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SEASONAL VARIATION IN THE PHYSICOCHEMICAL PARAMETERS OF DABERAM RESERVOIR DUTSI, KATSINA STATE, NIGERIA

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ABSTRACT

The knowledge of the physicochemical values of Daberam reservoir is optimal for proper functioning and growth of the aquatic organisms, the health of the individuals that consume it, and for sustainability of the aquatic animals. The study ascertained the physicochemical parameters of Daberam Reservoir in Dutsi Local Government Area of Katsina State. The water samples were collected from three different sites in an air tight container from January to December 2021, and were transported to the Biological Sciences Department at Federal University Dutsin-Ma for evaluation. The line graph were used to present the results, while regression was further used to compare the relationship among the parameters. The results uncovered that the physicochemical parameters significantly differed from each site and season. The lowest temperature was recorded in the month of January (19.1), while the highest temperature was in the month of June (30.3). Meanwhile, turbidity was highest in the month of May (18.0) and the lowest value were obtained in the month of September (4.1). In the aspect of dissolved oxygen, the month of August had the lowest value (6.2), followed by February to April which had the highest dissolved oxygen (7.6). The pH was lowest in the month of January and higher in the month of May and June (7 to 7.5). There were regression relationship between temperature and other physicochemical parameters in this study. At $\alpha = 0.05$, both t values are statistically significant since their corresponding P values are < 0.05.

Keywords: Variation in season, Water parameters, Daberam reservoir, Dutsi, Katsina State

INTRODUCTION

Ponds, rivers, dams, stream, creeks, lakes and reservoirs are used to study and monitor the richness and circulation of aquatic organisms (plants and animals) (Gilbert *et al*., 1989). It is well-known that the productivity/yield of a reservoir depends on its ecological conditions and monitoring the water quality. The physicochemical parameters of the water are the significant resource that influence the dynamics and formation of the planktons (Sharma *et al*., 2016). The species and organisms that inhabit the water body are influenced by the Changes in physicochemical parameters of the ecosystem. Subsequently, Seasonal variations also impart the distribution and periodicity of the freshwater biota.

Productivity can be increased to obtain maximum sustainable yield of aquatic biota (Peters *et al*., 2013). However, Wetzel (2001) reported that conservation of healthy aquatic environment, its sustainability and sufficient production of aquatic food in the reservoir are linked to successful reservoir culture operations. Lakes, Dams and reservoirs are invaluable environmental resources, it is used by the community for irrigation purpose, fishing, drinking and other domestic activities, which also serve as source of family revenue and animal protein (Subhankar and Musthafa, 2013). Nigeria is endowed with both fresh and marine water body in form of flood plains, rivers, lakes, and lagoons. However, there are factors that could affect the quality of the water, aquatic organisms, breeding process such as the fertility, hatchability of the eggs, fauna, floral which in turn impair the food chain it includes pollution, abnormal increase in the water quality parameters, climate change and agricultural activities (Santore *et al*., 2021). In addition, Mahad and Baawain (2019) reported that Waste water, seasonal variations, metals and metalloids, industrial sediments, nutrients, pharmaceuticals, polycyclic aromatic hydrocarbons, flame retardants, persistent organic pollutants, pharmaceuticals and illicit drugs, emerging contaminants, pesticides, herbicides, and endocrine disruptors are other factors that negatively affect water quality.

Water as a habitat for fish, should have favourable quality parameters such as dissolved oxygen, pH, Temperature, biological oxygen demand, minerals, ammonia, nitrate, nitrite, phosphate in such amounts that are not harmful to fishes (Null *et al*., 2017). Water quality which comprise of physical and chemical characteristics includes dissolved oxygen, suspended solids, temperature, pH, mineral contents and nitrate influence the reproduction and growth of the fish (Ahmad *et al*.,2014). Among a broad spectrum of aquatic pollutants, heavy metals are the most harmful/toxic agents. These contaminants can cause various environmental complications or affect different trophic levels in the food chains, which affect the aquatic environment and water quality parameters (Dietz *et al*., 2000). Physicochemical and biotic features of water bodies are correlated and are driven by the surrounding land use, it also determine the quality of the water before entrance into the freshwater streams (Gupta *et al*., 2017). Physicochemical parameters and nutrient in the water play a role in the distribution pattern and species composition of aquatic planktons (Sharma *et al.*, 2016). Daberam reservoir is efficiently used for irrigation purpose, public water source for both man and animals and for fishing. This study investigated the physiochemical water properties of the Daberam reservoir.

