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Assessment of Heavy Metal on Nasipit Port

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ABSTRACT

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This study aimed to assess the presence of heavy metals, specifically Cadmium (Cd), Copper (Cu), Lead (Pb), Magnesium (Mg), Nickel (Ni), and Silver (Ag), in Nasipit Port, Nasipit, Agusan Del Norte, Philippines. The study measured and quantified the concentrations of these heavy metals in various environmental compartments within and around the port area, including water and sediment samples. This study employed an experimental research design to investigate the presence of heavy metals in Nasipit Port. The research utilized DOST's laboratory equipment and did not involve human respondents. The sampling

method involved measuring the distance from the ship to collect water and sediment samples. The study ensured informed consent, voluntary participation, and privacy protection for the participants. The results showed that Cadmium, Copper, Lead, and Nickel were not detected, while Magnesium and Silver exceeded the standard limits set by the DENR. The study found no significant difference in heavy metal contamination between areas with and without ships, indicating that the port is still classified as safe for ecological risk assessment. The recommendations emphasize the importance of community engagement, continuous monitoring, and public awareness to protect the marine ecosystem and public health. Finally, future researchers are encouraged to expand the study to include other heavy metals and investigate their bioaccumulation in fish and other marine organisms.

INTRODUCTION

Sediments serve as a crucial reservoir for accumulating heavy metals in aquatic ecosystems, particularly prevalent in estuarine, coastal, and port areas where human-induced heavy metal deposition is standard (Tian et al., 2020). Most heavy metals exhibit an affinity for binding with suspended solids and organic matter in seawater, ultimately leading to their deposition within sedimentary layers. Therefore, heavy metal contents in the sediments can better correspond to the quality of the surrounding aquatic environment, contrasting the generally low concentration in the water column. While certain heavy metals, such as Cu, Zn, and Ni, play essential roles in supporting aquatic life, they can become toxic at elevated concentrations, posing risks to the biodiversity of aquatic ecosystems (Uddin et al., 2021). The build-up of these heavy metals in sediments can trigger detrimental effects on aquatic organisms, thereby exerting long-term impacts on the aquatic ecosystem. Additionally, this contamination threatens human health through the polluted food chain. As a result, sediments have proven to be a crucial environmental indicator for evaluating the repercussions of human-induced heavy metal pollution (Yi et al., 2021).

Sediments serve as a crucial reservoir for accumulating heavy metals in aquatic ecosystems, particularly prevalent in estuarine, coastal, and port areas where human-induced heavy metal deposition is standard. Most heavy metals exhibit an affinity for binding with suspended solids and organic matter in seawater, ultimately leading to their deposition within sedimentary layers (Wang et al., 2015). Therefore, heavy metal contents in the sediments can better correspond to the quality of the surrounding aquatic environment, contrasting the generally low concentration in the water column. While certain heavy metals, such as Cu,

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Evaluating heavy metals in ports is a crucial field that needs more investigation. Ecological Risk Assessment: Studies examining the ecological risks associated with heavy metal contamination in port environments, particularly sediments, might offer important information on possible effects on public health and marine ecosystems (Naik et al., 2023). Understanding the contamination patterns and determining the leading causes of heavy metal pollution can be aided by conducting additional research on the spatial distribution and possible sources of heavy metals in port environments. Research on the evaluation of potential health risks resulting from heavy metal pollution in port sediments, as well as the creation and application of efficient recovery techniques (Liu et al,. 2021).

Therefore, this study would like to assist with the spatial variation, contamination levels, and the potential ecological risks of heavy metals (Cu et al., As, and Fe) in Qianzhen Fishing Port sediments using multiple sediment pollution indices. These indices include pollution load index (PLI), Nemerow pollution index (NPI), enrichment factor (E.F.), geo-accumulation index (Igeo), mean ERM quotient (mERMq), and the sum of toxic units (ΣTU)

Moreover, the interrelationships between the sediments' properties, heavy metal contents, and potential sources along the fishing port area were evaluated.

