Research Article

Rapid Physicochemical Assessment of Kalawaig Creek in Bukidnon, Philippines

Lalace Albasin Damasco*, Vanessa Jean Delgado Arocha, Ella Bucag Quilang, Denzel Matthew Cutor Damole, Leandro Benedict Eduria Miones, Ian Jay Paspe Saldo

Integrated Basic Education Department, San Isidro College, Malaybalay City, Bukidnon, PHILIPPINES.

Submission Date: 11-02-2024; Revision Date: 11-02-2024; Accepted Date: 13-04-2024.

ABSTRACT

Aim/Background: Creeks found in the Philippines are essential to the ecosystem. Like Kalawaig Creek in Bukidnon, Philippines, it represents a unique ecosystem with its distinct set of physicochemical conditions supporting the continuous growth of flora and fauna. This study aimed to determine the physicochemical parameters, specifically Water Temperature, Total Dissolved Solids, Dissolved Oxygen (DO), Color, Hydrogen Ion Concentration (pH) and Total Alkalinity. **Materials and Methods:** This study utilized a descriptive approach combined with field research techniques to describe the physico-chemical parameters in Kalawaig Creek. A 4 L of water samples were collected from the up-stream, down-stream and middle stream of Kalawaig Creek to test for the Dissolved Oxygen (DO), color, Total Dissolved Solid and Total Alkalinity. At the same time, temperature and pH were measured *in situ*. **Results:** The physicochemical testing for the physical parameters revealed the total average temperature across all locations and trials, which is calculated as 27.51°C. Moreover, the average Total Dissolved Solids in Kalawaig Creek is 317 mg/L. For the chemical parameters, the calculated average for dissolved oxygen is 7.9 mg/L and the average apparent color is 15 CU. Meanwhile, the total average pH across all trials and locations is 6.67 and the average of the Total Alkalinity is 96.9. mg/L Wilcoxon Signed-Ranked Test was employed to determine whether there is a significant difference between the set standards of the physicochemical parameters and the results of the measured parameters in Kalawaig Creek. The statistical analysis results indicate a significant difference between the set standards for physicochemical parameters and the observed results in Kalawaig Creek. **Conclusion:** The analysis of physicochemical parameters in Kalawaig Creek indicates a generally healthy ecosystem; however, the study's findings emphasize that the physicochemical parameters in Kalawaig Creek do not align perfectly with the established standards for these parameters.

Keywords: Kalawaig Creek, Water Quality, Color, Dissolved Oxygen, Hydrogen Ion Concentration (pH), Total Alkalinity, Total Dissolved Solids, Water Temperature.

Correspondence:

Ms. Lalace A. Damasco

Integrated Basic Education Department, San Isidro College, Malaybalay City, Bukidnon-8700, PHILIPPINES

Email: damascolalace@gmail.com

INTRODUCTION

Water is frequently described as the "life force" of the Earth and is an asset crucial for the existence of all living beings. Rivers are dynamic ecosystems that play a pivotal role in maintaining ecological balance, providing a habitat for diverse species and serving as a vital source of freshwater for human and natural systems. River water pollution can harm living beings and make water unsuitable for various needs.[1] Creeks found in the Philippines, like the Kalawaig Creek, play an important role in our country's ecosystem. The Kalawaig Creek, located in Kaamulan Grounds-Folk Arts Malaybalay City, Bukidnon, is known for its refreshing and free-flowing cool waters. It is a minor tributary of a river. The creek's crystal clear pool, illuminated by natural skylight, creates a picturesque and dramatic scene. Surrounding the area are lush hardwood trees that not only preserve the tranquility but also provide a perfect backdrop.

SCAN QR CODE TO VIEW ONLINE

www.ajbls.com

DOI: 10.5530/ajbls.2023.13.23

The Kalawaig Creek represents a unique ecosystem with its distinct physicochemical conditions. The creek plays an essential ecological role, supporting several aquatic organisms and providing ecosystem services such as water regulation, irrigation and tourism. However, there is a lack of knowledge about the creek's physico-chemical parameters. While studies have been conducted on the physicochemical parameters of other creeks, rivers and, lakes in Bukidnon, Philippines, there is still limited information available on Kalawaig Creek. Hence, this study aims to determine the physicochemical parameters in Kalawaig Creek.

The intricacies of its physicochemical parameters, encompassing factors such as temperature, pH, turbidity, dissolved oxygen and nutrient levels, shape the very essence of its ecosystem. Creeks have a variety of physicochemical characteristics that can affect their quality and suitability for different uses. The need to assess and understand the physical-chemical parameters within this ecosystem has become increasingly evident in light of the growing human impact on the environment. As stated by,[2] ensuring the ideal quality and quantity of water in river systems is essential to monitor water quality. Consequently, the identification of these parameters in Kalawaig Creek have emerged as a pressing concern for environmental conservation and management.

In a study conducted by,[3] the physicochemical properties of water affect aquatic organism abundance, species composition and productivity. In addition, his research examines physicochemical parameters such as, salinity, dissolved oxygen and water temperature that affect the diversity and composition of zooplankton in rivers. While,[4] investigated the physicochemical characteristics of the Ialomita River in Romania, finding that heavy metals and other pollutants are present in the water due to various anthropogenic sources.[5] evaluated the physicochemical characteristics of surface water from the Orashi River in Nigeria, finding that while most parameters fall within acceptable limits, dissolved oxygen turbidity and biochemical oxygen demand were not within the recommended range for drinking water. These parameters influence the aquatic life within; steering the dynamics of biodiversity, growth and overall river health. Understanding the physicochemical characteristics of rivers is important for assessing their quality and suitability for different uses.

Thus, this study aims to determine the physico-chemical parameters in Kalawaig Creek. Identifying the specific physical and chemical characteristics of the water gives significance to protecting and managing the creek. Since there is a lack of research on analyzing physico-chemical parameters, specifically in Kalawaig Creek, this study was conducted. The findings of this study can provide understanding and monitor the health and quality of water.

MATERIALS AND METHODS

Research Design

With field research techniques to comprehensively describe the physico-chemical parameters in Kalawaig Creek. The study employed a descriptive approach to provide a thorough and holistic description of the physico-chemical parameters in Kalawaig Creek Furthermore, field research techniques were also used to collect data directly from the creek's ecosystem, ensuring accuracy and reliability in our observations. This study also utilized descriptive statistics to summarize and present the collected data. The chosen approach of descriptive research combined with field research techniques and descriptive statistics offers a robust and ethical way to achieve the research objectives. It allows the researchers to provide a detailed account of the physicochemical parameters in Kalawaig Creek.

