

Numerical simulations and fish diversity in relation to physico-chemical parameters of four aquatic stations in Badagry Division, Lagos, Nigeria

Abstract

Aim: This study investigated common fish assemblages in four aquatic stations (Gbaji, Topo, Agboju and Ajegunle) in relation to physico-chemical parameters of its water and as well simulates numerical values of the physico-chemical parameters for year 2024.

Methodology: Data were collected and computed using standard methods and algorithm machine learning model respectively. Statistical tools employed include ANOVA and Pearson correlation (r) test. All the parameters (except turbidity, chemical oxygen demand and biochemical oxygen demand) were within standard permissible limits.

Results: The results of Pearson's correlation analysis showed that increase in amount of fish species in the sampling stations was significantly and strongly linked to the decrease in value of biochemical oxygen demand ($r = -0.571$, $P = .05$), total dissolved solids ($r = -0.696$, $P = .05$) and conductivity ($r = -0.882$, $P < 0.01$) while increase in number of fish species was significantly and strongly linked to the increase in value of dissolved oxygen ($r = 0.991$, $P = .05$). However, salinity ($r = 0.387$), sulphate ($r = 0.212$) and turbidity ($r = 0.282$) had weak positive relationship with the number of fish species. The prediction by the machine learning algorithm modeling system revealed that at Agboju, total hardness would exceed permissible limit in February and September, carbon dioxide (CO_2) in February, May and June, 2024. On the other hand, level of CO_2 at Ajegunle would exceed permissible limit in January, May, August and September, and total hardness in November, 2024. For both Agboju and Ajegunle, turbidity and chemical oxygen demand level would exceed limits throughout the months in year 2024.

Conclusion: Hence, effects of higher parameters could result in declination of distribution of demersal fish species which often shuttle between the water bottom and surface.

Keywords: Fish diversity, numerical simulations, correlation, water quality.

1. Introduction

Water is affected by an array of physical, biological and chemical factors which in turn influence the species diversity and composition, as well as productivity and physiological conditions [1]. When various physical and chemical or biological factors are available in suitable qualities, it promotes an increased metabolic and reproductive activities and growth for aquatic organisms. Chindah [2] reported that the physico-chemical parameters of an aquatic ecosystem depend largely upon the season and some other environmental factors such as anthropogenic activities, among others. Studies have shown that seasonal variations in physico-chemical parameters have an important role in the distribution, periodicity, quantitative and qualitative composition of freshwater biota [3]. For instance, the study of the physico-chemical parameters of Ogunpa River in Ibadan revealed that low dissolved oxygen levels result in anaerobic decomposition products such as hydrogen sulphide, ammonia and methane gases, and these products are all deleterious to aquatic organisms [4]. However, the values obtained for physico-chemical parameters in the waters of Lagos Lagoon complex were within the acceptable levels for survival, metabolism and physiology of aquatic organisms [5]. Overall distribution and diversity of aquatic communities are significantly determined by the environmental and biochemical parameters of the system. Hence, the central area of interest for environmentalists over time has been on how to have better understanding of these factors and the response of the ecosystem towards the environmental

variables[6].Therefore, this study aims to determine the relationship between the physico-chemical parameters and fish assemblages from four aquatic stations in Lagos, Nigeria and as well simulates the value of these physico-chemical parameters for year 2024.

2. Materials and methods

2.1 Sampling Stations

Aquatic stations examined for this study were Gbaji, Agboju, Topo and Ajegunle which were located within Badagry Division of Lagos State, Nigeria (Figure 1). Gbaji (Lat. $6^{\circ} 20' N$, Long. $3^{\circ} 0' E$) and Topo (Lat. $6^{\circ} 20' N$, Long. $3^{\circ} 02' E$) are tributaries of Badagry creek, Agboju site is a tributary of Lagos Lagoon located on Latitude $6^{\circ} 40' N$ and Longitude $3^{\circ} 20' E$ while Ajegunle (Lat. $6^{\circ} 40' N$, Long. $3^{\circ} 22' E$) is a tributary of Ajegunle creek. Gbaji and Topo are located in Badagry Local Government Area (LGA), Agboju is located in Amuwo Odofin LGA while Ajegunle is located in Ajeromifelodun LGA.

2.2 Collection of water sample and assessment of fishers' catch composition

Sample of water were collected twice every month from the four sampling stations (Gbaji, Agboju, Topo and Ajegunle) for a period of 24 months (January 2018 to December, 2019) in line with standard procedures provided by APHA[7].At each station, two sampling points were chosen. The category of fish species landed at each station was noted using both virtual observation and taking of photograph at the sampling site while the numbers of each species in the catch were recorded when fishers sorted their catches at the landing site. Thereafter, the pictures of unidentified specimens were brought to the laboratory for identification by experts at the Department of Fisheries, Lagos State University.

2.3 Determination of physico-chemical parameters

Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), alkalinity, total hardness, sulphate, nitrate, phosphate, turbidity and Carbon dioxide (CO_2) were determined in the laboratory using methods described by APHA [7]. Temperature, pH, conductivity, salinity, Total Dissolved Solid (TDS), and dissolved oxygen of the water samples were measured in-situ by using a mercury-in-glass thermometer, HQ40D Portable Multi Meter (pH, Conductivity, Salinity, TDS, ORP and ISE for water, USA) and DO meter (Method: HACH 8157) while water turbidity was measured using nephelometer (Analite portable nephelometer Model 156, Mcvan Instrument, Mulgrave).