MATERIALS AND METHODS

Study area

The Daberam Reservoir as shown in plate 1 is located in Dutsi, Local Government Area of Katsina State , at latitude 13°21N and longitude 8°21E (Abdulaziz *et al*., 2019). Daberam Reservoir is situated on river Kigo and Riniyal which are seasonal rivers, as its sources of water and River is Dan-nakola and a tributary at Daura and Dutsi Local Government Areas, Katsina State. The reservoir lies in northern Sudan savannah zone the climate is characterized by distinct wet and dry seasons with an annual rainfall of 600 – 640mm. The reservoir has a total storage capacity of about 400 hectares of land, but because of siltation, only 200 hectares is fully been utilized. The depth of the reservoir is 42.6meter with a crest length of 2377.44 meters (Abdulaziz *et al*., 2019). Fish were collected at the following sampling stations; station A, station B, and station C. Station A is located at the entry of the reservoir on the channel of Kigo River. Station B is located at the middle of the reservoir where human activity is minimal except agricultural and irrigational activities. Station C is located at the extreme end of the reservoir.

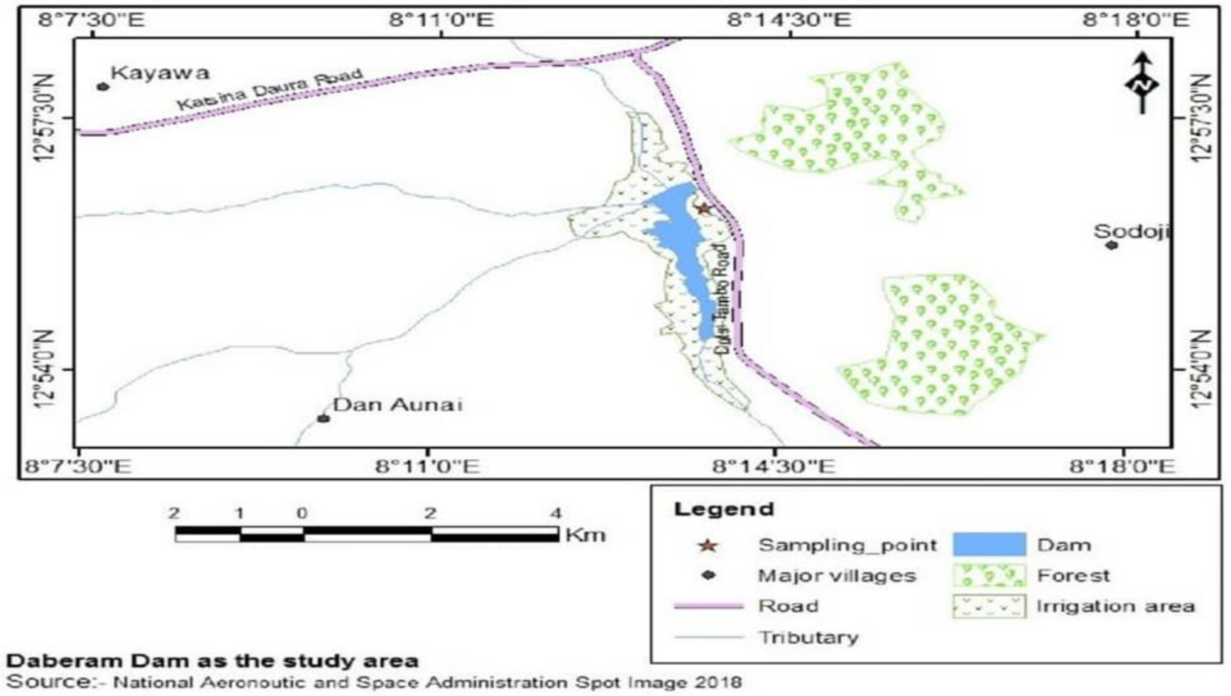

Plate 1: The map of Daberam reservoir

The Sampling Procedures of the Water and Duration

The Water samples from the three stations were collected twice every month from January to December 2021. The water samples were collected in a sample bottles, and transported back to the laboratory for analysis which includes pH, alkalinity, dissolved oxygen, ammonia-nitrogen, hardness, phosphorus, transparency, while temperature of the reservoir were taken immediately for accuracy, and they were determined following the methods described by Dauda and Akinwole (2014). All the procedure followed the standard methods (APHA, 2012)

Statistical analysis

The overall water quality parameters for the twelve months were presented using Line graph and histogram. While the regression were used to compare the relationship between temperature and the other parameters.

