Rapid assessment of water quality in Rio Grande de Mindanao, Philippines

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Abstract. This study evaluated the water quality of the Rio Grande de Mindanao across five sampling sites: Datu Piang, Mother Kabuntalan, Northern Kabuntalan, Sultan Kudarat, and Cotabato city, covering the upper, middle, and lower stream segments of the river. Physicochemical parameters such as temperature, pH, dissolved oxygen, and electrical conductivity were measured in situ using a multiprobe water quality meter, while river depth was manually determined with a weighted rope and steel tape. Grab sampling was employed to collect water samples, which were subsequently analyzed in accredited laboratories for nutrient content (nitrate and phosphate), microbial indicators (total coliform, fecal coliform, and *E. coli*), total organic carbon, and heavy metals (mercury, cadmium, chromium, and lead). Results shows that temperature (29.9-33.7°C), pH (7.16-7.42), dissolved oxygen (5.43-9.2 mg L^{-1}), and electrical conductivity (307.7-329.7 μS cm^{-1}) complied with Class C water quality standards. The recorded depths across all sites ranged from 0.7 to 8.9 meters. Nutrient concentrations were also within safe thresholds, with nitrate ranging from 0.60 to 1.200 mg L^{-1} and phosphate from 0.260 to 0.427 mg L^{-1}. Total organic carbon was measured at 2.97-3.716 mg L^{-1}, total coliform count ranged from 13 to 34.33 MPN/100 mL while fecal coliform and *Escherichia coli* counts are identical, which ranged from 1.33 to 6.66 MPN/100 mL. These Microbial counts and total organic carbon do not exceed permissible limits. Heavy metals were also found to be within allowable concentrations while plankton assessment showed low species diversity, dominated by *Spirogyra* sp., *Microcyclops* sp., and *Mesocyclops* sp. Overall, the findings provide baseline information indicating that the Rio Grande de Mindanao complies with Class C water quality standards, warranting continuous monitoring to ensure its ecological integrity.
Key Words: coliform, heavy metals, nutrients, physicochemical, plankton, Rio Grande de Mindanao, water quality.

Introduction. Water quality is a critical factor in public health, environmental sustainability, and economic development. Globally, over 3 billion people will remain at risk of waterborne diseases if inadequate data on water quality persists (UNEP 2021). In the Philippines, water pollution will continue to be a major concern, with approximately 3 million individuals relying on unsafe water sources daily and an additional 7 million lacking access to improved sanitation facilities (Filipenco 2024). A notable case is the Marilao River in Bulacan, which will likely remain one of the most polluted rivers in the country if contamination from industrial effluents and heavy metals is not addressed (Pleto et al 2018).

In addition, water quality parameters such as total phosphorus, nitrogen, and dissolved oxygen (DO) significantly affect aquatic biodiversity. Hydrological factors like water depth and flow velocity also play crucial roles in maintaining fish and algal diversity

(Zhao et al 2019). Water quality directly affects ecosystems; poor quality can disrupt aquatic life and biodiversity (Dubey et al 2022).

Understanding the water quality of a certain water body is important in policy-making and conservation measures as it reflects the functional value of water resources, informs effective water management strategies, and addresses pollution-induced shortages, ultimately supporting sustainable development and enhancing the overall water conservation society (Chen et al 2010). The Rio Grande de Mindanao also known as Mindanao River, plays a significant role in the region's economy as a source of water for agricultural, fisheries and domestic purposes. Aside from home to diverse aquatic fauna, it is also one of the most important resources in the region which supports local livelihood and food security (Kid et al 2025). Water quality directly affects this ecosystem and its services (Dubey et al 2022) therefore assessing the water quality is very important. However, data on water quality of Rio Grande de Mindanao is very limited, hindering proper management strategy and policy-making.

Chen et al (2010) emphasized the importance of assessing water quality for policy-making and conservation measures. This study provides a comprehensive water quality assessment of the Rio Grande de Mindanao, specifically the river's organic pollution, nutrient composition, physicochemical and biological characteristics. The findings of this study provide essential baseline data for sustainable water resource management and policy development aimed at mitigating water pollution and preserving aquatic biodiversity.

