

Water Security System Assessment in a Philippine Rural Area¹

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Abstract Water security remains a pressing but often overlooked issue in many rural communities in the Philippines, where limited infrastructure, weak governance, and socioeconomic challenges hinder the effective management of water resources. In Tabogon, a rural municipality in northern Cebu, these constraints contribute to persistent issues in water accessibility, safety, and regulation. This study aimed to assess the current water security status and related concerns in selected barangays of Tabogon. A descriptive qualitative approach was employed, with data gathered through structured interviews involving 408 adult household representatives. The majority of respondents were female (64.7%), aged over 51 (35.5%), high school graduates (34.8%), and housewives (45.3%), living in households of three to six members (72.5%). Farming (29.2%) was the most common livelihood, and 28.9% reported a monthly income exceeding PHP[24] 7,500 (approx. USD 129). Results indicated intermittent water supply, limited access to potable water, and weak enforcement of local water management policies. Furthermore, there was a noticeable absence of formal guidelines for groundwater use and poor implementation of existing water protection laws. These

findings highlight critical gaps in rural water governance and infrastructure. The study contributes empirical evidence to support local policy development and advocates for targeted, community-based water security interventions in similarly underserved rural areas.

Keywords Water Supply, Water Governance, Water Security, Rural Area, Tabogon, Cebu, Philippines

1. Introduction

Water security is a fundamental component of sustainable development, yet it remains a persistent challenge, particularly in rural areas, where socioeconomic and environmental factors influence resource availability and management. It is inherently dynamic and multidimensional, cutting across numerous scales and encompassing economic prosperity, social justice, sustainable practices, and the mitigation of water-related risks [1, 2].

At the community level, water security entails

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maintaining equitable and reliable access to water for domestic, agricultural, and livelihood needs, while safeguarding against contamination, minimizing disaster risks, and ensuring the protection of local ecosystems [3, 4].

Despite substantial research at the national and subnational levels, water security assessments at broader scales often obscure the importance of local water consumption behaviors and the specific challenges faced by rural communities [5].

Water security in rural areas is influenced by multiple interrelated factors, including seasonal variability in water availability, degradation of watersheds driven by increased demand, and the lack of sustained access to safe and potable water. These challenges are often compounded by inadequate infrastructure and weak regulatory enforcement, particularly in low-resource communities [6, 7]. Ensuring resilience to water scarcity in such contexts requires integrated planning, evidence-based decision-making, and the active engagement of both local communities and government institutions at various levels. Collaborative governance and inclusive water management approaches are critical for building sustainable and adaptive water systems in rural settings [4, 8].

In the Philippines, water security is shaped by a combination of technical, socioeconomic, environmental, and governance-related factors that influence the sustainability and functionality of water supply systems. For technical and infrastructure challenges, the reliability of water systems is often compromised by outdated infrastructure, inefficient distribution networks, and lack of regular maintenance. These deficiencies can lead to system failures, requiring upgrades and proactive management to ensure long-term operations [9, 10].

In the Philippine context, the standard water usage rate varies depending on household size, location, and access to supply infrastructure. The average daily water consumption per person in urban areas ranges from 100 to 150 liters, while in rural areas it is significantly lower—typically around 40 to 80 liters per capita per day [11, 12]. These disparities are often influenced by intermittent supply, affordability, and the availability of alternative water sources. Many rural households resort to multiple water sources and adopt conservation practices due to irregular supply and limited infrastructure [13]. Rural households tend to prioritize water for cooking and drinking, with limited volumes available for sanitation and hygiene, indicating critical implications for public health and water security planning in low-resource communities [14].