Locale of the Study

This research analyzes specific physico-chemical parameters in Bukidnon, Philippines, specifically in Kalawaig Creek, Malaybalay City. Kalawaig Creek, situated in Barangay 1, Kaamulan Ground in Malaybalay City, is central in the local landscape. As the capital of Bukidnon, Malaybalay City is a hub of cultural activities and environmental diversity. The researchers traversed recreational areas, starting with folk arts and then proceeding to the playground before concluding their visit to the zoo. The precise location of Kalawaig Creek at the confluence of these elements makes it an ideal subject for in-depth analysis. The samples were tested for Dissolved Oxygen (DO), color, Total Dissolved Solid and Total Alkalinity at the F.A.S.T Laboratory while testing for the temperature and pH was conducted *in situ*.

Establishment of the Study

The Kalawaig Creek is located in the city of Malaybalay. The researchers arranged suitable vehicles to transport them to the study site in Kaamulan Grounds-Folk Arts, Malaybalay City. This location is surrounded by Pine Trees and Golden Trees, is open to the public and houses are not located near the creek. The Kalawaig Creek is classified as Class A based on the Department of Environmental and Natural Resources Water Quality Guidelines and General Effluent Standards of 2016, which is intended for beneficial use as a source of water supply requiring conventional treatment. The upstream part of the creek was located at the back of the Folk arts theatre. The middle stream part of the creek was located near the Kaamulan Park Playground. The downstream part was located near the Bukidnon Zoological Park. A transect walk was used as a systematic method for collecting samples along the creek. Three sampling points were identified along the Kalawaig Creek. These include an upstream, downstream and middle-stream location. These points were chosen strategically to capture variations in water quality along the creek's length. The distance from Upstream to the Middle-Stream is 350 m and the distance from the Middle-Stream to Downstream is 200 m. For Dissolved Oxygen (DO), color, Total Dissolved Solids (TDS) and Total Alkalinity, the researchers collected water samples from the three selected sampling points. Temperature and pH measurements were conducted directly at the sampling points (*in situ*).

Preparation and Collection of Water Samples

Before sample collection, meticulous preparations were undertaken to maintain data integrity. The Researchers followed the protocol provided by F.A.S.T. Laboratories, which was based on the Standard Method for examining Water and Wastewater, APHA AWWA, 22nd ed Philippine National Standard for Drinking Water (PNSDW), 2007. Furthermore, for determining the physicochemical parameters, the researchers collected 4L of water samples from the up-stream, down-stream and middle-stream of Kalawaig Creek to test for the Dissolved Oxygen (DO), color, Total Dissolved Solid and Total Alkalinity. The water was collected through grab sampling taken at the mid-depth of each stream. The water samples were then stored in a polyethylene bottle and placed in a cooler chilled at 4°C. The 4L water samples were then sent to F.A.S.T. Laboratories, while testing for the temperature and pH was conducted *in situ*.

pH and Temperature Testing

The testing for water temperature measurement and pH were taken *in situ* using a handheld pH meter (Meter pH-100). The researchers gathered three trials at each site (upstream, midstream and downstream). In testing, the researcher used standard buffer solutions with known pH values of 4.00 at 25°C, 6.86 at 25°C and 9.18 at 25°C. The researchers cleaned the pH electrode with distilled water to ensure accurate measurements and avoid contamination between trials. Additionally, the study emphasizes the significance of pH levels in evaluating the suitability of water for various purposes, as indicated by.[6] pH levels are crucial indicators that help determine whether water is suitable for different applications.

Data Gathering Procedure

Permissions were secured for the study through requests to the school administration and the Department of Environment and Natural Resources. Parental consent was also obtained, clarifying the school's non-liability. Water samples were collected at 5 a.m. from Kalawaig Creek in Kaamulan Grounds, Malaybalay City and transported to the F.A.S.T Labs (First Analytical Services and Technical Cooperative Laboratory). The samples underwent comprehensive testing using specialized equipment. The following methods used are 2120 B. Visual Comparison for Apparent Color, 4500-0 C. Azide Modification for Dissolved Oxygen, 2540 C. Gravimetry for Total Dissolved Solids and 2320 B. Titrimetry for Total Alkalinity as $CaCO_3$. Thorough data analysis was conducted to derive meaningful results.

Apparent color-2120 B. Visual Comparison

Visual comparison is a core perceptual task in data visualizations.[7] Color in water can be caused by natural metallic ions, peat materials, plankton, weeds and industrial waste. Visual comparison indicates differences. The visual comparison method is applicable to almost all potable water samples. Pollution from certain industrial wastes can result in unusual colors that cannot be matched.[8] According to,[9] visual comparison involves determining apparent color by observing a sample in a bottle and representing only the initial information. Moreover, according to,[10] The formula for apparent color is Ax50/B. Where A=the estimated color of a diluted sample and B=the mL sample used for dilution.

Dissolved Oxygen (DO)-4500-O C. Azide Modification

The method to be used for the Dissolved Oxygen in this study is 4500-°C. Azide Modification. According to,[11] titration with a color indicator is the major instrumentation needed in performing this analysis with the specified method. Moreover, the sample is supplemented with manganous sulfate for the testing of 4500-O C. Azide Modification. The potassium iodide and sodium azide are combined to create a fundamental combination. To acidify the formed precipitate, sulfuric acid is used. Iodine is liberated by using a starch indicator and titrated with phenylarsine oxide.

Total Dissolved Solids-2540 C. Gravimetry

TDS, or Total Dissolved Solids, quantifies the quantity of organic and inorganic substances that was filtered out from a given volume per unit of the water that has been evaporated.[12] The 2540 C method in gravimetry is a standard test procedure for determining Total Dissolved Solids (TDS) in water samples. In this method, known volume of water is evaporated to dryness and the residue is then weighed to determine the TDS. Calculate TDS concentration using the formula: TDS (mg/L)=(Weight of Residue/Sample Volume)*1,000. The gravimetric analysis involves the quantification of a substance by measuring its mass. In TDS testing, this method helps determine the concentration of dissolved solids in water through the residual mass left after evaporation. This method is gravimetric because it relies on the measurement of mass. It provides accurate results but may take more time compared to other methods. Careful control of the evaporation and drying conditions is crucial to ensure accurate measurements. Additionally, the method may not capture volatile or organic components that could be lost during the evaporation process. According to,[13] TDS concentrations greater than 1200 mg/L are not suitable for drinking. Water bodies can be categorized as brackish or saline based on the amount of TDS present.