Material and Method

Study area. The study was conducted in October 2024 in the four municipalities and one city of Rio Grande de Mindano with selected barangays wherein the community lives near the river bank. The municipalities included Datu Piang, Mother Kabuntalan, Northern Kabuntalan and Sultan Kudarat in the province of Maguindanao, as well as Cotabato city. In the said areas, there were three selected levels of streams such as upper stream, mid-stream, and lower stream. Barangay Reina Regente of Datu Piang municipality was identified as the upper stream sampling site while Barangay Ganta of Mother Kabuntalan and Barangay Balong of Northern Kabuntalan for the mid-stream. Lastly, Barangay Maidapa of Sultan Kudarat and Mother Barangay (MB) Kalanganan of Cotabato city were identified as the lower stream (Figure 1).

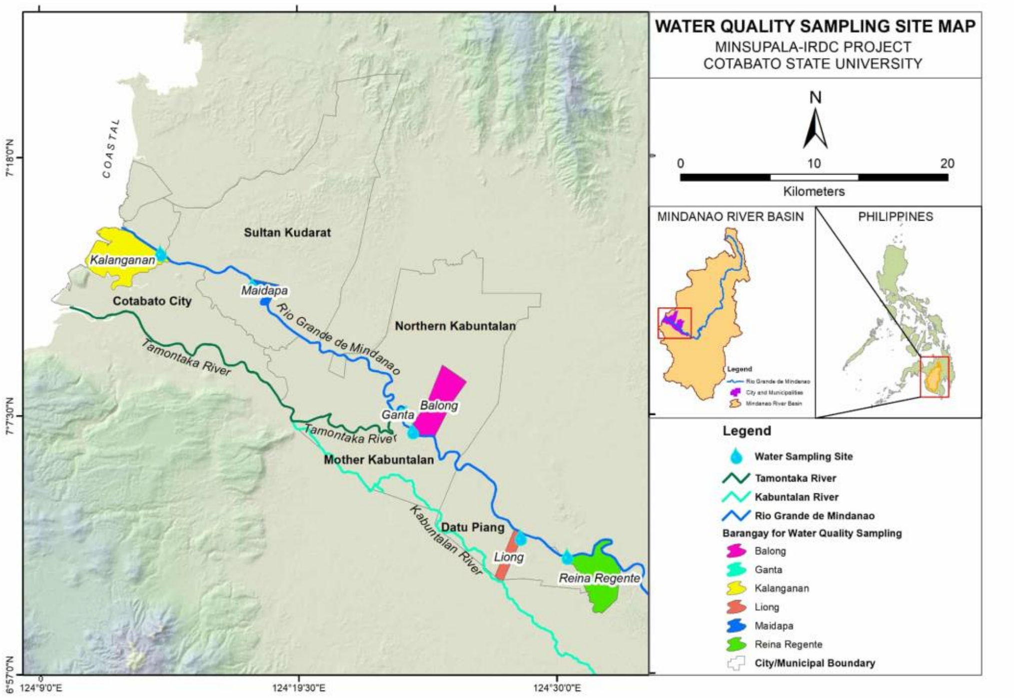

Figure 1. Geographical map of the Rio Grande de Mindanao showing the sampling locations of the study.

Data collection and analysis. This study is part of a consortium project under the MinSuPala Innovative Research and Development Consortium (IRDC) project with an overall duration of 12 months, including the preparatory activities and training during 2024. The sampling technique used was grab sampling technique, a method of collecting a water sample at a specific point in time and space (EMB-DENR 2022). The data collection was done on a sunny day for the four stations, and the sample collection from the the last station, Cotabato city, were collected at 6:15 pm. In collecting the data, the researchers started at the lower stream, followed by the mid-stream and the upper stream. The researcher used a banca/pump boat as a mode of transportation.

The physicochemical parameters, namely the temperature, DO, pH, and electric conductivity (EC), were gathered using the Multiprobe Water Quality Meter. The depth was measured with a modified instrument, which is a single stone weighing one kilogram tied with a rope and using a steel tape for measurement.

The researchers started gathering the data from the lower stream of the river, specifically in Mother Barangay (MB) Kalanganan, with three replications in the site, several meters apart. In every replicate, the data were recorded and documented. The same procedure was done in attaining the data in the midstream and upper stream. The coordinates of every station were also recorded. Other tests were done in laboratory settings, specifically the analysis for nutrient content, microbial content, heavy metals, and plankton composition.