Water security systems in the country display marked disparities between rural and urban areas, particularly in access, infrastructure, and governance capacity. Urban areas typically benefit from more advanced and centralized water supply systems managed by large utilities such as the Metropolitan Waterworks and Sewerage System (MWSS) or local water districts, allowing for higher service coverage and better water quality monitoring [12]. In

contrast, rural areas often rely on small-scale or informal water systems, such as communal wells, springs, or local vendors, which are more vulnerable to supply interruptions and contamination [15]. Furthermore, 95% of urban households have access to improved water sources, while only 85% of rural households enjoy similar access [14]. This implies governance challenges such as limited technical capacity, underfunded local water boards, and lack of maintenance exacerbate water insecurity in rural settings [16]. These differences reflect systemic inequalities in service delivery, infrastructure investment, and institutional support, necessitating targeted interventions to close the rural-urban water security gap.

Socioeconomic factors—such as income level, education, and the quality of local governance—significantly influence access to water. These elements shape a community's capacity to invest in, operate, and sustain water infrastructure systems [17, 18]. For the environmental and natural factors, water availability is highly affected by seasonal fluctuations, limited water sources, and natural disasters such as typhoons, which disrupt supply and distribution. Addressing these environmental challenges requires strategic planning and adaptive management [9, 10]. For financial sustainability, many rural water systems struggle with financial viability because user fees are often insufficient to cover operational costs. To achieve sustainable water management, targeted subsidies or alternative financing mechanisms are essential, particularly in underserved rural communities where affordability and investment capacity are limited [8, 19].

For the community and governance, effective water resource management relies on strong community participation and governance. Local government units are crucial in implementing policies, regulating water access, and ensuring equitable distribution [10].

Regarding social acceptance and behavioral factors, the successful implementation of integrated water systems depends on community acceptance and willingness to adopt new technologies and conservation practices. Attitudes toward water use significantly influence the long-term effectiveness of water management programs [20]. Rural communities, such as Tabogon, Cebu, may exemplify these water security challenges. With groundwater serving as the primary water source, many residents experience an intermittent supply, limited access to potable water, and inadequate regulatory mechanisms for water resource management.

The absence of clear policies and enforcement mechanisms exacerbates these challenges, leaving many households vulnerable to water scarcity and quality issues. Addressing these issues requires a comprehensive assessment of water availability, accessibility, quality, sanitation, disaster mitigation, and overall water sector management [5]. Therefore, this study was conducted.

This study aims to assess the current state of water security in selected barangays of Tabogon, Cebu, Philippines, by examining household-level water access,

usage patterns, and perceived challenges. It seeks to understand the interplay of socioeconomic, environmental, and governance-related factors that influence water availability and quality in a rural context. By identifying key barriers to reliable water supply and evaluating local water governance practices, the study intends to generate evidence-based insights that can inform policies, improve service delivery, and support the development of community-centered water security strategies in similar rural settings.

2. Materials and Methods

2.1. Research Design

The project employed a descriptive qualitative approach to gather information about participants' water utilization in Tabogon, Cebu, Philippines. Select indicators included water availability, accessibility, quality of water supply, hygiene, sanitation, overall water sector management, the potential to adapt to future changes, and citizen support for water security [5].

2.2. Research Participants

A total of 408 adult participants from different local villages (barangays) of Tabogon, Cebu (representing individual households) participated in the survey. Seven other local government officials were interviewed as key informants regarding concerns about water security in the area.

2.3. Research Environment

This study was conducted in Tabogon, a rural and coastal municipality in the island province of Cebu. The municipality has a land area of 101.35 square kilometers, constituting 2.05% of Cebu's total area. Its population of more than 40,000 residents (2020) represents about 1.25% of the total population of Cebu Province.

2.4. Research Instrument

The survey questionnaire for the community residents comprised three parts: a) respondents' profile, b) water utilization, and c) action from the local government. In each category, qualitative questions were included as a means of verification for the consistency of responses. For the key informants, five open-ended questions were asked during face-to-face interviews concerning water security-related endeavors, including water system distribution, actions and projects, plans, and challenges.

2.5. Data Gathering Procedure

A communication letter was sent to the local chief executive of Tabogon, Cebu, seeking approval to gather

data from different barangays. Survey administration and face-to-face key informant interviews were conducted with the research respondents and key Local Government officials. These key informants provided knowledge and understanding that addressed the community's social aspects and government participation. Confidentiality/anonymity of the data was ensured. Key informants were informed that their names and other potentially identifiable information would not be used in the final report or publication.