Total Alkalinity-2320 B. Titrimetry

One of the few measurable quantities that can be used to determine the concentrations of carbonate system species is total alkalinity.[14] This titration method is an analytical technique utilized to accurately measure the volume of a solution with a known concentration needed to react with the substance under analysis, as well as to determine the volume of the substance being analyzed. The solution with the accurately known concentration, known as the titrant, interacts with the substance being analyzed, referred to as the titrand. For this method, Alkalinity is commonly assessed using a digital titrator and sulfuric acid. In this process, a water sample was added with until the three main forms of alkalinity (bicarbonate, carbonate and hydroxide) are converted into carbonic acid. At a pH of 10, any hydroxide present reacts to form water. As the pH drops to 8.3, carbonate transitions into bicarbonate. At a pH of 4.5, both carbonate and bicarbonate are completely converted into carbonic acid. Below this pH, the water cannot effectively neutralize the sulfuric acid, resulting in a direct correlation between the amount of sulfuric acid added and the alteration in the sample's pH. As per the APHA-AWWA-WPCF guidelines, the formula for calculating alkalinity is as follows: The formula to calculate alkalinity (in mg $CaCO_3$/L) is given by Alkalinity=AxNx50,000/mL sample, where A represents the volume (in mL) of the standard acid titrant and N denotes the normality of the standard acid.

Statistical Analysis

The test data was carefully recorded in tables, analyzed and interpreted based on statistical results. In this study, inferential statistics were used by the researchers. The researchers employed the Wilcoxon Signed-Ranked Test in order to determine if there is a significant difference between the set standards of the physicochemical parameters and the results of the measured parameters in Kalawaig Creek. Furthermore, the Wilcoxon signed-rank test is a statistical method that evaluates two sets of scores originating from the identical population without relying on specific distribution assumptions.[15] It evaluates whether there exists a disparity in the mean ranks between two related samples, matched samples, or repeated measurements taken from a single sample.[16] According to,[17] To analyze significant differences using the Wilcoxon Signed-Ranked Test, first, determine the disparities between pairs of values. Next, arrange these differences in order of their absolute magnitudes, from smallest to largest. Subsequently, compute the test statistic W, which equals the smaller sum of positive ranks (W+) and the sum of negative ranks (W-), taking into account the signs "+" or "–" associated with the observed differences. Under the null hypothesis, an equal number of positive and negative ranks are expected, while under the research hypothesis, higher positive ranks are anticipated. Therefore, the Wilcoxon signed-ranked test was utilized to assess the statistically significant differences between the predefined standards of physicochemical parameters and the observed outcomes of the measured parameters.

Ethical Considerations

All data was professionally documented and tabulated by the researchers. Data, results, methodologies and procedures were collected and implemented as is. This is done to guarantee that the study's outcomes are as precise as feasible. Safety measures were implemented to prevent diseases or injury to the researchers.

RESULTS

Physical Parameters

Table 1: Temperature Result.

Parameter	Unit		Results			
Water Temperature	ºC		Trial 1	Trial 2	Trial 3	Average
		Up-stream	28ºC	27.7ºC	27.3ºC	27.67ºC
		Middle-stream	27.5ºC	28ºC	28ºC	28ºC
		Down-Stream	26.6ºC	27ºC	27ºC	26.87ºC
Total Average: 27.51ºC						

Table 1 presents temperature results for water samples collected from the different stream locations of Kalawaig Creek (Upstream, Middle-stream and Downstream) in three separate trials. The average temperature for each trial and the overall average temperature across all trials are shown in the table. Up-stream exhibited an average temperature of 27.67ºC, Middle-stream had an average of 28.0ºC and Down-Stream showed an average temperature of 26.87ºC. The total average temperature across all locations and trials is calculated as 27.51ºC.

Table 2: Total Dissolved Solids (TDS) Results.

Parameter	Unit	Up-stream	Middle-stream	Down-stream
Total Dissolved Solids (TDS)	mg/L	132	142	128
Average: 317 mg/L				

Table 2 shows the result of the Total Dissolved Solids in mg/L. In the Upper stream, it resulted in 132 mg/L; in the Middle Stream, it resulted in 142 mg/L; downstream, it resulted in 128 mg/L. The average of the Total Dissolved Solids in Kalawaig Creek is 317 mg/L.

Chemical Parameters

Table 3: Dissolved Oxygen (DO) Results.

Parameter	Unit	Up-stream	Middle-stream	Down-stream
Dissolve Oxygen (DO)	mg/L	7.8	7.9	8.1
Average: 7.9 mg/L				

Table 3 shows the Dissolved Oxygen (DO) result in mg/L. In the upstream segment, it resulted in 7.8 mg/L. Within the midstream section, it resulted in 7.9 mg/L; in the downstream segment, it resulted in 8.1 mg/L. Consequently, the calculated average for dissolved oxygen is 7.9 mg/L.

Table 4: Apparent Color Results.

Parameter	Unit	Up-stream	Middle-stream	Down-stream
Apparent Color	CU	15	15	15
Average: 15 CU				

Table 4 presents the results of an apparent color assessment for water samples collected from three distinct stream locations: Up-stream, Middle-stream and Down-Stream. The unit of measurement for apparent color is expressed in Color Units (CU). Up-stream recorded an apparent color value of 15 CU, Middle-stream exhibited an apparent color value of 15 CU and Down-Stream also showed an apparent color value of 15 CU. The table concludes with the average of 15 CU apparent colors across all locations.

Table 5: pH Results.

Parameter		Results			
		Trial 1 @ pH 4.00	Trial 2 @ pH 6.86	Trial 3 @ pH 9.18	Average
pH	Up-stream	4.00	6.86	9.16	6.67
	Middle-stream	4.00	6.85	9.16	6.67
	Down-Stream	4.00	6.86	9.16	6.68
Total Average: 6.67					

Table 5 summarizes pH results for three trials conducted at different locations (Upstream, Middle-stream and Downstream). The trials were conducted with pH values of 4.00, 6.86 and 9.18, respectively. The average pH for each trial and the overall average pH across all trials are shown in the table. Upstream and Middle Stream both exhibited an average pH of 6.67 and Downstream showed an average pH of 26.87. The total average pH across all trials and locations is 6.67.

