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Trend of climate change and Aquaculture Demand-Supply Gap in Nigeria: 1990-2019

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ABSTRACT

The study considered the trend of climate change and demand-supply gap of aquaculture in Nigeria and the role of climate change. The specific objectives were to: describe the trend of demand-supply gap and climate change (humidity, rainfall and temperature) in Nigeria; the study used time series data spanning from 1990-2019. Data on aquaculture demand and supply were collected from the Federal Department of Fisheries. Data on rainfall and temperature were collected from FAO. Humidity data were collected from NiMet. Data for this study were analysed using descriptive statistics such as mean, percentages and trend graphs. The result revealed that the demand-supply gap ranged between 862,653 and 1,892,944 with a mean of 1,427,795 tonnes. The latter represents a demand-supply gap of 92.53 percent on the average. Rainfall ranged between 1046mm and 1596 mm with a mean of 1273.95mm Humidity ranged between 78.4 and 85.00 percent with a mean of 81.27 percent while temperature ranged between 26.18^{0}C and 27.85^{0}C with a mean of 27.30^{0}C during the time period. The KPSS test for unit root indicated that all the variables are integrated of order one and can be stationary at first difference.

Keywords: Trend, Climate change, demand-supply, aquaculture, gap

1. INTRODUCTION

Fish demand increased steadily from 2006 (2,660,000 metric tonnes) to (3.420,000 metric tonnes) in 2014 by 3 percent and encountered a decline in 2015 with around 140,000 mt. The estimated demand for fish assumed a further upward trend from 2016 (3,280,000 mt) with a rise of around 3 percent to 4,515,000 mt in 2025. The average foreseen fish demand is 3,488,050. From 2006 the rise in estimated fish production increased slightly with an average rate of 3.19 percent. The average total supply was 1,954,116 mt. The estimated Demand-supply gap annually from 2006 to 2025 is 1,533,934 mt (Giwa *et al.*, 2018).

Cai and Leung (2017) worked on world aquaculture demand supply gap and estimated that the world trend growth in fresh water and diadromous finfish farming would produce 13.8 million tonnes of growth in supply, which accounts for 87 percent of the 15.8 million tonnes of demand growth engineered by level of income and population growth, resulting in a 2-million-tonne demand-supply gap.

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The trend growth in fresh water and diadromous finfish farming in 150 countries would not be enough to satisfy their demand growth; supply is envisaged to occur in 34 countries of the world. Country with relatively large freshwater and diadromous fish demand-supply gap (greater than 100,000 tonnes) include the following in ascending order with the respective regions Uganda in Africa; the United States of America in Americas; Thailand, the Philippines, Bangladesh, Myanmar, India and China in Asia (FAO, 2018).

FAO (2018) further estimated that the world trend growth in freshwater and diadromous finfish aquaculture is 4.9 percent per year from the mid-2010s to the early 2020s, which is a little less than the 5.5 percent growth that is required to meet the anticipated demand growth. The demand-supply for the freshwater and diadromousis negative unlike the marine fish whose demand-supply is positive (this is an indication of excess supply over demand).

A detailed comprehension of the previous and future pattern of climate change is realised by scientists mainly using observations and theoretical models to match past climate data, make future projections and link the causes and effect to the climate change (Salma *et al*., 2017; Dangana *et al*., 2022; Abera, 2022). Mann and Jones (2003) revealed the mean surface temperature over the past 2000 years and reported that the warmth experienced in the late 20th century was unprecedented and attributed to the anthropogenic forcing of climate change.

Jones (2001) observed that since the 19th century, average global surface temperature has been recording an increase of approximately 0.6^{0}C $\pm$0.2 (95 percent confidence interval). In the 20th century, an increase in temperature has been noted in two periods from 1910 to 1945 and 1976 to 2001. The warming rate from 1976 (0.76^{o}C/ decade) was slightly higher, as compared to the period between 1910 and 1945 (Solomon, 2007). More so, foreseen rise in temperature is expected in order of 1.4^{o}C to 5.8^{o}C over the 21st century, if the current rate of greenhouse gases (GHG) emissions continues (Folland *et al.,* 1999; Salman *et al.,* 2017). Change in climate change being observed within last 60 years is the warmest in the past 1000 years (Dodman, 2007).

Since incidence of the world average records from 1856, the period between 2000 to2010has been recorded the warmest (Salman, 2017). The National Oceanic and Atmospheric Administration, NOAA (2010) of Pakistan recorded that since 1876, there has been an increasing trend in the trend in mean November and December temperature by 2^{o}C to 1.5^{o}C respectively. Mean humidity in December has also been increasing since 1950.

