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Lead (Pb) and pH Levels Determination in the Banica River of Dumaguete City

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Abstract— *The study examines the environmental impact of a former landfill along the Banica River in Dumaguete, focusing on heavy metal pollution, particularly lead contamination, and pH levels. The research uses an experimental approach to assess water samples and compare them to 1994 records. Results show neutral pH levels and lead levels below the permissible limit. Remediation approaches include trash segregation, building barriers, and microbial remediation. Longitudinal monitoring is recommended for continuous assessment and response to environmental challenges.*

Keywords— *Lead levels, Neutral, pH levels, Remediation.*

I. INTRODUCTION

The Banica River in Dumaguete, Philippines, has been slowly contaminated by garbage, pollution, and chemicals *(DaisyB, 2018)*. The former Candau-ay dumpsite, also known as "Smokey Mountain," has caused water quality issues in four barangays, including Candau-ay, Cadawinonan, Balugo, Batinguel, and Camanjac *(Dc-Team, 2016)*. Since 1965, every rainfall has caused toxic chemicals and other pollutants to percolate into the groundwater or flow directly into the Banica River, making it non potable (*Keep Water of Banica River Clean*, n.d.). The existence of a previous landfill in the upper parts of the river basin is one of the major elements causing these worries. Heavy metals, which can have extremely damaging impacts on aquatic life and water quality, are thought to be a part of this contamination *(Mohammed, A. S., Kapri, A., & Goel, R., 2011)*. Conducting thorough research to evaluate heavy metal contamination and pH levels in the river is essential for successful environmental management and policy decisions. Lead contamination beyond the lead standard can lead to severe consequences for both the residents residing near these waters and the environment. pH, a crucial element of water quality, is also a critical factor in determining acidity or alkalinity. Lead is a naturally occurring heavy metal that can be toxic in its elemental, inorganic, and organic forms. Exposure to lead can cause hearing loss, reproductive organ toxicity, anemia, hypertension, kidney impairment, and immune system dysfunction. Dumaguete City's population continues to grow, particularly in Barangay Candau-ay, where a landfill or dump site near the river has negatively affected health. Silliman University Grade 12 STEAM students plan to conduct an intense study to assess the impact of heavy metals on the quality of water thrown at the Banica River. According to Juguilon, R. & Zamora, L. (1994), the pH of the water sample from the Banica River had the highest and lowest pH levels, with changes of 8.00 and 7.46, respectively. This means that the pH level was not in the acidic-to-neutral range.

The sanitary landfill in Candau-ay, Dumaguete, is one of the 300 planned by the DENR for the Philippines. Despite being out of operation, the landfill's materials, including heavy metals, have deteriorated, posing health and environmental concerns. The landfill's location near the Banica River raises concerns about lead and pH levels in river waters, potentially threatening residents and marine ecosystems. The research aims to determine these levels and raise awareness.

This study will cover the main objective to determine or assess the Pb level in Banica River as it may be influenced by the municipal waste disposal at the dumpsite area. This study aims to check for a significant difference in the Pb concentration and pH levels of the river water collected from the three sampling sites. The data collected will guide future researchers in addressing the pollution and improving the environment for people living near the river. The study will not include other bodies of water's heavy metal contamination, it will focus only on lead and pH levels. The data collected will be based on historical data from the time the landfill was present. However, practical limitations may affect sample sizes and coverage, limiting the generalizability of the findings to the entire river.

This study aims to primarily focus on answering the following questions, with a conceptual framework as a guide:

1. How contaminated is the Banica River with lead, and how does it compare to safety regulations in the various parts downstream from the former landfill?
2. What are the origins and routes of lead pollution in the Banica River connected to the abandoned landfill, and how do these factors affect the general deterioration of the water quality?
3. What natural processes or remediation techniques, taking into account the particulars of the previous landfill's role in the contamination, could successfully mitigate or reduce lead levels in the Banica River?

II. METHODS

Given the goals and objectives of this study, a collective decision was made to utilize an experimental design. The researchers utilized this approach to gather data and examine the validity of the hypothesis that the former landfill of Candau-

ay is the source of the lead (Pb) that dissolved into the Banica River downstream to the nearest sea.

Regarding the research environment, it was focused on the former Dumaguete City Sanitary landfill/dumpsite situated in the inner portion of Barangay Candau-ay, spanning 3.5 hectares purchased by the City Government of Dumaguete way back in 2017. Being Situated within the proximity of the Banica River, this open dumpsite raised concerns about water quality due to solid waste overflow. Considering the river's exposure to various contaminants, this study aims to conduct a water sampling assessment of Pb and its pH levels from near the landfill to the nearest sea to assess the quality of the water in the said river (*Salonga Center Convenes LGUs for Waste Management Discussion*, n.d.).

In the gathering of samples, discrete sampling, a grab sample method, was used, in which the researchers collected water samples at three distinct stations: Sampling Station 1 in Candau-ay, near the former landfill; Sampling Station 2, between the estuary in Canday-ong and Candau-ay's former landfill; and Sampling Station 3, in the estuary of the Banica River in Canday-ong. To test these samples, instruments used included filter paper, retort stand, clamp, beaker, Büchner funnel, and flame atomic emission spectrophotometry. This was to ensure that the samples were filtered first before they were sent to be analyzed as filtering removes materials that are dissolved in the water from debris and other substances that could change their composition.