Plankton composition was also done in a laboratory setting. Plankton sampling in the river was conducted using a standardized protocol to ensure representative samples were collected. For every station with three replicates, coordinates were taken and recorded. Replicates represent the sampling site/location of every station. In each sampling location, a minimum of 30 liters of water was collected using a clean bucket or white pail. Then, the water was filtered through a series of plankton nets with mesh sizes of 30 μm for zooplankton and 20 μm for phytoplankton, and then placed over a funnel, respectively. The collected plankton was carefully rinsed from the nets and sieved using distilled water into pre-labeled sample bottles. The mode of sample preservation was 10% buffered formalin and 95% absolute ethanol. Zooplankton samples were preserved with an equal volume of absolute ethanol, while phytoplankton samples were preserved with an equal volume of buffered formalin. To account for natural variability, the sampling procedure was repeated three times at each designated location. The collected plankton were transported or delivered to the Environmental Biochemistry Laboratory of Mindanao State University, General Santos city. Plankton samples were settled for 24-48 hours and concentrated by decantation. Decanted samples were mixed uniformly by gentle inversion. An aliquot of the sample was pipetted onto the glass slide for microscopy.

A hemocytometer was used to count the phytoplankton sample, while the zooplankton sample was examined using a Sedgewick-Rafter counting chamber. Plankton samples were counted using a Koppace inverted microscope.

Samples were collected using clean containers and promptly transported under chilled conditions to the designated laboratories to maintain their integrity. Subsequently, nutrient, microbial, and plankton analyses were conducted at the Regional Science Research Center and the Environmental Biochemistry Laboratory of Mindanao State University – General Santos City. In addition, heavy metal analysis was performed at Davao Analytical Laboratories Inc. Phosphate and nitrate (mg L^{-1}) were measured using the SMEWW, APHA-AWWA methods. Phosphate was determined using the Ascorbic Acid Method, forming a blue complex measured at 880 nm, while nitrate was analyzed by the Ultraviolet Spectrophotometric Screening Method based on UV absorption at 220 nm. The following methode were employed in microbial analysis for total coliform (TC), fecal coliform (FC), and *Escherichia coli*. The Multiple-Tube Fermentation Technique involves serial dilution and incubation of water samples in selective media to detect gas formation as an indication of coliform presence. Confirmatory tests for FC and *E. coli* were conducted using incubation at elevated temperatures and verification with specific biochemical reactions. Furthermore, total organic carbon (TOC) was determined by UV persulfate oxidation. For heavy metal testing, 4-liter samples were sent to Davao Analytical Laboratories Inc. Mercury was analyzed using the SMEWW3112B method, which employs the cold-vapor atomic absorption spectrometric (CV-AAS) technique. In this method, mercury in the water sample is oxidized and then reduced to elemental vapor using stannous chloride, after which it is measured spectrophotometrically at the mercury absorption wavelength. Cadmium, chromium, and lead were analyzed with the SMEWW3120B method, which utilizes inductively coupled plasma–atomic emission spectroscopy (ICP-AES). In this procedure, samples are digested with acid to ensure that all metals are in solution. The elements are then atomized and excited in an argon plasma, and their concentrations are quantified based on the intensity of their characteristic emission lines. Plankton identification followed the methods of Bellinger & Sigee (2015).

Results and Discussion

***Physicochemical parameters*.** The results of the study are presented in tables, graphs, and figures, and discussed through descriptive analysis. Table 1 presents the results of various physicochemical parameters, including depth, temperature, DO, pH levels, and EC of the water.

In terms of depth, the Rio Grande de Mindanao exhibits a range of 2.4-8.9 meters in depth in the middle, with Ganta and Reina Regente being the shallowest and deepest, respectively (Table 1). Shallow water is considered to be less than 8 meters, while deep water is typically over 8 meters (Princeton Hydro 2015). Following this classification, the river was deepest in Barangay Reina-Regente and Barangay Maidapa, with depths of 8.9 and 8.1 meters, respectively. In contrast, Barangay Ganta, near Mother Kabuntalan, had shallow water with a depth of 2.4 meters. All sides of the river were also measured, with widths ranging from 0.7 to 5.1 meters. While Rena Regente is the deepest in the middle part, the results also revealed that it has the shallowest sides among the sampling sites, with depths of 0.7 and 2 meters for Side 1 and Side 2, respectively (Table 1). These findings suggest that while some parts of the Rio Grande de Mindanao are deeper and may be favorable for aquatic resources, there may be localized areas where depth-related stressors, such as siltation and sedimentation, may affect fish productivity and habitat quality. This is evident in the shallower part of the Rena Regente, where Kid et al (2025) reported low fish diversity in the area.

