



Water Consumption and Utilization of Various Sectors in Basco, Batanes, Philippines



ABSTRACT

Increasing population and growing commercial and business establishment translate to rising demand for water. Water is a finite resource needing proper management to continuously provide humans' basic needs. In the Philippines, the most populated municipality in the northernmost island province, Basco, Batanes, is highly dependent on Racuaranum Spring within Mt. Iraya watershed as its source of water. The municipality faces challenges with its water resource management coupled with the growing water demand from households, commercial establishments, institutions, and tourism. The water utilization of these sectors were recorded and a 10-year projection of their demand and supply were plotted. Sectoral survey, focus group discussion, and the strengths, weaknesses, opportunities, and threats analysis were employed to assess their water consumption and utilization. The households extract water for general use from groundwater and from the watershed. The other sectors mostly sourced their water through the Basco Waterworks System (BWWS). With the growing number of water consumers, the demand-supply projection showed a high-water demand in the domestic and commercial sectors surpassing actual and potential supply. To address this, the study suggested enactment of municipal ordinances on proper water resource management and service facilities taking into consideration its growing commercial sector, including but not limited to its tourism industry.

Keywords: *water, domestic consumption, water utilization, demand-supply, Basco, Batanes*

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INTRODUCTION

Water is an important resource, necessary for maintaining the integrity of the environment. It is also an important commodity for individuals' social and economic development. However, globally, several factors affects the quality of water resources and its distribution. This includes population growth, urbanization, climate change, unsustainable management practices, and pollution (Butler and Adamowki 2014).

Though the world is covered by 70% water, only 3% of it is freshwater and about 1/3 of freshwater sources are available for use (WWF 2020). Thus, freshwater is a finite resource made scarcer by the numerous global challenges which places further pressure on its availability. Globally, over two billion people experience water scarcity exacerbated by water inaccessibility like the lack of infrastructure (UNESCO 2018). Moreover, numerous global aquifers are facing heightened stress due to groundwater depletion (UNESCO 2021). According to UNESCO (2021), this pressure to the global aquifers is mostly attributed to the extraction in the agriculture sector for irrigation, aquaculture, and livestock raising practiced

in some developing countries including the Philippines. Furthermore, trends in the global water use projected that pressure on water supply will worsen due to the changing consumption patterns caused by population growth and industrialization (UNESCO 2021).

In the case of the Philippines, despite the abundance of its freshwater resources due to its archipelagic nature with high rainfall and numerous groundwater and surface water sources, it is one of the most water security-challenged countries in Asia based on the 2016 Asian Water Development Outlook Report. The country is indeed vulnerable to climate change and water-related disasters further aggravated by issues on wastewater management (ADB 2016). Studies show that the country might face water shortage by 2040 because of the growing demand in all sectors as indicated in the local future projections (World Resources Institute 2015, Pulhin 2018). Thus, this poses challenges in the country's development.

A water secured area means having sufficient good

quality water to minimize water-related risks. Also, a water secured area ensures access to both quantity and quality of water to sustain the needs of human beings, in turn, promoting socio-economic development (*UN-Water Task Force on Water Security 2013*). In addition, ecosystem preservation and protection from water-related disasters encompass water security (UNDESA 2014). Thus, by ensuring a water-secured country, we consequently protect and preserve the ecosystem. In the 2020 report of the Asian Water Development Outlook (AWDO) on National Water Security Index (NWSI), the Philippines rank 16th out of 49 member countries (*Asian Development Bank 2020*). The NWSI ranking is the status of a country in relation to the water and sanitation sector based on five Key Dimensions: Rural Household Water Security; Economic Water Security; Urban Water Security; Environmental Water Security; and Water-related Disaster Security. Water security challenges in the country were brought about by supply, allocation/distribution, demand, disaster, and management dynamics (*Lee et al. 2020*).

Basco is one of the most concentrated municipalities in Batanes in terms of development efforts. The municipalities receives numerous development efforts so that the municipality can cater to the needs of its population while taking into consideration the increasing number of tourists (*BPLS 2017*). The development and maintenance of locally managed water services facilities and infrastructure is one of the hurdles in most rural communities in the country. In most rural areas, households rely on availability of water resources not only for domestic use but also for agricultural, and enterprise purposes. The complexity and interlinkages of multiple water purposes and issues requires addressing the challenges in a holistic perspective on the full spectrum of resource sustainability.

Moreover, institutions, both public and private, influence the people on how they can access and utilize the resources. Since these institutions establish an acceptable system of rules within the society, it provides power and limits resource use (*Aquino and Rebancos 2019*). Thus, they are part of the important backbone of the management towards natural resources conservation.

In the case of Basco, it is one of the most concentrated municipalities in Batanes in terms of development efforts spearheaded by numerous institutions. The municipalities receives numerous development efforts so that the municipality can cater to the needs of its population while taking into consideration the increasing number of tourists (*BPLS 2017*).

Water Consumption and Utilization in Basco, Batanes

The study assessed the consumption and utilization of several water users in the Municipality of Basco in terms of trends and issues in water supply and demand and competing water users' projections. Specifically, it sought to provide an overview of the water users in the municipality; present a water demand and supply projection in the next 10 years; and recommend possible interventions and management strategies towards sustainable water service management in Basco.

MATERIALS AND METHOD

Location of the Study

Basco, a 5th class municipality and the capital of Batanes Province, is situated in the northern part of the Philippines. It is situated in 20°27' North 121°58' East in the island of Batan with a total land area of 34,691,800 m², which is primarily utilized for agriculture. It is also considered a coastal municipality with six barangays: Chanarian, Kaychanarianan, Kayvaluganan, Kayhuvokan, San Antonio, and San Joaquin. It is the most populated municipality in the Province of Batanes with 8,579 population (*PSA 2015*).

Data Collection and Analysis

Primary data gathering was conducted from July to September 2018 through face-to-face facilitated survey, key informant interviews (KII), and focus group discussions (FGD). Survey was facilitated to capture the socio-demographic and socio-economic information of the respondents, and knowledge on water utilization.

Key Informant Interview was also conducted to the representatives from municipal offices to further understand the water resource management schemes and arrangements of the agencies working on water issues. FGD intended to situate the past and current conditions of the municipality in terms of water resource management schemes, strategies, plans, and programs.