Table 6: Total Alkalinity Results.

Parameter	Unit	Up-stream	Middle-stream	Down-stream
Total Alkalinity	mg/L	96.1	97.3	97.3
Average: 96.9 mg/L				

Table 6 shows the result of the Total Alkalinity in mg/L. In the Upper stream, it resulted in 96.1 mg/L, while in the Middle Stream and downstream, both resulted in

97.3 mg/L. The average of the Total Alkalinity is 96.9 mg/L.

Wilcoxon Signed Rank Test

Table 7: Wilcoxon Signed-Rank Test Results.

Parameter	Standard	Results	Difference	Absolute Difference	Rank	Sign
pH	7	6.67	0.33	0.33	1	+
Temperature	28ºC	27.51ºC	0.49	0.49	2	+
DO	5 mg/L	7.9 mg/L	-2.9	2.9	3	-
Color	10 CU	15 CU	-5	5	4	-
TDS	1000 mg/L	317 mg/L	683	683	6	+
Total Alkalinity	110 mg/L	96.9 mg/L	13.1	13.1	5	+
W+ = 14 *W*- = 7 *T* = 7						

Table 7 displays the results of the Wilcoxon signed-rank test, which was performed to determine if a notable distinction exists between the prescribed standards for water quality parameters and the findings obtained from water samples collected from Kalawaig Creek. The Wilcoxon signed-rank test involves several key steps. First, the differences between standard and observed values were calculated for each parameter. Then, the absolute differences were ranked and the sum of positive and negative ranks (W+ and W-) was determined. The sum of positive ranks (W+) is 14 and the sum of negative ranks (W-) is 6. Hence, the test statistic is T=min {W+, W-}=min {14,7}=7. The test statistic is 7.

DISCUSSION

Physical Parameters

Temperature

According to,[18] Temperature is an important factor in understanding water quality because it has a direct impact on pH and dissolved oxygen. Water temperature can affect organisms' metabolic and biological activities and higher temperatures increase metabolic activities, requiring more oxygen for breathing. Table 1 show that the average temperature of Kalawaig Creek is 27.51ºC, with a range of 26-28ºC. The temperature is still in the normal range based on DENR- DAO 2016-08. Normal temperatures in rivers or creeks can indicate a stable and healthy ecosystem, suggesting resistance to long-term air temperature change.[19] However, it is important to account that river water temperature can be affected by various factors, such as climate change and anthropogenic heat emissions.[20] Even when meteorological variability is taken into account, lower river flows are associated with warmer river water.[21] Urban rivers thermal cooling can also restore river water quality and habitats.[22] The results of this study are different from the study of,[23] which observed that stream temperatures in the Loire River basin in France have been increasing faster than air temperatures, potentially impacting the temperature of creeks in the region.[24] Also noted that the temperature of streams inhabited by the San Pedro Martir trout in Baja California varies significantly, with some sites being more vulnerable to global warming.

Total Dissolved Solids (TDS)

TDS represents the collective concentration of both organic and inorganic materials dissolved within a specified volume of water. These constituents span minerals, salts, metals and ions. TDS essentially encompasses all dissolved substances in water, excluding H_2O molecules. Water serves as a solvent, assimilating soluble substances encountered, thereby contributing to the total dissolved solids content.[25] The table shows that the average TDS concentration in Kalawaig Creek is 317 mg/L. Referring to the DAO 34-08 and DAO 2016-08, the concentration levels remained below the 1000 mg/L limitation, indicating that the water quality in Kalawaig Creek is still in good condition. The results of this study are similar to the findings of,[26] which examined the Water Qualityof Creeks within the Economic Mining Zone in Sta. Cruz, Rosario, Agusan Del Sur, Philippines. Their data revealed average concentration ranges spanning from 90 to 230. According to DAO 34-08 and DAO 2016-08, these concentrations remained below the 1000 mg/L threshold, indicating that the water quality remained within acceptable parameters.

Chemical Parameters

Dissolved Oxygen (DO)

DO is a key measure of river metabolic activity and plays a vital role in assessing water quality. It provides valuable information about the biological and biochemical processes occurring in aquatic environments.[27] The normal dissolved Oxygen (DO) amounts range between 6.5 mg/L to 9.5 mg/L.[28] The average of Dissolved Oxygen (DO) is 7.9, which means a DO level of 7-8 mg/L is a positive indicator of the health of a creek.

The results differ from the findings studied by,[29] where the observed Dissolved Oxygen levels were low. The reduced dissolved oxygen levels can be attributed to heightened organic pollution, thereby initiating biodegradation facilitated by biotic microorganisms within the creek environment. By the findings of,[30] the decrease in dissolved levels is posited to instigate a cascading sequence of detrimental impacts on ecosystems, thereby culminating in harmful effects.

Apparent Color

The apparent color assessment reveals uniformity in water color across all three stream locations. Each site, including Up-stream, Middle-stream and Down-Stream, recorded an apparent color value of 15 CU. This consistency suggests a lack of significant variation in the visual perception of water color among the sampled locations. Furthermore, given that the standard for apparent color is set at 10 CU, the apparent color results from the water samples exceed the established standard. This indicates a potential deviation from the recommended color level for water quality. Using the 2120 B. visual comparison method, it was determined that the specific color associated with 15 CU is mostly clear with a slight light- yellow undertone.

A factor to consider as to why Kalawaig Creek has a high apparent color is that it runs through the Malaybalay City Provincial Zoological Park. Furthermore, the apparent color of creeks can be influenced by a variety of factors. Changes in land use, particularly afforestation, can result in an elevation in surface water browning. This is often attributed to higher levels of dissolved organic carbon and iron concentrations.[31] Suspended solids, such as organic particles and planktonic organisms, can also contribute to turbidity and apparent color in water bodies, affecting light penetration and photosynthesis rates.[32] Additionally, the presence of specific particles, such as suspended aluminosilicate particles, can cause light scattering and a change in water color.[33] These factors, along with others such as precipitation and temperature, can collectively contribute to the high apparent color observed in creeks.

