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Effects of Anthropogenic Activities on Water Quality and Distribution of Zooplankton in Kawo Dam, Kontagora, Niger State

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Abstract: *This study examines the influence of anthropogenic activities on water quality and zooplankton distribution in Kawo Dam, Kontagora, Niger State, Nigeria, over a six-month period (May to October 2024). Four sampling stations at the dam's inlet, middle, outlet, and an area near agricultural runoff were established to capture spatial variability. Water quality parameters, including dissolved oxygen, biochemical oxygen demand, pH, temperature, electrical conductivity, turbidity, and nutrient levels, were measured in situ, and zooplankton samples were collected fortnightly. Results showed significant seasonal variations in water quality, with lower dissolved oxygen and higher biochemical oxygen demand during the early months, likely due to organic runoff. Additionally, elevated turbidity was noted, especially near agricultural runoff areas, indicating sediment and pollutant introduction. Zooplankton populations, particularly copepods and rotifers, displayed notable fluctuations, with species abundance influenced by changes in water conditions. Amphipods were most abundant, while other species declined in response to reduced water quality. The study highlights how human activities, including agricultural runoff, affect water quality and zooplankton diversity, underscoring the need for improved water management practices to protect aquatic ecosystems.*

Key words: anthropogenic activities, water quality, zooplankton distribution.

INTRODUCTION

The increasing uncontrolled human activities such as agricultural production, municipal effluents, industrial discharges, industrial production and mining activities have negatively affected many of our water bodies all over Africa in many areas including changes in flow regimes which is the major factor that determines the physical characteristics, habitat, local aquatic species composition, erosion, siltation of water ways, loss of habitat diversity, loss of flora, fauna and nutrient enrichment etc. not only do these activities negatively impact the aquatic ecosystem, but they also threaten the availability of fresh water for human consumption. The increasing threats on the freshwater ecosystems have made it imperative to effectively conserve and manage freshwater biodiversity and ecological functions, (Ahmed et al., 2022)

There is need to maintain environmental quality and water renewal rates as a very important resource for biodiversity and human need; otherwise it may have ecological and societal implication (Coe and Foley, 2002; Gregory and Benito, 2003). The sustainability of our aquatic resources is dependent on proper management and conservation of these resources.
Measurement of the extent and magnitude of domestic effluents, concentrations of the pollutants emanating from the surrounding communities into the water bodies is of a great necessity in assessing vulnerability to flooding so as to guide the decision making process towards a better way of dealing with high floods in the surrounding water body. Monitoring water quality will assist in identifying potential pollution sources which can have negative effects on aquatic biodiversity and provide the basis for effective measures of tackling water pollution (Altenburger et al., 2019).

Most of the water bodies near cities have been polluted by human activities namely: indiscriminate disposal of sewage and domestic effluents into the waterways often carrying toxic loads of nutrients, heavy metals, pesticides and contaminants from sewage plants, chemical factories, refineries and industries. Increased environmental awareness of the impacts of point source and a change of attitudes of the Communities in and around these resources are vital in achieving ecologically sustainable development of our freshwater and marine resources. Most of the early works on aquatic environment in Nigeria have been on aspects of the physicochemical and Fisheries study of such habitats. There is an urgent need for more comprehensive and extensive studies on those aquatic ecosystems in other parts of the country where some of the aquatic environment has not been fully studied.

Anthropogenic influence around so many water bodies can threaten species survival and ecological health of aquatic ecosystem with devastating consequences in Niger State Nigeria. This impact may affect the aquatic environment by reducing availability of water, food and aquatic resources which can consequently lead to unhealthy competition and conflict among the communities.The study of the conditions of the aquatic environment and the impact of human activities on these ecosystems are very important in evaluating and critically observing social and economic pressures, the life styles and values placed on these water bodies by the surrounding communities of Kawo Dam, in Kontagora Local Government of Niger State.
In recent times, freshwater has become a scarce commodity due to over exploitation and pollution,hence it is necessary to evaluate quality of water in order to assess its suitability for various uses(Ingrao et al., 2023). Water quality assessment is of immense importance involving the use of water bodies such as in the management of fisheries, water supply, pollution control, irrigation and sewage, reservoir and impoundment, to mention but a few. Pollution status of water bodies are usually expressed as biological and physicochemical parameters. Physico-chemical means are used in detecting effects of pollution on the water quality but changes in the

tropic status of a water body is reflected in its biotic community-structure including species patterns distribution and diversity (Misman et al., 2023).