RESULTS

The result of the Daberam water temperature in Figure 1 ranged from 19.1 in January to 30.3 in June. While the figure 2 revealed a turbidity of 4.1 in September and October and 18.6 in June. The dissolve oxygen as shown in figure 3 were 6.2 in August and 7.6 in February, April and July.

The pH of the Daberam water are recorded in figure 4. The lowest pH was observed in the month of January and August (6.1) while the highest was in the month of October (7.6). Meanwhile, the alkalinity level of Daberam reservoir is recorded in figure 5, the least was obtained during the month of December (25.3) while the highest alkalinity was in the month of October (35.6). Figure 6 showed the ammonia level which ranged from 0.05 in January to 2.9 in September. While water hardiness is recorded in figure 7, the highest was in the month of May (100.2) while the least was in the month of September (65). The water Phosphate value was shown in figure 8, October and November had the highest (2.0) while January had the least (1.0). Table 1 and table 2 showed the regression analysis and how the parameters were closely related. There was regression relationship between temperature, dissolve oxygen, pH, turbidity, ammonia, nitrate and alkalinity of the Daberam reservoir.

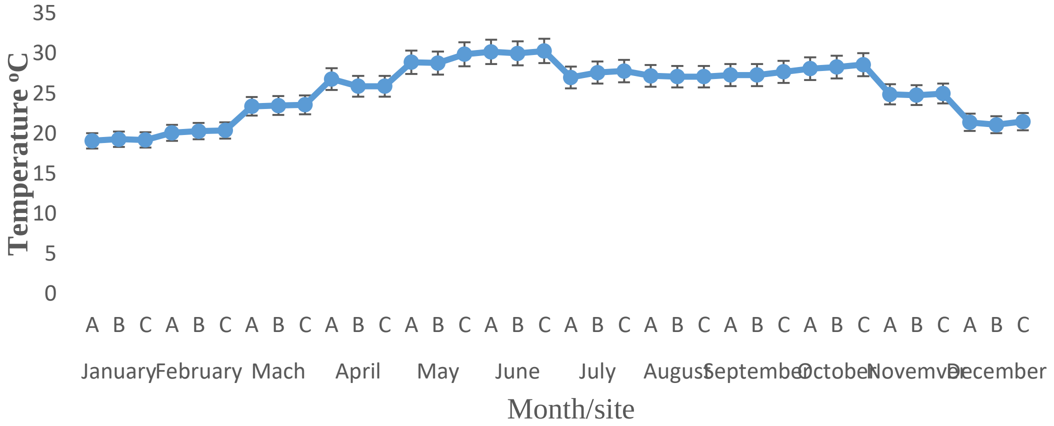

Figure 1: The temperature of the three stations of Daberam water body

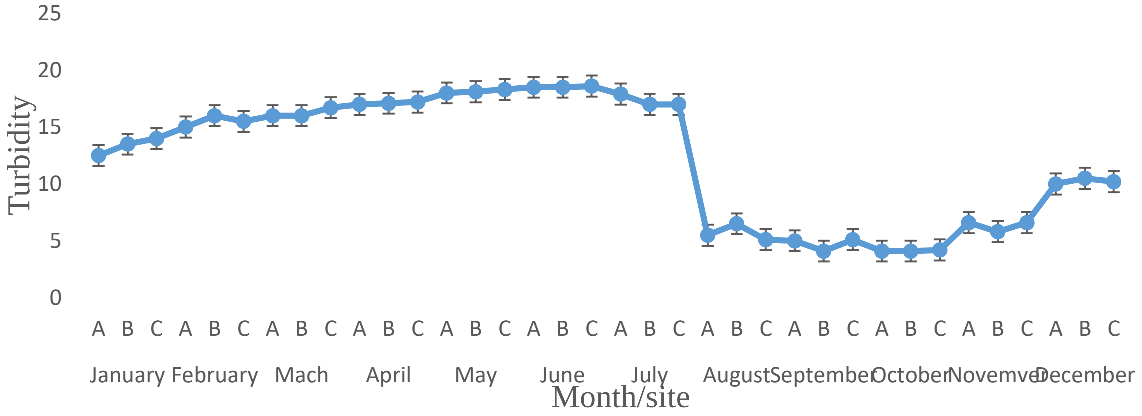

Figure 2: The turbidity of the three stations of Daberam water body

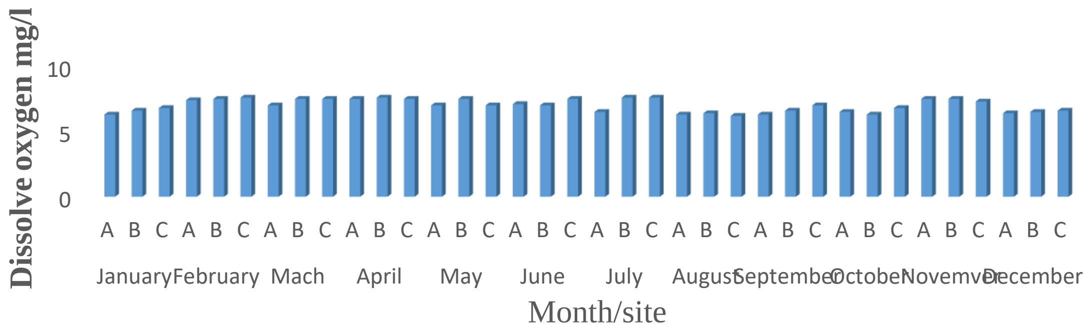

Figure 3: The dissolve oxygen of the three stations of Daberam water body

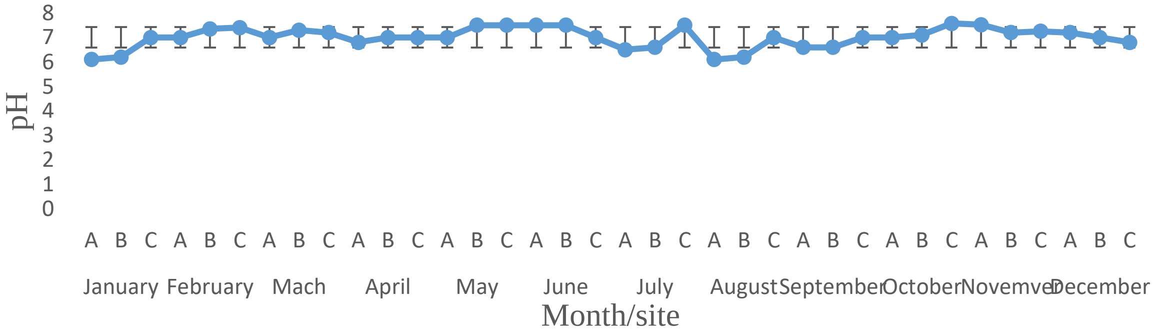

Figure 4: The pH of the three sampling stations of Daberam water body

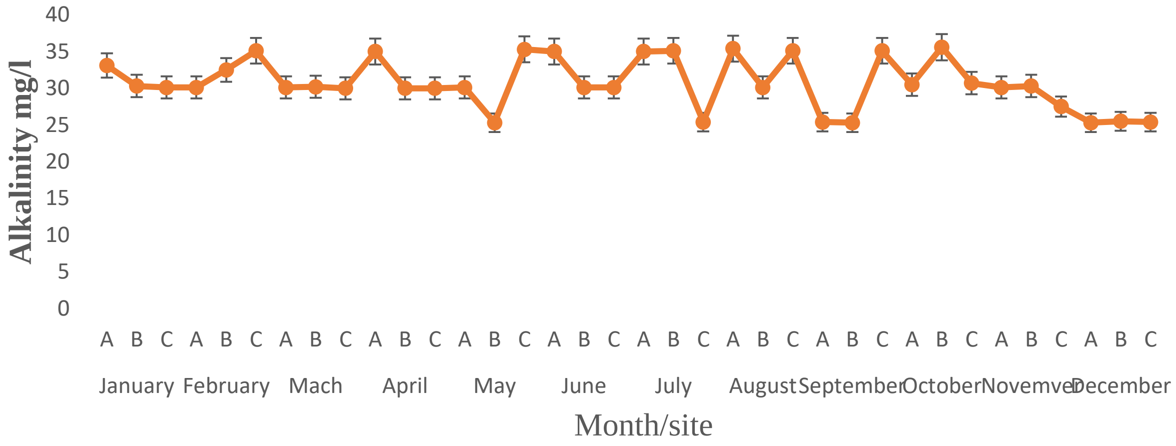

Figure 5: The alkalinity of the three sampling stations of Daberam water body

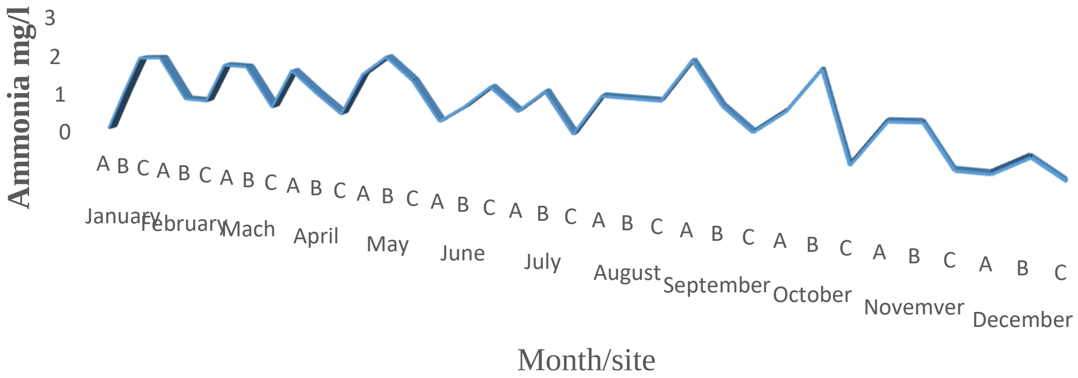

Figure 6: The ammonia of the three sampling stations of Daberam water body

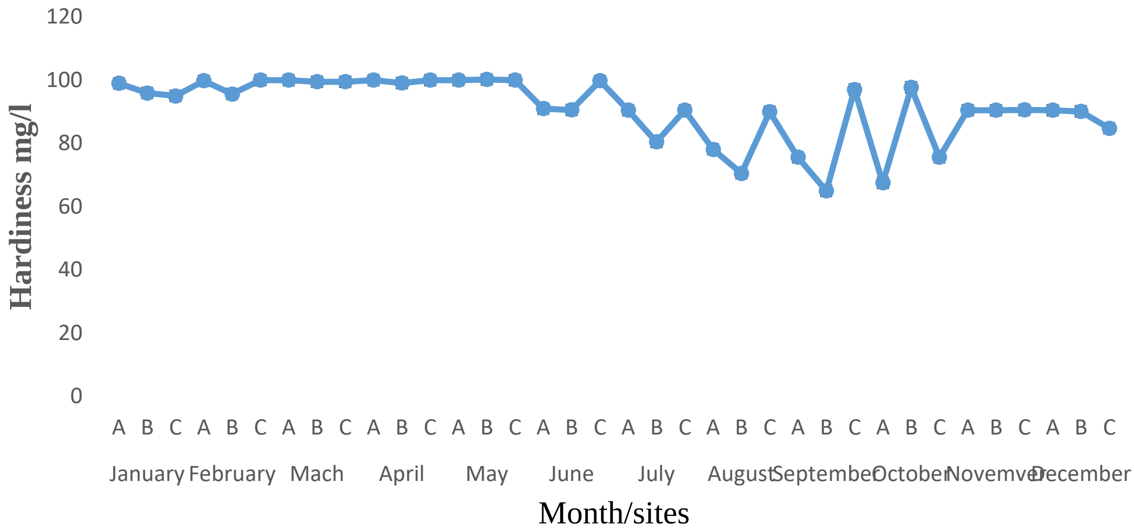

Figure 7: The hardiness of the three sampling stations of Daberam water body

