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Characterization of Waterfalls Based on Water Quality Index in Calaitan Falls, Bayugan City

Orvin A. Lobitos[1*], Bobby E. Caingles[2], Rheanne D. Budumo[3], Julliane Isabelle Riene C. Cordero[4]

[1,2,3,4]Association of Science and Mathematics, Coaches of the Philippines, Philippine Association of Teachers and Educational Leaders Philippine, Institute of 21st Century, Educators Inc., Philippines.*

Corresponding Email: [1]orvin.lobitos@deped.gov.ph*

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***Abstract:** Many tourists from other cities visit Calaitan Falls in Bayugan City even the local people came to visit this waterfall. Therefore, it is imperative to characterize the water quality parameters if they suit human consumption and to investigate if it is safe for the tourist to visit these water falls in Bayugan City. The presence of physical and chemical elements affected the condition of the waterfalls. The result of this study could serve as the baseline data of physicochemical and bacteriological contaminants of the Calaitan waterfalls as it is the first research study of this kind in Bayugan City, Agusan Del Sur Province. The researchers examined the chemical components found in the Calaitan. The WQI can be computed by considering several significant characteristics, including pH, total hardness, alkalinity, nitrate, sulphate, chloride, iron, and dissolved oxygen. One naturally occurring resource for drinking is groundwater. The quality of drinking water should be periodically monitored and publicized, just like other natural resources. Any WQI model provides a straightforward figure that indicates the degree of water contamination. According to the findings of the study, researchers have concluded that the tested water's quality is lower than acceptable drinking levels, which is a troubling reality that our investigation has found. Because of the serious health hazards associated with toxins and pollutants, corrective action is urgently needed to improve the water's appropriateness for human use. To protect public health and guarantee access to clean drinking water, it is imperative that the issues that have been discovered be addressed and mitigate.*

***Keywords:** Physicochemical, Bacteriological, Wqi (Water Quality Index), Parameters, Waterfalls.*

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1. INTRODUCTION

1.1 Background of the Study

Water is an essential resource for humans to survive. According to the 2021 World Water Development Report released by UNESCO, in the past decades the global use of fresh water has increased and has been growing by 1% per year since the 1980s. Since water consumption increased, water quality is facing severe challenges; Agricultural production, Industrialization, and urban life have affected our environment, adversely affecting the water bodies (oceans and rivers) necessary for life, it affects human health and sustainable social development (Xu et.al 2022). Seasonal variations may affect the quality of river water and lead to different attributes for different seasons such as temperature and precipitation, in both anthropogenic and natural processes (Islam et al., 2018).

In India, the underground water is tested by examining the physicochemical properties within the water quality standards, and whether the quality of water is good and if it is for drinking purposes (Vt.Patil et.al 2022). Untreated effluent from factories is directly or indirectly discharged into rivers, causing pollution of surface water (Hasan et al., 2019). The improvement and development of water resources promotes the socio-economic situation of different countries in the world. Due to human activities, water resources are threatened by pollution and irresponsible human actions. In developing countries, drinking water is scarce due to pollution and environmental degradation. (Cabello, Canini & Lluisma, 2022).

One naturally occurring resource for drinking is groundwater. The quality of drinking water should be periodically monitored and publicized, just like other natural resources. Any WQI model provides a straightforward figure that indicates the degree of water contamination. WQI is commonly used for the detection and evaluation of water pollution and may be defined as a reflection of the combined impact of several quality factors on the water's overall quality. This has been determined by collecting thirteen groundwater samples. Subjecting samples to a comprehensive physicochemical analysis are made using the standard procedure as per ISI standards. Key factors like pH, total hardness, alkalinity, chloride, nitrate, sulphate, iron, and dissolved oxygen have all been taken into consideration when calculating the WQI. (Yallurkar, S., 2019)

To evaluate the water environment, ecosystem, hydrochemistry, and ecology and restore water quality, monitoring of the physicochemical water quality parameters is essential (Islam etal., 2019). Many tourists from other cities visit Calaitan Falls in Bayugan City, even the local people came to visit this waterfall. Therefore, it is imperative to characterize the water quality parameters if they suit human consumption and to investigate if it is safe for the tourist to visit these water falls in Bayugan City.

The presence of physical and chemical elements affected the condition of the waterfalls. Therefore, this research study aimed to assess the water falls quality for drinking by quantifying various Physico-chemical groundwater parameters based on Philipines National Standards of Drinking Water (PNSDW, 2007). The result of this study could serve as the baseline data of physicochemical and bacteriological contaminants of the Calaitan waterfalls as it is the first research study of this kind in Bayugan City, Agusan del Sur Province.