The ootf this study are similar to the study of,[34] where the results of the study indicate that the color parameter exceeded the set limits for a significant number of days, particularly in the Pelotas Stream and showed a positive and significant correlation with rainfall, suggesting a potential association with agricultural activities in the basin area.

pH

The pH of creeks can be influenced by various factors, including temperature, electrolytic conductivity and the presence of ablation waters and sedimentation traps.[35] pH measures the acidity or alkalinity of a substance based on the concentration of hydrogen ions present. It is quantified on a scale from 1 to 14, where a pH of 1 indicates strong acidity, 7 represents neutrality and 14 indicates high alkalinity.[36] According to the DAO 2016-08 normal range for pH is 6.8-8.5. The table shows that the average pH of Kalawaig Creek is 6.67, which is still within the range. This indicates the pH in Kalwaig is still within the normal range. When creeks have normal pH levels, it can indicate a relatively stable and healthy aquatic environment.[35]The results of this study align with,[35] which found that most creeks in their study had slightly acidic to alkaline pH levels, suggesting a balanced ecosystem. However, this study differs from,[37] which noted that high pH and turbidity in Chanomi Creek, Nigeria, could indicate pollution and sediment resuspension.

Total Alkalinity

Alkalinity is the capacity of water to counteract or neutralize acids. It outlines the effectiveness of a buffer solution made up of weak acids and their associated conjugate bases. Alkalinity measures the solution's capability to neutralize acids.[38] According to,[39] the permissible range of total alkalinity is 20-200 mg/L. The average of the Total Alkalinity is 96.9 which mean that it is within the standard. Therefore, the average value of Total Alkalinity indicates that the water from Kawalaig Creek has the capacity to neutralize acids and maintain a stable pH which can have potential positive effects on aquatic life and organisms may be able to thrive.

This study aligns with a study conducted by,[40] the Pagbanganan River's water alkalinity values were within the permissible limit of 20 mg/L-200 mg/L. The comparatively high total alkalinity results indicate that the river has an excellent buffering capacity, which enables the living creatures to survive and develop. The results of the study indicate that the water has a greater to resist changes in pH that lead to acidity or neutralize acids, maintaining a fairly stable pH. The elevated water alkalinity could be due to extensive sand and gravel quarrying activities, which have increased the presence of certain dissolved solids sourced from inorganic origins such as rocks containing calcium carbonate and other minerals. However, the result from the study of,[41] reveals that the Egana River Antique Philippines identifies a level of alkalinity that is less than the standard, which can impact water quality. As stated by[42] lower total alkalinity indicates that the river has a lower capacity to neutralize acids and maintain a stable pH therefore, it can have a negative effect on aquatic life and the water cycle.[43]

Wilcoxon Signed-Rank Test

The critical value from the Wilcoxon signed-rank table is employed to assess the significance of the results. In the conducted two-tailed test with a significance level of 0.05, the critical value is 1. The null hypothesis of the Wilcoxon signed-rank test states that there is no significant difference between the paired observations, while the alternative hypothesis suggests there is a significant difference. Comparing the test statistic and the critical value, since 7 is greater than 1, we reject the null hypothesis at the 0.05 significance level. The Wilcoxon Signed-Rank Test results indicate a significant difference between the set standards of the physicochemical parameters and the results of the measured parameters in Kalawaig Creek. The results show that the results of physicochemical parameters in Kalawaig Creek are not perfectly aligned with the set standards for the said parameters. However, it is important to note that while the Wilcoxon signed-rank test indicates that there is a significant difference, it doesn't provide information about the direction of the difference. It only indicates that the two groups are not identical, but it doesn't specify whether one group tends to be consistently larger or smaller than the other.[44] Although there is a significant difference between the physicochemical parameter results in Kalwaig Creek and the set standards for the tested parameters, it does not determine the creek's health.

The results of this study align with,[45] which used the test to compare pre and post-monsoon groundwater samples, finding a significant difference in water pollution index values. Similarly,[46] applied the test to assess the suitability of Bharalu River water for irrigation, with the results indicating a significant difference in water quality.[47] The test was also utilized to assess the seasonal and spatial fluctuations in water quality within the Lower Danube, pinpointing noteworthy distinctions in water quality classifications. Lastly a study by[48] also employed the Wilcoxon Signed-Rank Test to categorize a dataset of water quality across various locations in India, revealing significant differences in water quality among the different regions.

CONCLUSION

Based on the comprehensive analysis of physicochemical parameters in Kalawaig Creek, the study concludes the following, For the physical parameters, the study found that the average temperature of Kalawaig Creek is 27.51ºC, within the normal range according to environmental standards. This temperature range indicates a stable and healthy ecosystem. The investigation also analyzed Total Dissolved Solids (TDS) with an average concentration of 317 mg/L, well below the 1000 mg/L limitation. This reinforces the conclusion that the water quality in Kalawaig Creek is within acceptable limits.

For the chemical parameters, the study found favorable Dissolved Oxygen (DO) levels, with an average of 7.9 mg/L, contributing positively to the creek's health. However, the apparent color of the water exceeded the recommended standard of 10 CU, possibly influenced by factors such as land-use changes and the water's proximity to the Malaybalay City Provincial Zoological Park. pH levels were within the normal range, averaging 6.67, indicating a stable aquatic environment. Total Alkalinity, with an average of 96.9 mg/L, was within the recommended range, suggesting that the creek can neutralize acids and maintain a stable pH.

The Wilcoxon Signed-Rank Test showed a significant difference between the observed physicochemical parameters in Kalawaig Creek and the established standards. While the test does not indicate the direction of the difference, it highlights that the creek's water quality parameters do not perfectly align with the set standards. However, based on the individual comparison and the calculated differences between each parameter, aside from the apparent color, the parameters in Kalawaig Creek are still within the set standards and the test results have positive implications regarding the overall health of the creek.

Overall, the analysis of physicochemical parameters in Kalawaig Creek indicates a generally healthy ecosystem. The average temperature, Total Dissolved Solids (TDS) and Dissolved Oxygen (DO) align with environmental standards. Although apparent color exceeded recommended levels, other chemical parameters like pH and Total Alkalinity remained within acceptable limits. The Wilcoxon Signed-Rank Test highlighted a significant difference between observed parameters and standards, primarily influenced by apparent color. However, individual parameter comparisons suggest that, excluding apparent color, the creek's parameters generally meet set standards, implying a positive outlook for its overall health. Ongoing monitoring and collaborative conservation efforts are recommended for sustainable management.