In conclusion, the study of the effect of anthropogenic activities on water quality and zooplankton distribution in Kawo Dam, Kontagora, Niger State, is crucial for understanding the intricate relationships between human actions, and aquatic ecosystems. This research aims to bridge the knowledge gap on the specific impacts of anthropogenic stressors on the Dam's water quality and zooplankton community, providing valuable insights for sustainable management and conservation strategies. Therefore, by investigating the spatial and temporal variations in water quality parameters and zooplankton distribution, this study seeks to inform evidence-based policies and interventions to mitigate the adverse effects of human activities on Kawo Dam's ecosystem, ensuring the long-term sustainability of this vital water resource for both human and environmental well-being.

MATERIALS AND METHODS

Study area/location

The Kawo Dam, located in Kontagora Local Government Area of Niger State, Nigeria, serves as an essential water infrastructure in the region. It was constructed to support agricultural activities, provide potable water, and help mitigate flooding issues within the Kontagora area. Positioned in northern Niger State, Kontagora is a key agricultural and administrative hub, and the Kawo Dam contributes significantly to local irrigation, helping sustain farming, especially during dry seasons. Additionally, the dam's construction was part of broader initiatives by the Nigerian government to improve water supply, irrigation, and flood control in the region. The dam's reservoir supplies water to nearby communities and has aided in boosting agriculture, which is a primary livelihood for the majority of the residents in Kontagora. However, like many dams in Nigeria, it has faced challenges, including maintenance issues, which have sometimes impacted its efficiency and effectiveness in water supply and management.

Experimental Design/Sampling Stations

For this research, four sampling stations were selected from the dam, designated as stations 1, 2, 3, and 4.Station 1 (inlet), station 2 (middle), station 3 (outlet), and station 4 (near agricultural runoff).To capture spatial variability in water quality, four sampling stations were established along the Dam's length, spaced approximately 500 meters apart. The sampling stations were selected after preliminary survey of the sites based on factors such as accessibility, permission for usage, size of water depth and human activities. Four (4) sampling stations were chosen and samplings were conducted forth-nightly for six (6) calendar months. The distance between each station is 500 meters apart. Zooplanktons were equally sampled at each of the sampling stations.

Sample Collection

A total of eight (8) water sample was collected, two from each sampling stations representing inlet, middle, outlet, and near agricultural runoff. Twelve (12) Zooplankton sampling was also done in the morning between 7.00am and 8.30am in the four (4) Sampling stations 1, 2, 3, and 4.Samples were collected in triplicate.

Determination of Physical-Chemical Parameters
Analyses of the following physicochemical parameters were carried out in-situ at the four sampling stations in the Dam.

Water Temperature (ºC), Hydrogen Ion Concentration (pH) and Electrical conductivity (EC)(µm/s).

Temperature, hydrogen ion concentration (pH) and electrical conductivity (EC) of the water sample was determined in-situ with Jenway 430 Multi-parameter instrument that measures temperature/pH/conductivity. The probe was inserted into the water sample of about 12cm and the displayed reading was recorded.

Depth:
A long graduated cord with attached weight of 25g was used to measure the depth of each sampling station by lowering the cord into the water body until the cord settle at the bottom and the level which were recorded before the cord is recovered. Readings were expressed in cm and converted to meter by simply dividing the value by 100. E.g 200 ÷100 =2.

Turbidity
Turbidity of the water was determined in-situ using a portable turbidity metre Model SGZ 200BS, the probe was inserted into the water sample of about 12cm and the displayed reading wasrecorded.