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1.2 Statement of the Problem

The main problem of the study is to investigate the characterization of waterfalls based on water quality index in Calaitan falls, bayugan city and to determine the water quality if it is good for drinking purposes and to ensure the safety of the tourist that visits the local falls in Bayugan City, specifically it ought to answer the following questions:

1. To examine the chemical components found in the Calaitan Falls.
2. To determine the water quality of Calaitan Falls in terms of drinking, irrigation and for human consumption.
3. To get the multifaceted water quality data into simple information that is comprehensible and useable by public, by calculating water quality index.

1.3 Statement of the Problem

The purpose of this study is to investigate the impact and effectiveness of daily reading practice on the literacy development of seventh grade students. This research will specifically answer the following questions:

1. Do engaging in daily reading practice improve:
   a) Reading comprehension.
   b) Vocabulary.
   c) Writing skills.

2. Identify significant differences in the literacy development of students before and after engaging in daily reading practice.
3. Determine the number of students that have improved their literacy proficiency.

1.4 Significance of the Study

This study was conducted to be able to determine the efficiency of the PMFC System for electricity generation in Bayugan City, Agusan Del Sur. This study will give significant benefits to the following:

Bayugan City DENR

This study is significant and will benefit Bayugan City's DENR because examining the chemical components found in Calaitan falls would help them determine if it's good and drinkable to be the source of water in the local area.

Future researcher

This study could help them evaluate the characterization of waterfalls based on water quality and can be used as additional knowledge for future similar studies.

Local Government Unit

The LGU officials could provide insights and feedback to the water quality of calaitan falls for the residents of Calaitan to believe that the water quality of Calaitan falls is clean, safe, and drinkable.

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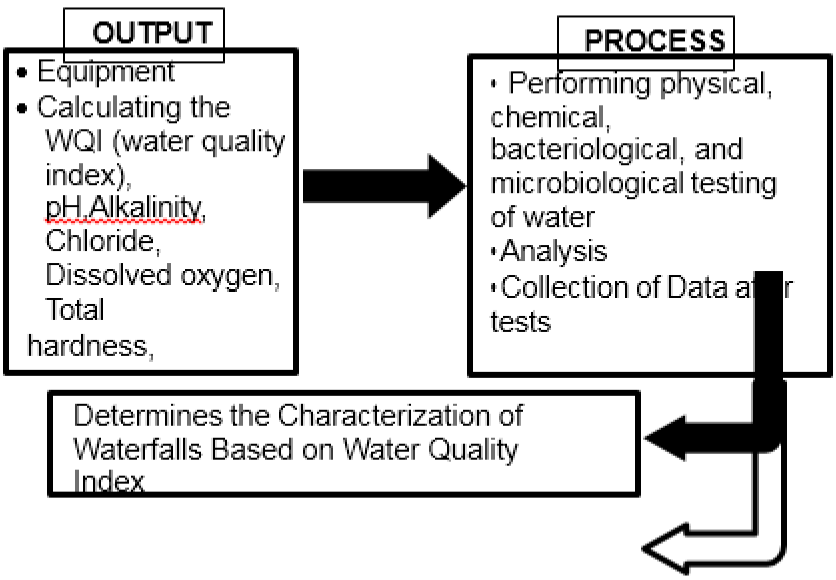
1.5 Scope and Delimitation

This study focused on assessing the water quality of Calaitan Falls in Bayugan City, Philippines, using the Water Quality Index (WQI) and physicochemical parameters outlined in the Philippines National Standards of Drinking Water (PNSDW, 2007). The study includes evaluating the suitability of the water for human consumption and its safety for tourists visiting the falls. This study aims to establish baseline data for physicochemical and bacteriological contaminants in the groundwater of Bayugan City.
The study focuses on physicochemical parameters, neglecting microbiological aspects for water safety assessment. It may not consider long- term trends or pollution sources and may not cover all contaminants in groundwater. The applicability beyond Bayugan City may be limited due to water quality variations. The study may not provide an exhaustive assessment of the ecological impact on the Calaitan Falls ecosystem.

Conceptual Framework

The concept of this study is characterization of waterfalls based on water quality index in Calaitan Falls, Bayugan City, Agusan del Sur.

The Research Paradigm Shows the Scientific Process of Determining the Characterization of Water Index in the Chosen Barangay of the City.