The sources of secondary data are provincial and municipal development plans, Batanes Protected Landscapes and Seascapes (BPLS) Management Plan, Rapid Assessment of Water Supply Sources, Tourist Arrival Data, and Ancestral Domains Sustainable Development and Protection Plan.

Survey Instrument and Sample Size Calculation

A structured questionnaire was used to gather primary data from residential, commercial

establishments, and institutions. The main respondents were household members, preferably household heads. For commercial establishments and institutions, heads or any representative was surveyed. The survey instrument covered socio-demographic, socio-economic, and water utilization practices. The survey also covered perceived challenges of the respondents on the existing water management in Basco.

A consent form was signed by the respondent indicating their willingness to be interviewed. The form also stated the respondent's approval to utilize all the information that were gathered from the survey for the purpose of this research only and treated with strict confidentiality.

Using the Cochran method (Israel 1992), a stratified random sampling was used to determine the sample size of household respondents. The equation is as follows:

$$n = \frac{n_0}{[1 + \frac{(n_0 - 1)}{N}]} \quad (1)$$

where: n = sample size

N = population size

$n_0 = Z^2 pq / e^2$

Z is the abscissa of the normal curve that cuts off an area

α at the tails;

p is the estimated proportion of an attribute that is present in the population;

q is $1 - p$;

e is the desired level of precision

Data gathering was conducted from July to September 2018 while follow up and validation were done in January 2020. Data were analyzed using the Statistical Program for SocialScience (SPSS) version 21 and Microsoft Excel.

A focus group discussion was also conducted to have an in-depth understanding of the data collected from surveys and interviews (Figures 2 and 3). This was intended to map out existing facilities and establishments in the municipality in relation to its land uses and locate water resources through a community resource map. SWOT Analysis was administered as supplementary information to establish the positive and negative internal and external factors affecting water services management in Basco. The participants were heads and representatives from the Provincial and Municipal Offices: Mayor's Office, Planning and Development Office, Provincial and Municipal Agriculture Office, and Municipal Engineering Office. Present also in the FGD were business owners/operators, and some locals of Basco.

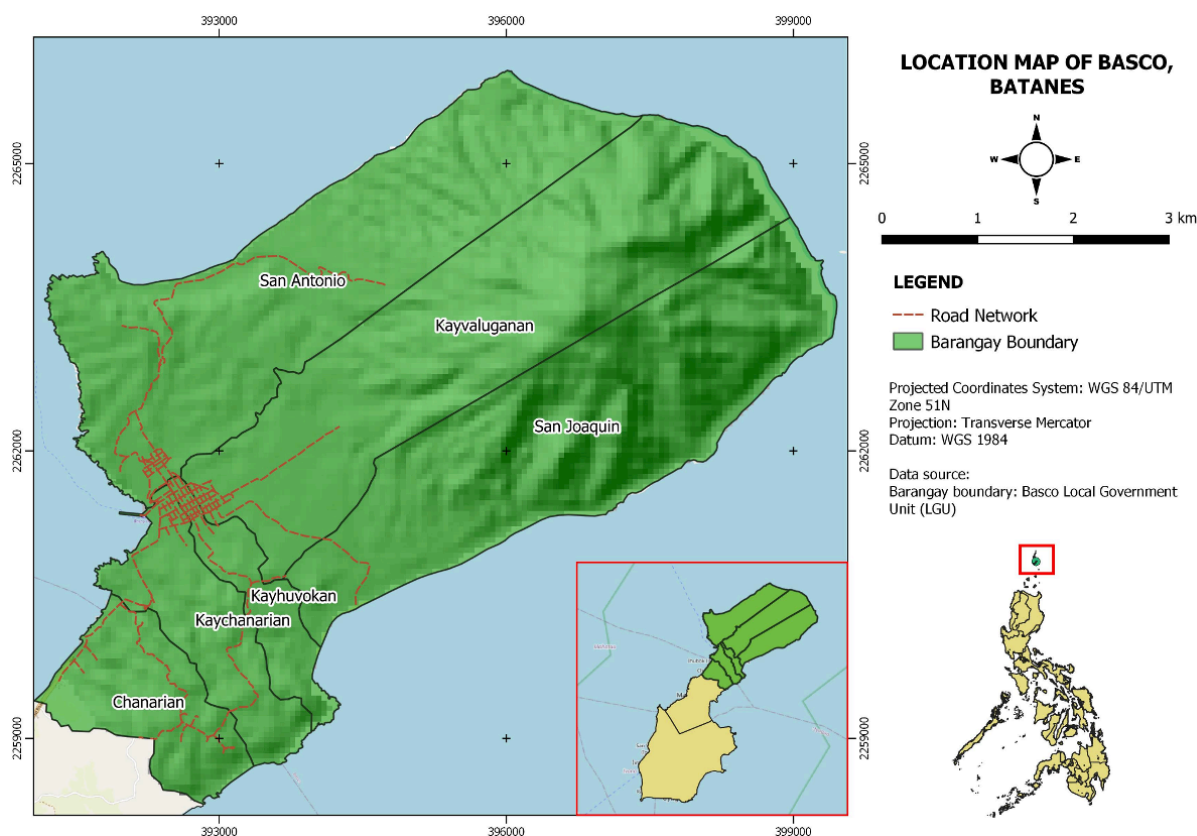


Figure 1. Location Map of Basco, Batanes in the Philippines.

Table 1. Calculated sample size of the respondents in the study of water consumption and utilization in Basco, Batanes, Philippines using Cochran Method.

Sector	Number of Respondents
Residential	354
Commercial	94
Institutions	5

Similarly, to establish trends and to determine management strategies toward water sustainability, population and water demand-supply, scenario designs were presented using the data on the consumption rate of water users. The projection covers only residents, commercial, and institutions. The projection of exponential rate of population was computed using Equation 2:

Exponential population growth rate projection (PSA 2015).

$$P_t = P_0 e^{r(t)} \quad (2)$$

Where:

P_t = population at time t ;

$r(t)$ = growth rate;

P_0 = initial size population

e = Euler's number

To show the supply-demand analysis trend, two scenarios were done using the long-term water demand projection in comparison with actual water supply and potential water supply. In projection of demand, the study used an assumption that population and economic development in the next years until 2030, is growing in an exponential manner. In each scenario, three levels of consumption range (minimum, average, maximum) per sector were considered.