RECOMMENDATIONS

Based on the study's findings about Kalawaig Creek's physicochemical parameters, the following recommendations were drawn to guide further research and conservation efforts to sustain the creek's health and ecological balance. To better understand Kalawaig Creek's dynamics, we recommend conducting a comprehensive longitudinal study that monitors the creek's physicochemical parameters over an extended period. This study will help identify seasonal variations, trends and potential long-term changes in water quality. Moreover, it is also recommended to determine the sources contributing to the apparent coloration of Kalawaig Creek, knowing the origin of the coloration, whether it is due to natural processes, land-use changes, or human activities, will help inform strategies to enhance water quality. Another possible continuation for this study is to evaluate the ecological impact of the observed physicochemical parameters in Kalawaig Creek by comprehensively assessing the aquatic flora and fauna. This assessment will consider biodiversity, reproductive patterns and overall ecosystem health to provide a thorough understanding of the ecological implications of water quality. Future researchers can also broaden the study to encompass sediment analysis, which can reveal the presence of suspended solids and other pollutants, providing valuable information on potential sources of water quality issues. By incorporating sediment analysis, gain a more comprehensive understanding of the creek's ecosystem dynamics.

Lastly, incorporating microbial analysis into the research to assess microbial diversity and the presence of potential pathogens in Kalawaig Creek may also further the knowledge about the creek. This water quality aspect is crucial for human and ecological health and the analysis can offer valuable insights. Through these recommendations, future researchers may better understand the creek's water quality and ecosystem health. Overall, ongoing research and implementation of these recommendations are crucial for maintaining the long-term health and resilience of Kalawaig Creek, ensuring its well-being for future generations.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ACKNOWLEDGEMENT

The researchers would like to express their deepest gratitude and heartfelt appreciation to everyone who contributed to the success of this study. To F.A.S.T Laboratories, for their guidance and assistance in collecting and conducting the sample testing. Their involvement significantly contributes to the analysis of this research. The researchers are also grateful to their parents, family, colleagues and classmates for their unwavering love and support, advice and feedback that helped them. A heartfelt appreciation to all individuals who offered support and guidance in accomplishing this research.

FUNDING

The researchers and the Office of Vice President For Research Extension and Development of San Isidro College.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The researchers wrote a formal letter to the school and office heads requesting permission to collect the data. All data was professionally documented and tabulated by the researchers. Data, results, methodologies and procedures were collected and implemented as is. This guarantees that the study's outcomes are as precise as feasible. Safety measures were implemented to prevent diseases or injury to the researchers.

ABBREVIATIONS

TDS: Total Dissolved Solids, **DO:** Dissolved Oxygen, **TA:** Total Alkalinity.

SUMMARY

For physical parameters, the temperature in Kalawaig Creek, which was recorded at 27.51ºC across all locations and trials falls within the range specified by DENR DAO 2016 08. This indicates that the ecosystem in Kalawaig Creek is resilient and able to maintain stability despite influences like climate change and human-induced heat emissions. Additionally, Kalawaig Creek maintains a concentration of Total Dissolved Solids (TDS) at 317 mg/L, which is below the limit of 1000 mg/L stated in DAO 34 08 and DAO 2016 08. Moving on to the chemical parameters we observe that the level of Dissolved Oxygen (DO) in Kalawaig Creek measures 7.9 mg/L falling within the range of 6.5 9.5 mg/L. This indicates a positive health indicator for the creek's ecosystem despite studies suggesting DO levels may be associated with organic pollution. Furthermore, our assessment of color consistently reveals a value of 15 CU across all locations surpassing the limit of 10 CU. It's worth considering that this heightened apparent color could be influenced by factors such as changes in land use or suspended solids present, in the water potentially affecting its quality. Moreover, it's important to note that Kalawaig Creek demonstrates a pH level of 6.67 which falls within the range specified by DAO 2016 08 (6.5-8.5). The pH level being, within the range suggests that the aquatic environment is stable. The recorded average Total Alkalinity is 96.9 mg/L, which falls below the recommended range of 100-250 mg/L. Total alkalinity signifies a reduced ability to neutralize acids, which could potentially affect life and overall water quality. Lastly, the statistical analysis using the Wilcoxon Signed-Rank Test reveals a significant difference between predetermined standards and measured parameters in Kalawaig Creek. While indicating a notable difference, does not specify the direction or offer insights into the overall health status of the creek.