In the Agusan del Norte municipality of Nasipit, there is a tiny harbor. The Philippine Ports Authority, or PMO Nasipit, is in charge of the port. It is the kind of pier, jetty, or wharf that can hold boats longer than 500 feet. The Spanish colonists established Nasipit as a pueblo in 1880, marking the beginning of the town's history. According to legend, the name "Nasipit" came from an incident in which an immigrant asked a resident the name of the site after being bitten by a crab.

OBJECTIVES OF THE STUDY

This study aimed to assess the presence of heavy metals specifically, Cadmium (Cd), Copper (Cu), Lead (Pb), Manganese (Mn), Nickel (Ni), Silver

(Ag), in Nasipit Port, Nasipit, Agusan Del Norte, Philippines. Specifically this study aims to (1) measure and quantify the concentrations of heavy metals (Cadmium, Copper, Lead, Magnesium, Nickel, Silver) in various environmental compartments within and around Nasipit Port and (2) identify the significant difference between the distance contamination of heavy metals on without ships and near ship.

MATERIALS AND METHODS

Research Design

Since the study focused on the assessment of the presence of heavy metals in Nasipit Port, the research methods used were experimental research, the researcher used DOST's laboratory equipment, and there were no human respondents. To check the heavy metals sampling, the researcher uses measuring distance of the ship. This entails getting study participants' informed consent, ensuring voluntary participation, and safeguarding participants' privacy. In addition, researchers should consider and take precautions against the possible harm that heavy metal pollution may do to the environment and human health. Lastly, researchers should guarantee that their procedures are clear, consistent, and logical and that their findings can be accessed upon justifiable request.

Research Site

The study focused on the assessment of heavy metals at Nasipit Port. This area is located at District 9 Yakal Talisay, Nasipit, Agusan Del Norte, and was founded on August 1, 1929.

The Philippines' Nasipit, Agusan del Norte, has served as a study site for heavy metal assessments, especially when it comes to port-related activities. Numerous investigations have assessed the concentration of heavy metals in several environmental components within this domain. As an illustration of heavy metals in the environment, a study evaluated the content of heavy metals in the water in Nasipit, Agusan del Norte, Philippines. Furthermore, the heavy metal concentration of Acanthaster planci and Linckia laevigata taken from Carmen, Agusan del Norte, a town near Nasipit, was assessed in another study. Permissible limits for heavy metals in soil were also specified in a study on the species and their importance values at Kabagtokan, Ata-atahon, and Nasipit in Agusan del Norte. These studies show that Nasipit, Agusan del Norte, has served as a hub for measuring the quantities of heavy metals in different environmental components, offering important information about how port-related operations affect the pollution caused by heavy metals in the region.

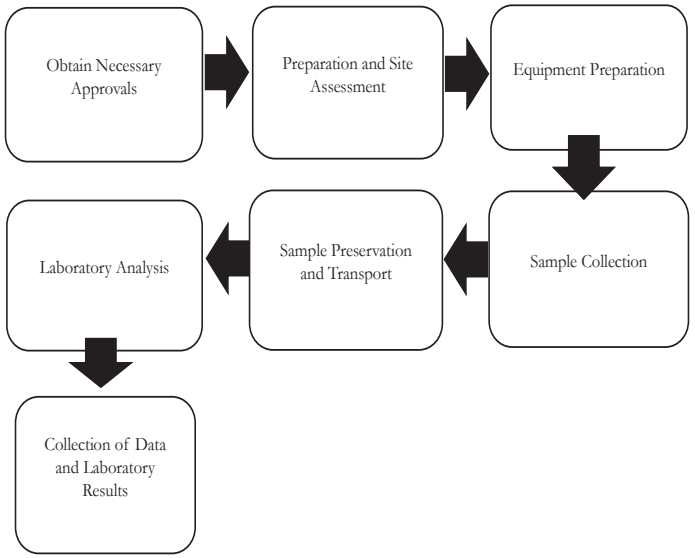
Research Ethics Protocol

The research title "Assessment of Heavy Metals on Nasipit Port" calls for an ethical statement that highlights the ethical issues involved in conducting the study. The research's possible effects on the environment and public health should also be discussed.