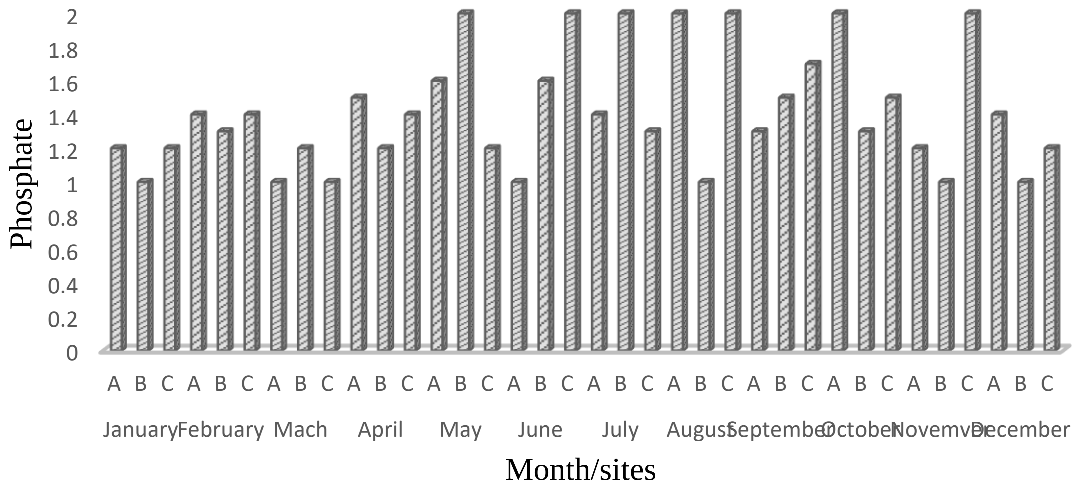

Figure 8: The phosphate of the three stations of Daberam water body

Table 1. The value of the multiple regression Model of Daberam reservoir

Model	Sum of Squares	Degree of freedom	Mean Square	F value	P-value
Regression	221.754	7	31.679	4.237	0.003[b]
Residual/Error	209.338	28	7.476		
Total	431.092	35			

a. Dependent Variable: Temperature
b. Predictors: (Constant), Phosphate, pH, Alkalinity, Ammonia, Turbidity, Hardness, Dissolve Oxygen

Table 2. The Coefficient value of the multiple regression of Daberam reservoir

Model	Coefficient	Std. Error	t statistics	P-value	Lower Bound 95%	Upper Bound 95%
Intercept	6.142	10.218	0.601	0.553	-14.790	27.073
Turbidity	0.236	0.121	1.950	0.061	-0.012	0.485
Dissolve O	-0.777	1.335	-0.582	0.565	-3.512	1.958
pH	3.170	1.348	2.351	0.026	0.408	5.932
Alkalinity	0.264	0.143	1.852	0.075	-0.028	0.556
Ammonia	2.069	0.817	2.533	0.017	0.396	3.741
Hardness	-0.175	0.065	-2.707	0.011	-0.308	-0.043
Phosphate	2.866	1.438	1.993	0.056	-0.080	5.813