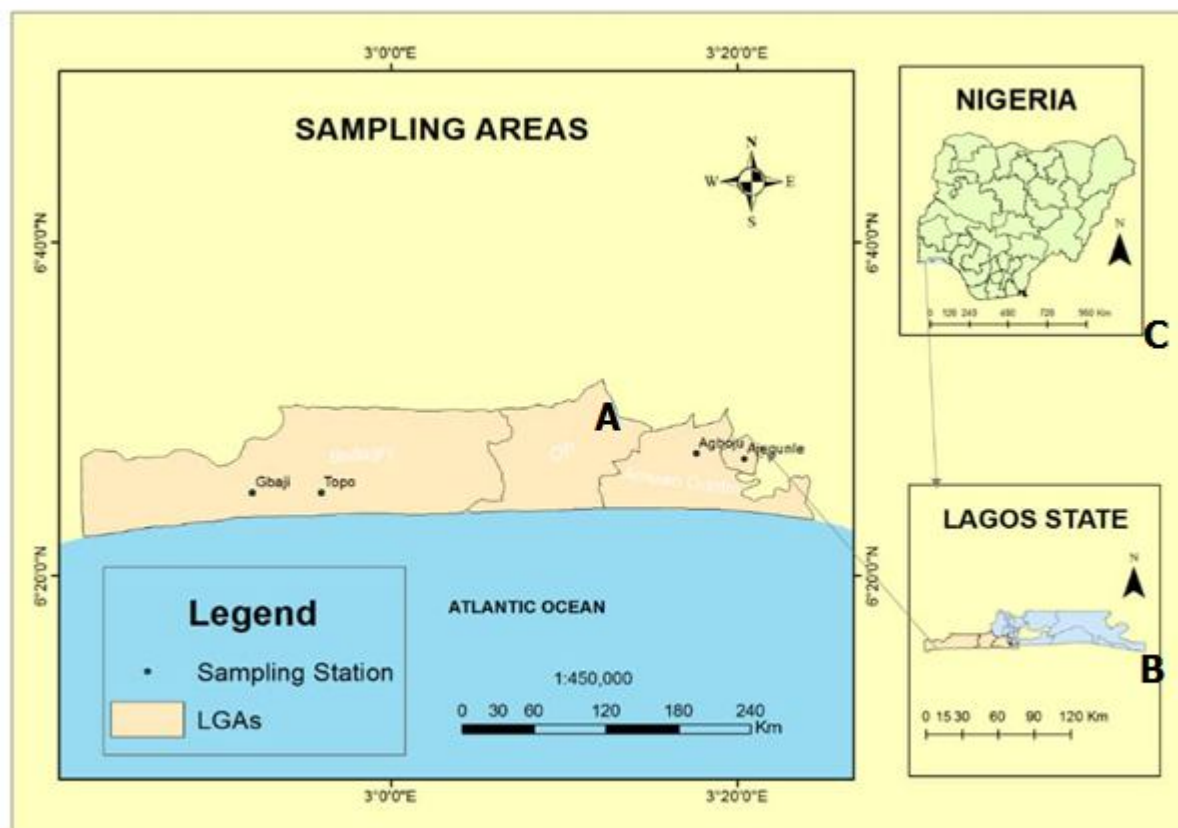


Figure 1: Locations of sampled stations
A= Badagry division, B= Lagos State and C=Nigerian map

2.4 Simulation of levels of physico-chemical parameters in the sampling stations

The modeling system employed for the simulation was algorithm machine learning model. Raw data (Physico-chemical parameters in water) were coded into machine language accordingly. A website was designed using the algorithm machine for the prediction as shown below. With this website, the concentration of physical and chemical properties of the selected aquatic ecosystems can be predicted.

i. **Url for physico-chemical parameters (prediction):**

<https://www.wolframcloud.com/obj/b449e356-3d59-4b89-a2ab-f2913f1d1d17>

2.4.1 Coding of the Data for Modeling

Raw data of sample of water collected twice every month from the four sampling stations (Gbaji, Agboju, Topo and Ajegunle) for a period of 24 months were coded as follows. The coded values assigned to the physico-chemical parameters were in the orders: Alkalinity-1, temperature-2, biochemical oxygen demand (BOD)-3, conductivity-4, total dissolved solids (TDS) -5, carbondioxide-6, total hardness-7, chemical oxygen demand (COD)-8, turbidity-9, phosphate-10, dissolved oxygen (DO)-11, pH-12, salinity-13, sulphate-14 and nitrate-15.

2.4.2 Coding of Sampling Stations, frequency of sampling and months

Agboju was coded as 1, Gbaji as 2, Ajegunle-3 and Topo as 4. The number of collection per month was designated as 'attempt'. The first time of collection was assigned 1, while second

collection was assigned 2. Month of January was coded as 1, February-2, March-3, April-4, May-5, June-6, July-7, August-8, September-9, October-10, November-11 and December-12.

2.5 Statistical Analyses

All Data for spatio-temporal physico-chemical parameters were computed with the Statistical Package for Social Scientists (SPSS) version 20.0 software. The computed data were tested by one-way Analysis of Variance (ANOVA) and Pearson correlation while Least Significance Difference (LSD) Post-hoc test was used to separate the means. The level of significance was set at $P=.05$ except for the Pearson correlation where both $P<0.01$ and $P=.05$ were considered. The prediction of future variance in physico-chemical parameters at the sampling stations were done via model and developed website for this study.

3.RESULTS

3.1 Spatio-temporal variation of water physico-chemical parameters

The spatio-temporal variation of water physico-chemical parameters in the stations are presented in figure 2. Water in Gbaji had average temperature of $28.08\pm 1.88^{\circ}\text{C}$, Agboju ($28.62\pm 2.14^{\circ}\text{C}$), Topo ($27.98\pm 1.99^{\circ}\text{C}$) while Ajegunle had average temperature of $29.19\pm 1.78^{\circ}\text{C}$. However, there was no significant difference in spatio-temporal variation in regards to the values of water temperature across the sampling stations. The results showed significant difference ($P=.05$) between the values of dissolved oxygen (DO) recorded in Ajegunle ($6.42\pm 1.58\text{mg/L}$) in comparison with values of dissolved oxygen recorded in Gbaji ($8.76\pm 0.99\text{mg/L}$), Agboju ($7.92\pm 1.48\text{mg/L}$) and Topo ($7.93\pm 2.12\text{mg/L}$). The trend of values of pH across the sampling stations was 6.94 ± 0.98 at Gbaji to 7.62 ± 1.18 at Ajegunle. On the other hand, the mean pH in Agboju was 7.35 ± 0.56 while Topo had pH of 7.13 ± 0.77 . Among the sampling stations, Agboju had the highest alkalinity ($52.90\pm 10.12\text{mg/L}$), followed by Gbaji ($51.35\pm 8.26\text{mg/L}$) and then Topo (50.65 ± 7.38) while the least alkalinity was recorded at Ajegunle ($46.75\pm 4.21\text{mg/L}$). However, there was no significant spatio-temporal variation in values of alkalinity recorded between Topo and Gbaji stations and pH across the stations.

The least values of biochemical oxygen demand (BOD) was recorded in Topo ($214.66\pm 22.39\text{mg/L}$) while the highest was recorded in Ajegunle ($229.50\pm 29.73\text{mg/L}$). While BOD recorded at Agboju was $222.54\pm 21.64\text{mg/L}$, Gbaji had $215.48\pm 30.21\text{mg/L}$. All the values of BOD across the stations were significantly different ($P=.05$). The highest value of total dissolved solids (TDS) was recorded at Gbaji ($135.89\pm 6.96\text{mg/L}$), followed by Topo ($132.88\pm 5.23\text{mg/L}$), then Ajegunle ($130.97\pm 11.38\text{mg/L}$), while the least was recorded in Agboju ($127.45\pm 10.48\text{mg/L}$). There was significant ($P=.05$) spatio-temporal variation for the TDS across the sampling stations. The mean values of carbon dioxide (CO_2) in Gbaji, Agboju, Topo and Ajegunle were $8.40\pm 1.11\text{mg/L}$, $8.42\pm 1.75\text{mg/L}$, $8.19\pm 0.99\text{mg/L}$ and $10.24\pm 1.19\text{mg/L}$ respectively. However, only values of CO_2 from Ajegunle was significantly ($P=.05$) higher than values of CO_2 from other sampling stations. There was significant ($P=.05$) spatio-temporal variation in values of total hardness recorded from the sampling stations with the highest total hardness recorded in water from Ajegunle ($244.25\pm 10.91\text{mg/L}$), followed by Agboju ($211.65\pm 16.82\text{mg/L}$), then Topo ($208.67\pm 9.55\text{mg/L}$) while Gbaji ($203.45\pm 12.89\text{mg/L}$) had the least value of total hardness. The phosphate level in water from Gbaji, Agboju, Topo and Ajegunle were $5.13\pm 1.48\text{mg/L}$, $8.69\pm 1.12\text{mg/L}$, $4.89\pm 1.82\text{mg/L}$ and $7.12\pm 2.02\text{mg/L}$ respectively. However, only the values of phosphate recorded in Gbaji and Topo had no significant spatio-temporal variations. Similarly, there was no significant spatio-temporal variation in the values of salinity across the stations. Specifically, salinity levels of $0.589\pm 0.06\text{ppt}$, $0.774\pm 0.040\text{ppt}$, $0.620\pm 0.082\text{ppt}$ and