RESULTS AND DISCUSSION

A community resource map (**Figure 2**) was developed during a focus group discussion participated by 19 representatives from the Local Government Unit (LGU), Basco Waterworks System (BWWS), commercial/business owners, and some residents of the area. This situated the available water sources and showed existing land uses and establishments in Basco, Batanes. Also, the current and potential water sources and their proximity to the central district were mapped out by the stakeholders.

The land use was indicated in the map showing

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that the area is mostly open forest and grassland. Several business establishments, hotels, resorts, church, schools, offices, and similar social service institutions located under built-up areas are mostly found in the Poblacion or central business district. The stakeholders verified the 2015 land cover classification of National Mapping and Resource Information Authority (NAMRIA) which will be further used in a hydrological assessment of Basco, Batanes.

The locations of deep wells were concentrated on the central business district to augment the supply from Miaga and Racuaranum springs. The Racuaranum Spring of Mt. Iraya is the major source of water of five barangays, namely Kayhuvokan, Kaychanarianan, San Antonio, San Joaquin, and Kayvaluganan currently served by Basco Waterworks System. It has 64.35 m³ of water capacity servicing 2,789 households.

Despite the abundance of springs surrounding the central district, the community still resorted to deep wells as some springs do not have sufficient yield and are situated in challenging locations. To date, there are about 216 unaccounted wells being managed by private individuals; and 15 deep wells managed by the local government.

Water Users in Basco, Batanes

Being the capital of Batanes, Basco is the most populated municipality of the province with 8,579 population and 2327 households (PSA 2015). Moreover, as Basco is the main entry to the province, its development efforts not only cater to the population but also to the increasing number of tourists coming in.

Based on the survey, the socio-demographic information showed that most of the household respondents were male (68%) and majority were married (60% female and 40% male). As most of the respondents are married, this can contribute to the growing population of the community which can consequently affect the water demand (**Table 2**).

Moreover, the age group of the respondents belong to the labor force based on the PSA's age bracket (15-64 years old) constituting almost 80% (51% female and 27% male) of the total household sample population. As reflected in their occupation, most of the respondents are laborers (27.7%) and less than a quarter (24.3%) are government employees. Eleven percent are farmers and only 1.7 % are fisherfolk. A portion of the respondents are business owners (10.5%) and professionals (2.5%)

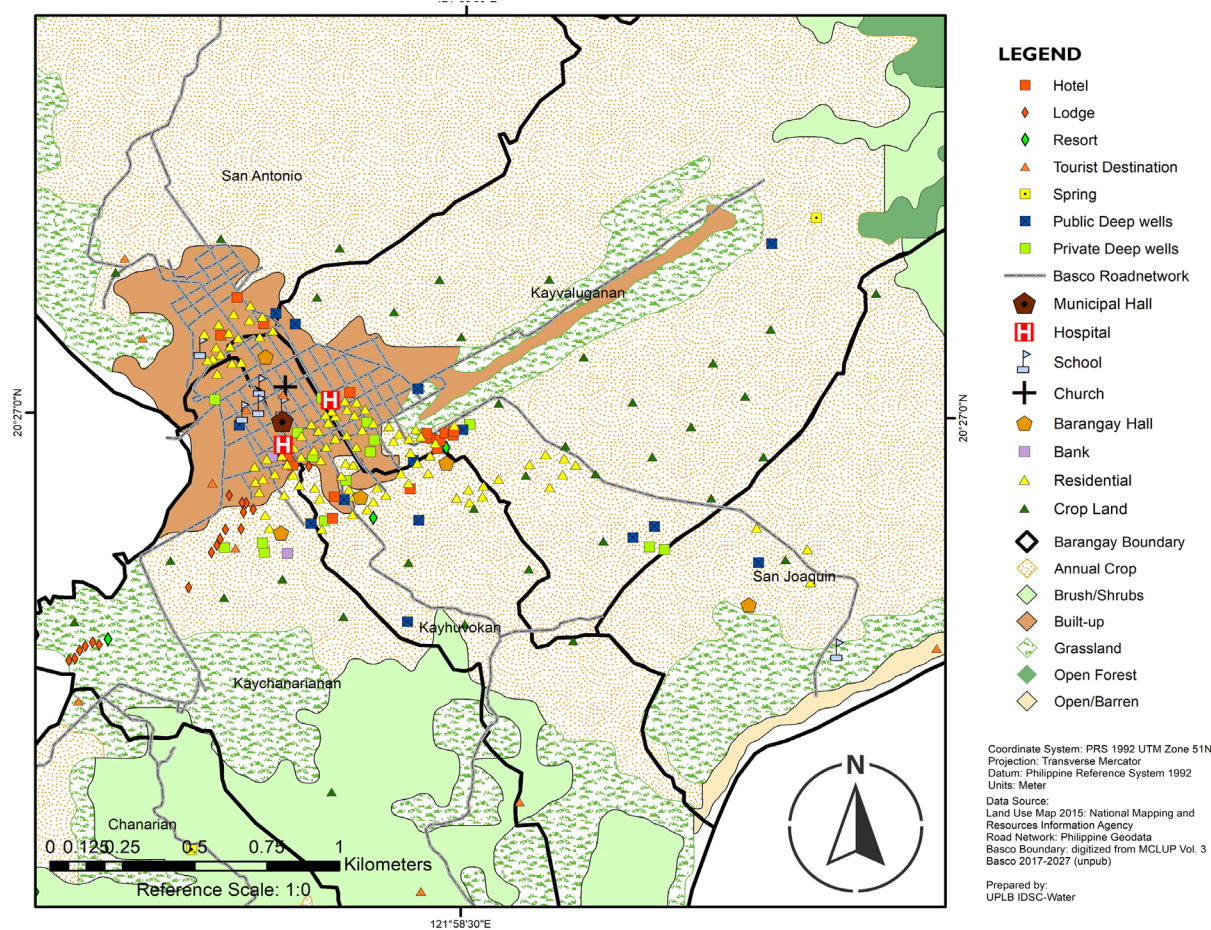


Figure 2. Digitized community resource map of Basco, Batanes, Philippines based on focus group discussion of key stakeholders of Basco Municipality.