To collect sufficient data for the study, the researchers proceeded with data collection by utilizing three small containers to get the three water samples from the three different stations. The researchers then worked in collaboration with the Metro Dumaguete Water Station to analyze the samples. Before analysis, extraction of any substances or debris, such as sand or microplastics, using sedimentation and filtration will be implemented if found to ensure clarity and for accurate observation. For determining the pH levels of the samples, the researchers used pH test strips which produced results that were to be compared to historical or past pH level assessments conducted in 1993 to investigate for significant changes in water quality.

Ensuring proper treatment of data, the gathered samples were all sealed and submitted to the chemist for testing. The results served as a guide and reference for the study's discussion, addressing questions, concerns, and gaps related to the research. Budgetary allocation included categories such as water analysis, filtration process, water sample collection, and 2L distilled water. As for ethical considerations, the researchers made sure to follow adherence to standards, protection of privacy, objectivity, proper referencing, openness to criticism, careful evaluation, and a commitment to data accuracy and sincerity. Furthermore, the investigation ensured the well-being of individuals and animals involved, using only the data or information discovered during the experiment for the investigation.

III. Results and Discussion

The research's discovery will be organized into tables, and the keywords for this study will be discussed further by answering this study's main questions and objectives.

TABLE 1. The pH levels of the Banica River in Dumaguete City Downstream.

Sampling Sites	pH levels
Sampling site 1	7.4
Sampling site 2	7.5
Sampling site 3	7.4

The results in Table 1 showed that the pH level of the Banica River in sampling site 1 is 7.4. In sampling site 2, it is 7.5, and in sampling site 3, it's 7.4. These indicate that the pH levels of the Banica River are neutral

TABLE 2. The Physico-Chemical Analysis Result from Metro Dumaguete Water of the Banica River.

Sampling Sites	Parameter	Method	Result	Units of Measurement
Barangay Candau-ay	Lead	Electrothermal-AAS	<0.003	mg/L
Barangay Bagacay	Lead	Electrothermal-AAS	<0.003	mg/L
Barangay Canday-ong	Lead	Electrothermal-AAS	<0.003	mg/L

The findings given above in Table 2 show that in each sampling site which are, Barangay Candau-ay, Barangay Bagacay, and Barangay Canday-ong have the same lead concentrations which are <0.003 mg/L.

To get the results of this study, it was said that it would be analyzed in the Silliman University Chemistry Department Laboratory. However, since it lacks a specific material, namely argon, to commence the analysis, the researchers were then moved to the Metro Dumaguete Water.

Table 1 shows pH levels in three sampling sites of the Banica River, indicating the water's acidity. In the past research about the Banica River by Silliman University students under the Chemistry Department, in partial fulfillment of their Bachelor's Thesis, the highest pH level was 8.00, while the lowest was 7.46 in 1994. In contrast, the pH level in 2023, or the most recent, is 7.4, 7.5, and 7.4, indicating neutrality. The changes in pH levels indicate a gradual increase in acidity over time, from not being in the acidic range to neutral in 1994 down to stable neutral in 2023. This indicates a growing acidity in the water.

The researchers discovered that the water samples from Barangay Candau-ay, Barangay Bagacay, and Barangay Canday-ong show less than 0.003 mg/L (3 µg/L) of lead. However, the results are based on the regulatory limit of 15 µg/L for drinking water (Lead in Drinking Water, n.d.). Furthermore, the origins of lead pollution in the Banica River are linked to the abandoned landfill, which led to the deterioration of water quality and increased acidity in the river. Remediation techniques including segregating garbage, building a barrier, and using microbial remediation can help mitigate the lead levels in Banica River. Microbial remediation involves using microorganisms to lower the bioavailability of

pollutants, making them less toxic to the ecosystem (*Cleaning Up of Contaminated Soils by Using Microbial Remediation: A Review and Challenges to the Weaknesses*, 2019). This technique involves breaking down pollutants into water and carbon dioxide for organic pollutants or into less toxic forms.

IV. Conclusion And Recommendations

The results show that the pH levels at the designated sampling sites in Banica River indicate a neutral condition, showing a shift from the pH samples taken in the year 1944. Water pollution levels in Barangay Candau-ay, Bagacay, and Canday-ong are all below the regulatory limit of 15 g/L, suggesting that the water may be deemed safe for various uses, not necessarily for drinking, based on the observed lead concentration levels. The study connects the source of lead pollution in the Banica River to an abandoned landfill, emphasizing the significance of proper waste disposal. Although the Pb concentration is on a safe level in the Banica River as represented in those sampling sites, proposed remediation options include proper waste disposal of Pb-associated household and consumer products such as but not limited to chlorine and bleach including used paint cans, plumbing tools, etc., the installation of barriers between the river and the landfill, and microbial remediation. This research contributes to addressing environmental issues related to landfill operations by emphasizing the importance of preventive measures and educated decision-making by focusing on lead contamination and pH levels and investigating the extent of heavy metal pollution and oscillation of the water quality of Banica River using a theoretical framework and comparison of previous studies.

Based on the findings, the Banica River is not contaminated with Lead (Pb) chemicals. Its pH levels have risen from non-acidic to neutral, showing signs that it has become more acidic throughout the years caused by various potential factors such as chemicals used in laundry. The researchers urge future studies to focus on mitigating chemical levels such as Lead (Pb), and chlorine to lower and maintain the pH levels in the river at a neutral, non-acidic level or basic.

The researchers found that these results and findings of this study will benefit the: (a) people residing near the Banica River, (b) the general people in Dumaguete City, (c) the future researcher regarding this study, and (d) the aquatic ecosystems. Implementing longitudinal monitoring and regular sampling and analysis of the river quality in Banica River can assist in identifying patterns and potential sources of contamination and enables researchers to detect issues and investigate the environmental effects.

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