0.924±0.06ppt were recorded in water sampled from Gbaji, Agboju, Topo and Ajegunle respectively. Significant (P=.05) spatial variation were recorded for conductivity across the stations. The order of values of conductivity in $\mu\text{s}/\text{cm}$ recorded across the stations was 225.27±10.97, 233.59±45.60, 237.60±40.48 and 268.65±36.41 from Gbaji, Agboju, Topo and Ajegunle respectively. The respective values of nitrate from Gbaji, Agboju, Topo and Ajegunle were 6.86±0.94mg/L, 5.32±1.16mg/L, 5.22±1.44mg/L. and 7.12±1.64mg/L. However, there was no significant spatio-temporal variation in the values of nitrate recorded across the sampling stations. Ajegunle had the highest value of chemical oxygen demand, COD (240.46±25.18mg/L) while Gbaji had the least value of 192.86±14.44mg/L. Values of COD in Agboju and Topo were 237.62±15.70mg/L and 198.50±18.34mg/L respectively. All the values of COD across the sampling stations are significantly different (P=.05).

The differences in the concentrations of sulphate from Gbaji (4.68±1.65mg/L), Agboju (5.98±2.09mg/L) and Topo (4.79±1.24mg/L) were not statistically significant. However, value of sulphate recorded in Ajegunle (8.78±0.98mg/L) were significantly (P=.05) higher when compared with the other three sampling stations. While there was no significant spatio-temporal variation between values of turbidity recorded at Topo (41.68± 9.15 NTU) and Ajegunle (41.63±7.08 NTU), values of turbidity in Gbaji (39.65±8.26 NTU) and Agboju (45.37±9.69NTU) were significantly (P=.05) different. Furthermore, level of turbidity at both Topo and Ajegunle varies significantly (P=.05) from turbidity level at both Gbaji and Agboju.

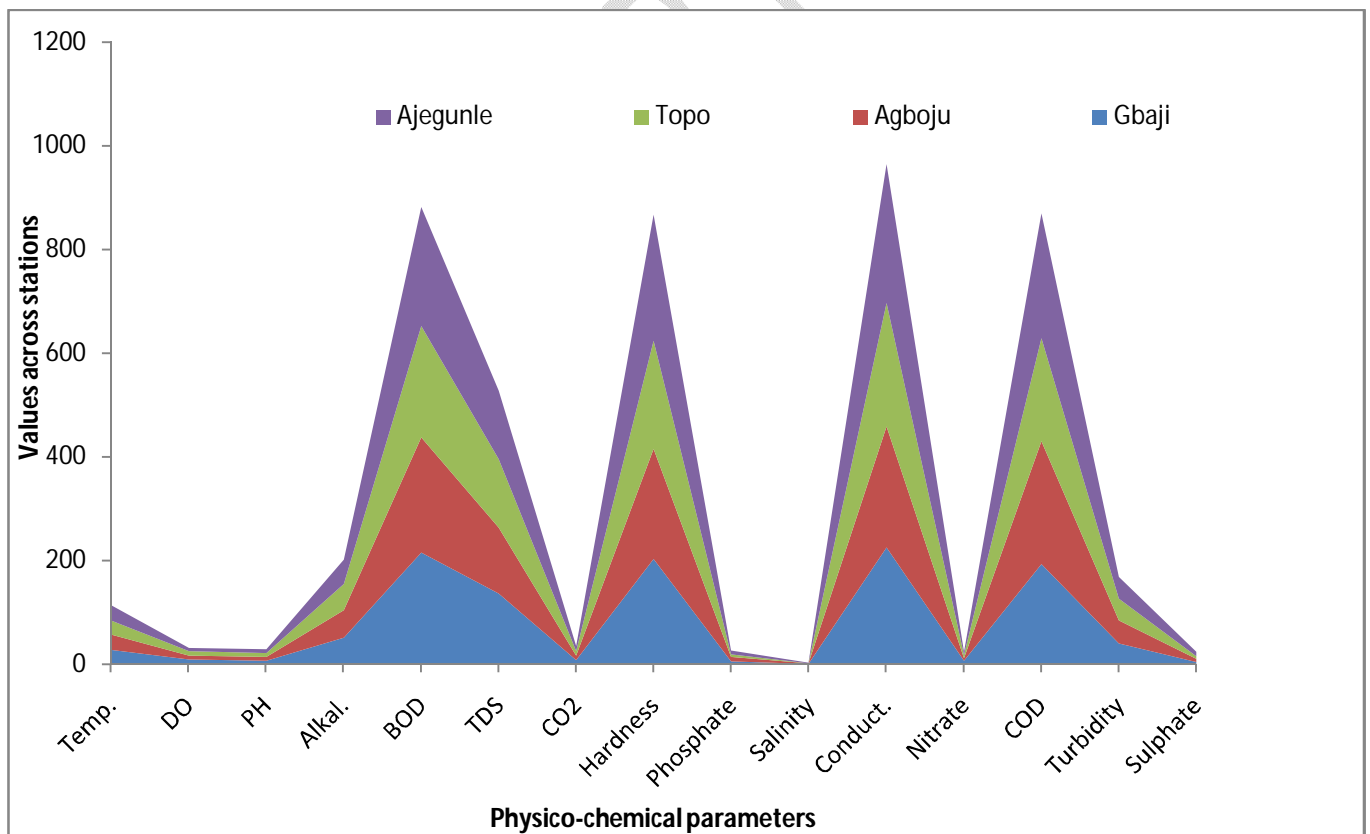


Figure 2: Spatio-temporal variation of water physico-chemical parameters from the sampled stations

3.2 Fish species and its correlation with physicochemical parameters

Sixteen (16) fish species were most common at the four stations (Table 1). Across the stations, *Tilapia guineensis* constituted 17.80%, 15.70%, 20.82% and 17.22% of the fish species recorded at Gbaji, Agboju, Topo and Ajegunle respectively. But the least percentage was observed in *Sardinellamaderensis*(1.05%) in Gbaji, *Sardinellaaurita*(1.79%) and *Bathysoleaprofundicola*(1.79%) in Agboju, *Papyrocranusufer*(0.79%) and *Pellonulaleonensis*(0.79%) in Topo, and *Liza falcipinnis*(1.73%) in Ajegunle.

The results of Pearson's correlation analysis to estimate the association between the water quality and the distribution of fish species across the sampling stations was shown in Table 2. The population/abundance of the fish species was negatively correlated to three parameters (BOD, TDS and conductivity) and positively correlated to twelve physico-chemical parameters (Temperature, Dissolved Oxygen, Alkalinity, Carbondioxide, Total Hardness, Phosphate, Salinity, Nitrate, Chemical Oxygen Demand, Sulphate, Turbidity and pH). The increase in number of fish in the sampling stations was significantly and strongly linked to the decrease in value of Biochemical Oxygen Demand ($r = -0.571$, $P=.05$), Total Dissolved Solids ($r= -0.696$, $P=.05$) and Conductivity ($r=-0.882$, $P<0.01$) while increase in number of fish was significantly and strongly linked to the increase in value of Dissolved Oxygen($r= 0.991$, $P=.05$). However, only Salinity ($r= 0.387$), Sulphate ($r = 0.212$) and Turbidity ($r= 0.282$) had weak positive relationship with the number of fish species.