Table 2. Socio-demographic profile of household respondents in Basco, Batanes, Philippines in 2018..

	Male	Female	No Answer	Total (n=354)	Percentage (%)
Age					
Below 20	4	6	0	10	2.82
20 – 29	13	33	0	46	12.99
30 – 39	26	41	1	68	19.20
40 – 49	29	48	2	79	22.32
50 – 59	16	38	0	54	15.25
60 – 69	11	23	0	34	9.60
70 and above	8	39	1	48	13.57
No response	6	8	1	15	4.25
Civil Status					
Single	28	68	0	96	27.11
Married	67	101	1	169	47.74
Widowed	1	33	1	35	9.89
Separated	3	7	1	11	3.11
Common-law/live-in	2	5	0	7	1.98
No response	12	22	2	10.2	10.17

(Figure 3). As water is a necessary resource, regardless of occupation, the respondents are reliant on water supply. However, with the diversity of jobs in the area in relation to modernization, such occupation may require activities dependent on water like sanitation. Other jobs are also

water-intensive by nature like farming and business operations.

According to key informants, water sources in Basco are characterized as conventional wherein naturally

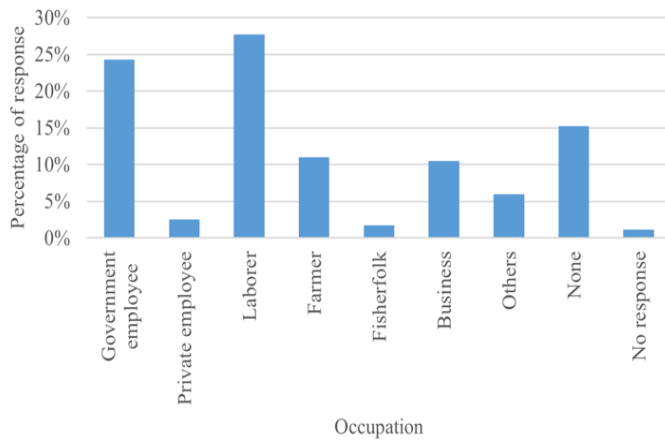


Figure 3. Occupation of household respondents in Basco, Batanes, Philippines in 2018.

occurring water from the surface, ground, and rain are being utilized for several purposes, such as for laundry (Figure 4). Households rely mostly on BWWS for general use: 74.8% for kitchen use; 74.9% for bathing; 74.6% for laundry; 72% for cleaning; and 59.8% for gardening which are connected to level III water systems or piped water systems with individual house connections. Others rely on deep wells and rainwater for such purposes. For drinking, 61.9% of the household gets water from refilling stations which is sourced out from deep wells. Commonly, Filipino families rely on water refilling stations as their source of drinking water (PSA



Figure 4. Laundry is one of the many household purposes of water in Basco, Batanes, Philippines.

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2019). Similarly, 27.9% of the households use drinking water directly from BWWS. Others get water directly from deep wells (7.6%); and rainwater (2%) (Figure 5).

In relation to this, 77.70% of households are not practicing water treatment for drinking since most of them rely on refilling stations while 15% are treating their water through boiling and 7.30% through filtration method (Figure 6). Parallel to the PSA 2019 survey, most Filipino households do not use any water treatment methods to ensure safe drinking water. Nonetheless, those who treat their water rely on the common method or treatment like water boiling, straining using cloth, and chlorination (PSA 2019; Pradhan et al. 2018). Given the respondents' water utilization for their general use, most of their water sources are extracted from groundwater, directly from deep wells or through BWWS and refilling stations, and only a portion of it is from Mt. Iraya and rainfall.

Commercial establishments are also high-intensive water users. Based on the *Comprehensive Land Use Plan* (2017), the Municipality of Basco had 972 commercial establishments. Prominent commercial establishments are resorts, hotels, restaurants, transport, wholesale, and retail trade. This study covers the major water users from the business and tourism sector, such as restaurants, accommodation, refilling stations, and other businesses such as stores/marts.

Most of the business establishments surveyed are those engaged in wholesale and retail services which constitute 75% of the total number of establishments in the municipality (CLUP 2017). Of the surveyed establishments, 28.70% are from hotel accommodations (hotels and resorts) and lodging establishments (Figure 7). It is followed by restaurants which comprised about 20.20% and water refilling stations at 3.20% from the total

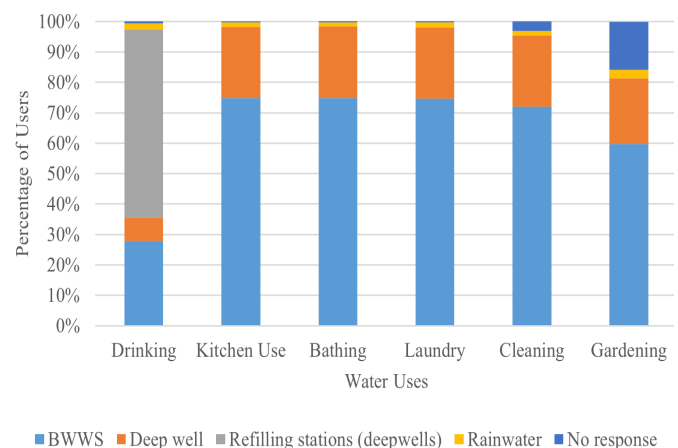


Figure 5. Domestic water usage and their sources in Basco, Batanes, Philippines in 2018.

