Assessment of Solib Dam to Serve as a Source of Supplementary Water Supply in Solib, Floridablanca, Pampanga

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Abstract: Water supply is distributed unevenly across the nation and by 2025, the entire nation will be dealing with water shortage especially in the National Capital Region (NCR), Regions III (Central Luzon), IV (Southern Tagalog), and VII (Central Visayas). The researchers decided to create a study about the assessment of Solib Dam to serve as a source of supplementary water supply in Solib, Floridablanca, Pampanga. The objectives of this study are to conduct a community-based survey about their current and alternative water supply, showing that most of the people in Solib have metered connections and there is no alternative water supply in case of any water shortages. The researchers also assess the quality of the water that comes directly from Solib Dam based on the primary indicators set by the Philippine National Standards for Drinking Water (PNSDW) of 2017. The water parameters tested are divided into 3 classifications which are the physical, chemical, and microbiological parameters. Through this water quality testing procedures, the researchers were able to identify the water parameters such as the turbidity, color, temperature, and settleable solids for physical parameters, and the total coliform and e. coli, heterotrophic plate count, and thermotolerant coliform for the microbiological parameters. All these parameters failed to meet that national standards and the researchers find the best possible water treatment procedures necessary for each parameter like the coagulation and flocculation, disinfection and chlorination, sedimentation, and filtration. Furthermore, the researchers suggest that simulate all the water treatments recommended to improve the quality of water from Solib Dam, to identify the quantity of water Solib Dam can produce, determine the benefit cost ratio, and add more validations from professional respondents for the Solib Dam to serve as a source of supplementary water supply for the people of Solib.

Key Words: — ***Dam, Supplementary Water Supply, Water Quality, Philippine National Standard for Drinking Water 2017.***

I. INTRODUCTION

Over 663 million people all around the world have limited or no access to a safe and sustainable water supply. [1] More than 40% of the world's population lives in water-scarred areas, and the challenge affects about a quarter of the world's Gross Domestic Product (GDP).

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It is estimated that by 2040, one in four of her children will live in an area of extreme water scarcity. Furthermore, catastrophic weather events (such as floods and droughts) and chronic water shortages are considered major threats to global peace and prosperity. More and more people are realizing how rapidly droughts and water scarcity are worsening. [2] Seven million people in the Philippines lack access to improved sanitation and more than three million rely on safe and unreliable water sources. [3]

Water resources are distributed unevenly across the nation, leading to water shortages in densely populated places, particularly during the dry season. [4] The National Capital Region (NCR, Metro Manila), Regions III (Central Luzon), IV (Southern Tagalog), and VII (Central Visayas) are the four

urban areas that are deemed to be in critical condition in terms of water quality and quantity.

As part of preventing the continuous rise of water instability in the Philippines, various stakeholders are encouraged to give help in attaining a sustainable water security in the country. Mainly local government units (LGUs) provide most of the funding for most infrastructure projects, especially in remote communities in the region. Financial institutions can plan and provide financing for water development. It could be part of their sustainability efforts. A more generous version of the Agri-Agra Act, the Rural Development Financing Act (R.A. 11901), allows financing for canals, dams, and irrigation projects. [5]

Dams are constructed to channel or hold back a body of water. Dams generate reservoirs, which are manmade lakes. Dams are used for various purposes for other liquid substances such as flood control, irrigation, power generation, environmental protection, and especially, water supply; it also offers a combination of purposes. [6, 7] Surface water is understood to mean all surface waters such as streams, rivers, lakes, marshes, reservoirs, streams. [8] Surface water and groundwater are two of the numerous forms of water that might satisfy a community's water supply requirements. [9]

By 2025, not only the city and town of Pampanga, but the entire country will suffer some form of water shortage, according to a study supported by the United States Agency for International Development (USAID). [10] The dam could also help households to at least mitigate the impact of expected water shortages in Pampanga.

For this reason, this study focused on providing an alternative water source for the province. This study also aimed to assess the Solib Dam as a supplementary water source. The study specifically focused: (1) To conduct a community-based survey to assess the various water resources of people in Solib, Floridablanca, Pampanga in terms of: a) current water supply, and b) alternative water supply; (2) To determine the quality of Solib Dam water in terms of primary indicators in accordance to the Philippine National Standards for Drinking Water of 2017; (3) To recommend water treatment techniques to ensure the use of Solib Dam water as a supplementary supply to the nearby community.