Table 1: Relative Abundance of Most Common Fish Species caught in the sampling Stations

Fish Species	Gbaji	Agboju	Topo	Ajegunle	Overall Relative Abundance
<i>Caranx hippos</i>	67 (11.70)	46 (6.86)	82 (16.11)	51 (8.87)	246 (10.58)
<i>Sardinellaaurita</i>	27 (4.71)	12 (1.79)	43 (8.45)	12 (2.09)	94 (4.04)
<i>Sardinellamaderensis</i>	6 (1.05)	27 (4.04)	27 (5.30)	57 (9.91)	117 (5.03)
<i>Ethmalosafimbriata</i>	67 (11.70)	82 (12.26)	18 (3.54)	32 (5.57)	199 (8.56)
<i>Tilapia guineensis</i>	102 (17.80)	105 (15.70)	106 (20.82)	99 (17.22)	412 (17.71)
<i>Chrysichthysnigrodigitatus</i>	64 (11.17)	42 (6.28)	31 (6.09)	67 (11.65)	204 (8.77)
<i>Papyrocranusufer</i>	20 (3.49)	27 (4.04)	4 (0.79)	12 (2.09)	63 (2.70)
<i>Callinectespallidus</i>	18 (3.14)	47 (7.02)	12 (2.36)	52 (9.04)	129 (5.54)
<i>Oreochromisniloticus</i>	40 (6.98)	65 (9.71)	71 (13.95)	32 (5.57)	208 (8.94)
<i>Sarotherodonmelanotheron</i>	32 (5.58)	35 (5.23)	43 (8.45)	12 (2.09)	122 (5.25)
<i>Bathysoleaprofundicola</i>	42 (7.33)	12 (1.79)	19 (3.73)	20 (3.48)	93 (4.00)
<i>Pegusalascaris</i>	18 (3.14)	46 (6.88)	12 (2.36)	50 (8.70)	126 (5.42)
<i>Pellonulaleonensis</i>	20 (3.49)	24 (3.59)	4 (0.79)	15 (2.60)	63 (2.70)
<i>Eleotrisvitata</i>	9	47	14	42	112

	(1.57)	(7.02)	(2.75)	(7.30)	(4.82)
<i>Solenocera africana</i>	20	27	5	12	64
	(3.49)	(4.04)	(0.98)	(2.09)	(2.75)
<i>Liza falcipinnis</i>	21	25	18	10	74
	(3.66)	(3.74)	(3.53)	(1.73)	(3.18)
Total	573	669	509	575	2326

values in parenthesis are percentages

Table2: Pearson correlation between the physico-chemical parameters and fish species assemblages

Parameter	Correlation Coefficient	Nature of relationship
Temperature	0.569	Strong
Dissolved Oxygen	0.991*	Strong
Alkalinity	0.585	Strong
Biochemical Oxygen Demand	-0.571*	Strong
Total Dissolved Solid	-0.696*	Strong
Carbondioxide	0.970	Strong
Total Hardness	0.978	Strong
Phosphate	0.891	Strong
Salinity	0.387	Weak
Nitrate	0.916	Strong
Chemical Oxygen Demand	-0.643	Strong
Sulphate	0.212	Weak
Turbidity	0.282	Weak
pH	0.694	Strong
Conductivity	-0.882**	Strong

** correlation is significant at the 0.01 level (2-tailed)

* correlation is significant at the 0.05 level (2-tailed)

3.3 Model for predictions of future values of physico-chemical parameters

For the prediction, the machine learning algorithm modeling systems generated the decision tree whose Geometric Mean Probability Density was 0.0297462, Mean Cross Entropy (3.51505), Mean Deviation (8.51192) and Standard Deviation of 14.8721. Figure 3 showed comparison plot for the machine learning model for physico-chemical parameters. The outcome of the plot showed a perfect prediction as most of the predicted values was not farther disjointed from the principle of line of best fit. The probability density Histogram for the machine learning model for physico-chemical parameters is presented in Figure 4 which illustrates the trend of frequency of prediction of future values for the water physico-chemical parameters when the coded value for each attempt, location, and parameters has been input. However, figure 5 presented the Residual plot for the machine learning model for physico-chemical parameters, which illustrates that there was both close and wide gap between the initial actual values of parameters measured during the sampling periods and the forecasted values for future.

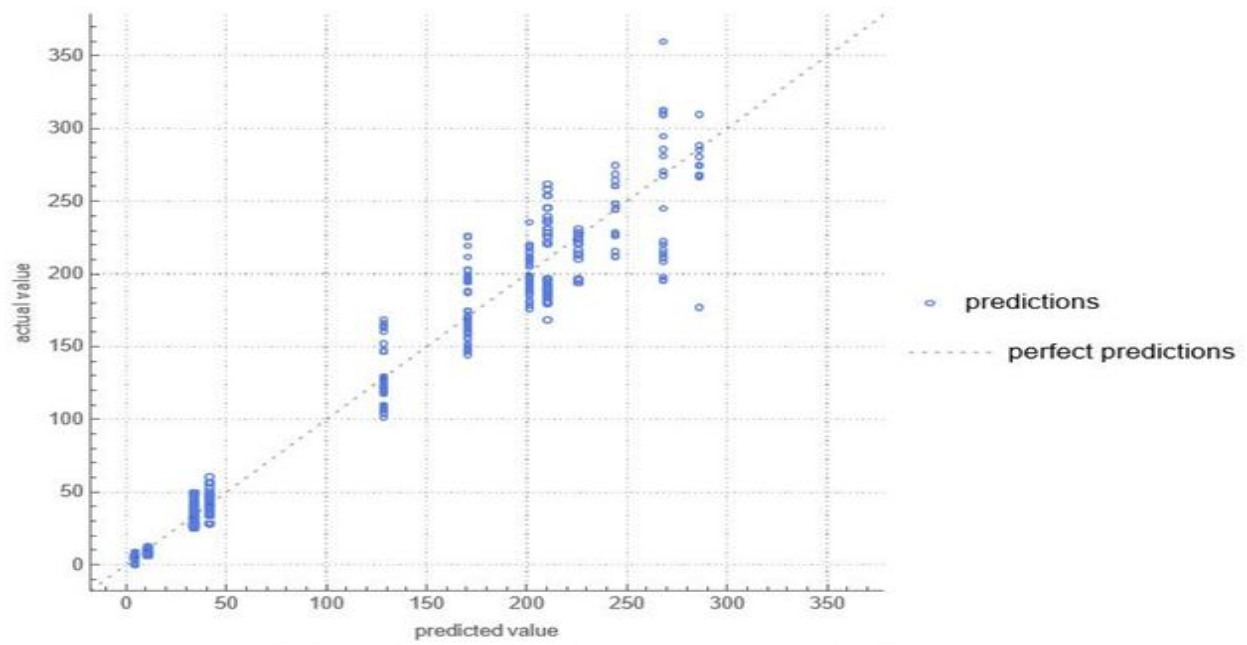


Figure 3: Comparison plot for the machine learning model for physico-chemical parameters