REFERENCES

1. Ramakrishnan, S., G Anusha, K Kirupasankar, Venkatesh, C., and S. Pradeep. A Study on the Water Quality Assessment of Bhavani River in Tamil Nadu. *IOP Conference Series*, 2021;1145(1):012068. https://doi.org/10.1088/1757 899x/1145/1/012068
2. Villarmino, J., Quevedo, E. (2021). Physicochemical Characterization of the Water in Pagbanganan River, Baybay City, Leyte, Philippines. ResearchGate. https://www.researchgate.net/publication/353314435_Physicochemical_Characterization_of_the_Water_in_Pagbanganan_River_Baybay_City_Leyte_Philippines
3. Majeed, O. A., Nashaat, M. R., and Ahmed. Physicochemical Parameters of River Water and their Relation to Zooplankton: A Review. IOP Conference Series: Earth and Environmental Science, 2022;1120(1):012040. https://doi.org/10.1088/1755-1315/1120/1/012040
4. Ionita, I., Avram, D., Ana-Maria Hossu, and Aurora Anca Poinescu. (2023). *The physicochemical characteristics of the Ialomita River in Dambovita county*. https://doi.org/10.1117/12.2642091
5. Edori, O. S., and Edori, E. S. Evaluation of Physicochemical Characteristics of Surface Water from Orashi River, Rivers State, Southern Nigeria. *ATHENS JOURNAL of SCIENCES*, 2021;8(2):105-22. https://doi.org/10.30958/ajs.8-2-2
6. Oa, A., Oik, U., and F, A. Morphometric Characters and Meristic Counts of Black Chin Tilapia (*Sarotherodon melanotheron*) From Buguma, Ogbakiri and Elechi Creeks, Rivers State, Nigeria. International Journal of Poultry and Fisheries Sciences, 2018;2(1). https://symbiosisonlinepublishing.com/poultry-fisheries-science/poultry-fisheries-science06.php
7. Jardine, N., Ondov, B. D., Elmqvist, N., and Franconeri, S. The Perceptual Proxies of Visual Comparison. *IEEE Transactions on Visualization and Computer Graphics*, 2020;26(1):1012. https://doi.org/10.1109/tvcg.2019.2934786
8. Matlen, J., Gentner, D., and Franconeri, S. (2020). Journal of Experimental Psychology: Human Perception and Performance. *American Psychology Association*. https://psycnet.apa.org/manuscript/2020-27480-001.pdf?fbclid=IwAR2OEIN0QmAxcnREQMLDzV0DjvkTGCDoU19W-3WPWPs-_YyDdhlvrLWqZZQ
9. T Kubínová and M Kyncl 2021 IOP Conf. Ser.: Earth's Environ. Sci 900 012018, https://iopscience.iop.org › pdf
10. ShieldSquare Captcha. (n.d.). Iopscience.iop.org. Retrieved January 9, 2024, from https://iopscience.iop.org/?fbclid=IwAR12pQ1PbY5EIw5L7D8zkyNdKe0MyNS3w736Q ge9hj4YEihv4bYSfH60CT8
11. NEMI Method Summary-8229. (n.d.). Www.nemi.gov. https://www.nemi.gov/methods/method_summary/4786/
12. McCleskey, R. B., Cravotta, C. A., Miller, M. P., Tillman, F., Stackelberg, P., Knierim, K. J., *et al*. Salinity and total dissolved solids measurements for natural waters: An overview and a new salinity method based on specific conductance and water type. Applied Geochemistry, 2023;154:105684. https://doi.org/10.1016/j.apgeochem.2023.105684
13. Adjovu, G. E., Stephen, H., James, D., and Ahmad, S. Measurement of total dissolved solids and total suspended solids in water systems: A review of the issues, conventional and remote sensing techniques. Remote Sensing, 2023;15(14):3534. https://doi.org/10.3390/rs15143534
14. Seelmann, K., Aßmann, S., and Körtzinger, A. Characterization of a novel autonomous analyzer for seawater total alkalinity: Results from laboratory and field tests. Limnology and Oceanography: Methods, 2019;17(10):515-32. https://doi.org/10.1002/lom3.10329
15. Sahin, E. K. Assessing the predictive capability of ensemble tree methods for landslide susceptibility mapping using XGBoost, gradient boosting machine and random forest. SN Applied Sciences, 2020;2(7). https://doi.org/10.1007/s42452-020-3060-1
16. Xia, Y. (2020). Wilcoxon Signed Ranks Test-an overview | ScienceDirect Topics. Www.sciencedirect.com. https://www.sciencedirect.com/topics/medicine-and-dentistry/wilcoxon-signed-ranks-test#:~:text=Wilcoxon%20rank%2Dsum%20test%20is
17. McClenaghan, E. (2023). The Wilcoxon Signed-Rank Test. Informatics from Technology Networks. https://www.technologynetworks.com/informatics/articles/the-wilcoxon-signed-rank-test-370384
18. Tasnim, N., Sultana, Mst. A., Tabassum, K., Islam, Md. J., and Kunda, M. A review of the water quality indices of riverine ecosystem, Bangladesh. *Archives of Agriculture and Environmental Science*, 2020;7(1):104-13. https://doi.org/10.26832/24566632.2022.0701015
19. Worrall, F., Howden, N. J. K., Burt, T. P., and Hannah, D. M. River water temperature demonstrates resistance to long-term air temperature change. *Hydrological Processes*, 2022;36(11). https://doi.org/10.1002/hyp.14732
20. Liu, S., Xie, Z., Liu, B., Wang, Y., Gao, J., Zeng, Y., *et al*. Global river water warming due to climate change and anthropogenic heat emission. *Global and Planetary Change*, 2020;193:103289. https://doi.org/10.1016/j.gloplacha.2020.103289
21. Booker, D. J., and Whitehead, A. L. River water temperatures are higher during lower flows after accounting for meteorological variability. *River Research and Applications*, 2021;38(1):3-22. https://doi.org/10.1002/rra.3870
22. Abdi, R., Endreny, T., and Nowak, D. A model to integrate urban river thermal cooling in river restoration. *Journal of Environmental Management*, 2020;258:110023. https://doi.org/10.1016/j.jenvman.2019.110023
23. Jusayan, R. R., and Vicencio, M. C. G. The macrofungi in the island of San Antonio, Northern Samar, Philippines. International Journal of Trend in Scientific Research and Development, 2019;3(3):968-75. Retrieved from https://www.ijtsrd.com/papers/ijtsrd23228.pdf
24. Meza-Matty, I. A., Ruiz-Campos, G., Daesslé, L. W., Ruiz-Luna, A., López-Lambraño, Á. A., *et al*. Daily, seasonal and annual variability of temperature in streams inhabited by the endemic San Pedro Martir trout (Oncorhynchus mykiss nelsoni), in Baja California, Mexico and the predicted temperature for the years 2025 and 2050. *Journal of Limnology*, 2021;80(2). https://doi.org/10.4081/jlimnol.2021.2001
25. Woodard, J. (2023, September 15). What is TDS in Water and Why Should You Measure It? Fresh Water Systems. https://www.freshwatersystems.com/blogs/blog/what-is-tds-in-water-why-should-you-measure-it?fbclid=IwAR2AzsscQRT6PnIh1Fe1xTdbulBn2ThMcuZnePtGbXTMTUEqX5vyFX0nOfE
26. Acopiado, Ma and Manglicmot, Dennis and Arcilla Jr, Felix. Water Quality Analysis of Creeks within Economic Mining Zone In Sta. Cruz, Rosario, Agusan Del Sur, Philippines. IAMURE International Journal of Ecology and Conservation. 2020;33:1-17.
27. Zhi, W., Feng, D., Tsai, W.-P., Sterle, G., Harpold, A. A., Shen, C., *et al*. From Hydrometeorology to River Water Quality: Can a Deep Learning Model

Predict Dissolved Oxygen at the Continental Scale? 2021;55(4):2357-68. https://doi.org/10.1021/acs.est.0c06783