In view of the dearth of particulars on the study project titled "Assessment of Heavy Metals on Nasipit Port," it is critical to draw attention to the moral precepts that should direct the investigation. For the purpose of managing intellectual property and transferring technology, the Department of Science and Technology (DOST) has established protocols. The DOST Research and Development Institutes (DOST-RDIs) must follow these protocols in order to identify, safeguard, manage, and commercialize intellectual properties (IPs) and/or intellectual property rights (IPRs) resulting from research and development projects that the DOST funds. This Protocol issued as DOST Administrative Order Na 004 dated February 01, 2016 is hereby amended to be consistent with Joint DOST-IPOPHL A.O. No. 001 s. 2019, Amending the Implementing Rules and Regulations of R.A. No. 10055.

Figure 1

Flowchart for Sampling Procedure



Procedure

This were the procedure in gathering data:

Step 1: Obtained Necessary Approvals

1. Permits and Clearances: Obtained all necessary permits and clearances for conducting research in the Nasipit Port area, ensuring compliance with environmental regulations and securing permissions from port authorities.

Step 2: Preparation and Site Assessment

After all necessary permits and clearances for conducting the research were obtained from the Nasipit Port area to ensure compliance with environmental regulations and secure permissions from port authorities, the researcher travelled to Nasipit Port and identified and assessed the specific port areas for sample collection.

Step 3: Equipment Preparation

1. Ensure all necessary equipment was ready, including sterile containers for sample collection, including marker, Glass container, Tape and sampling materials

Step 4: Sample Collection

1. The researcher went to a specific area and coordinated within the port., as the authorities had given there the permission before collection.
2. Collected seawater samples under two conditions: when vessels were present and when no vessels were present, adhering to specific guidelines for each condition.

Step 5: Sample Preservation and Transport

1. Sample Preservation: Preserved water samples were placed with ice to stabilize the heavy metals. Preserve sediment samples in a cool and dark environment to prevent contamination and degradation.
2. Transport: Ensure that samples are securely packed and transported to the laboratory for further analysis. Maintain proper temperature conditions during transportation.

Step 6: Laboratory Analysis

1. Sample Preparation: In the laboratory, samples were prepared for analysis. This involved filtering water samples, drying and homogenizing sediment samples, and digesting the samples as needed.
2. Heavy Metal Analysis: The appropriate analytical instruments, such as atomic absorption Spectropotometers (AAS) or Inductively Coupled Plasma Mass Spectrometers (ICP-MS), were used to measure the

concentrations of heavy metals in the samples.

Step 7: Collection of Data and Laboratory Results

1. Collected the data and Laboratory results from the Department of Science and Technology (DOST).

Materials

- Water Sampling Equipment: Water sampling bottles. Where collected water samples, from different locations within the port area were placed.
- Sediment Sampling Equipment:

Sediment corers or grab samplers. Collected sediment samples from the bottom of the port.

Sieves and sieving equipment: Separated fine particles from sediment samples.

Sediment sample containers: These are used to store and transport sediment samples to the laboratory.

- Safety Equipment:

Personal protective equipment (PPE). This includes gloves, lab coats, safety goggles, and masks to protect researchers from potential exposure to hazardous substances.

If required, set up a long-term monitoring program to track changes in heavy metal levels over time and assess the effectiveness of any remediation efforts. Throughout, the research process, prioritize safety, adhere to ethical guidelines, and pay attention to quality control and quality assurance to ensure the accuracy and reliability of the results. Collaboration with experts in environmental science and chemistry is essential to conducting a successful heavy metal assessment in Nasipit Port, Agusan del Norte.

RESULTS AND DISCUSSION

This chapter presents the results of the assessment of the heavy metals Cadmium (Cd), Copper (Cu), Lead (Pb), Magnesium (Mg), Nickel (Ni), and Silver (Ag) in the seawater samples from Nasipit Port, Nasipit, Agusan del Norte.

Pollution is the main cause of the global reduction in water quality that is affecting ecosystems. Heavy metals from agriculture and manufacturing are among the pollutants in the river (Ojekunle, 2016). Tchounwou (2012) states that heavy metal is an element that occurs naturally in the environment and has a high specific gravity and atomic weight. It is also ecologically stable. However, because of human activity, they are introduced into water bodies at high levels of contamination, endangering both human health and ecosystem health (Roy Chowdhury et al., 2018).