DISCUSSION

The physicochemical parameters have to do with the physical and chemical properties of the water. Water is essential for the survival and productivity of the aquatic animals that directly depend on it. The study revealed changes in the physicochemical parameters of the water. The water temperature was lowest in the month of January (19.1ºC) and highest in the month of June (30.3ºC). Water quality monitoring can help researchers predict and learn from natural processes in the environment and determine human impacts on an ecosystem (Loucks and van Beek, 2017). On the above Chapman and Sullivan (2022) inferred that it is an essential parameters that determine the living and sustainability of the aquatic organisms, the ability of the fish to feed and utilize the nutrients for increase in size, number and value. Subsequently, Masood *et al*. (2015) reported that the physicochemical parameters of the water is basic towards a successful breeding process. Therefore, the physical, chemical and biological properties of the water is important for the fish to have optimum productivity. All the water quality parameters are essential for the functioning and survival of the aquatic organisms which includes fish, zooplanktons and phytoplanktons (Sadauki *et al*., 2022). However the most basic that commonly affect the water body in Nigeria includes pH, DO, Temperature, Alkalinity, Ammonia, Hardiness, turbidity and phosphate. All the determined water quality parameters from the three stations in the study showed variations as a result of the season, climate change (Agada and Habu 2022), depth and time of the day (French-McCay *et al*., 2018), closeness to the community and agricultural activities. Meanwhile, they are categorized within the endorsed range for best performance of tropical species of fish. Nevertheless, the fluctuations in temperature will affect growth, reproduction and survival. There are several factors that could lead to fluctuations in water quality parameters, it includes climate change, water depth (French-McCay *et al*., 2018) rise in the water level, and agricultural activities around the water body. The study revealed that there were no significant difference in the water temperature across the three sites for the period of the research (January - December) nevertheless, it came to diminution in the month of December, January and February and raised in the month of April and pinnacle in the month of June and then declined in the month of July which is the raining season. The change in the water temperature could be attributed to the fluctuation in the atmospheric temperature, climate change and the season of the year which includes dry season, hot season and raining season (Sadauki *et al*., 2022). Turbidity is the level of photoperiod that penetrate the water body which is spread by suspended particles in the water (Grobbelaar, 2009). Furthermore, Shmeis (2018) state that turbidity can be caused by suspended materials or dissolved particles in the water which make the water look cloudy or murky. The particulate matter includes mud, clay and silt particles, plant pieces, melting glaciers, sawdust, wood ashes or chemicals in the water fine organic and inorganic matter, soluble colored organic compounds, algae, microscopic organisms. The turbidity increased from the month of February to July while the least was in the month of August to November which is the peak of the raining season to early stage of the dry season this disagreed with (Sadauki *et al*., 2022) who reported increase in the transparency of Ajiwa and Zobe reservoir from the month of September to February. Meanwhile the increase in the turbidity of the water during the raining season can be linked to rise in water flow and high sediments from runoff (Zhou *et al*., 2015). Rain can also directly increase the level of total suspended solids through precipitation. In other words, low turbidity can be connected to erosion, debris, wastewater that has a residual particles or decay particles from both plant and animal materials (Shmeis, 2018). Considering the water body under