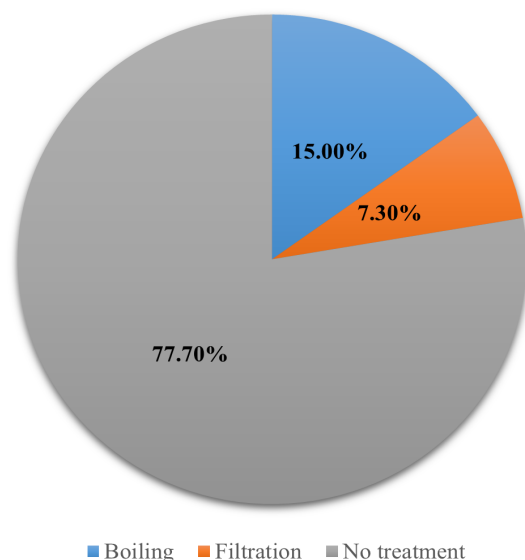


Figure 6. Practices of drinking water purification among household respondents in Basco, Batanes, Philippines in 2018.

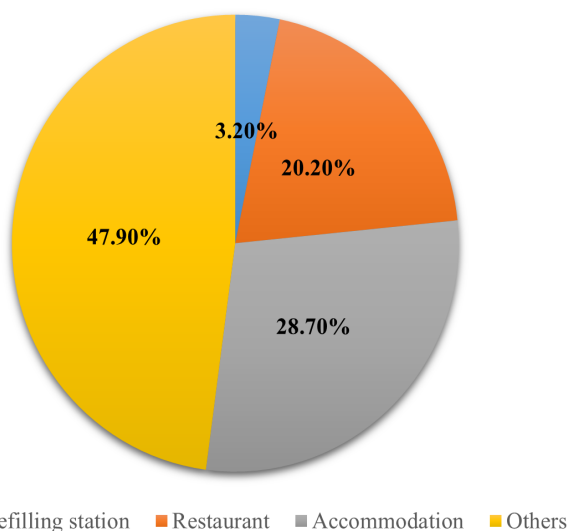


Figure 7. Types of commercial establishments in Basco, Batanes, Philippines in 2018.

sample population. There were 10 hotels and restaurants in 2010 and it tripled the number of establishments in 2015 to 30 hotels and restaurants as cited in the Municipal Comprehensive Land Use Plan.

There were 38 commercial establishments that get their water from BWWS through a piped system. About 33 establishments got their water from deep wells. Six of these deep well users acquired their own pumps.

Water Demand and Supply in Basco, Batanes

The potential groundwater for all the regions in the Philippines is approximately 20,200 million m³,

Institutions surveyed for this study are composed of 5 representatives from the municipal hall, barangay hall and hospitals. Four out of five respondents stated that their respective institution/offices' water supply is provided by BWWS (**Figure 8**). Population growth and the increase of tourism-related activities as reflected in the composition of commercial establishments in Basco also calls for an increase in water demand thus putting pressure on the municipality's water supply.

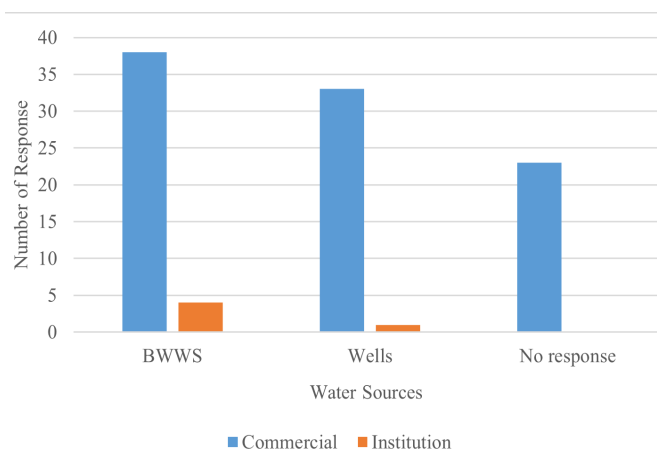


Figure 8. Sources of water of commercial and institutional sectors in Basco, Batanes, Philippines in 2018.

estimated to be 14% of the potential water resource. Similarly, the country has 125,790 million m³ surface water which accounts for 86% of total water resource potential. However, this potential source has been declining through the years in many parts of the county (NSCB 2004). This decline is caused by various factors that also influence water demand and supply.

Among these drivers are demographic factors characterized by population growth and rural-urban migration, economic growth, land use changes, and climate change (Pulhin 2018). Further, household consumption is driven by internal and external factors (Rondinel-Oviedo and Sarmiento-Pastor 2020; Ougougdal et al. 2020). Internal factors include usage patterns such as social, economic, and cultural variables, and infrastructure which are directly related and controlled by users. External factors considered were climate, water pricing, policies, and population growth.

The demand and supply of water were projected to establish trends toward water sustainability in the Municipality of Basco. Thus, water management strategies in the form of technical, managerial, and administrative works for the water service providers and the local government unit are instituted. Similarly, water demand- supply projections could be of use to the water

users, for efficient and effective water management efforts at the individual (or household) and community level.

Projections were solely based on the 2019 baseline data on the number of consumers not considering other factors, such as level of urbanization, development patterns, other demographic attributes (i.e., death rate), among others. Increasing population and economic growth would also mean growing water demand, directly (drinking and domestic purposes) and indirectly (food production and business facilitation).

By 2030, the household users in the municipality of Basco was projected to increase 6 times higher than the 2019 population which is 4205. Meanwhile, the commercial sector recorded a growth rate of 0.11 from 2017 to 2019 and is projected to increase by 32% in 2030 (**Figure 9**). This entails an increasing water demand of the municipality with implications on water supply distribution and accessibility if no regulatory measures will be implemented. Institutions are considered to have fixed projections since changes in the number of institutional services is very minimal to none (i.e., establishment of church, schools, government offices).

The residential or domestic sector is the highest water utilizing sector in the municipality. Though consumption per household ranges from 5 - 44 m³, lower than the other sector, population size of the domestic sector affects their overall consumption (**Table 3**). It is followed by commercial and institutions, respectively. The commercial sector is categorized into two: resorts, hotels, and restaurants; and other business establishments. (**Figures 10 and 11**).

