

# Analyzing the Water Quality Variation of Physicochemical Parameters in Bangon River in Palo, Leyte During Wet and Dry Weather

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**Abstract:** The increasing global concern over the deteriorating water quality of rivers is significantly influenced by climatic factors like precipitation in tropical countries like the Philippines. This study aims to analyze the water quality variation of physicochemical parameters in the Bangon River of Palo, Leyte during wet and dry weather. Water samples, collected from five monitoring stations along the Bangon River from April 2024 to March 2025, revealed significant variations of water quality during wet and dry weather conditions. While temperature, pH, conductivity (EC), total dissolved solids (TDS), and salinity were significantly lower during wet weather, dissolved oxygen (DO) increased due to colder temperatures and higher turbulence. An increasing trend of EC, TDS, TSS, TS, and salinity was also observed while moving downstream. No significant wet and dry weather condition differences were found for total suspended solids (TSS) and total solids (TS). Correlation analysis showed contrasting relationships of TSS with EC, TDS, TS, and salinity, influenced by the dilution effect of precipitation and potentially the mobilization of pollutants through surface runoff. These findings provide crucial baseline data for understanding the vulnerability of tropical river systems to changing precipitation patterns and underscore the necessity of considering both wet and dry conditions in surface water management in the Philippines. This study addresses the pressing need for effective monitoring and data collection of river water quality in the face of drastic changes brought about by climate change and urbanization.

**Key Words:** dry weather; rainfall; tropical; water quality; wet weather

## 1. INTRODUCTION

The water quality of rivers in urban and rural areas around the world is deteriorating due to natural and anthropogenic factors (Nguyen et al., 2023). While land use and urbanization are the key elements affecting river health in urban areas, vegetation, catchment conditions, and climate conditions are influential in the water quality of rural rivers. Precipitation, a key determinant of climate conditions, varies according to locations and seasons. In tropical countries, where seasonal changes are mainly driven by rainfall, the impact of precipitation on water

quality poses a greater concern (Ling et al., 2017). In recent years, an increase in rainfall variability and extreme rainfall events have been occurring globally as a result of climate change. Particularly, rainfall facilitates the transport of substantial amounts of pollutants into rivers via rainfall-induced runoff which significantly alters the physicochemical characteristics of water bodies.

In the Philippines, a tropical country endowed with vast water resources, 6.8 million hectares of watersheds are identified by DENR to be susceptible to deterioration, including water pollution, and 43% or 180 of 421 rivers face significant water



quality challenges ranging from pollution from untreated domestic sewage, industrial wastes, and agricultural runoff, exacerbated by rapid urbanization and industrialization (SEPO, 2025). By estimate, 70% of the Philippines' total area is watershed areas.

The Palo River Basin, covering portions of the Municipalities of Santa Fe, Palo, Alangalang, Pastrama, Dagami, Jaro, Burauen, and Ormoc City in Leyte is identified as one of 140 critical watersheds in the country by the DENR-RCBO (Paringit & Morales, 2017). Its main stem, the Bangon River, houses 12 of the 33 barangays of Palo, Leyte along its immediate vicinity, namely: Baras, Buri, Guindapunan, Arado, San Fernando, Cavite West, San Miguel, Salvacion, Cavite East, Santa Cruz, NagaNaga, and Cogon. Eight of these barangays are classified as urban and are located downstream: Arado, Cogon, Naga-Naga, Cavite East, Cavite West, Luntad, San Miguel, and Buri. Considering its geographical location at the downstream of two major rivers and increase human activity in the area, it's the water quality of receiving streams

This study aims to analyze the water quality variation of physicochemical parameters in the Bangon River of Palo, Leyte during wet and dry weather. Specifically, the following were addressed: the water quality of Bangon River during wet and dry conditions, a significant difference in the water quality of the river between each weather condition, and the relationship among water quality parameters during each weather. This study targets four of the 17 United Nations Sustainable Development Goals (SDGs), SDGs 6 (Clean Water and Sanitation), 11 (Sustainable Cities and Communities), 13 (Climate Action), and 14 (Life Below Water) by contributing to the establishment of systematic investigation, creation of new knowledge, and collection of pertinent data on the quality of surface water during wet and dry weather. Results of this study can enhance the adaptation strategies in the water sector and improve the management and protection of key watersheds, supporting the achievement of a more sustainable and equitable future.