2.6. Data Processing and Analysis

Survey data were systematically entered and pre-processed in Microsoft Excel before being imported into IBM SPSS Statistics for comprehensive quantitative analysis. Responses were structured and coded to facilitate statistical interpretation, ensuring accuracy and consistency. Descriptive and inferential statistical analyses were performed to identify trends and relationships within the dataset. For qualitative data, responses were analyzed, employing a structured thematic analysis approach wherein emerging themes were identified through an iterative coding process. A data reduction technique was applied to refine and extract relevant insights, ensuring that only meaningful and significant information was retained. Thematic analysis was conducted to systematically categorize and interpret qualitative responses, providing a nuanced understanding of the water security system in rural areas. This rigorous analytical approach enhances data validity and ensures that findings are aligned with the study's research

2.7. Ethical Considerations

Ethical clearance procedures were followed, including the Declaration of Helsinki and informed consent from the respondents. The study received ethical approval from the Cebu Technological University.

3. Results and Discussion

3.1. Profile of the Respondents

A total of 408 residents from various barangays in Tabogon, Cebu, participated in the study. The majority of the participants (35.5%) were aged above 51, including females (64.7%), high school graduates (34.8%), and housewives (45.3%). With a range of three to six family members (72.5%) in the household, farming (29.2%) was the primary source of income, with a monthly income of more than 7,500 pesos (28.9%) (Table 1). This implies that the participants generally belonged to a lower-income group. Households that rely primarily on agriculture for their livelihood tend to exhibit higher poverty incidence, particularly in rural areas where access to diversified

income sources is limited. Addressing rural poverty in the context of growing populations requires sustained efforts in agricultural modernization and intensified support for smallholder farmers through technology, infrastructure, and capacity building [21, 22]. Without such interventions, improvements in rural living standards may remain slow and uneven. As water availability and accessibility are

significant constraints for agricultural production, resolving this issue is critical for water-stressed locations. Since there is a significant link between a country's water resources and its ability for food production, estimating irrigation demands is critical for water resource planning to satisfy food needs while avoiding excessive water consumption [23].

Table 1. Profile of the respondents interviewed on water supply and use in a rural area in Cebu, Philippines (n=408)

Category	Parameters	Freq	%	Remarks/Observations
Age	≤ 25	14	3.4	Lowest percentage
	26-30	31	7.6	
	31-40	108	26.5	
	41-50	110	27.0	Largest proportion
	≥ 51	145	35.5	
	Total	408	100	
Sex	Male	144	35.3	
	Female	264	64.7	More females than males
	Total	408	100	
Position in Household	Head	98	24.0	
	Housewife	185	45.3	Most respondents are housewives
	Father	53	13.0	
	Mother	52	12.7	
	Siblings	13	3.2	
	Others	7	1.7	
	Total	408	100	
Educational Attainment	Elementary Level	44	10.8	
	Elementary Graduate	43	10.5	
	Highschool Level	76	18.6	
	Highschool Graduate	142	34.8	The highest proportion completed high school
	College Level	66	16.2	
	College Graduate	36	8.8	
	Masters	1	0.2	Very few attained a master's degree
	Total	408	100	
Number of Family Members	≤ 2	41	10.0	
	3-6	296	72.5	The majority have 3-6 family members
	7-9	58	14.2	
	≥ 10	13	3.2	
	Total	408	100	
Primary Source of Income	Farming	119	29.2	Most common livelihood
	Livestock	84	20.6	
	Convenience store	59	14.5	
	Eatery	5	1.2	Least common livelihood
	Employment (Private sector)	42	10.3	
	Employment (Government)	59	14.5	
	Others: Dependent on family	109	26.7	
	Total	Error	Error	Check the total frequency values