Dissolved Oxygen (DO):
Dissolved Oxygen were measured in-situ at each sampling station using portable Dissolved Oxygen analyzer (JPB607A), the probe was inserted into water sample and the displayed reading was be recorded.

Biochemical Oxygen Demand (BOD):
The biochemical oxygen demand (BOD) was determined in the laboratory using the same method for analyzing dissolved oxygen (DO). Water sample of 250ml was collected in a Dissolved Oxygen sample bottle, proper caution wastaken not to trap air bubbles into the sample bottle from the field, and this was analyzed for dissolved oxygen after 5 days of incubation. Biochemical oxygen demand was calculated as follows:
BOD = $(DO_1 – DO_2)$ mg/L
DO_1 = Dissolved oxygen (initial)
DO_2 = Dissolved oxygen after 5 days of incubation
The result was expressed in mg/l

Determination of Nutrient Parameters

Phosphate (P_4O^{2-}) mg/L

The phenol disulphuric acid method described by Idowu*et. al.*, (2004) was used. 100ml of water sample in 250ml Erlenmeyer flask was evaporated to dryness, 2ml phenol disulphuric acid was also added to the residue and left for about 10 minutes. Furthermore, 10 – 15ml of distilled water was then added followed by the addition of 5ml strong ammonia solution. The mixture wasstirred and allowed to cool. The absorbance at 410nm was measured using a Spectro-photometer, concentration was also determined from the calibration. Calibration curve was prepared by placing the electrode in a series of well stirred standard solutions.

Alkalinity, Nitrate (NO_3) and Hardness

The total alkalinity, Nitrate (NO_3) and total Hardness was measured with Hanna multi-parameter water analyzer in accordance with standard method of analysis for each of the parameters as specified in operational manual for Hanna Model HI 83200 multi-parameter Bench Photometer for laboratories. Results were expressed in mg/L.

Zooplankton Sampling

Zooplankton was sampled with improvised 30cm diameter cylindrical scooper net with attached mesh size of 96µm from the surface of the dam water due to the varying depth (0.38m – 1.11m) of the sampling sites and less water volume.The samples collected were preserved in a plastic sampling bottle fixed with 70% ethanol at a final concentration of 4%, this was to enable the samples to concentrate or sediment for 24 hours. After 24 hours the bottle containing the samples were decanted using sieve of 50µm as described by (Haney and Hall, 1973,Urabe, 1990). Identifications was carried out on Wild Photographic Olympus microscope (AH Vanox 7) and a binocular microscope model BH2 as described by (Willen,1976).

Zooplanktons obtained were sorted into main taxonomic groups by using identification as describe by Merrit and Cummins (1984), Filter and Manuel (1986), Peannak (1989). The samples were fixed with Lugol's solution and then preserved with ethanol at final concentration of 4% as described by Ogbeibu, (2001); Idowu, (2004); Idowu *et al*. (2015). Samples were collected in triplicate.

RESULTS AND DISCUSSION

Table1 show the results of this study's parameters, whereas table show the results of phytoplankton distribution for the study period. During the study period, water temperatures were quite consistent between locations. The tables provide a water quality analysis and phytoplankton distributions for a period of six months (May to October 2024).

Table 1: Physicochemical Parameters of Kawo Dam from May to October 2024

Months	Code	Depth (m)	D.O (g/l)	BOD (mg/l)	pH	Temp (ºC)	E.C (µs/cm)	Turb. (NTU)	PO_4^{3-} (mg/L)	NO_3^- (mg/L)	Alkalinity (mg/L)	Total Hard. (mg/L
May	S1	0.45	1.4	0.7	7.2	32	388	15.2	1.1	0.68	30	215
	S2	0.65	2.5	1.7	6.8	31.4	433	21.7	0.6	0.51	30	243
	S3	0.30	0.5	0.3	7.6	31	716	22.0	1.0	0.75	196	261
	S4	0.55	0.7	0.3	7.5	29.8	701	14.7	0.6	0.68	220	252
June	S1	0.64	1.2	0.9	7.1	30.1	202	9.8	0.6	0.57	100	202
	S2	0.92	3.4	1.5	7.0	30.0	120	8.3	0.6	0.54	100	198
	S3	0.63	0.7	0.5	7.4	29.2	570	19.3	1.0	0.68	110	224
	S4	0.58	1.1	0.7	7.5	28.9	640	23.2	0.3	0.64	120	230
July	S1	0.85	4.7	2.0	7.1	28.5	120	12.9	0.5	0.54	70	97
	S2	1.04	4.6	2.5	7.6	28.3	140	5.6	0.5	0.51	100	103
	S3	0.76	5.7	4.3	8.0	28.2	154	23.4	0.5	0.63	95	125
	S4	0.65	5.2	3.7	8.0	27.2	154	14.2	0.6	0.61	95	125