## 2. METHODOLOGY

### 2.1 Study Location and Sampling Stations

The selected study location is a section of the Bangon River traversing the Municipality of Palo,

Leyte, specifically the barangays Baras, Buri, Guindapunan, Arado, San Fernando, Cavite West, San Miguel, Salvacion, Cavite East, Santa Cruz, NagaNaga, and Cogon. Bangon River, also called Palo River, is a Class C waterbody, primarily serving as (1) Fishery Water for the propagation and growth of fish and other aquatic resources, (2) Recreational Water Class II for boating, fishing or similar activities, and (3) for agriculture, irrigation and livestock watering. Figure 1 maps the locations of the sampling sites along the length of the river, as listed from downstream to upstream in Table 1. Palo, Leyte is a 3rd class municipality experiencing fast development and growth in recent years. The region experiences a Type IV climate which is characterized by rainfall more or less evenly distributed throughout the year or wet seasons but no dry seasons. Its average annual temperature is 2,377 mm. The driest month is April, with a total of 131 mm of rainfall (CLUP-Palo, 2024).

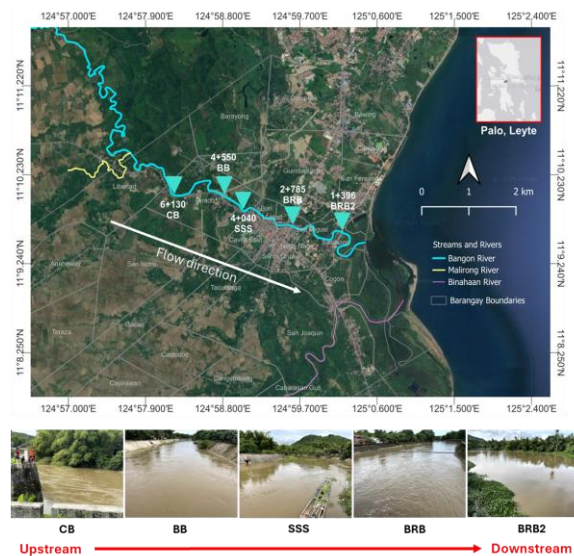


Fig. 1. Water sampling site locations along Bangon River in Palo River Basin

Table 1. Description of the sampling locations located in the Palo River Basin from downstream to upstream

Code	Site Name	Coordinates	Stationing
BRB2	Bernard Reed Bridge II	11.1599, 125.0032	1+396
BRB	Bernard Reed Bridge	11.1610, 124.9935	2+785
SSS	San Salvador Street	11.16372, 124.9839	4+040
BB	Bangon Bridge	11.1666, 124.9803	4+550
CB	Canbanwa Bridge	11.1666, 124.9705	6+130

## 2.2 Sample Collection, Transportation, and Analysis

Water samples were collected by the Manual on Ambient Water Quality Monitoring of the Department of Environment and Natural Resources - Environment Management Bureau (DENR-EMB, 2008). Sample collection was conducted bimonthly from April 2024 to March 2025. At least 33 samples were collected at each sampling location by casting a water sampler into the river over the bridge and or at riverbanks. Among the 15 sample collections, 7 were classified as wet and 8 as dry. The former were sampling campaigns occurring during wet weather, hours after rainfall, and days after occurrences of consecutive rainfall with no adjacent dry days, otherwise, these were classified as the latter. Samples were tested on-site for temperature in °C and physical parameters pH, electrical conductivity (EC) in  $\mu\text{s}/\text{cm}$ , dissolved oxygen (DO) in mg/L, total dissolved solids (TDS) in mg/L, and salinity using a portable multiparameter meter (MultiLine® Multi 3630 IDS) and contained in 1L PET containers for investigation of total suspended solids (TSS) in mg/L and total solids (TS) in mg/L. All samples were transported at 4–8 °C within 8 hours after collection for storage and testing at Philippine Science High School - Eastern Visayas Campus in Palo, Leyte.