Table 1 continued

Average Monthly Income	100-1400	23	5.6	
	1500-3000	93	22.8	
	3500-5000	116	28.4	The largest proportion falls in this range
	5500-7000	50	12.3	
	≥ 7500	118	28.9	Second highest income group
	Others	8	2.0	
	Total	408	100	

3.2. Water Utilization

As shown in Table 2, the majority of respondents reported having piped water connections from a local supplier—primarily the Metro Cebu Water District (MCWD) (60.5%)—as their main source of water for general household purposes, while water refilling stations (80.4%) were their primary source for drinking water. Although national statistics suggest that around 92% of Filipinos have access to improved water sources [24], many households are not directly connected to utilities, and concerns persist regarding water safety due to aging and corroded distribution infrastructure [25]. Households obtained water from a range of sources, including treated piped supply, groundwater, shallow wells, boreholes, springs, rivers, and streams [4].

In terms of water consumption, most participants used less than 40 liters per day (40.2%) for overall household needs and 5-10 liters (33.8%) for drinking and cooking. Water usage patterns varied, with priorities ranging from cooking and bathing to laundry and irrigating household gardens—similar to findings in other developing regions [26]. The average monthly expenditure on water ranged between PHP 100 and 300 for 61.9% of the households. Despite this, 92.2% reported experiencing weekly water shortages, although 70.3% believed they still had a sufficient amount of household water. The local government was considered responsive by 53.7% of participants, particularly in addressing supply disruptions. As a solution, 44.1% of participants suggested that the local government establish a local water refilling station (WRS), and 40.9% preferred that water distribution be provided through these stations. Rising water demand—driven by population growth, urbanization, climate variability, and infrastructure stress—continues to strain local water systems, underscoring the urgency for adaptive strategies in rural settings [27, 28].

The Philippine freshwater environment is plagued by pollution and the growing price of drinkable water delivery. Although surface water provides almost three-quarters of freshwater supplies, many of the main rivers and lakes, particularly those that run through or near metropolitan areas, are badly polluted. Local governments have the authority to manage natural resources within their

jurisdictions and can compel citizens to follow the best practices in water resource management [29].

Regarding safe water, the participants affirmed that they had very safe (38.5%) water used by households. In addition, participants expressed their point of view on the unavailability of WRS (39.7%) as one of the main reasons for unsafe water for household consumption. As they agreed, the effectiveness of WRS (97.5%) near the area helped solve issues related to safe drinking water (72.5%) and water supply. An appropriate, clean, and safe water supply is one of the most critical components for sustaining human life and ecosystems. More than a fourth of the world's population, 2.1 billion out of 7.5 billion, still lacks access to safe drinking water. In the Philippines, 9 million of 101 million Filipinos still suffer from unimproved, unsafe, and unsustainable water sources [30].

Inadequate and intermittent water supply continues to impact rural areas, low-income urban settlements, and even highly populated cities like Metro Manila. Although the Millennium Development Goals (MDGs) significantly improved global water access by 2015, many communities still lack consistent and safe drinking water [31]. To address these gaps, frameworks such as the Water Safety Plan (WSP) have been developed to guide water service providers in delivering safe and high-quality drinking water [32]. In the Philippines, the implementation of WSPs was institutionalized through Department of Health Administrative Order No. 2014-0027, mandating all water service providers to develop and operationalize WSPs customized to their specific systems.

Water refilling stations (WRS), which serve as key water service providers in many rural communities, are subject to regular monitoring by local health offices. Compliance with national drinking water standards—which require testing for 54 parameters—must be verified by laboratories accredited by the Department of Health [33]. In this study, 97.8% of participants expressed willingness to use services provided by a nearby WRS, recognizing its potential to address water supply issues. However, 50.2% also indicated that additional costs associated with WRS use could hinder access, especially among low-income households. However, the impact of feeling secure on health and safety (73%) can be brought about by having an accessible safe water supply in one's daily routine.