study is a reservoir the tendency of the increased turbidity is high during rain and dry season. The dissolved oxygen increased from February to June (7.1 – 7.6) and reduced from July to October which is high compared to the acceptable value 5mg/l (Bozorg-Haddad *et al*., 2021) for water body, this agreed with Apollos *et al*. (2016) who reported similar results in Zobe reservoir Dutsin-ma. However, temperature and turbidity have a significant effects in dissolved oxygen of the water (Bozorg-Haddad *et al*., 2021). Gomez *et al*. (2017) further reported that low dissolved oxygen level is an indication of contamination. The pH of the water ranged from 6.1 in the month of January and August to 7.6 in October, there were fluctuations in the pH value of the reservoir, hence, (Boyd, 2000) stated that pH levels of a water can fluctuate due to photosynthesis and respiration in the water. The level of change correlate with the water alkalinity. Furthermore, Carbon dioxide is a causative agent of acidity in the water, while the alkalinity of the *water* is from carbonate and bicarbonate ions, and this also can be used to buffer *water* against immoderate *pH change.* Another essential water quality parameter is Ammonia-nitrogen, it involves both non-ionized (NH3) and ionized (NH4 +), it is the prevalent pollutant in the surface water. Its source is from human activities such as kitchen waste, metabolic, agricultural and industrial processes, and from disinfection with chloramine (Fu *et al*., 2012). Ammonia-nitrogen concentration in surface water is mostly influenced by hydrogeology and climate change. There was an increase in the ammonia level in the months of September and October, while there was a diminution in December and January the fluctuations in the ammonia level of the water could be linked to climate change, breaking down of organic particles, agricultural activities along the reservoir bank. The result obtained in the research agreed with Sadauki *et al*. (2022) who reported increase in the ammonia level in the Ajiwa reservoir. Alkalinity and hardiness has a positive correlation, it is usually similar because of calcium, magnesium, bicarbonate, and carbonate ions in the water are descended in similar quantities from the mixture of limestone in geological deposits. However, in this study there was a difference between the hardness and alkalinity of the water, Sadauki *et al*., (2022) recorded similar trend in both Ajiwa and Zobe reservoir. There was a regression relationship between temperature, dissolved oxygen, pH, ammonia, hardness, turbidity, phosphate and alkalinity. F statistics is a test of significance for the entire regression process, therefore, at $\alpha = 0.05$ revealed that the regression was statistically significant because the corresponding p-values is <0.05. Hence, all the water quality parameters are significantly useful in the prediction of temperature. Furthermore, individual coefficient exposed that each of the variables contribute meaningful information in the prediction of temperature. Temperature is an important factor to consider when assessing water quality. In addition Mondal *et al.* (2016) reported that temperature have a positive correlation with other water quality parameters, furthermore, it can modify the physical and chemical properties of water. In this regard, water temperature should be accounted for when determining physicochemical parameters of the water.

CONCLUSION

The study revealed that there is a measure of association between temperature and other physicochemical parameters of the water. The parameters studied did not exceed the recommended range for proper functioning and sustainability of aquatic organisms. It can further be treated before been used for fish farming and aquaculture activities. Subsequently there is a probability of the pH rising towards alkalinity level which can impair aquatic life. The rise in the dissolved oxygen and ammonia level during dry season revealed that there is a farming activities taking place around the river bank.

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