## 2.3 Statistical Analysis

The statistical analyses used in this study were descriptive statistics and correlation tests. Student's t-test was used to compare the water quality

of the river between the wet and dry seasons. Pearson analysis was performed to determine the relationship among the water quality parameters of the river during each season.

## 3. RESULTS AND DISCUSSION

### 3.1 Comparison of Physicochemical Parameters in Wet and Dry Weather Conditions

Table 2 and Figure 2 show that rainfall has a significant impact on the water quality parameters of the Bangon River. The mean water temperature was observed to be significantly lower ( $p \leq 0.05$ ) during wet weather throughout all the stations along the Bangon River. Lower pH values were recorded after rainfall events which can likely be attributed to the intrusion of surface runoff containing organic matter into the river after rain (Ling et al., 2017). DO values were observed to be significantly higher ( $p \leq 0.05$ ) during wet weather and negatively correlated with temperature, as cold water holds more oxygen. Mean DO values during wet weather were higher than the DENR-EMB water quality minimum value of 5 mg/L for Class C rivers, however, four of the five stations, except CB (located downstream), fell below during dry (Nguyen et al., 2023). Higher mean concentrations of EC across sites were recorded during dry weather compared to wet weather, with values ranging from 97.3  $\mu\text{s}/\text{cm}$  to 6371  $\mu\text{s}/\text{cm}$  in dry conditions and from 85.70  $\mu\text{s}/\text{cm}$  to 2182  $\mu\text{s}/\text{cm}$  in wet conditions. Due to the dilution effect of precipitation, a reduction of pollution during wet seasons can be observed (Zhao et al., 2018; Diwyanjalee & Premarathne, 2024). Salinity, which is highly correlated with EC, ranged from 0 - 1.10 during wet weather and 0.10 to 3.20 during dry. The mean value of salinity was significantly higher ( $p \leq 0.05$ ) during dry conditions compared to wet. TDS exhibited similar results. Highest EC concentrations, TDS, and salinity values during wet and dry conditions were recorded at BRB2, the site proximal to the mouth of the river. Mean TSS values at all sites during wet and dry conditions, except BRB2 during dry seasons, were within acceptable limits set by DENR-EMB (i.e. 80 mg/L). The elevated TSS value could be linked to the bridge widening occurring in the area during the sample collection. While higher mean TSS concentration was