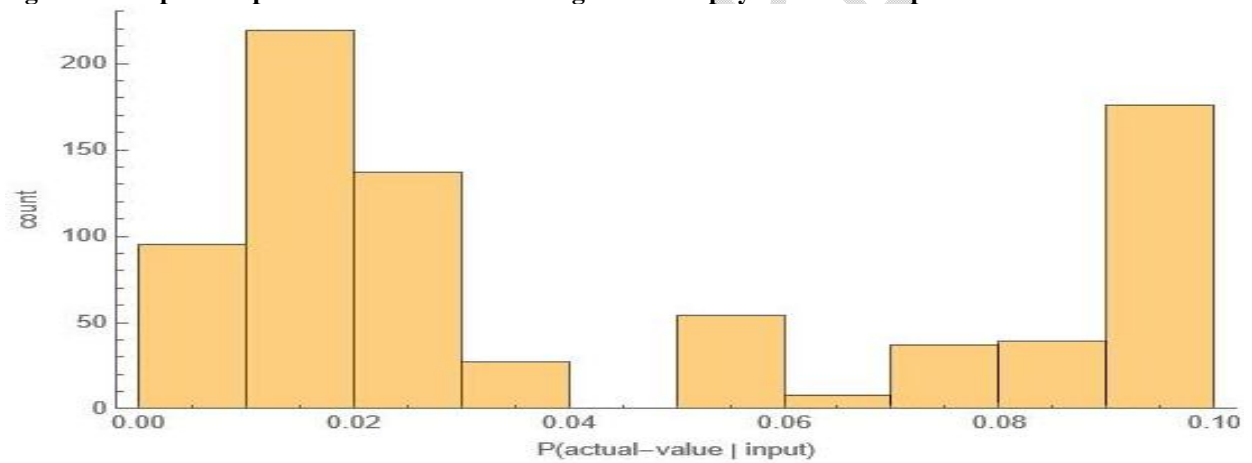


Figure 4: Probability Density Histogram for the machine learning model for physico- chemical parameters

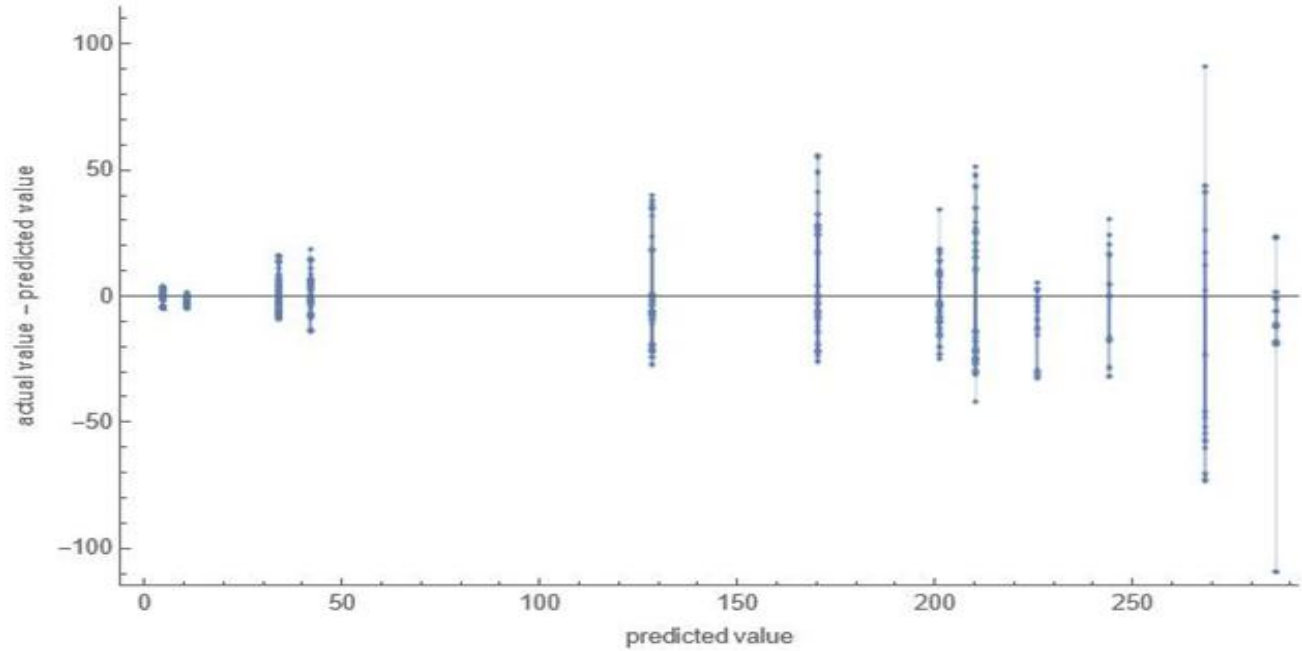


Figure 5: Residual Plot for the machine learning model for physico-chemical parameters

3.4 Outcome of Prediction using machine learning algorithm model

Results of machine learning algorithm modeling systems indicated that Agboju and Ajegunle would have 26% of its water parameters (specifically total Hardness, carbondioxide, chemical oxygen demand, and turbidity) exceeding permissible limit at certain months in year 2024. For Agboju site, mean hardness would exceed limit in February and September (Figure 6) while that of Ajegunle site would exceed limit in November. For carbondioxide at Ajegunle site, mean CO₂ would exceed limit in January, May, August and September (Figure 7) while that of Agboju site would exceed limit in February, May and June. As shown in figure 8, chemical oxygen demand at both sites (Agboju and Ajegunle) would be above limits throughout the year. Similarly, turbidity level for these stations (Figure 9) would be above limit threshold.