In terms of temperature, Ganta had the highest temperature, at 33.7^{o}C, while Reina Regente had the lowest, at 29.9^{o}C (Table 1). Measuring river temperature is crucial for assessing water quality, influencing chemical properties, the adequacy of cold-water fish habitats, and overall river ecosystem health. Monitoring temperature variations helps to understand and manage aquatic biota, as well as maintain ecological balance in river systems (Ferchichi & St-Hilaire 2023). Van der Grinten et al (2007) recommended a maximum temperature of 25^{o}C for good ecological status and a lower maximum of 20^{o}C to support aquatic life. The temperature range in Rio Grande de Mindanao falls within the typical tropical river range, but is near the upper limit. This could either enhance metabolism and feeding if DO is sufficient, or cause thermal stress in sensitive species. Higher temperatures lower DO solubility, especially in shallow areas (Patel & Jariwala 2023).

DO is a measure of how much oxygen is dissolved in the water, and it is the amount of oxygen available to living aquatic organisms. It is also an important measure of water quality, as it is a direct indicator of the water body's ability to support aquatic life. Running water dissolves more oxygen than stagnant water, such as a pond or lake. DO levels below 5 mg L^{-1} are usually hazardous for fish. If the levels drop below 1 mg L^{-1}, fish and other aquatic organisms may be compromised (United States Environmental Protection Agency 2025). All the five stations in this study exhibit high levels of DO, indicating that these areas are suitable for the optimal growth and survival needs of fish (Table 1).

Table 1
Depth and physicochemical parameters (temperature, dissolved oxygen, pH, and conductivity) of surface water at selected sites in the Rio Grande de Mindanao

Location	*Coordinates*	*Depth (m)*			*Temp (°C)*	*DO (mg L^{-1})*	*pH*	*EC (µS cm^{-1})*
		S_1	*M*	*S_2*				
Mother Kalanganan, Cotabato City	N: 7°14′7″ E: 124°13′56″	0.85	4.3	5.1	30.9	9.2	7.42	329.7
Maidapa, Sultan Kudarat, Mag. del Norte	N: 7°12′46″ E: 124°17′40″	4.7	8.1	3.2	32.2	8.3	7.26	307.7
Ganta, Mother Kabuntalan	N: 7°7′35″ E: 124°23′55″	2.4	2.4	2.8	33.7	7.87	7.17	321.7
Balong, Northern Kabuntalan	N: 7°6′52″ E: 124°24′10″	1.7	3.9	4.4	30.7	5.43	7.29	311
Reina Regente, Datu Piang, Mag.	N: 7°1′45″ E: 124°30′26″	0.7	8.9	2	29.9	6.83	7.16	320.3

Note: Temp = temperature, DO = dissolved oxygen, EC = electric conductivity, S_1 = side 1, M = middle, S_2 = side 2.

When it comes to the pH, the river exhibits a range of 7.16-7.42, with Mother Kalanganan being the highest and Reina Regente being the lowest (Table 1). pH refers to the alkalinity and acidity of soil and water. It plays a crucial role in promoting the growth of aquatic life. Measuring the pH of water determines whether aquatic life can utilize the environment. Typical pH ranges include 6.5-8.6 for surface water systems, 7.0-8.5 for drinking water supplies, and 6.0-8.5 for groundwater systems. Very high pH levels cause damage to the gills and skin of aquatic fish and other organisms. If the pH levels continue to rise above 10.0, aquatic organisms will die from ammonia poisoning (Atlas Scientific 2022). Low pH levels also encourage heavy metals to dissolve in the water, and as the concentration of heavy metals increases in the water, so does their toxicity. The results of the pH level in the study areas were neutral, with a range of 7.16 to 7.42, indicating that the area poses no risk to the growth and development of fish and other aquatic organisms. The study area is classified as a Class C type of water, and the pH range or limit for a Class C water body is 6.5-9.0 (DENR 2016).