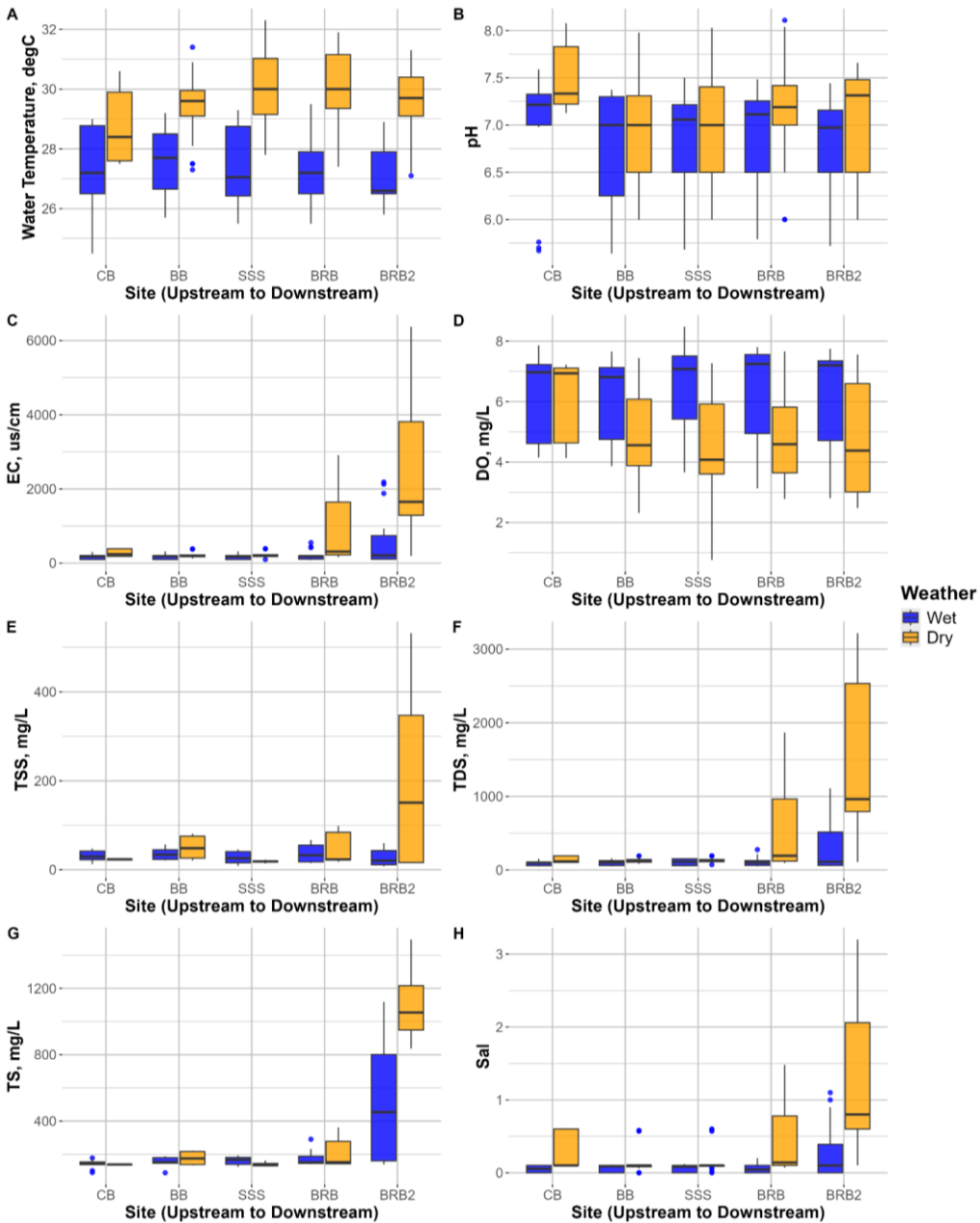


Fig. 2a-h. Boxplot graph of water quality parameters of Bangon River at different locations during wet and dry weather conditions: (a) Water temperature, (b) pH, (c) electrical conductivity, (d) dissolved oxygen, (e) total suspended solids, (f) total dissolved solids, (g) total solids, and (h) salinity

recorded during the dry conditions, no significant differences ( $p > 0.05$ ) in TSS levels were observed between wet and dry weather (Banunle et al., 2025). Similar results were found for TS concentrations. Noticeably, an increasing trend of EC, TSS, TDS, TS, and salinity values moving downstream was observed.

Table 2. Mean difference of water quality parameters of Bangon River during the wet and dry weather

Parameter	Mean Difference	p Values
Temperature	-2.3	0
pH	-0.23	0.008
EC	-535.87	0
DO	1.43	0
TSS	<b>-38.05</b>	<b>0.15</b>
TDS	-313.81	0
TS	<b>-118.67</b>	<b>0.187</b>
Sal	-0.33	0

The significant difference at p value  $> 0.05$  is indicated in bold.