28. Carvalho, A., Costa, R., Neves, S., Oliveira, C. M., and Silva, R. J. N. B. Determination of dissolved oxygen in water by the Winkler method: Performance modelling and optimisation for environmental analysis. *Microchemical Journal*, 2021;165:106129. https://doi.org/10.1016/j.microc.2021.106129
29. Emmanuel, B., and Obafemi, A. Efficiency and species selectivity of baited galvanized wire gauze trap in Abule Agege and Abule Eledu Creeks of the Lagos Lagoon Article Information Keywords *Correpsonding author. Annals of Animal and Biological Research, 2022;2(1). https://aabrjournalaaua.org.ng/wp-content/uploads/2022/09/EMMA-OBAFEMI-AABR-2022.pdf
30. Kulkarni, S. A Review on Research and Studies on Dissolved Oxygen and Its Affecting Parameters. International Journal of Research and Review (Www.gkpublication.in), 2016;3(8), 18.https://www.ijrrjournal.com/IJRR_Vol.3_Issue.8_Aug2016/IJRR004.pdf
31. Škerlep, M., Steiner, E., Axelsson, A., and Kritzberg, E. S. Afforestation driving long-term surface water browning. *Global Change Biology*, 2019;26(3),1390-9. https://doi.org/10.1111/gcb.14891
32. Boyd, C. E. (2019). Suspended Solids, Color, Turbidity and Light. *Water Quality*, 119-133. https://doi.org/10.1007/978-3-030-23335-8_6
33. Kumar, V. Light scattering and consequent color change in Lukha River due to suspended aluminosilicate particles during winter months. *International Journal of Energy and Water Resources*, 2021;6(1)121-32. https://doi.org/10.1007/s42108-021-00126-4
34. Sória, M., Tavares, Q., Alves, M., Stumpf, L., Daiane Hellnvig Zarnott, Bubolz, J., *et al*. Evaluation of physicochemical water parameters in watersheds of southern Brazil. *Revista Ambiente and Água*, 2020;15(5), 1-1. https://doi.org/10.4136/ambi-agua.2596
35. Potapowicz, J., Szumińska, D., Małgorzata Szopińska, Czapiewski, S., and Żaneta Polkowska. Electrical Conductivity and pH in Surface Water as Tool for Identification of Chemical Diversity. *Ecological Chemistry and Engineering*, 2020;27(1):95-111. https://doi.org/10.2478/eces-2020-0006
36. Cirino, E. (2019). What pH should My Drinking Water Be? Retrieved on June 10, 2020 from https://bit.ly/3m2SiEC
37. Onyena, A. P., Nkwoji, J. A., and Chukwu, L. O. Evaluation of hydrochemistry and benthic macroinvertebrates in Chanomi Creek, Niger Delta Nigeria. *Regional Studies in Marine Science*, 2021;46:101907. https://doi.org/10.1016/j.rsma.2021.101907
38. Islam, S., Majumder, H. (2020). Alkalinity and Hardness of Natural Waters in Chittagong City of Bangladesh. ResearchGate. https://www.researchgate.net/profile/Md-Islam-Ph-D/publication/350663970_International_Journal_of_Science_and_Business_Alkalinity_and_Hardness_of_Natural_Waters_in_Chittagong_City_of_Bangladesh_International_Journal_of_Science_and_Bbusiness/links/606c7f9d299bf13f5d5f7c5c/International-Journal-of-Science-and-Business-Alkalinity-and-Hardness-of-Natural-Waters-in-Chittagong-City-of-Bangladesh-International-Journal-of-Science-and-Business.pdf
39. World Health Organization, WHO, World Health Organisation Staff Guidelines for drinking-water quality. 2004;1. World Health Organization.
40. Villarmino, J., Quevedo, E. 2021;1. Physicochemical Characterization of the Water in Pagbanganan River, Baybay City, Leyte, Philippines. ResearchGate. https://www.researchgate.net/publication/353314435_Physicochemical_Characterization_of_the_Water_in_Pagbanganan_River_Baybay_City_Leyte_Philippines
41. Rolando A. Alimen, Zima I. Tarantan, and Antonio E. Nonesco. Determining the Water Quality of Egaña River in the Province of Antique, Philippines. IAMURE International Journal of Ecology and Conservation, 2019;28(1):1. https://ejournals.ph/article.php?id=14757andfbclid=IwAR0VNfUlqJn83-D1vriT1YB1ieEnEcG-weiQ6IJt0ct5pgnRhewke93Y-Qg Marie
42. Soha Mann. (n.d.). Www.thirteen.org. https://www.thirteen.org/edonline/studentstake/water/UpperHudson/alkalinity/alkalinity.htm#:~:text=River%20Water%20is%20between%20100
43. *[EnvirSci Inquiry] Lehigh River Watershed Explorations*. (n.d.).Ei.lehigh.edu. https://ei.lehigh.edu/envirosci/watershed/wq/wqbackground/alkalinitybg.html
44. García-Ávila, F., Zhindón-Arévalo, C., Valdiviezo-Gonzales, L., Cadme-Galabay, M., Gutiérrez-Ortega, H., and del Pino, L. F. A comparative study of water quality using two quality indices and a risk index in a drinking water distribution network. *Environmental Technology Reviews*, 2022;11(1)49-61. https://doi.org/10.1080/21622515.2021.2013955
45. Hossain, M., and Patra, P. K. Water pollution index-A new integrated approach to rank water quality. *Ecological Indicators*, 2020;117:106668. https://doi.org/10.1016/j.ecolind.2020.106668
46. Singh, K. R., Goswami, A. P., Kalamdhad, A. S., and Kumar, B. Development of irrigation water quality index incorporating information entropy. *Environment, Development and Sustainability*, 2019;22(4):3119-32. https://doi.org/10.1007/s10668-019-00338-z
47. Calmuc, M., Calmuc, V., Arseni, M., Topa, C., Timofti, M., Georgescu, L. P., *et al*. A Comparative Approach to a Series of Physico-Chemical Quality Indices Used in Assessing Water Quality in the Lower Danube. *Water*, 2020;12(11):3239. https://doi.org/10.3390/w12113239
48. Hassan, Md. M., Akter, L., Rahman, Md. M., Zaman, S., Hasib, K. Md., Jahan, N., *et al*. (2021). Efficient Prediction of Water Quality Index (WQI) Using Machine Learning Algorithms. *Human-Centric Intelligent Systems*. https://doi.org/10.2991/hcis.k.211203.001

Cite this article: Damasco LA, Arocha VJD, Quilang EB, Damole DMC, Miones LBE, Saldo IJP. Rapid Physicochemical Assessment of Kalawaig Creek in Bukidnon, Philippines. Asian J Biol Life Sci. 2024;13(1):176-86.