II. METHODOLOGY

The study was conducted with a combination of deductive and quantitative approach. The study generally focused on the area of Barangay Solib, Floridablanca, Pampanga as well as the Solib Dam located in the area. The data of the study generally focused on identifying what is the community's main and alternative source of water supply and determining if it is accessible and safe for the people of Solib, Floridablanca, Pampanga.

The data gathering was conducted through a community-based survey, as well as the data from the water quality assessment through the laboratories of the Department of Science and Technology (DOST) and CRL Environmental Corporation. Cochran's formula was used to identify the sample size of the population that follows a confidence level of ninety-five percent.

$$n_o = \frac{Z^2 pq}{e^2}$$

Where:

n_o – initial sample size

Z – abscissa of the normal curve (1.96)

p – population proportion (0.50)

q – 1-p

e – margin of error (0.05)

Substituting values:

$$n_o = \frac{1.96^2(0.50)(1-0.50)}{0.05^2}$$

$$\boldsymbol{n_o} \approx 384.16\ say\ \mathbf{385}\ \boldsymbol{Solib\ residents}$$

To calculate the final sample size:

$$n = \frac{n_o}{1 + \frac{n_o - 1}{N}}$$

Where:

n – final sample size

N – total population (1511 residents)

Substituting values:

$$n = \frac{385}{1 + \frac{385 - 1}{1511}}$$

$$\boldsymbol{n} \approx 306.98 \; \textit{say} \; \textbf{307} \; \boldsymbol{Solib \; residents}$$

The respondents were selected randomly. The data gathered from the responses of the residents from Solib were statistically treated using descriptive ratings as shown in Table 1. The statistical tools used to present the data from the responses were: Likert Scale, percentage, weighted mean, and general weighted mean.

Table.1. Likert Scale

Scale Value	Range Interval	Description
4	3.26 – 4.00	Strongly Agree
3	2.51 – 3.25	Agree
2	1.76 – 2.50	Disagree
1	1.00 – 1.75	Strongly Disagree

III. RESULTS AND DISCUSSION

3.1. Survey Results

Table 2 shows the water supply of the residents of Barangay Solib. It shows that 297 residents from Barangay Solib used metered connection as their main source of water supply, while 10 residents were using jetmatic water pump. This only implies that the majority of households in Solib were supplied by a metered connection which serves as their main water supply. On the other hand, 225 residents have no alternative water supply, while 72 used hand pump. This means that most of the residents of Solib have no existing alternative water supply in case of water interruption.

Table.2. Water Supply

Water Supply	Main		Alternative	
	Responses	%	Responses	%
Metered Connection	297	97%	-	-
Hand Pump	-	-	72	24%
Jetmatic Hand Pump	10	3%	-	-
Community Wells	-	-	10	3%
None	-	-	225	73%

Table 3 presented the responses of the residents from various water treatment in which they are familiar. The most known water treatment in Barangay Solib is boiling followed by filtration. This implies that the community has no knowledge about the different basic water treatments that are available to make the water potable. The residents were only familiar to the common water treatment which is boiling.

Table.3. Familiarity to Water Treatments

Water Treatment	Responses	%
Filtration	170	30.63%
Distillation	70	12.61%
Purification	21	3.78%
Boiling	289	52.07%
If others	5	0.90%

It is presented in Table 4 that fifty-five percent of the residents consumes the water directly from their main water source. In line with this, the majority of the residents are satisfied enough to the quality of water the intake.

Table.4. Main Water Supply

Main Water Supply	Responses			
	YES	%	NO	%
Consuming water directly from the main water supply	169	55%	138	45%
Water quality satisfaction	161	95%	8	5%

For the different water treatment used to treat water from the respondents' main source is shown in Table 5. There is filtration, distillation, purification, boiling, it could also be none or other options if there are any.

Among the total respondents who are not satisfied with the quality of water, 84 of them use boiling as a water treatment and 52 of them chooses none. This signifies that community

only resort to the most common water treatment and almost none of them have a knowledge about the different water treatment that can be used.