### 3.2 Pearson Correlation of Physicochemical Parameters During Wet and Dry Weather Conditions

Figures 3 and 4 show the correlation coefficient matrices of the various water quality parameters for weather conditions wet and dry, respectively. Larger absolute values between parameters indicate stronger relationships. During wet and dry periods, strong positive correlations link EC with TDS, TS, and Sal. A positive relationship between pH and DO during both weather conditions was also observed. The pronounced inverse correlation between DO and Temp ( $r = -0.77$ ) is typical of warmer, less turbulent waters. Contrasting correlations of TSS with EC, TDS, TS, and salinity were observed during wet and dry weather conditions, likely indicated by increase of particle concentration due to reduced flows. These contrasting correlation structures highlight the profound impact of precipitation patterns on water quality dynamics.

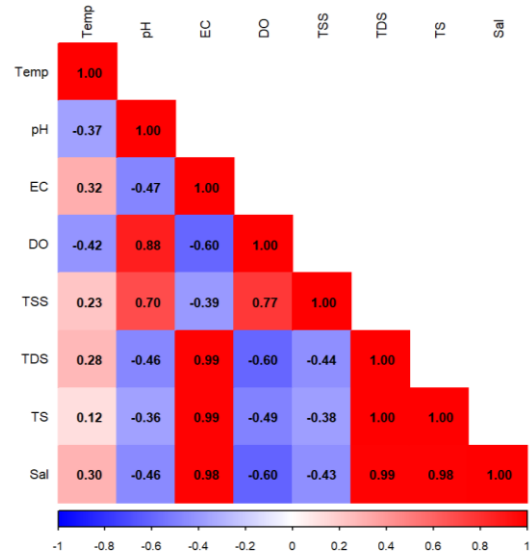


Fig. 3. Correlation of the water quality parameters of Bangon River during wet weather

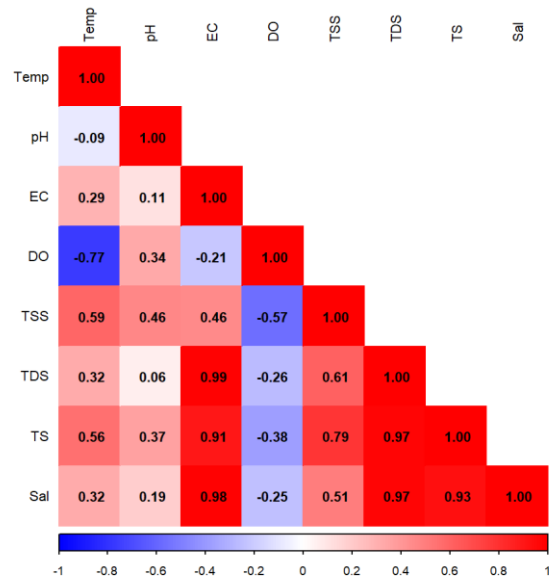


Fig. 4. Correlation of the water quality parameters of Bangon River during dry weather

#### 4. CONCLUSIONS

This study demonstrates the influence of precipitation on the water quality of the Bangon River. During wet periods, lower levels of temperature, pH, EC, TDS, and salinity were observed and could be attributed to dilution. While rainfall led to lower pH due to intrusion of runoff, higher DO levels were recorded, likely attributed to lower temperature and increased turbulence. In contrast, dry periods showed higher levels of temperature, pH, electrical conductivity, total dissolved solids, and salinity due to concentration when rainfall is absent. The amount of TSS and TS did not significantly change between wet and dry conditions. Notably, the levels of solids increased downstream.

Other water quality parameters like nutrients, metals, and emerging contaminants should be investigated to identify potential sources of pollution and for more comprehensive findings. Future studies on runoff quantity and quality, rainfall-runoff relationship, and factors affecting runoff could be conducted for a more robust understanding on the increase of nutrients and pollutant loads to rivers. Monitoring changes and the effect of factors to the water quality of rivers is crucial to the management and preservation of watersheds.

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