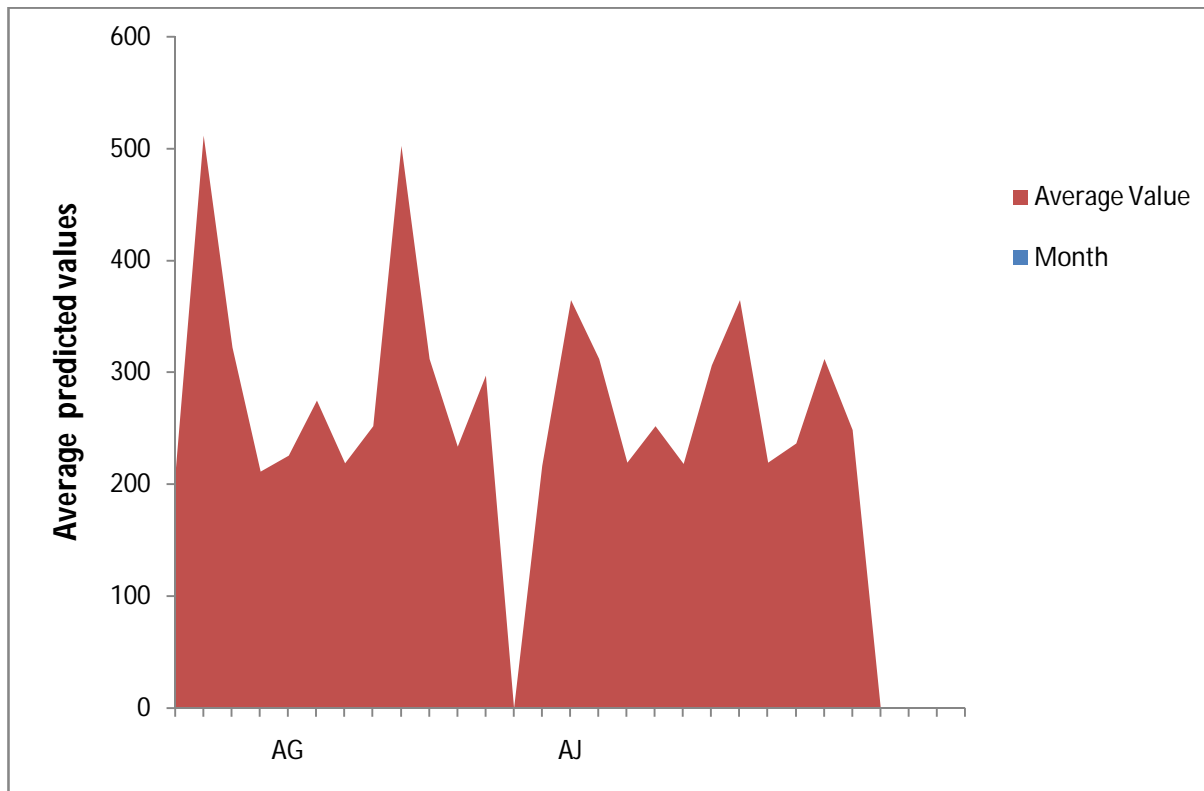


Figure 6: Average value predicted for hardness at Agboju (AG) and Ajegunle (AJ) for 2024 (Jan-Dec)

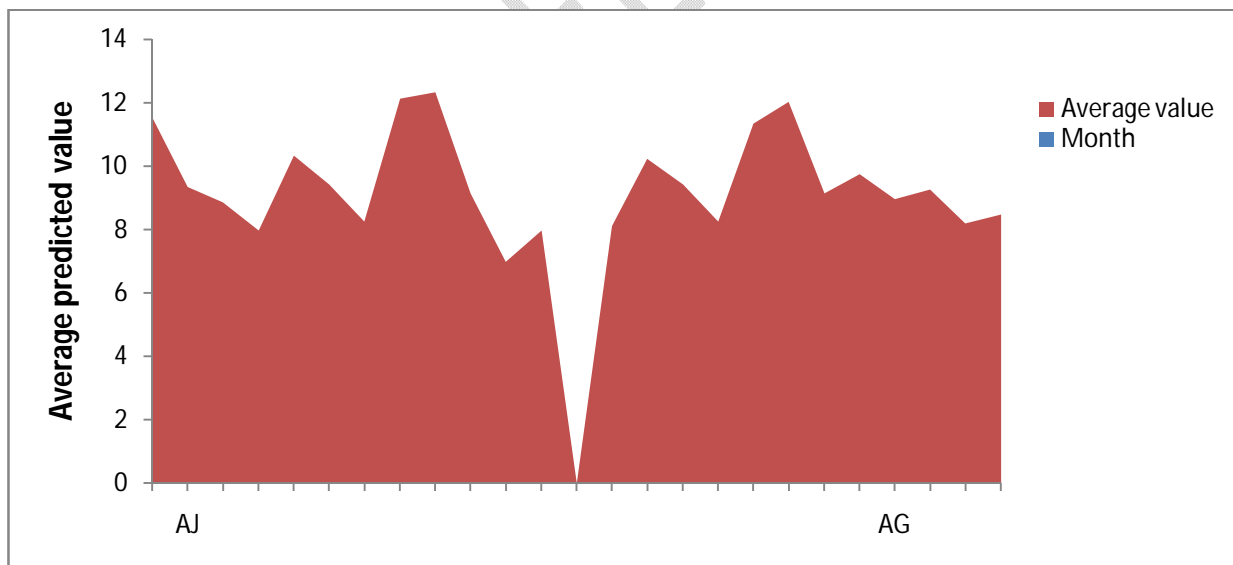


Figure 7: Average value predicted for carbondioxide at Ajegunle (AJ) and Agboju (AG) for 2024 (Jan-Dec)

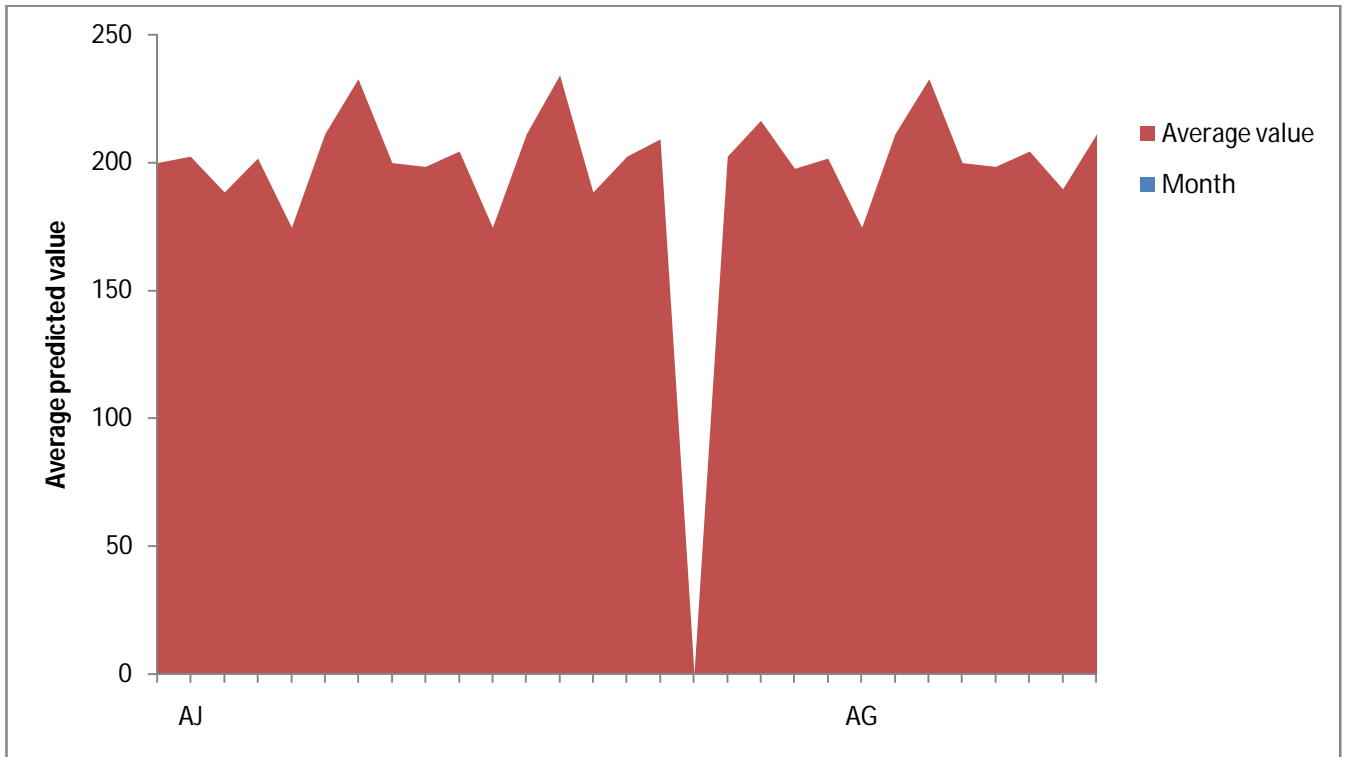


Figure 8: Average value predicted for chemical oxygen demand at Ajegunle(AJ) and Agboju (AG) for 2024 (Jan-Dec)