Months	Code	Depth (m)	D.O (g/l)	BOD (mg/l)	pH	Temp (ºC)	E.C (μs/cm)	Turb. (NTU)	PO_4^{3-} (mg/L)	NO_3^- (mg/L)	Alkalinity (mg/L)	Total Hard. (mg/L
August	S1	0.97	5.5	4.0	7.8	25.8	188	19.2	0.0	0.55	110	194
	S2	1.20	4.4	3.1	7.9	26.2	114	19.2	2.2	0.50	65	67
	S3	0.95	5.9	5.2	7.8	25.5	127	46.0	0.5	0.59	40	103
	S4	0.76	5.6	5.0	7.9	25.2	87	50.0	0.4	0.60	35	58
September	S1	0.96	4.8	2.3	7.6	27.8	150	25.3	0.0	0.49	110	118
	S2	1.05	5.2	2.7	7.9	28.8	140	15.2	0.6	0.46	95	115
	S3	0.80	4.3	3.8	7.7	29.1	150	25.4	0.2	0.57	70	121
	S4	0.66	4.2	3.6	7.5	29.7	140	23.8	0.1	0.61	65	117
October	S1	0.91	6.5	5.7	7.6	27.0	281	7.2	0.6	0.50	40	162
	S2	1.01	4.5	3.0	8.6	30.1	268	4.6	0.7	0.45	45	153
	S3	0.74	4.3	2.3	8.5	28.6	302	62.4	0.7	0.55	65	178
	S4	0.58	5.6	3.8	8.6	26.7	194	28.3	0.3	0.53	40	103

Table 2: Monthly distribution of Zooplankton from May – October, 2024.

Zooplankton Taxon	Species	May	June	July	August	Sept.	Oct.	Total	% abundance
Copepod	*Amphipod*	54	18	14	28	10	8	132	28.70
	Zoea	4	0	2	0	3	0	9	1.96
	Calanolda	22	6	7	6	4	0	45	9.78
	Cyckiose	10	4	3	2	6	4	29	6.30
	Harpacticolda	15	0	4	0	8	2	29	6.30
	Corycaeus	3	0	2	4	6	9	24	5.22
	Nauplias	3	0	4	0	0	8	15	3.26
	Calaus	6	7	12	4	0	0	29	6.30
Cladocera	*Moina*	10	5	2	3	6	2	28	6.09
	Daphnia	1	3	3	6	9	0	22	4.78
Rotifer	*Euchianis*	6	18	10	17	14	13	78	16.96
Cilliopora	*Vioticella*	0	8	2	4	6	0	20	4.35
Total	12	134	69	65	74	72	46	460	100

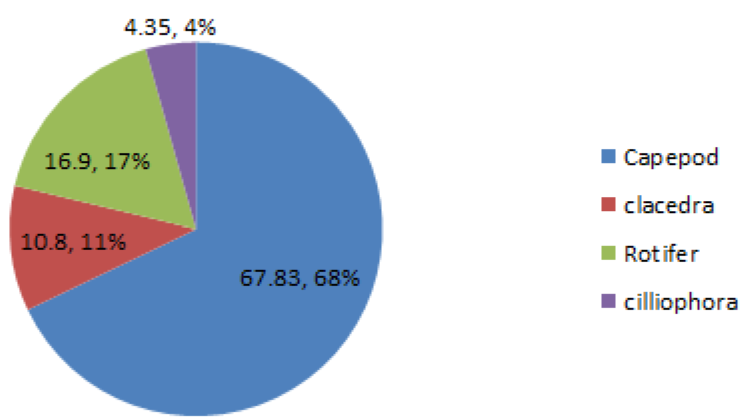

Figure 1: Percentage (%) total distribution of zooplankton for the period of study