Objective 1: To measure and quantify the concentrations of heavy metals (Cadmium, Copper, Lead, Magnesium, Nickel, Silver) in various environmental compartments within and around Nasipit Port.

Table 1

The Level of Heavy Metals in Nasipit Port

	Results (in mg/L)		Standards (in mg/L) DENR, 2016	Qualitative Description
	with ship	w/out ship		
Heavy Metal	Station 1	Station 2		
Cadmium	ND	ND	0.01	Not Detected
Copper	ND	ND	0.04	Not Detected
Lead	ND	ND	0.1	Not Detected
Magnesium	337.74	337.57	4	Above Standard value
Nickel	ND	ND	0.3	Not Detected
Silver	0.1350	0.1235	0.0032	Above standard value

Table 1 shows the levels of heavy metals: cadmium, Copper, Lead, Magnesium, Nickel, and Silver. It is presented based on the standard limits by the DENR 2016 and its qualitative description.

As shown in the table, the Cadmium, Copper, Lead, and Nickel were not detected. This shows that the presence of these heavy metals was not detected, and it is a good sign that the place is not yet contaminated with these kinds of metals. One of the most prevalent trace metals on the planet, magnesium is present in trace amounts in most plants, waterways, soil, and other natural environments. Serious cases of magnesium toxicity mainly affect the neurological system, although they have also been connected to cancer and Parkinson's disease (Taylor & Nkosi, 2022).

To find out whether some species of silver are more hazardous than others, a critical assessment of research evaluating exposures to the different forms of silver was carried out (Drake & Hazelwood, 2005).

The outcome supports the study's findings that metallic chemical elements, including heavy metals, are harmful or poisonous at low concentrations when their density is relatively high (Lenntech, 2004). According to Lenntech (2004), heavy metals have a variety of effects on both living and non-living things on our planet. Drinking seawater that has been tainted by heavy metal contamination

could be detrimental to the resident's health, claiming that poisonous chemicals and deadly microorganisms found in contaminated water can harm aquatic life both above and below the water's surface (Joseph et al., 2019). With time, it developed into a worldwide threat to the economy and a worldwide issue that requires care.

Test For Significant Relationship Between the Heavy Metal Contamination With Ship and Without Ship

Table 2

Test for Significant Relationship between Heavy Metal Contamination in With Ship and Without Ship

Heavy Metals in With Ship and Without Ship	Confirmatory test with ship	Confirmatory test without ship	Decision on Ho	Decision
With Ship and Without Ship				
Cadmium and Cadmium	ND	ND	reject Ho	there is no significant difference
Copper and Copper	ND	ND	reject Ho	there is no significant difference
Lead and Lead	ND	ND	reject Ho	there is no significant difference
Magnesium and Magnesium	337.74	337.57	reject Ho	there is no significant difference
Nickel and Nickel	ND	ND	reject Ho	there is no significant difference
Silver and Silver	0.1350	0.1235	reject Ho	there is no significant difference

Table 2 shows the results of testing the significant differences in the heavy metals (cadmium, copper, lead, magnesium, nickel, silver) between those with and without a ship; it shows that there is no significant difference based on the statistical analysis. The R-values and p-values indicate that there is a strong correlation or association between these variables. Therefore, the null hypothesis (Ho) is rejected, suggesting that there is no significant difference between this study's heavy metals in the near ship and heavy metals without a ship.

The results of Tables 1 and 2 imply that the cadmium, copper, lead, and nickel levels of heavy metal were not detected, except for magnesium and silver, which exceeded the standard of DENR Administrative Order 2016-08. The significant build-up in the port may be caused by anthropogenic waste from adjacent human activities such as mining and others, water effluents from the river connecting the

seawater, and oil spills from commercialized motor-generated vessels. Therefore, this study concluded that the seawater in Nasipit Port, Nasipit A.D.N is not safe for fishing and recreation.

Since heavy metals such as cadmium, copper, lead, and nickel from all two sampling areas did not exceed the permissible value and standard, government agencies should continue to monitor the level of heavy metals, especially magnesium and silver, which exceeded the DENR standard. This will give baseline information to the authorities, indicating that there will be possible contamination in the future.