Climate in Nigeria has been changing with evidence of temperature increase, varying rainfall, rise in seal level, flooding, drought, desertification, land degradation and more frequent extreme weather issues (Elisha *et al.,* 2017; Otokiti *et al*., 2021).

Empirical studies have been conducted on climate change and aquaculture. For instance, Barange *et al*. (2018) examined the impacts of climate change on fisheries and aquaculture but did not analyse the effect of climate change on the demand and supply gap of aquaculture. Onada and Ogunbadejo (2016) proposed a sustainable approach to increasing fish production in the face of climate change in Nigeria. Their work focused more climate change mitigation and not on climate change effects. Akinrotimi *et al.* (2011) worked on environmental friendly fish farming in Nigeria. The study was about the impact of aquaculture on the environment. Rosita *et al.* (2015) measured climate change effect but limited the work to some states in Malaysia. However, this study is designed to evaluate the trend of climate change and aquaculture demand-supply gap in Nigeria, a necessary research gap to fill. The specific objectives are to:

i. describe the trend of aquaculture demand-supply gap in Nigeria and
ii. describe the trend of climate change (rainfall, temperature and relative humidity) in Nigeria

2. METHODOLOGY

The study on growth rate and Direction of aquaculture Demand-Supply Gap and climate change in Nigeria: 2020 to 2035 was carried out in Nigeria as the study area. The federal republic of Nigeria is located in West Africa between latitude 4^{0}N and longitude 3^{0}E -15^{0} E. It is bordered by the Gulf of Guinea to the South, Benin to the West, Niger to the North, Cameroun and Chad to the East. Nigeria comprises of 36 states and its Federal Capital Territory, Abuja.

Secondary data were used for the study, a time series data on rainfall were collected from FAO, temperature and humidity were collected from NiMet and Aquaculture data from Federal Department of Fisheries, FDF. Graphical trend analysis was used to describe the trend of rainfall, temperature and humidity (objective 1 and 2).

Model specification

The model of the KPSS test with the constant term and trend is as follows:

KPSS= $T^{-2}\sum_{t-1}^{\gamma} S_t^2/\hat{\sigma}_{\infty}^2$ (1)

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where t= 1, 2,…,n

T is the number of observations

$S_t = \sum_{j-1}^{t} \widehat{\omega}_j$ (2)

$\widehat{\omega}_j = Y_t - \bar{Y}$ is the residual of y_t and j

$\hat{\sigma}_{\infty}^2 = \lim_{t\to\infty} T^{-1} VAR\ (\sum_{t-1}^{T} \varepsilon_t)$ is a constant estimate if the calculated test is higher than the critical value of significance of 5 percent.

Growth model

Growth or trend model was used to ascertain the direction and growth rates of variables of interest. The trend equation is given as:

$Y_t = Y_0(1+r)^t$ (3)

where:

Y_t = rainfall, temperature and humidity in year t

Y_0 = rainfall, temperature and humidity in the base year.

R = Compound rate of growth of Y,

t = time trend variable

By taking the natural logarithm of both sides, the linear form of the equation was obtained making it amenable to OLS as:

$\ln Y_t = \ln Y_0 + t\ln(1+r)$ (4)

Substituting in InY_0 with α and In(1+r) with β, equation (4) is rewritten as

$\ln Y_t = \alpha + \beta_t$ (5)

Adding the disturbance or error term to equation (5), we obtain

$\ln Y_t = \alpha + \beta_t + U_t$ (6)

Equation (6) is the growth rate model developed for this study.

For the variables of interest, equation (6) which is an exponential growth model can be specifically stated as follows:

$\ln Temp_t = \alpha + \beta_{Temp}t + \mu_t$ (7)

$\ln Rhum_t = \alpha + \beta_{Rhum}t + \mu_t$ (8)

$\ln Rain_t = \alpha + \beta_{Rain}t + \mu_t$ (9)

$\ln AQDS_t = \alpha + \beta_{AQDS}t + \mu_t$ (10)

where:

Temp, Rhum, Rain and AQDS, represents aquaculture demand-supply gap, temperature, humidity and rainfall respectively.

α = intercept

β = vector of the trend variable and μ is the econometric error term.

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β_{AQDS}, β_{Temp}, β_{Rhum}, β_{Rain}= coefficients of the trend variable for aquaculture demand-supply gap, temperature, humidity and rainfall respectively.

The parameter of utmost interest in equations (6-10) is coefficient of β, the slope coefficient which measures the constant proportional/relative change in the dependent variables for a given absolute change in the value of the regressor t.