DISCUSSION

Table 1 provides monthly variations a water quality analysis of Kawu Dam, Kontagora, Niger State over six months (May to October 2024) with parameters that include dissolved oxygen (DO), biochemical oxygen demand (BOD), pH, temperature, electrical conductivity (E.C), turbidity, phosphate (PO_4^{3-}), nitrate (NO_3^-), alkalinity, and total hardness across four sampling stations (S1, S2, S3, S4). The discussion focused on trends in depth, dissolved oxygen (DO), biochemical oxygen demand (BOD), pH, temperature, electrical conductivity (E.C.), turbidity, and nutrient levels (phosphate and nitrate), along with alkalinity and total hardness.

The recorded depths generally varied between 0.3 m and 1.2 m across the months, with slight increases during the rainy months of July through September, potentially due to higher water levels from increased rainfall. This variation in depth likely influenced other parameters, as shallower water tends to heat up faster and can show higher biological activity. The results of this research are consistent with those reported by Nygren et al. (2020) indicating significant correlation in seasonality of groundwater fluctuation with respect to increased rainfall.

The DO levels in Kawo Dam in table 1, varied from 0.5 mg/L (May, Site S3) to a peak of 6.5 mg/L (October, Site S1), with lower values noted in May and higher levels by the end of the rainy season in October. The low DO levels in May might be attributed to organic matter decomposition or reduced water flow, both of which are likely aggravated by agricultural runoff and effluent discharges from nearby activities. This reduced DO can limit zooplankton diversity and abundance, as zooplankton generally thrives in oxygenated environments. The findings support the previous work of Pomelo (2022), that the lower levels in May suggest a period of lower water circulation and possible increased microbial activity, which consumes oxygen.Similarly, BOD levels ranged from 0.3 mg/L (May, Sites S3 and S4) to 5.7 mg/L (October, Site S1), indicating varying levels of organic pollution. High BOD values in October could signify an increase in organic pollutants, potentially from agricultural or domestic sources, which would increase microbial decomposition and oxygen depletion. Elevated BOD levels can lead to hypoxic conditions, thus stressing the zooplankton community and affecting their distribution and survival. Higher BOD in the warmer months suggests greater biological activity, correlating with temperature. The findings are consistent with those reported by Kamarudin et al. (2020).

The pH of Kawo Dam ranged between 6.8 and 8.6, suggesting that the water was generally neutral to slightly alkaline throughout the study period. The slight acidity in May (pH 6.8) might result from acidic runoff, potentially affecting species sensitive to pH fluctuations. As the pH rose in later months, peaking at 8.6 in October, it could have been influenced by increased alkalinity from agricultural runoff, which may include lime or other soil amendments. Alkaline waters can support specific zooplankton species adapted to these conditions, while others might be adversely affected, leading to shifts in community composition. Furthermore, the temperature showed seasonal cooling from 32°C in May (S1) to as low as 25.2°C in August (S4). This cooling trend corresponds with the rainy season, which typically reduces ambient and water temperatures. Temperature changes directly influence zooplankton metabolic rates, growth, and reproduction. Warmer temperatures favor higher metabolic rates but can lead to decreased oxygen solubility, indirectly affecting zooplankton populations. Lower temperatures observed in later months might have favored the survival and activity of specific zooplankton species that are less tolerant of high temperatures. To support this, Maldonado et al. (2016), reported that, in Central America, warmer tropical North Atlantic sea surface temperatures are associated with increased early rainy season precipitation due to favorable atmospheric conditions. The finding also validate the observations by Zhou et al. (2020), that May surface temperatures in eastern China significantly influence the East Asian summer monsoon, with cooler temperatures weakening the monsoon and altering precipitation patterns. Conversely, electrical conductivity (EC) levels in the dam spanned from 87 μs/cm (August, S4) to 716 μs/cm (May, S3), suggesting variable ionic concentration, likely influenced by runoff carrying dissolved salts and ions. Higher EC values in May reflect increased dissolved solids, likely from agricultural or industrial effluents, while lower EC levels later in the season could indicate dilution due to rainfall.

