ST strategy (using strength to overcome threats) can be carried out by providing affordable infrastructure in operational costs, such as using hydro pumps that do not use electricity to operate. Having a clean water distribution infrastructure can enhance people's quality of life. People do not have to walk far to find water in fairly steep locations.
- The WT strategy (minimizing weaknesses to avoid threats) can be implemented by forming a community group concerned with managing the area and water potential of the Pesiraman Manik Tirta spring.

The SWOT analysis position diagram in Fig. 9 determines the current priority strategic positions. This diagram is based on Table 2, where the location of the existing condition is in quadrant 1. There are four quadrants, each with a unique category. Because it uses strength to take advantage of chances already present, Quadrant 1 is a very advantageous position. In this situation, the best course of action is to promote a policy of rapid expansion.

In the second quadrant, there is internal strength even in the face of several threats. The plan is to use strength combined with a diversification strategy to seize long-term chances. The company is in quadrant three and has many prospects but has significant internal limitations and vulnerabilities. In this role, the strategic priority is to reduce internal company issues so that the organization can take advantage of more excellent prospects. Due to several internal risks and weaknesses, the organization is in Quadrant 4, a very unfavorable condition.

Fig. 8 shows that the chosen strategic position is in quadrant 3, where it can be implemented as the management model for the Pesiraman Manik Tirta Springs Area as an effort to fulfill sustainable water needs in Timuhun Village. This management can be done by providing affordable infrastructure for operational costs, such as using hydro pumps that do not require electricity.

The availability of a clean water distribution infrastructure can improve people's quality of life. No one needs to travel far to find water in fairly steep places. From the Pesiraman Manik Tirta spring, water can be distributed without using energy by creating the necessary infrastructure, which will enhance the standard of living for the residents of Timuhun Village.

VII. Conclusion

Timuhun Village is faced with several challenges related to water access and management. Despite having a population of 3,314 people, roughly evenly split between males and females, residents struggle to obtain water due to the distance from water sources and the challenging terrain. The level of education in the village is primarily at the elementary level, hindering the establishment of a sustainable water management pattern. Most residents are housewives or students, and their low income prevents them from employing electric pumps for water distribution. Climatically, Timuhun Village experiences relatively high rainfall, with an average of 1,630.3 mm per year, which impacts the flow of the Pesiraman Manik Tirta Spring. The average temperature is 26.56°C, with minimal temperature fluctuations. Water quality tests indicate that the spring water meets the criteria for drinking water, making it an ideal source for the village. A Pesiraman Manik Tirta Springs Area SWOT analysis reveals various strengths, weaknesses, opportunities, and threats. Strengths include continuous spring water flow, suitable water quality, and community support for conservation. Weaknesses include water supply facilities, steep terrain, and limited community income. Opportunities include meeting the community's water needs, boosting the local economy, and promoting religious ecotourism. Threats involve water scarcity, land conversion, pollution, excessive water resource use, and inadequate area management. Based on the SWOT analysis, several strategies are proposed. These include leveraging strengths to maximize opportunities, minimizing weaknesses to capitalize on opportunities, using strengths to overcome threats, and minimizing weaknesses to avoid threats. The chosen strategic position is in quadrant 3, focusing on providing affordable infrastructure for operational costs, such as hydro pumps that do not require electricity. This approach aims to enhance the quality of life for Timuhun Village residents by improving access to clean water, creating a sustainable water management model and reducing operational costs.

In the future, researchers can investigate the design of affordable infrastructure for water distribution, such as hydro pumps that do not require electricity. Research on affordable infrastructure design for water distribution, like hydro pumps that do not rely on electricity, is a highly relevant and beneficial topic, especially in areas with limited access to electricity and remote locations.

Acknowledgements

We thank the Indonesian Directorate General of Higher Education, Research, and Technology, particularly for the KEDAI REKA Matching Fund Program. We also thank the Rector of Warmadewa University for his assistance in the administrative process. Lastly, we thank the relevant parties who contributed the data.

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Manuscript received Mei 2023, revised November 2023

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