EC measures the ability of water to conduct an electrical current, and it is measured in microsiemens per centimeter. The typical range limit for EC in river water is thoroughly considered to be between 50 and 1,500 μs cm^{-1}; most rivers fall within the mid-range of 200 to 1,000 μs cm^{-1} (DENR 2016). The values of EC at all the five stations do not exceed the mid-range conductivity limit, and the study area has a normal conductivity range, indicating less pollution in the water.

Nutrient analysis. Assessment of phosphate and nitrate concentrations in water is crucial for understanding biogeochemical cycles, assessing environmental quality, and preventing issues such as eutrophication. Accurate measurement ensures the effective management of water resources and the protection of aquatic ecosystems (Zhu & Ma 2020).

Table 2 shows the results of phosphate and nitrate analysis. They are major nutrients essential for the physiological processes of living organisms, but when their concentration exceeds the recommended limit, they are considered pollutants that can deplete oxygen in water bodies and cause harm to aquatic organisms (Weis 2024). The values of nitrate ranged from 0.600 to 1.200 mg L^{-1}, while those for phosphate ranged from 0.260 to 0.427 mg L^{-1}. These results do not exceed the limits on phosphate and nitrate for Class C water, based on water quality guidelines and general effluent standards of the DENR (2016). Optimal nitrate and phosphate levels in water refer to concentrations that support healthy aquatic ecosystems, promoting phytoplankton growth without causing harmful effects such as algal blooms or eutrophication. These levels are crucial for maintaining ecological balance and water quality (Hakkim et al 2024).

Table 2

Nutrient analysis of phosphate and nitrate concentrations in water samples from selected locations in the Rio Grande de Mindanao

Locations	*Phosphate (mg L^{-1})*	*Nitrate (mg L^{-1})*
Mother Kalanganan, Cotabato	0.300	0.600
Maidapa, Sultan Kudarat, Mag. Del Norte	0.333	1.007
Ganta, Mother Kabuntalan	0.427	0.600
Balong, Northern Kabuntalan	0.427	0.707
Rein-Regente, Datu Piang, Maguindanao	0.260	1.200

Microbial and total organic carbon analysis. Table 3 shows the results of the microbial analysis. The total coliform count (TCC) in the river ranges from 13 to 34.3 MPN/100 mL, with Balong, Northern Kabuntalan being the highest and Mother Kalanganan being the lowest. The standard for TCC in Class C rivers or water bodies in the Philippines, according to DENR (1990), is 5,000 Most Probable Number (MPN) per 100 mL. All sampling sites do not exceed this limit. This could indicate a tolerable TCC concentration, suggesting acceptable levels for recreational use and aquatic life (Anisafitri et al 2020). The data suggest that the river water is still clean and safe according to standards, but regular monitoring should be maintained to ensure it remains uncontaminated.

The fecal coliform count (FCC) in the Rio Grande de Mindanao ranged from 1.33 to 6.66 MPN/100 mL, with Reina-Regente, Datu Piang showing the highest concentration and Maidapa recording the lowest. According to the Department of Environment and Natural Resources (DENR) under DAO 2016-08, the Water Quality Guideline for Class C rivers is 200 MPN/100 mL. All measured FCC values in the study fall far below this threshold, indicating that the river currently maintains a good microbiological quality in terms of fecal contamination. Although the results are favorable, fecal contamination in rivers can fluctuate due to rainfall, upstream activities, waste disposal practices, and changes in land use. Thus, it remains crucial to sustain regular monitoring and enforce watershed protection measures to ensure that FCC levels remain compliant with DENR standards. Continued vigilance will help preserve the ecological integrity of the Rio Grande de Mindanao and maintain its suitability for fisheries, recreation, and other Class C water uses.

Table 3

Microbial counts and total organic carbon concentrations in water samples from different locations in the Rio Grande de Mindanao

Locations	*Microbial analysis*			*TOC (mg L^{-1})*
	TCC (MPN/ 100 mL)	*FCC (MPN/ 100 mL)*	*E. coli (MPN/ 100 mL)*	
Mother Kalanganan, Cotabato City	13	4	4	2.97
Maidapa, Sultan Kudarat Mag. Del Norte	16.33	1.33	1.33	3.716
Ganta Mother Kabuntalan	26	2	2	3.456
Balong, Northern Kabuntalan	34.33	4.33	4.33	3.276
Reina-Regente, Datu Piang	22.66	6.66	6.66	3.456

Note: TCC = total coliform count, FCC = fecal coliform count, MPN = most probable numbers, TOC - total organic carbon.