Table 2. Water Utilization of select community households in a Philippine rural area (Tabogon, Cebu) (n=408)

Category	Parameter	Frequency (n)	Percentage (%)	Remarks/Observations
Household Water Consumption	≤ 40L (≤10 gal.)	164	40.2	The majority of households consume less than 40L per day.
	40-70L (10-20 gal)	118	28.9	Nearly 30% of households fall within this range.
	70-110L (20 - 30 gal.)	54	13.2	Moderate water consumption observed.
	110-150L (30-40 gal.)	28	6.9	Lower percentage consumes higher amounts of water.
	>150L (>40 ga.)	38	9.3	Few households use high amounts of water.
	Others	6	1.5	Minimal variations exist in water usage.
	Total	408	100.0	Complete sample.
Source of Water Supply for Household Use	Piped water lines (MCWD)	247	60.5	Majority rely on municipal water supply.
	Deep well (tabay)	92	22.5	A significant number depend on deep wells.
	Water refilling station	84	20.6	A portion purchases water from refilling stations.
	Spring (tubod)	44	10.8	Natural sources like springs are also used.
	Supplied by the local government	18	4.4	Limited households receive government-supplied water.
Drinking and Cooking Water Consumption	≤5L	137	33.6	One-third consume less than 5L per day.
	5L - 10L	138	33.8	Most households consume between 5 and 10L daily.
	10L - 20L	82	20.1	Moderate consumption level observed.
	20L - 30L	29	7.1	Few households consume between 20 and 30L.
	>30L	18	4.4	Minimal number exceeds 30L daily.
	Others	4	1.0	Rare cases of outliers.
	Total	408	100.0	Complete sample.
Source of Water for Drinking	Water refilling station	328	80.4	Most households purchase drinking water.
	Piped water lines (MCWD)	66	16.2	Limited use of piped water for drinking.
	Spring (tubod)	24	5.9	A small percentage uses spring water.
	Deep well (tabay)	20	4.9	Few rely on deep wells for drinking water.
	Others	6	1.5	Minimal alternative sources used.
Household Water Expenses (Monthly)	100 - 300 PHP	250	61.9	Majority spend minimal amounts on water.
	301 - 600 PHP	120	29.7	Nearly 30% spend moderately.
	601 - 900 PHP	22	5.4	Higher water expenses for some households.
	901 - 1200 PHP	13	3.2	Few households have high water costs.
	>1200 PHP	3	0.7	Very rare high expenses observed.
Total	408	100.0	Complete sample.	
Water Sufficiency	Yes	287	70.3	Most households report having sufficient water.
	No	121	29.7	Nearly one-third experience water shortages.
	Total	408	100.0	Complete sample.
Water Shortages Experienced	Yes	376	92.2	Severe water shortage issues observed.
	No	32	7.8	Few households do not experience shortages.
	Total	408	100.0	Complete sample.
Local government Responsiveness to Water Issues	Yes	219	53.7	The slight majority find local government responsive.
	No	189	46.3	Nearly half perceive local government as unresponsive.
	Total	408	100.0	Complete sample.

Table 2 continued

Perceived Safety of Household Water	Very safe	157	38.5	Less than half perceive water as very safe.
Perceived Safety of Household Water	Slightly safe	85	20.8	Some confidence in water safety.
	Neutral	141	34.6	Uncertainty in water safety perception.
	Unsafe	10	2.5	Few consider water unsafe.
	Very unsafe	15	3.7	Minimal perception of highly unsafe water.
	Total	408	100.0	Complete sample.

WRS have become an increasingly common and preferred source of drinking water, particularly in areas where a piped water supply is either unreliable or of questionable quality. The demand for WRS continues to grow as consumers perceive filtered water from these stations to meet, and in many cases exceed, national drinking water standards [34]. Providing potable water at the household level increases treatment costs, and water refilling stations—primarily run by private operators—offer a more affordable and accessible alternative to bottled water or home-based filtration systems [35]. In the Philippines, Presidential Decree No. 856, or the Sanitation Code, mandates that local governments issue sanitary permits, health certificates, and certificates of potability for WRS operations, as well as conduct regular inspections [33]. Public preference for WRS has also been influenced by past failures of municipal water systems, including waterborne disease outbreaks linked to unsafe pipe connections and contamination [36]. The continuous reliance on WRS reflects not only public health concerns but also the persistent gaps in water governance and infrastructure.