2. RELATED WORKS

The unhygienic practice of indiscriminate garbage disposal in Calabar city poses a potential threat to groundwater purity. Most of the city's solid waste is disposed of in open dumping grounds without prior categorization, sorting, or treatment. While some of these sites are still operational, others have been shut down. The possibility of contaminating the city's water sources, along with the risks to public health and the environment, raises significant concerns. This prompted a comprehensive examination of groundwater quality in Calabar. The work

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aims to utilize interpolation methods and water quality indicators for a thorough and site-specific evaluation of groundwater quality in the Calabar metropolis, as well as to ascertain whether heavy metal presence in water poses a potential risk to human health. This research is particularly crucial given that only 30% of Calabar residents have access to public water (Inah Okon, Chukwudi G. Njoku, 2018).

Despite the shortcomings of municipal water supply systems, groundwater remains one of the most reliable alternative sources of potable water (in terms of availability) in several developing countries. The risk is exacerbated by the misconception among the public, lacking in knowledge, that groundwater is safe for consumption without any form of treatment or regular quality control and assurance testing. The multitude of health hazards associated with consuming contaminated water cannot be disregarded, especially in developing nations where human activities have a more pronounced impact on groundwater quality. Strategic waste management in relation to the water sector is imperative to mitigate risks to human health (O J Oyebode, A O Coker, 2021).

In response, researchers worldwide have been engaged in exploring the fundamental mechanisms governing crucial hydro-chemical ions in groundwater, as well as assessing the potential implications of groundwater pollution on human health and the natural environment. Several works have been undertaken in recent years to investigate the hydrogeochemical characteristics and quality of groundwater (staoğlu, F., Tepe, Y., Taş, B., 2019).

3. METHODOLOGY

Research Design

This research employs quantitative research, an experimental design utilizing descriptive technique and will be using the WQI (Water Quality Index) parameters (USF Water Institute,2023) water index is calculated through getting the average using the 5 categories: turbidity dissolved oxygen concentration, oxygen demand and chemical demand, total nitrogen or phosphorus and bacteria. To evaluate the water environment, ecosystem, hydrochemistry, and ecology and restore water quality, monitoring of the physicochemical water quality parameters is essential (Islam et al., 2019). The study is conducted and dealt with determining the Characterization of waterfall- based on water quality Index in Calaitan falls, Bayugan City.

Research Instrument

The physicochemical parameters such as pH, alkalinity, dissolved oxygen, total hardness, calcium, magnesium, chloride, nitrate, sulfate, fluoride, iron, and nitrate were the components of the instruments that were used to calculate the water quality index of Calaitan Falls, and these parameters will be determined in the laboratory. The collection of water samples will be handpicked and stored in sterile bottles, sealed, labeled, stored in a cooler container, and then transported to the laboratory for analysis. Microbiological and bacteriological analysis is also implemented to determine if there is the presence of bacteria and microorganisms such as coliforms and other biological contaminants, which can be concluded for the characterization of waterfalls based on the water quality index in Calaitan Falls, Bayugan City.

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Data Gathering Procedure
Drinking water samples were collected from Calaitan Falls, Bayugan City. Samples of water were taken in pre-claimed plastic polyethylene bottles, which were then promptly placed in the coolers with cold packs. Using the Department of Science and Technology (DOST) Regional Standard and Testing Laboratory Caraga facilities, the samples were analyzed within one to ten days after the collection. To acquire a complete data set of the water quality, the water samples were analyzed for the following parameters: pH, Alkalinity, Chloride,
Dissolved oxygen, Total hardness, Fluoride, Sulphate, Iron, Nitrite. Once the data needed to launch our project has been gathered, a thorough exploratory survey is conducted. The sampling locations found are based on easy accessibility of water from various sources. When the results of the water quality in Calaitan falls were finalized. Then, the data were analyzed and interpreted using the most appropriate statistical procedure. Afterwhile, conclusions will be next and can be drawn about the water quality of the Calaitan falls if it's safe and for drinking purposes.

Data Analysis
The Water Quality Index (WQI) is a valuable tool for assessing and summarizing the overall quality of water from a specific source, in this case, Calaitan Falls in Bayugan City. It assigns a single value to the water quality, making it easier to understand and compare different samples. The WQI is calculated using a specific methodology, which involves the following steps:

1. Weight Assignment: Each of the nine parameters is assigned a weight (wi) based on its importance in assessing water quality. For example, nitrate, being a significant factor, is assigned the maximum weight of 5.
2. Relative Weight Calculation: The relative weight (W) for each parameter is calculated b summing the weights and dividing by the number of parameters. This step determines the relative importance of each parameter.
3. Quality Rating: A quality rating scale (qi) is assigned to each parameter by comparing its concentration in the water sample to the respective standard according to guidelines, and then multiplying by 100. This step assesses how each parameter compares to the recommended standards.
4. Subindex Calculation: The subindex (Sli) for each parameter is calculated using the quality rating (qi) and is specific to each parameter.
5. WQI Calculation: The WQI is computed by using the subindex values, and it provides a single score that summarizes the overall water quality of Calaitan Falls. This score is then classified into one of five categories, ranging from "excellent water" to "water unsuitable for drinking".