Generally, turbidity varied significantly, with peak values of 62.4 NTU in October (S3) and lower values around 4.6 NTU in October (S2). Elevated turbidity reduces light penetration, which can limit primary productivity (algae and phytoplankton), ultimately affecting zooplankton that rely on these organisms as food sources. High turbidity is often associated with sediment runoff or wastewater discharge, both of which could introduce pollutants detrimental to zooplankton health and habitat suitability.Unlike the nutrients (Phosphate and Nitrate) were relatively low throughout, ranging from 0.0 mg/L in September to 2.2 mg/L in August. Nitrate levels were also low, peaking at 0.75 mg/L in May, with a decline through October. The nutrient levels suggest minimal eutrophication, although the slight increase in phosphate in August may be linked to agricultural runoff. This low nutrient level is beneficial for preventing algal blooms and maintaining water quality. The findings supports the previous work reported by Li et al. (2015), posited that, seasonal variations in rainfall and stratification periods significantly impact water quality, with continuous heavy rainfall potentially improving water quality by mixing the reservoir, while isolated events during stable stratification may have limited effects. In the other hand the results from table 1, showed fluctuations in alkalinity and total hardness. Alkalinity ranged from 30 mg/L in May to 220 mg/L in May at S4, while total hardness peaked at 261 mg/L in May at S3 and dropped to its lowest (58 mg/L) in August. The fluctuations indicate that water hardness was influenced by seasonal changes and dilution during rainfall. High alkalinity and hardness values in May suggest mineral-rich water, likely concentrated due to lower water volume before heavy rains.Alkaline and hard waters are generally conducive to certain zooplankton that can tolerate such conditions, though extreme changes may still impact species diversity and abundance.

Zooplankton Distribution in Kawo Dam

Table 2, provides valuable insights into the changes in zooplankton populations over time. The results show distinct fluctuations in the zooplankton community, particularly among *Copepods*, *Cladocera, Rotifers*, and *Cilliophora*, across the period from May to October 2024. This variability could be attributed to different factors, potentially including water pollution, seasonal changes, nutrient influx, and habitat modifications resulting from human activities around the dam.

Notably, *amphipods*, a type of *copepod*, dominated the zooplankton population throughout the study period, accounting for 28.7% of the total abundance. This high prevalence might indicate favorable conditions for Amphipods or a specific resilience to changing water quality. Their population peak in May and subsequent decline may suggest sensitivity to shifts in water quality, temperature, or nutrient levels over the study months. Results from table 2 also showed seasonal distribution patterns, because the most significant population declines occurred among species like *calanoida*, *Nauplias*, and *calaus*, which were absent in certain months, particularly toward October. This drop might correspond with reduced water quality or limited food resources. Additionally, *rotifers*, especially *euchlanis*, showed high resilience, maintaining a presence in each month and peaking in June, which coincides with an increased nutrient load from runoff during the rainy season. Correspondingly, *Moina (cladocera)* and *euchlanis(rotifer)* displayed relatively stable populations, though they were influenced by monthly fluctuations. The *rotifereuchlanis*, with 16.96% abundance, indicates adaptability to varying water conditions, potentially due to their dietary flexibility, as they consume a wide range of organic particles and phytoplankton.

Significantly, the presence of pollutants or nutrient overloads may have impacted the diversity of zooplankton, favoring certain species while reducing others. This could be linked to agricultural runoff, domestic waste, or other pollutants from surrounding human activities. The less abundant species, like *zoea* and *vioticella*, may be more sensitive to such conditions, as they showed lower population levels throughout the study. Therefore, the study suggests that changes in zooplankton populations can serve as indicators of water quality in Kawo Dam. The fluctuations in species abundance and composition could reflect the impacts of anthropogenic activities on the dam's ecosystem. Monitoring zooplankton provides a useful bioindicator for understanding broader ecological impacts and for assessing the sustainability of aquatic habitats under pressure from human influence.