Table.5. Water Treatments Used

Water Treatment	Responses	%
Filtration	14	9.09%
Distillation	4	2.60%
Purification	-	-
Boiling	84	54.54%
None	52	33.77%
If others	-	-

Table 6 shows that 302 or 98% of collected data from the respondents were aware of the existence of Solib Dam in their community. This means that every resident of Solib is aware of what exists in their environment, especially the Solib Dam. It is also presented that sixty-six percent are willing to consume the water from the dam if it were proven potable to consume or after it was treated. On the other hand, 252 residents will consider Solib Dam as their supplementary water supply– signifies that most of them want an alternative water supply through the Solib Dam in case that the projected water shortage happens.

Table.6. Solib Dam

Solib Dam	Responses			
	YES	%	NO	%
Aware about its existence	302	98%	5	2%
Willing to consume the water stored in the reservoir if proven safe or after undergone water treatment	204	66%	103	34%
Willing to consider it as a supplementary water supply	252	82%	55	18%

Table 7 shows the accessibility and convenience of Solib Dam. All of the statements obtained a descriptive rating of "strongly agree" except for third, due to the fact that the majority of the residents have no access to an alternative water supply. In overall, accessibility and convenience gathered a general weighted mean of 3.24 which is equivalent to an "agree" in the descriptive rating.

Table.7. Accessibility and Convenience

Statements	Weighted Mean	Description
1. My current main source of water is accessible.	3.73	Strongly Agree
2. Having an alternative water source in case of water interruption or water shortage is convenient.	3.41	Strongly Agree
3. My current alternative water source (jetmatic, hand pump, community well) is accessible.	1.86	Disagree
4. Having a nearby alternative water source is convenient.	3.57	Strongly Agree
5. Solib Dam is accessible if it were to serve as a potential alternative water source.	3.29	Strongly Agree
6. Having an additional water source aside from my usual alternative water sources is convenient.	3.55	Strongly Agree
General Weighted Mean	**3.24**	**Agree**

It is presented in Table 8, the results about the safety of water. Also, it includes the weighted mean, general weighted mean, and descriptive interpretation of each statement in the conducted community-based survey. With a general weighted mean of 2.79, residents agreed that they were aware of the safety of water intake.

Table.8. Safety

Statements	Weighted Mean	Description
1. I am well aware of the safety of water from my current main water source.	3.64	Strongly Agree
2. The water from my current source is safe.	3.46	Strongly Agree
3. I am aware of the safety of water from Solib Dam.	2.22	Disagree
4. The water from Solib Dam at its current state (raw or unprocessed) is safe.	1.20	Strongly Disagree
5. The water from Solib Dam if it were to be processed or	3.41	Strongly Agree

undergo water treatment such as filtration, distillation, etc. is safe.		
General Weighted Mean	**2.79**	**Agree**

3.2. Water Quality

Table 9 shows the laboratory test results for physical parameter. For color, the water samples resulted to 15 CU, while the standard value specified in the PNSDW of 2017 was 10 CU. The water samples collected obtained an average temperature of 20.8˚C. Under turbidity, the value of 6.5 NTU resulted to not meet the Maximum Allowable Level (MAL) of less than 5 NTU set by the PNSDW. While on the parameter involving the taste and odor, DOST said that there are no standard levels or value set for this parameter.

For collected data from different solids, the water samples obtained a raw value of 333 mg/L for total solids. While for total suspended solids, it resulted to a raw value of 3.0 mg/L which met the standard value set to less than 50 mg/L. On the other hand, the water samples resulted in a raw value of 331 mg/L of total dissolved solids which meet the maximum allowable level of 600 mg/L. Lastly, a raw value of 1.0 ml/L of settleable solids was obtained by the samples collected, the standard set for this parameter is less than 0.0005 ml/L. This implies that most of the parameters tested failed to meet the standard value— water treatment is needed.