For the first scenario, the projected water demand is compared to the actual water supply in the municipality

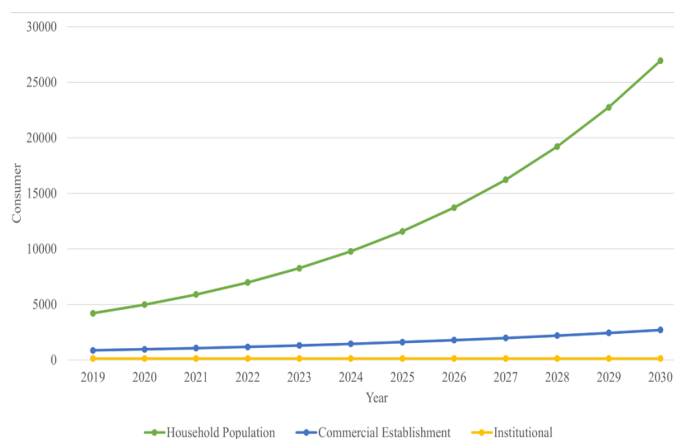


Figure 9. Long-term water consumer projections in Basco, Batanes, Philippines (2019-2030)

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Table 3. Water consumption rate of different water users in Basco, Batanes, Philippines 2019.

Consumer	Min	Ave	Max
	Cubic meter m ³ month ⁻¹		
Domestic ¹	5.00	19.37	44
Commercial ²	5.94	32.87	76.36
Hotels and Restaurant	5.00	17.16	72.23
Other business establishments	5.00	105	795.31
Institution ²			

¹Domestic- per household/individual

²Commercial and institutions - per establishment

with a 104,274.86 m³ month⁻¹ calculated volume based on flow rate (**Figure 10**). From the results, the first assumption indicates that given that there is a minimum demand for all sectors, the overall demand will exceed the actual water supply by 2028 at 3.5% (108,070.81 m³ month⁻¹). Using the business-as-usual assumption (average), the actual water demand has an exceedance of 11.30% (117,563.77 m³ month⁻¹) for this 2020 in the domestic sector. Similarly, an increased demand of water for domestic and commercial uses are evident using the maximum demand assumption. In 2019, the total demand of all sectors is 257,666.47 m³ month⁻¹ indicating approximately 60% water shortage in the municipality.

The second scenario compares the projections of water demand and the potential water supply in the municipality with a calculated volume of 147,027.11 m³ month⁻¹ based on simulated watershed area and precipitation (**Figure 11**). Using the minimum demand assumption, there is about 15% water shortage in the municipality by 2030. Using the average demand of all sectors, a total of 160,640 m³ month⁻¹ is needed to address the monthly water demand of all sectors in 2022, accounting for 8% water supply deficit. In 2019, there is a 43% water deficit in the municipality assuming a maximum consumption for all sectors (257,666.47 m³ per month).

Water Service Management and Challenges in Basco

Several offices and groups in Basco, Batanes cater to the provision and regulation of water supply. These institutions play a huge role in the management and sustainability of water resources in the area. The Local Government Units, through its offices, manages water related concerns. Specifically, the Municipal Planning and Development Office ensures budget for operations of water systems and development of related plans and programs; the Engineering Offices oversees maintenance and assistance to waterworks systems; and the Municipal Health Office and local hospitals oversee water-related health and sanitation concerns.

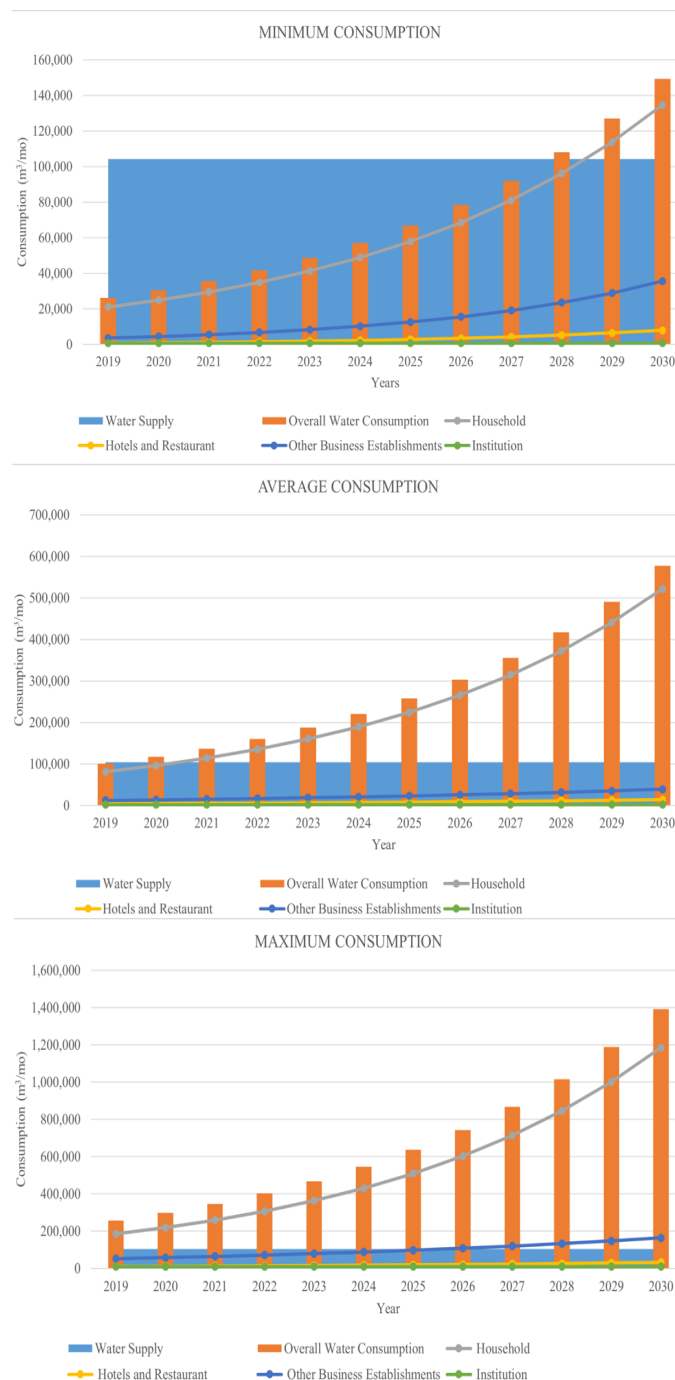


Figure 10. Long-term water demand projection in comparison with the actual water supply in Basco, Batanes, Philippines (2019-2030)