According to Odonkor & Mahami (2020), a zero count of *E. coli* per 100 mL of water is considered safe; a count of 1-10 MPN/100 mL is regarded as low risk; 11-100 MPN/100 mL is medium risk; and an *E. coli* count greater than 100 MPN/100 mL is considered high risk. The results of this study show a range of 1.33 to 6.66 MPN/100 mL. This means that the concentration of *E. coli* in Rio Grande de Mindanao is near the optimum and regarded as low risk.

TOC is a critical indicator of water quality, representing the total amount of carbon found in organic compounds within a water sample. It serves as a measure of water pollution, particularly from organic substances (Nekrasova 2022). In terms of TOC analysis in Rio Grande de Mindanao, the results show a range of 2.97 to 3.716 mg L^{-1}, with Maidapa being the highest and Mother Kalanganan being the lowest. These values are all below the recommended threshold of 4.0 mg L^{-1} for untreated surface water sources, as set by the United States Environmental Protection Agency (TCEQ 2019). The results indicate that the organic carbon content in the sampled rivers is within acceptable limits for raw water sources that could potentially be used for public supply.

***Heavy metal analysis**.* Table 4 presents the results of heavy metal analysis for mercury, cadmium, chromium, and lead. The results show that the Mercury levels at the five stations were all less than 0.02 μg L^{-1}. The standard for mercury concentration in water bodies is 0.0005 mg L^{-1} (0.5 μg L^{-1}) for quality class I, 0.001 mg L^{-1} (1 μg L^{-1}) for classes II and III, and 0.005 mg L^{-1} (5 μg L^{-1}) for class IV (Wałkuska et al 2010). The observed mercury concentration (< 0.02 μg L^{-1}) is well below the Class C water quality standard of 1 μg L^{-1}, indicating compliance with regulatory limits and the absence of mercury contamination. This means that the Rio Grande de Mindanao is suitable for fisheries, agriculture, and recreational activities where direct body contact is limited or unlikely such boating and fishing (DENR 2016).

Table 4
Laboratory results of heavy metal analysis (Hg, Cd, Cr, Pb) in water samples from selected stations along the Rio Grande de Mindanao

Laboratory Ref. No.	*Sample ID*	*Mercury ($\mu g\ L^{-1}$)*	*Cadmium ($mg\ L^{-1}$)*	*Chromium ($mg\ L^{-1}$)*	*Lead ($mg\ L^{-1}$)*
W_3^- 24-6254	Mother Kalanganan	< 0.02	< 0.002	0.009	< 0.005
W_3^- 24-6255	Maidapa, Sultan Kudarat	< 0.02	< 0.002	< 0.002	< 0.005
W_3^- 24- 6256	Ganta, Mother Kabuntalan	< 0.02	< 0.002	0.02	< 0.005
W_3^- 24-6257	Balong, Northern Kabuntalan	< 0.02	< 0.002	< 0.002	< 0.005
W_3^- 24-6258	Reina Regente	< 0.02	< 0.002	< 0.009	< 0.005

Cadmium is another contaminant from both point and nonpoint sources in rivers near agricultural and industrial areas. Measuring cadmium in rivers is crucial due to its toxic effects on wildlife and potential risks to human health. Monitoring bioaccumulation helps detect environmental stressors, ensuring ecosystem health and safety, particularly in areas near agricultural contamination sources (Vallese et al 2024). The analysis for cadmium concentration in this study revealed values of less than 0.002 mg L^{-1} at all sampling sites. These concentrations were well below the Class C freshwater limit of 0.01 mg L^{-1} prescribed by the Department of Environment and Natural Resources (DENR 1990). The low cadmium concentration (< 0.002 mg L^{-1}) suggests minimal contamination and effective natural dilution or sediment adsorption processes within the river system. It indicates that the aquatic environment is not significantly influenced by industrial or agricultural discharges containing cadmium.

In terms of chromium level, the study area exhibits a range of < 0.002 to 0.02 mg L^{-1}, respectively, with Maidapa and Balong being the lowest and Ganta being the highest. Measuring chromium levels is crucial because chromium is a toxic pollutant that can pose significant health risks to humans and aquatic life. Regular testing ensures that water quality remains within safe limits, protecting ecosystems and public health, and helps in maintaining compliance with environmental regulations. The standard for chromium concentration in river water is 0.05 mg L^{-1} (Sulistyowati & Yanti 2021). All chromium levels in the sampling sites, including the highest value (0.02 mg L^{-1}), are below the standard limit of 0.05 mg L^{-1}, which suggests no immediate risk of chromium contamination in the sampled river system.