3.3. Emerging Themes

Actions taken by the local government to address the scarcity of water

Most respondents reported that they had not observed any local government-led initiatives to improve water access. Even in areas with piped connections, water supply was insufficient to meet household demand—particularly in upland barangays facing acute scarcity. Similar challenges have been noted in other rural Philippine settings, where supply interruptions, aging infrastructure, and limited institutional capacity constrain water delivery [37, 38]. Conversely, some participants acknowledged emergency responses by the local government, such as water distribution through fire trucks during supply interruptions, consistent with practices adopted by local governments to cope with reduced per capita water availability due to watershed degradation and rising demand [39]. Scheduled water distribution was implemented in certain barangays to promote equity, but uneven application—where some communities received more favorable schedules—reflected underlying governance issues, including weak enforcement and

planning inefficiencies [40]. Despite these concerns, several respondents recognized the local government's efforts to improve water systems, echoing recent calls for localized, inclusive governance models that empower communities in resource management [39].

Respondents' recommendations to the local governments to meet the demand for the water supply to their constituents

The majority of participants recommended consistent monitoring and maintenance of water pipelines to ensure reliable and equitable water distribution throughout their communities. Many reported experiencing intermittent supply due to broken or aging infrastructure. These concerns reflect a broader global issue, as aging and deteriorating water distribution systems are increasingly unable to meet rising water demands, leading to significant losses and inefficiencies [40, 41]. Participants also urged the local government to secure adequate funding for the development of public water wells and alternative sources to buffer against supply disruptions. The use of multiple water sources by households—such as wells, surface water, refilling stations, and informal connections—is consistent with the multiple-use water services (MUS) approach, which highlights the need to recognize diverse water needs in rural settings [42]. In areas with poor infrastructure and limited formal access, residents often resort to self-provision strategies, including drawing water from unsafe or unregulated sources, underscoring the urgent need for sustainable, community-responsive water solutions [38]. In contrast, water from shallow wells is widely used for purposes other than drinking, such as washing clothing, owing to its simplicity of access, cost, and consistency of supply [43].

Furthermore, the establishment of water refilling stations (WRS) was deemed necessary by participants to ensure access to safe and high-quality drinking water. With rising concerns about water contamination and the increasing cost of domestic water purifiers and bottled water, WRS operated by local entrepreneurs have emerged as affordable and convenient alternatives, especially in areas lacking centralized filtration systems [44]. While water refilling stations can effectively improve drinking water quality beyond conventional piped systems, improper handling and sanitation practices during storage and distribution may still pose contamination risks [45]. Therefore, routine

inspection and strict quality control are essential to safeguard public health.

To achieve water security in rural settings, a holistic approach must be implemented—one that includes access to safe drinking water, adequate supply for domestic and agricultural uses, effective water treatment at the household level, and sustainable sanitation management. Integrated water supply and sanitation strategies are crucial to improving both water quality and hygiene, especially in underserved areas [46]. Advances in low-cost, decentralized water technologies and community-based management models have proven effective in enhancing resilience and reducing water-related vulnerabilities in developing countries [47].

4. Conclusions

The findings highlight the persistent challenges faced by the community, including intermittent water supply and limited access to safe drinking water. Participants reported an apparent lack of regulations governing the utilization of alternative water sources, such as groundwater, which may contribute to unsustainable extraction and potential quality issues. Despite these challenges, the local government has played a crucial role in providing emergency water supply assistance during periods of disruption. However, ensuring long-term water security in rural areas requires a more proactive and structured approach. The local government must strengthen its water sector governance by formulating and enforcing clear policies on sustainable water resource management while fostering community participation. Collaborative efforts between the government and residents are essential to developing resilient and inclusive water management strategies that address both supply reliability and water quality concerns.

Declaration of Conflicting Interests

The authors declare that they have no competing interests.

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