Data Analysis

The table's data analysis shows the results of Masao Port's heavy metal concentrations, with particular emphasis on silver, nickel, copper, lead, magnesium, and

Cadmium. The outcomes are contrasted with the benchmarks established in 2016 by the Department of Environment and Natural Resources (DENR).

Cadmium, Copper, Lead, and Nickel: The levels of copper, cadmium, Lead, and Nickel are below the detection limit, as indicated by the reports of "Not Detected" (ND) for both Stations 1 and 2. This shows that these heavy metals are not present in the port water at any appreciable levels.

Magnesium: The magnesium concentration at Station 1 it is reported as 337.74 mg/L, while at Station 2, it is reported as 337.57 mg/L. Although the standard value is not specified in the table, magnesium is generally considered an essential nutrient at low concentrations but can be toxic at high levels.

Silver: The concentrations at Station 1 are reported as 0.1350 mg/L, while at Station 2, they are reported as 0.1235mg/L. Although the standard value is not specified in the table, silver is generally considered an essential nutrient at low concentrations, and it can be toxic at high levels.

Similar Studies: Determination of metals in wine with atomic spectroscopy - This study reviews the use of atomic spectroscopy techniques for the determination of metals in wine, which is relevant to the analysis of heavy metals in port water (Aceto et al., 2002). Heavy metal pollution in aquatic ecosystems - This study discusses the impact of heavy metal pollution on aquatic ecosystems, highlighting the importance of monitoring and regulating heavy metal levels in water bodies like Masao Port. Water quality monitoring programs - This report emphasizes the need for regular water quality monitoring programs to detect and mitigate the effects of heavy metal pollution in water bodies. Mining and water quality in Compostela Valley - This study examines the impact of mining activities on water quality in Compostela Valley, which is relevant to the analysis of heavy metal

levels in Masao Port (Orbita et al., 2006).

Handling data and cybersecurity. The Butuan City Water District's annual report, which is comparable to the analysis shown in the table, includes the findings of water quality monitoring, including a heavy metal analysis. Development of infrastructures other than ports: This paper addresses the necessity of taking environmental considerations such as heavy metal contamination into account while developing infrastructures, including ports. RO/RO port for improving mobility: The growth of RO/RO ports, which could be impacted by heavy metal pollution, is covered in this section of the paper.

Studies that Contrast: Heavy Metal Analysis in Agricultural Soil. This study concentrates on heavy metal levels in industrial wastewater rather than port water; the results will be in contrast (Rasulov et al., 2020). Heavy metal levels in industrial wastewater: Because this study concentrates on heavy metal levels in industrial wastewater rather than port water, it will present divergent results. Heavy metal bioremediation: This study focuses on the elimination of heavy metals through bioremediation rather than their analysis in port water. Therefore, the results will be incongruous. Heavy metal toxicity in aquatic organisms: Rather than analyzing heavy metal levels in port water, this study focuses on the toxic effects of heavy metals on aquatic organisms, which will yield divergent results.

CONCLUSION

The investigation carried out at Nasipit Port concluded that no detectable levels of cadmium, copper, lead, or nickel were observed, and that there was no discernible variation in the quantities of these elements across regions with and without ships. To safeguard the marine ecology, the study suggests that the amounts of magnesium and silver in seawater be continuously monitored. While high amounts of silver can injure aquatic life and bioaccumulate in the food chain, posing concerns to human health, elevated levels of magnesium can induce physiological stress and have an adverse effect on the health of marine species. The study emphasizes how crucial it is to continuously monitor heavy metal levels in the marine environment, particularly those of magnesium and silver, in order to protect the ecosystem and public health.

TRANSLATIONAL RESEARCH

Practical conclusions are provided by the heavy metal presence investigation conducted in Nasipit Port. The findings should be disseminated through educational materials and community involvement, working with the media to

raise awareness, pushing for more stringent enforcement of environmental laws, and pressing for increased government agency monitoring. It is essential to work with port authorities to develop efficient management procedures, investigate remediation techniques, obtain money for cleanup, and track advancements. Public health awareness relies heavily on educating the community about health dangers, performing health examinations, and putting in place biomonitoring programs. The study can influence awareness, decision-making, and the preservation of the environment and public health at Nasipit Port by converting findings into communication, regulations, and remediation strategies.

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