Lead testing is important to prevent health risks, particularly for vulnerable populations such as children. The World Health Organization (WHO) standard for lead concentration in water is 0.01 mg L^{-1}. Elevated lead levels can lead to significant non-cancer and cancer risks (Munene et al 2023). The results of the lead testing in this study show consistent levels of < 0.005 mg L^{-1} at all sampling sites. This suggests that the lead concentration in the river is within acceptable limits.

Plankton analysis*.* Studying plankton in rivers is crucial for biological monitoring, assessing ecosystem health, and understanding the impacts of environmental changes. Plankton dynamics reflect hydrological and abiotic variations, providing insights into the resilience and functioning of riverine ecosystems (Naskar et al 2020).

Figure 2 illustrates the composition of phytoplankton species in the sampled aquatic environment, showing a clear dominance of a single species. *Spirogyra* sp. was overwhelmingly the most abundant phytoplankton, accounting for 86.50% of the total population. This suggests that *Spirogyra* is either thriving in highly favorable conditions for growth or that the ecosystem is experiencing an algal bloom. They are photosynthetic and play a significant role in the overall carbon dioxide fixation process. They increase the level of oxygen in their habitat, but the large bloom of *Spirogyra* algae can deplete oxygen levels in the water, leading to fish kills and other negative impacts on aquatic organisms. They are also a food source for a variety of aquatic organisms (Shing et al 2018). The remaining species were present in much smaller proportions. *Gomphonema* sp. contributed 4.50%, followed by *Navicula* sp. at 3.60%. Both *Nitzschia* sp. and *Pediastrum* sp. made up 1.80% each, while *Trachelomonas* sp. and *Fragilaria* sp. were the least represented, each contributing only 0.90% to the total population.

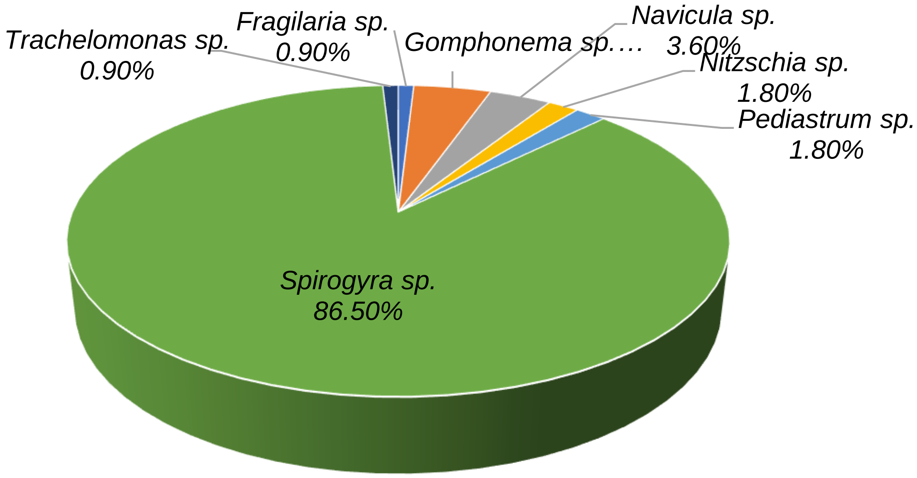

Figure 2. Relative abundance of phytoplankton collected from selected sites of Rio Grande de Mindanao.

Figure 3 shows the composition and relative abundance of zooplankton species in a sampled aquatic environment. The data reveal a highly uneven distribution, with *Microcyclops* sp. dominating the community at 51.85%, followed by *Mesocyclops* sp. at 31.98%. Together, these two copepod genera account for over 83.83% of the total zooplankton population, indicating a community structure characterized by low species diversity but high dominance. This suggests that environmental conditions, such as water temperature, nutrient availability, or the absence of significant predators, are favorable to these species. The presence of *Brachionus falcatus* (6.89%) and *Arctodiaptomus dorsalis* (2.43%) indicates a moderate level of diversity, with other rotifer and cladoceran species, such as *Lecane luna*, *Hexarthra* sp., *Ceriodaphnia cornuta*, and *Brachionus calyciflorus,* each contributing less than 1.5% to the total population. The minor presence of multiple species, such as *Filinia* sp., *Asplanchna* sp., and various *Brachionus* species (each at around 0.40%), further suggests that the ecosystem may be experiencing selective pressures that limit the proliferation of less competitive or more sensitive species.