At the local level, Basco Waterworks System (BWWS) under the Local Government Unit (LGU) of Basco is mandated to manage water supply systems in the entire municipality. It works on the operation, distribution, maintenance, and collection of fees. Similarly, the private sectors and business operators that utilize water as a commodity (goods and/or raw material to facilitate businesses), serve as the end-users. They also play a vital role in financing water resource management through investments in drinking water

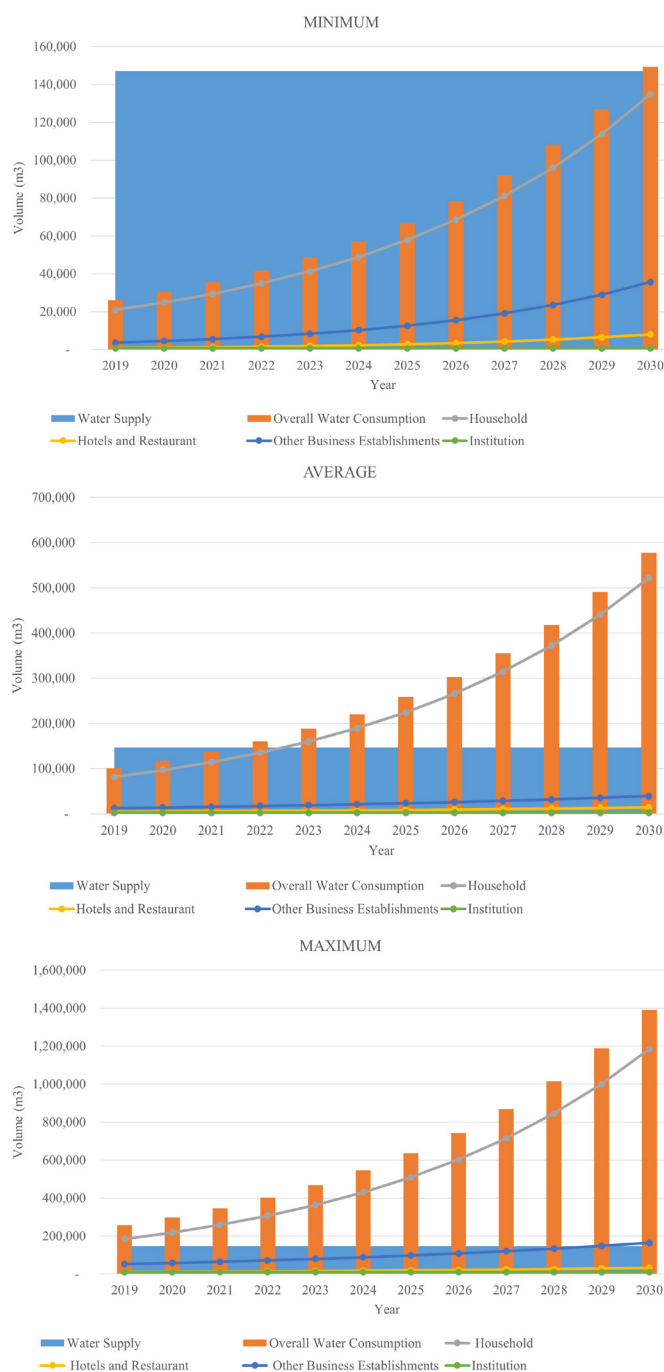


Figure 11. Long-term water demand projection in comparison with the potential water supply in Basco, Batanes, Philippines (2019-2030)

(e.g., refilling stations), in Basco. Lastly, the general public pertains to people residing in the common area and also serve as end-users. At a household level, the general public has to manage their water usage to conserve water and compensate for the increasing water demand.

These sectors have several roles and purposes for harnessing the available water for various uses. Nonetheless, these sectors are also considered as stewards

by ensuring that there is enough quality water for all for drinking, health and sanitation, food production, energy supply, etc. while maintaining healthy water ecosystems (World Bank 2017). The mandates and concerns of each sector vary (Gooch and Stalnacke 2010). While these concerned groups are trying to manage the water resources, there are still alarming challenges, particularly on the complexity of the system to sustain and attain water security. In relation to this, water users in Basco were also asked about their knowledge and awareness on the existing initiatives related to water supply provision and management in their area (**Table 4**).

Lack of public involvement in the creation and implementation of strategies and policies to enhance, conserve, and manage water supply systems could hinder provisions of adequate water (Ahiablame *et al.* 2012). The willingness of the community to pay for and maintain the water supply system is one of these strategies. Information, Education, and Communication campaigns have a significant role to improve public awareness and practices on water conservation. The gap

between perceived water consumption and actual consumption by the public is significantly present (Fan *et al.* 2014). Socio-economic characteristics affect public perception of water use. However, the more significant factor is the water conservation knowledge. Consumers with limited water conservation knowledge tend to underestimate their water consumption. One of the drivers of water resource vulnerability is their existing water resource management practices (Chang *et al.* 2013). Thus, increased coordination across multi-levels to govern water resources would help reduce vulnerability. Additionally, one of the effective measures is volumetric water pricing to promote economic efficiency and regulate water consumption (Grafton *et al.* 2011).

A SWOT analysis of the water resources and management in Basco, through a focus group discussion, was participated by various stakeholders from the local government units (LGUs), businesses owners/operators, among others. Identified strengths of the water resources and management in Basco include the abundance of water resources and institutionalization of LGU-run water

Table 4. Existing water-related programs, projects, activities (PPAs) in Basco, Batanes, Philippines, 2018.

Programs, Projects, Activities (PPAs)	Office-in-Charge
Development of Iraya water system	Basco Waterworks System (BWSS), Engineering Office,
Provision of emergency funds for water sources maintenance	Municipal Planning and Development Office (MPDO)
Information, Education and Communication (IEC) campaigns on Disaster Readiness and Preparedness in schools and communities through radio and house to house visit	Municipal Disaster Risk and Reduction Management Office (MDRRMO)
Earthquake drills	Municipal Disaster Risk and Reduction Management Office (MDRRMO) and hospitals
Institutionalization of Basco Emergency Action Team (BEAT), the team who is overall responsible during calamities	Municipal Disaster Risk and Reduction Management Office (MDRRMO)
Tree planting activities to restore Mt. Iraya Watershed	Municipal Disaster Risk and Reduction Management Office (MDRRMO)
Coastal clean-up drives every quarter or every after calamities	Basco LGU headed by Municipal Environment and Natural Resources Office (MENRO), Municipal Disaster Risk and Reduction Management Office (MDRRMO),
Water conservation policy implemented	Basco LGU headed by Municipal Environment and Natural Resources Office (MENRO), Municipal Disaster Risk and Reduction Management Office (MDRRMO), Hospitals and Municipal Health Office

Table 5. SWOT Analysis of water resources and management in Basco, Batanes, Philippines, 2018.