Water Quality Index (Wqi)
Water quality indices use one or more systems to convert a list of elements and their concentrations in a sample into a single value that represents the water quality of a source. Then, using each sample's index value, one may compare the quality of several samples.
A Water Quality Index (WQI) is a way to consistently summarize data on water quality for public reporting. It informs us, in plain language, on the quality of drinking water from a

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drinking water supply and is comparable to the UV or air quality indices. The three measurements are combined into a single score by the WQI, which assesses the extent, frequency, and amplitude of water quality exceedances. The result of this computation is a score between 0 and 100. The greater the water quality, the lower the score. Following that, the scores are categorized into one of the five groups listed below:

Table 1. Water Quality Classification Based on WQI Value

WQI Value	Water Quality
< 50	Excellent
50 – 100	Good Water
101 – 200	Poor Water
201 - 300	Very Poor Water

The WQI is a summary tool, and the Department does not intend to use the WQI to replace detailed analysis of drinking water quality data. The Department continues to closely monitor and analyze drinking water quality to protect drinking water safety on a proactive basis.
The result of the WQI can help determine the suitability of water for various purposes, such as drinking, irrigation, and human consumption. It allows for an easy comparison of water quality over time and across different sources, providing valuable information for residents, government officials, and future researchers.

4. RESULTS AND DISCUSSIONS

Data gathering, as seen in Chapter 2, has been completed. A pretest has been administered to gather initial data as to where our research should focus. An intervention is being made that causes this intervention to take effect in the process. Upon analysis, the result of the pretest, as shown in Table 1, suggests that more than half of the students may have a score below the median (10), indicating a lack of understanding among a significant portion of the group. This prompted an intervention for the student's current literacy capabilities.
The intervention appears to have a pronounced positive influence, as evidenced by the increased number of students labeled "passed" and the noteworthy increase in mean scores from the pretest (6.87) to the posttest (13.47). The presented data reveals a substantial positive shift from pretest to posttest, with a mean difference of 6.60. Together with the T-computed value of -13.58040 and a p-value less than 0.001, it strongly proves the statistical significance of the treatment's impact. Additionally, the decrease in standard deviation from pretest (1.9952) to post-test (1.1872) supports the interpretation that the daily reading practice treatment not only brings about an overall improvement but also contributes to more consistent performance among participants. Collectively, this solidly supports the assertion that there is a significant difference between the two groups and indicates a robust positive impact of the daily reading practice on the student's literacy development.

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Table 2. Water Quality Analysis in Calaitan, Bayugan City Agusan Del Sur

S. No.	Parameter	Requirement Limit	Experimental Result	Remark
1	Color	5	3-4	May be extended up to 50 if toxic substances are suspected
2	Turbidity	10	12	May be relaxed up to 25 in The absence of alternate.
3	pH	6.5 to 8.5	7.2 -7.5	May be relaxed up to 9.2 in the absence
4	Total Hardness	300	420	May be extended up to 600
5	Calcium as CA	75	***	May be extended up to 200
6	Magnesium as Mg	30	***	May be extended up to 100
7	Copper as Cu	0.05	*	May be relaxed up to 1.5
8	Iron	0.3	*	May be extended u to 1
9	Manganese	0.1		May be extended up to 0.5
10	Chlorides	250		May be extended up to 1000
11	Sulphates	150		May be extended up to 400
12	Nitrates	45	1.235*	No relaxation
13	Fluoride	0.6 to 1.2		If the limit is below 0.6 water should be rejected, Max. Limit is extended to 1.5
14	Phenols	0.001		May be relaxed up to 0.002
15	Mercury	0.001		No relaxation
16	Cadmium	0.01		No relaxation
17	Selenium	0.01		No relaxation
18	Arsenic	0.05		No relaxation
19	Cyanide	0.05		No relaxation
20	Lead	0.1		No relaxation
21	Zinc	5.0		May be extended up to 10.0
22	Chromium as Cr +6	0.05		No relaxation

Here is a list of water quality testing parameters and the Water quality testing methods which are used to analyze the quality of water:

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Table 3. Water Quality Testing Parameters