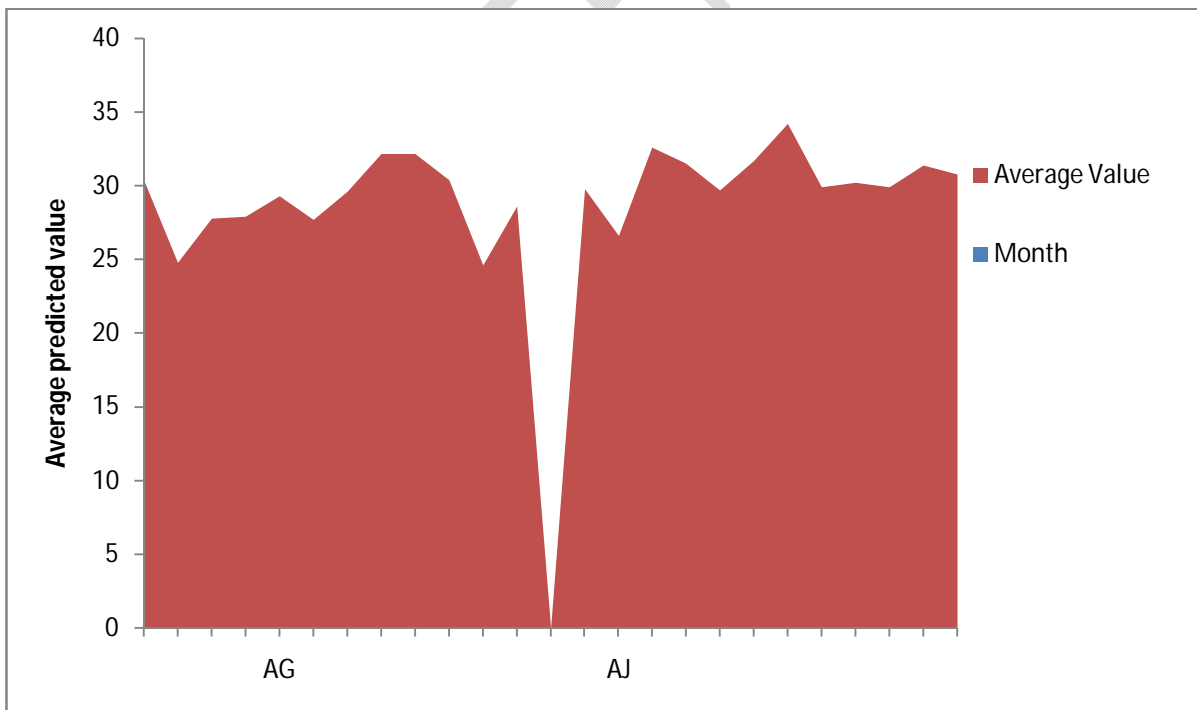


Figure9: Average value predicted for turbidity at Ajegunle (AJ) and Agboju (AG) for 2024 (Jan-Dec)

4. Discussion

The spatio-temporal variation of dissolved oxygen, temperature, salinity, pH, phosphate and nitrate in this study that were not significantly different across the aquatic ecosystems suggest that there could be an easy migration of the aquatic biota to any of the aquatic ecosystem in case their primary habitat is altered. Similar observation for the above parameters has been reported during the preliminary survey of the environmental health status of Ajegunle, Gbaji, Agboju and Topo aquatic stations [8]. Among the fifteen physico-chemical parameters examined in this study, only the values of biochemical oxygen demand, turbidity, chemical oxygen demand across the sampling stations, with carbon dioxide at Ajegunle exceeded the recommended maximum permissible limit of 40mg/L, 5NTU, 40mg/L, $\leq 10\text{mg/L}$ respectively [9-10]. High biochemical oxygen demand, chemical oxygen demand, and turbidity across the sampling stations, could imply sequential alteration in the quality of the water which might be due to unregulated and none monitoring of the anthropogenic activities of the users of these aquatic ecosystems. However, the values of all water parameters recorded in this study were lower in comparison to that of Ologe Lagoon and Majidun River [11-12] but were higher than those reported in Lekki Lagoon, Owo river, and in water from Wadi Hanifah, Saudi Arabia [13-15].

A total of sixteen (16) fish species were common across the four stations where *Tilapia guineensis* constituted the highest percentage of the catch while *Papycrocranus afer* and *Pellonulaleonensis* were the least. The highest number of fish (669) and lowest (509) were obtained from Agboju and Topo respectively. Getting more *T. guineensis* in this study could suggest that Cichlid family were prominent in Nigerian water bodies. For instance, 46 species belonging to 28 genera and 16 families was identified in the flood plain of Cross River, Nigeria with members of the Bagridae family forming the most abundant followed by the Cichlids and Clariidae while the eight major fishes commonly found in the coastal waters of Lagos State of Nigeria were *Pseudotolithus senegalensis*, *Coptodon zilli*, *Trachinotus goreensis*, *Polydactylus quadrifilis*, *Pomadasy jubelini*, *Ethmalosa fimbriata*, *Chrysichthys nigrodigitatus* and *Sphyraena piscatorum* [16]. However, the investigation of fish species abundance *vis a vis* frequency of occurrence and number of occurrence of fishes in Agboyi creek in Lagos State indicated that there were occurrence of 25 species belonging to 17 families in which *Coptodon zilli* constituted 81.52% of the catch followed by *Oreochromis aureus*, *O. niloticus* and *Hemichromis fasciatus* [17]. Similar to the observation in this study, macrobenthic community in Lake Qarun, Egypt was found to comprise of sixteen species belonging to three phyla [18].

In this study, the increase in amount of fish species obtained across the sampling stations was significantly and strongly linked to the decrease in value of biochemical oxygen demand, total dissolved solids and conductivity but significantly and strongly linked to the increase in value of dissolved oxygen. Therefore, highest numbers of fish recorded in Agboju station could be attributed to its low total dissolved solid and biochemical oxygen demand levels. However, the over water quality parameters in this study especially for most of the parameters being within permissible limits indicated that the water is still suitable for fish in all the stations. Findings of authors had shown that the structure and abundance of aquatic organisms (e.g. macrobenthic species) were adversely affected by pollutants such as drainage water contaminated with sewage [18]. In this study, there were insignificant positive correlations between abundance of fish species with temperature, dissolved oxygen, alkalinity, carbon dioxide, total hardness,

phosphate, salinity, nitrate, chemical oxygen demand, sulphate, turbidity and pH. Similar findings has been reported in River Swat, Pakistan where water parameters like conductivity, pH and total dissolved solid showed negligible impact upon species abundance [19].