Strengths	Weaknesses	Opportunities	Threats
• Availability and abundance of water resources • Established waterworks system and capacitated staff • Immediate response of LGU to water issues and problems	• Power interruption affecting water availability and distribution • Lack of funds and equipment for the maintenance of water system • Unmonitored groundwater extraction • Unequal water distribution	• Availability of financial assistance from national and provincial government for the improvement of water system • Research and studies being conducted by various sectors concerning water • Sustainable tourism industry	• Natural calamities (e.g., typhoons, landslides) • Tourist influx

service, specifically the BWWS. Thus, the LGU can immediately address issues on water supply and delivery services (**Table 5**).

Even with an LGU-run water service, the water sector faces challenges internal to the municipality like power interruption causing unavailability of water supply. The water sector's weaknesses include the limited funds of BWWS for water system maintenance, and insufficient capacity and funds for groundwater monitoring. According to *Goncalves et al. (2019)*, limited capital for water system infrastructure development is a significant factor that hinders the expansion of area coverage as well as the monitoring and control of water quality. Thus, such weaknesses in water management in Basco need to be addressed. Nonetheless, opportunities for the water sector in Basco include financial assistance received from government agencies for the improvement of the water system. Also, numerous research and studies are being conducted in the water sector to address identified weaknesses.

Some threats that limit the water supply for the residents in the area were typhoons and landslides occurrences. Threats arise from natural and anthropogenic activities (*Idu 2015*). Natural threats from climate change and hydrological extremes such as changes in precipitation and temperature, saltwater intrusion, and decreased discharge rate. Increasing numbers of tourists, as reflected in the rise of the commercial sector in the area, also cause competition (domestic vs. tourism) on Basco's limited water supply. *Gossling et al. (2012)* concluded that the indirect water requirements of tourism such as food production, transport, and infrastructure are more significant to account than direct uses such as accommodation and activities. Although tourism activities are increasing globally, it has less water consumption compared to other sectors. The major concern is that tourism activities differ based on time and space, and most tourist populations increase during dry months where water supply is limited.

CONCLUSIONS AND RECOMMENDATIONS

Water resources management and supply provision in Basco, Batanes is spearheaded by the Local Government Unit. It is responsible for the planning and effective management of water supply services to address the needs of the community. Rapid population growth and business expansion in Basco, Batanes result in a significant increase in demand across water sectors. Together with this increase, is the growing concern of unsustainable use of natural resources, specifically water.

Basco mainly sourced their water from Miaga and Racuaranum springs. The community also utilizes groundwater through deep wells and private water pumps to meet the local demand and the increasing tourism needs reflected through the booming commercial establishment in the area. This growing water demand may pose threats to the quality and quantity of water resources if appropriate management systems will not be established. Issues on water are exacerbated by the pressure brought by natural hazards since the whole Province of Batanes is highly susceptible to typhoons, floods, landslides, El Niño, earthquakes, among others.

The competing water uses between and among residential, commercial, and institutional sectors are evident in the study. Both actual and projected scenarios predicted a high-water demand, especially in the domestic/residential sector surpassing its actual and potential supply. Hence, water resource management is one of the key challenges in the Municipality of Basco. As projected, the municipality will not be able to meet the water demand of its stakeholders. It entails not just enough water supply, but also good quality water.

Planning at the local level is crucial to ensure that water supply meets Basco's long-term water demands. According to *Turton (2001)*, managing water demand can achieve economic efficiency, social equity, and environmental sustainability. Thus, it is vital to look for strategic ways on managing water sustainably. Without proper water resource management, the increasing demand for water of the various sectors can alter the water services provided by Racuaranum, which is the biggest spring of Mt. Iraya watershed and community's main source of potable and non-potable water supply. Moreover, increasing water demand correlates to increasing water cost. Consequently, high water cost serves as a regulatory measure for proper conservation of water resources to lower demand and keep prices in check.

The challenge in establishing water security is not only an issue in governance but a challenge faced by the stakeholders as well. Sustainable water resource management is the concern of several groups of the society. They are composed of users from various stakeholders: government, civil society, and scientists who affect and may be affected by the water resource management from decision-making to implementation and monitoring.

Given the initiatives by the LGU and other stakeholders in the Municipality of Basco, several gaps need to be addressed for water resource management and water supply provision. These include efficient and

affordable water supply; maintenance of water service facilities through regular cleaning, monitoring, changing of old pipes and immediate repair of damaged pipes and regular water treatment; equal and regular distribution of water; improvement of drainage system; public consultation on water pricing mechanisms; provision of additional water tanks; provision of generators to address inadequate supply during power interruption; intensification of tree planting activities; tourist regulations; and investment in management strategies to promote water conservation through rational use to reduce waste and leakage.

From the supply perspective, infrastructure development and maintenance of water structures are some of the urgent concerns. Exploring alternative methods of obtaining water, such as rainwater harvesting, re-use of grey water and other water recycling techniques could augment the current available water. Similarly, management and technical capabilities of water service providers and the local government units with unified agreements and stakeholders' participation are needed to meet the high demand of water in Basco.

On the consumption side, water demand regulations and proper water management and water conservation advocacies could be of help in managing increasing demand for water. The use of Information Education and Communication (IEC) campaigns tailor-fitted for the Basco community, considering their sociodemographic profile and experiences, could help inculcate social behavior change on water conservation and resource management. At a household level, consumers can efficiently reduce unnecessary water wastage through simple practices. Also, small-scale water recycling and rainwater harvesting techniques could offset demand for water for individual domestic use.

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