Table.9. Physical Parameter

Parameter	Raw	Standard
Color	15 CU	10 CU (maximum)
Temperature	20.8˚C (mean)	-------
Turbidity	6.5 NTU	< 5 NTU
Taste and Odor	No Objectionable Taste and Odor	No Objectionable Taste and Odor
Total Solids	333 mg/L	---------
Total Suspended Solids	3.0 mg/L	< 50 mg/L
Total Dissolved Solids	331 mg/L	600 mg/L (maximum)
Settleable Solids	1.0 ml/L	< 0.0005 ml/L

Table 10 shows the laboratory test results for chemical parameter. For pH, the water samples resulted to a mean raw value of 7.27– water is not acidic. The water samples collected obtained a mean value of 98.59 for alkalinity. This supports the computed pH level because a higher alkalinity means the higher chance of decreasing the water's acidity. While on the chloride parameter, it resulted to 14 mg/L which met the set standard value of 250 mg/L as the maximum allowable level. Lastly for total hardness, the water samples obtained a raw value of 113 mg/L. The set standard value for total hardness was at a maximum level of 300 mg/L. This only implies that all the chemical parameters meet the set standard value.

Table.10. Chemical Parameter

Parameter	Raw	Standard
Potential of Hydrogen (pH)	7.27 (mean)	-------
Alkalinity	98.59 (mean)	-------
Chloride	14 mg/L	250 mg/L (maximum)
Total Hardness	113 mg/L	300 mg/L (maximum)

Table 11 shows the laboratory test results for the microbiological parameter. For the total coliform and e. coli, the water samples resulted to greater than 8 MPN/100mL for total coliform in which it failed to meet the standard of less than 1 MPN/100mL; e. coli was also present to the water samples which it failed to meet the standard of the absence of e. coli. The heterotrophic plate count resulted to 2.8 x 10^3 CFU/mL. The standard for the heterotrophic plate count was less than 500 CFU/mL, where the samples failed to meet. Lastly, for thermotolerant coliform which resulted to greater than 8MPN/100mL in which it failed to meet the standard of less than 1.1 MPN/100mL. This implies that all the microbiological parameters tested did not qualified with the set standard.

Table.11. Microbiological Parameter

Parameter	Raw	Standard
Total Coliform	> 8 MPN/100 mL	< 1 MPN/100 mL
E. coli	Present	Absent
Heterotrophic Plate Count	2.8 x 10^3 CFU/mL	> 500 CFU/mL

Thermotolerant Coliform	> 8 MPN/100 mL	< 1.1 MPN/100 mL

3.3. Recommended Water Treatments

Table 12 shows the recommended water treatments for the different water quality parameters. Researchers drew this water treatment methods needed based from the laboratory results of the water samples collected from the Solib Dam.

Table.12. Recommended Water Treatments

Parameter	Recommended Water Treatments
Settleable Solids	• Coagulation and Flocculation • Sedimentation
Turbidity	• Coagulation and Flocculation • Sedimentation • Filtration
Color	• Coagulation and Flocculation
Taste and Odor	• Filtration
Microbiological	• Disinfection and Chlorination

IV. Conclusion And Recommendation

Serving as a precautionary measure on the projected water shortage on the year 2025 in all Region 3 provinces, the researchers made a study about having Solib Dam as a supplementary supply alongside their main water supply. The community-based survey focused on knowing the residents of Solib about their main water supply, and if there were any alternative water supply is part of this study. After all the respondents were surveyed, it clearly shows that most of them have no access to an alternative water supply.

The researchers also test the water quality of Solib Dam and what are the water treatments needed to propose Solib Dam as a supplementary supply for the whole community. With all data gathered and analyzed, water quality from the reservoir failed to meet the standards.

Knowing that the water from Solib Dam failed to meet the standards, but with proper water treatments and process such as: coagulation and flocculation, disinfection and chlorination, sedimentation, and filtration; it can be a suitable supplementary supply combining with their main water source.

Based on the conclusion, researchers drew the following recommendations:

- Future researchers advised to further develop this study through simulation of design that involves all the water treatments recommended in this study.
- It is advised to evaluate and assess the volume of evaporated water or water loss, the discharge, and the minimum water quantity that Solib Dam can produce to further validate its chance to be a supplementary supply alongside the residents' main water connections.
- It is suggested to get more validations from professional respondents to further assess and validate the Solib Dam as an alternative water supply.
- It is advised to determine the benefit cost ratio to further determine if it is beneficial to the residents of Solib.

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