The prediction by the machine learning algorithm modeling system revealed that total hardness in Agboju would exceed permissible limit in February and September, carbon dioxide level would exceed permissible limit in February, May and June, while turbidity and chemical oxygen demand (COD) level would be above limits throughout the months in year 2024. Moreso, this study divulged that level of total hardness at Ajegunle station would exceed limit in November, 2024 while carbon dioxide level would exceed permissible limit in January, May, August and September. However, COD and turbidity would exceed limits in these stations throughout the twelve months in year 2024. Though, aquatic organism in this water bodies can still thrive but the effects of these higher parameters could result in declination of distribution of demersal fish species which often shuttle between the water bottom and surface. As revealed by Recknagel [20], machine learning has been effectively applied to ecological modeling and ecological time-series modeling and is also applicable in Fisheries. Synonymous to the outcomes of simulation using machine learning algorithm in this study, physicochemical particularly pH has been reported to influence the spatial distribution of species in Densu Estuary [21]. Also, the number of fish species and water physico-chemical have both very strong negative and positive correlation [22].

5. Conclusion

The study has established that there exist a significant relationship between increase in amount of fish species and decrease in value of biochemical oxygen demand, total dissolved solids and conductivity while increase in number of fish species was significantly and strongly linked to the increase in value of dissolved oxygen. Across the stations, *Tilapia guineensis* constituted highest fish species, followed by *Sardinella maderensis* and *Liza falcipinnis* while *Papyrocranus afer* and *Pellonula leonensis* were the least in term of abundance. The study has also revealed how physico-chemical can be predicted using the machine learning algorithm modeling system. Such prediction could facilitate pro-activeness of aquatic monitoring towards providing panacea to aquatic quality deterioration often generated by anthropogenic sources. The study further divulged that for both Agboju and Ajegunle, turbidity and chemical oxygen demand (COD) level would exceed limits throughout the months in year 2024. Thus, positive action is required by water monitoring agencies as effects of higher water parameters could result in declination of distribution of demersal fish species which often shuttle between the water bottom and surface.

COMPETING INTEREST

Authors have declared that no competing interests exist.

REFERENCES

- [1] Anwan HR, Anetekhai MA, Mekuleyi GO. Assessment of Physico-Chemical Characteristics and Heavy Metal Concentrations of Stubbs Creek, Ibeno, Akwa Ibom, Nigeria. International Journal of Advanced Academic Research, 2021; 7(5):15-26.

- [2]Chindah AC. Response of periphyton community to salinity gradient in tropical estuary, Niger Delta. *Pollution Journal of Ecology*,2004;52(1): 83-89.
- [3]Ogbuagu DH, Ayoade AA,AC-Chukwuocha NB.Spatial dynamics in physicochemistry and bacterio- and myco-plankton assemblages of Imo River in a Niger-Delta community in Nigeria. *African Journal of Microbiology Research*,2011;5(8): 872-887
- [4]Ogidiaka E, Esenowo IK, and Ugwumba, AAA.Physio-chemical parameters and benthic macroinvertebrates of Ogunpa River at Bodija, Ibadan, Oyo State. *European Journal of ScientificResearch*, 2012;85(1): 89-97.
- [5]Ayo-Olalusi CI, Ayoade AA.Biometric Characteristics of *Sphyraenaafra* from the coastal waters of Lagos State. *Journal of Biology, Agriculture and Healthcare*,2017;7(8): 1-9. 3
- [6]Odulate DO, Samsons Y, Omoniyi IT.Multivariate analysis of fish species and environmental factors in marine coastal waters of the gulf of Guinea, Southwest Nigeria. *Croatian Journal of Fisheries*,2014; 72: 55-62. DOI: 10.14798/72.2.729.
- [7]American Public Health Association (APHA).American Water Works Association and Water PollutionControl Federation, Washington, DC.*Standard Methods for the Examination of Water and Wastewater*.2005; 18th edition.
- [8]Mekuleyi GO, Anetekhai MA, Aderinola OJ, Adu AA.Environmental Health Status of Some Aquatic Ecosystems in Badagry Division of Lagos State, Southwest, Nigeria. *International Journal of Ecotoxicology and Ecobiology*, 2019; 4(4): 93-102.
- [9]United States Environmental Protection Agency (USEPA).Risk assessment, Regional Screening Levels (RSLs) for chemical contaminants at superfund sites-User's guide and summary generic tables, 2018.
- [10]World Health Organization (WHO).Guidelines for drinking-water quality: fourth edition incorporating the first addendum. Geneva: World Health Organization; 2017. Licence: CC BY-NC-SA 3.0IGO.T.
- [11]Ndimele PE, Kumolu-Johnson CA.Some Aspects of the Physicochemistry and Heavy Metal Content of Water, Sediment and Cynothrissamento (Regan, 1917) from Badagry Creek, Lagos, Nigeria. *Trend in Applied Science Research*, 2012; 7: 724-736.
- [12]Oladunjoye RY, Fafioye OO. Biochemical and Physico-Chemical Characterization of Majidun River Water, South-West, Nigeria. *International Journal of Environmental Chemistry and Ecotoxicology Research*, 2016;1(1): 1-11.
- [13]Kuton MP, Ayanda IO, Uzoalu IA, AkhiromenDI, GeorgeA, AkinsanyaB.Studies on heavy metals and fish health indicators in *Malapteruruselectricus* from Lekki Lagoon, Lagos, Nigeria. *Veterinary and Animal Science*, 2021; 12:1-7.
- [14] Clarke EO, Ndimele PE, Mekuleyi GO, DisuMO.Ecological Impacts of Sand Mining on some Aspects of Fisheries of Lagos Lagoon Complex, Lagos State, Nigeria. *Nigerian Journal of Fisheries and Aquaculture*,2019;7(1):31-39.
- [15] Abdel-Baki A, Dkhil M, Al-Quraishy S.Bioaccumulation of some heavy metals in tilapia fish relevant to their concentration in water and sediment of WadiHanifah, Saudi Arabia. *African Journal of Biotechnology*, 2013; 10(13): 2541–2547.
- [16]Bolarinwa JB, OkeowoTO.The Species Composition and Diversity of the Coastal Waters of Badagry, Lagos State, Nigeria. *Global Journal of Agricultural Research*, 2017; 5(2): 26-31.
- [17]Olawusi-Peters OO, Ayo-Olalusi CI. Finfish diversityinAgboyi Creek, Lagos State of Nigeria. *Proceedings of the Conference of Fisheries Society of Nigeria*, 2009; 244-247.

- [18].Gawad SA, Abdo MH, Al-AfifyAD. Variations in the macrobenthic invertebrates in relation to physico-chemical characteristics and WQI in Lake Qarun, Egypt. The Egyptian Journal of Aquatic Research. 2022 Dec 1;48(4):349-358.
- [19]Sohail M, Khattak MNK, Tauseef I, Korai AL, Shah A, Lashari KH. Ichthyodiversity in relation to physico-chemical parameters of River Swat. Sindh Univ Res J., 2014; 46: 525-530.
- [20]Recknagel F. Applications of machine learning to ecological modeling. Ecological Modelling (Elsevier), 2001; 146: 303-310.
- [21] Akita LG, Laudien J, Akrong M, Biney C, Nyarko E, Addo S. Physicochemical influence on the spatial distribution of faecal bacteria and polychaetes in the Densu Estuary, Ghana. African Journal of Environmental Science and Technology, 2020; 14(6): 139-158.
- [22]Niyoyitungiye L, Giri A, Mishra BP. Assessment of Physico-chemical Characteristics of Water at Selected Stations of Lake Tanganyika, Africa with Special Emphasis on Pisciculture Purposes. International Journal of Basic and Applied Biology, 2019; 6(3): 211-217.