Sr. No.	Water Testing & Analysis Parameter	Water Testing and Analysis Method
1	Colour	Visual comparison, Spectrophotometric method
2	pH	pH paper, Universal indicator or pH meter
3	Turbidity	Nephelometric method
4	Dissolved Oxygen (DO)	Winkler method
5	Biological Oxygen Demand (BOD)	Winkler method
6	Chloride (Cl)	Argentometric method
7	Hardness – Ca and Mg	EDTA method
8	Total Dissolved solids	Gravimetric method
9	Sulphate as SO4	Turbidimetric method
10	Nitrate as NO3	Colorimetric method
11	Iron (Fe)	AAS
12	Sodium (Na)	AAS
13	E. coli	MPN – completed test for E. coli (*fc* – 13/25)
14	Total Coliform Bacteria	MPN – (4/9 for 3 sets)
15	Total Bacteria	Enumeration method

All the physical and chemical factors are thoroughly evaluated in the results. The observed data in Table 1 is approximated or computed using many physical and chemical characteristics, including color, turbidity, pH, total hardness (TH), Ca, Mg, Cu, Fe, Mg, chloride, sulphate, nitrate, fluoride, phenol, and mercury. The data also highlights some important aspects. To assess the quality of the water, table 2 displays the parameters and procedures for water quality testing.

Based on the data collected, the researchers determined that the water in Calaitan falls is not drinkable because of the e coli, and coliform bacteria, through the result that we conducted. The water suggests the water may contain pathogens that can cause diarrhea, vomiting, cramps, nausea, headaches, fever, fatigue, and even death sometimes. Based on the data collected after examining the water quality, it shows a negative result because of the elements that is not suitable for our health. By this result, the researchers proved that it is not good to drink water from Calaitan falls located in Bayugan City.

The table contains various parameters for water quality testing, including the limits, experimental results, and testing methods. The parameters include color, turbidity, pH, total hardness, dissolved oxygen, chloride, total dissolved solids, sulphate, nitrate, iron, sodium, E. coli, total coliform bacteria, total bacteria, and several heavy metals and other substances. The study appears to be focused on the characterization of waterfalls based on the quality index in Calaitan Falls. The table presents the limits and experimental results for each parameter, along with any potential extensions or relaxations of the limits. Additionally, it includes the water testing and analysis methods for each parameter.

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The data provided can be used to assess the water quality in Calaitan Falls by comparing the experimental results with the specified limits and by employing the corresponding testing methods. The study's objective may be to evaluate the water quality in Calaitan Falls by analyzing various parameters and establishing a quality index based on the results. This index could be used to assess the overall water quality and to identify any potential issues or areas for improvement. The comprehensive nature of the parameters and testing methods suggests a thorough investigation into the water quality of the falls. The information presented in the table offers a detailed overview of the water quality testing parameters and methods, providing a solid foundation for the characterization of water quality in Calaitan Falls.

Summary, Conclusions and Recommendation

The study aimed to identify if the water is drinkable or not because if the locals get their supply of water from the waterfalls, they might be contaminated if it is not drinkable. Despite the beauty of these natural water resources, we must make a thorough investigation to make sure it is safe to drink. Researchers conducted a thorough analysis of the water samples collected from the Calaitan falls.

By this, parameters such as microbial contamination, chemical pollutants and over all water composition were examined to evaluate the water if it is drinkable. However, the results revealed that the Calaitan Waterfalls did not meet the necessary standards for its water to be drinkable. High levels of contaminants were found, including microbial agents and chemical pollutants that might harm those people that will drink the water coming from the Waterfall.

5. CONCLUSION

In conclusion, our research has discovered a concerning reality regarding the tested water's quality, revealing a water quality index that surpasses safe levels for drinking. The presence of contaminants and pollutants poses significant health risks, emphasizing the urgent need for remedial measures to enhance the water's suitability for consumption. This conclusion indicates the critical importance of addressing and mitigating the identified issues to safeguard public health and ensure access to safe drinking water. According to the findings of the study, researchers have concluded that the tested water's quality is lower than acceptable drinking levels, which is a troubling reality that our investigation has find. Because of the serious health hazards associated with toxins and pollutants, corrective action is urgently needed to improve the water's appropriateness for human use. To protect public health and guarantee access to clean drinking water, it is imperative that the issues that have been discovered be addressed and mitigate.

This paper contains the recommendations throughout the study "Characterization of Waterfalls based on Water Quality Index in Calaitan Falls Bayugan City" for the future researcher and for the purpose of improving the study. The following will be the recommended implementations from the study:

- Collecting information from the people resides in Calaitan Falls through survey or interview about their activities or other people activities that may affect the quality of the water.

- The local government unit, Bayugan LGU, should be strict on the waste disposal of the residents that resides in Calaitan.
- The residents should be aware that the water in Calaitan has numerous bacteria and that they should be careful in the usage of water.

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