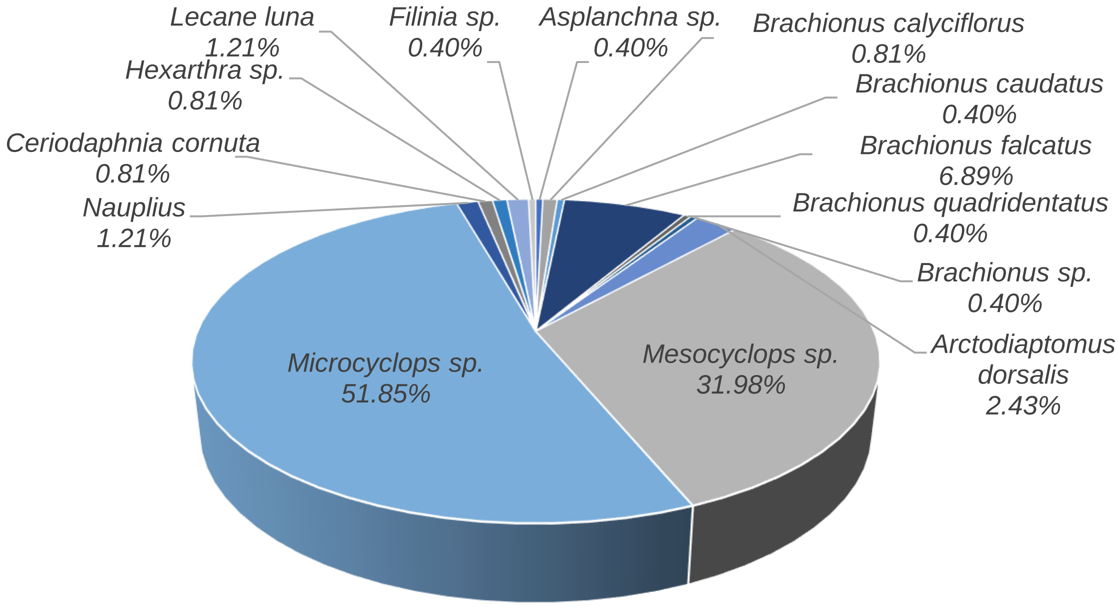

Figure 3. Relative abundance of zooplankton collected from selected sites of Rio Grande de Mindanao.

Overall, the zooplankton community appears to thrive under specific ecological conditions, but it exhibits relatively low biodiversity, which could pose a risk to long-term ecosystem stability if dominant species continue to outcompete others.

Conclusions. The assessment of the Rio Grande de Mindanao revealed that physicochemical parameters, including temperature, dissolved oxygen, pH, electrical conductivity, and depth, were within the acceptable limits for Class C water bodies, indicating suitable physical conditions for aquatic life. Nutrient analysis showed that phosphate and nitrate concentrations remained within the recommended levels, and total organic carbon levels did not exceed the safety threshold for untreated surface waters.

The total coliform levels in all sites were within the safe limit. *Escherichia coli* counts were low, and fecal coliform concentrations remained minimal. Overall, the microbial quality of the Rio Grande de Mindanao was within acceptable standards. Similarly, heavy metal analysis indicated that mercury, cadmium, chromium, and lead concentrations were below the national and international safety limits. Plankton analysis revealed low biodiversity, characterized by a dominant presence of *Spirogyra* sp. in the phytoplankton community and *Microcyclops* sp. and *Mesocyclops* sp. in the zooplankton community.

These findings provide critical baseline data for the effective management and protection of the river system. Regular monitoring is recommended to track changes in water quality, particularly microbial and planktonic indicators. Strengthening wastewater treatment and sanitation infrastructure is essential to reducing microbial contamination. Additionally, promoting ecological balance through biodiversity conservation and implementing community-based watershed management strategies will support the sustainable use of the Rio Grande de Mindanao and its ecosystem services.

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Conflict of interest. The authors declare that there is no conflict of interest.

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