Monthly and species-specific observations

- *Amphipod*: The dominance of Amphipods, peaking at 54 in May, indicates that early seasonal conditions, such as temperature and nutrient availability, may strongly favor this species. The gradual decline after May might reflect lifecycle patterns or interspecific competition.
- *Euchianis(rotifer)*: Representing 16.96% of the total, *Euchianis* shows sustained presence across the months, with a notable peak in June (18 individuals). As a *rotifer*, *Euchianis* might indicate changes in water conditions, such as nutrient influx, potentially affecting reproductive cycles.
- *Calanoida* and *Calaus* (*copepods*): Both species contribute notably with 9.78% and 6.30% abundances, respectively. Calanoida peaks in May (22 individuals), indicating

similar seasonal advantages as Amphipods, while Calaus has a more stable but slightly fluctuating presence across the months, with a mid-summer peak in July (12 individuals).

- *Vioticella(Cilliophora)*: While comprising only 4.35% of the total, *Vioticella* exhibits a significant presence in June and September, suggesting periodic blooms possibly linked to particular environmental triggers, such as temperature shifts or food resource changes.
- Less Abundant Species: Species like *Zoea* and *Nauplias* exhibit low overall counts (1.96% and 3.26%, respectively). These may reflect specific niche adaptations or life stages sensitive to seasonal conditions.

Ecological Implications

Therefore the study highlights the complexity of zooplankton communities and the potential influence of abiotic factors such as temperature, nutrient availability, and competition. The high percentage of *Amphipods* and *Euchianis* suggests a robust adaptation to seasonal shifts, possibly surpassing other species or benefitting from their biological and reproductive cycles. Furthermore, the distribution patterns observed provides valuable insights into ecosystem health and dynamics during the warmer months.

CONCLUSION

The physicochemical properties of Kawo Dam exhibit clear seasonal variations, with water quality parameters influenced by anthropogenic activities such as agriculture, urban runoff, and wastewater discharge,rainfall and temperature changes. These variations impact the aquatic environment and, subsequently, the distribution and diversity of zooplankton. Elevated BOD and turbidity, alongside nutrient influxes, create variable oxygen and light conditions, which can lead to shifts in zooplankton populations and potentially favor pollution-tolerant species. The observed trends underscore the impacts of natural water mixing and runoff on dam water quality, important for monitoring and managing aquatic ecosystems in Kawo Dam. The distribution patterns of zooplanktons observed provided valuable insights into ecosystem health and dynamics during the warmer months. Similarly, the study highlights the need for regular monitoring of water quality and zooplankton populations in Kawo Dam, emphasizing the importance of managing human activities around water bodies to maintain ecological balance. Effective conservation strategies, including pollution control and habitat protection, could help preserve both zooplankton diversity and the overall health of the dam ecosystem.

Recommendations/and future perspective

1. Monitoring and pollution control measures are essential to safeguard the ecosystem health and the sustainability of aquatic life in Kawo Dam.
2. Further investigation into temperature, salinity, and food web interactions may clarify the ecological roles and drivers behind the variations in zooplankton abundance.

3. Formulate conservation strategies to mitigate the impact of human activities, such as runoff management and restrictions on effluent discharges, coupled with ecological zoning to protect sensitive areas of the dam.
4. Government should establish a long-term monitoring program that evaluates water quality parameters and zooplankton populations, especially during and after peak rainfall months, to identify trends and inform conservation measures.
5. Conduct targeted studies on pollutants from agricultural, domestic, and industrial sources in the Kawo Dam area, analyzing their contribution to fluctuations in zooplankton populations and water quality.
6. Government should conduct periodic studies on the nutrient loading of phosphate and nitrate throughout the year, particularly during the rainy season, to assess the potential for eutrophication and its influence on zooplankton species distribution.

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