Unit root test

The KPSS test for unit root was employed to test whether or not a variable is stationary and also to determine the order of integration of the variable (table 1). The null hypothesis of the KPSS test is that the series of interest is stationary; hence the rejection of the null hypothesis implies that the variable is not stationary. The result indicated all the variables were integrated at order one and stationary at first difference. This implies that the variables exhibit random walk (unit root) or the future values of these variables do not converge from the past values.

Tables 1. KPSS Unit Root Test

	Level		First difference		Inference
Variable	**LM-stat**	**Prob.**	**LM-stat**	**Prob**	
Demand-supply gap	0.6842	0.000	0.0529	0.243	1(1)
Humidity	0.579	0.000	0.2974	0.713	1(1)
Temperature	0.404	0.000	0.2184	0.664	1(1)
Rainfall	0.643	0.000	0.217	0.782	1(1)

Source: Data Analysis, 2021

3. RESULTS & DISCUSSION

Trend of Aquaculture Demand –Supply Gap in Nigeria

The trend of aquaculture demand-supply gap is presented in figure 1. but the demand–supply gap was fairly constant between 1990 and 2004 but however had a sharp decrease in 2005 and decreased slowly until 2019 where there was a slight increase compared to the previous year, 2018.This decrease in gap in recent years could be as a result of the aquaculture policy on backward integration which encouraged all fish importers to invest in aquaculture which has realized an estimated annual increase of 20,000 metric tonnes as estimated by Worldfish (2018).

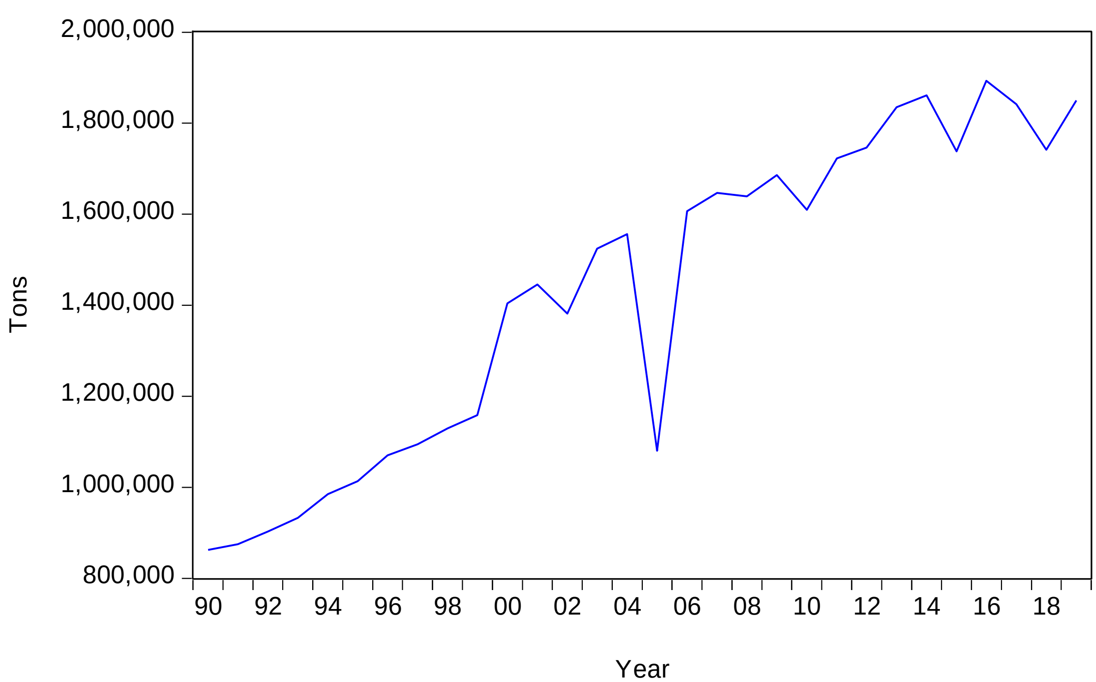

Figure 1: Trend in Aquaculture Demand-Supply Gap (Source: Data Analysis, 2021).

This finding is in line with the work of Oyinbo and Rekwot (2013) who posited that the trend in fish production and fish deficit in Nigeria indicated that there has been an increase in fish demand and supply over the years with fluctuations. The demand-supply gap is rising much faster than the level of supply. This is also similar to the findings of Nwiro (2012) who found out that the demand-supply gap stands at a staggering 1.8 million tonnes despite popularity of aquaculture in Nigeria.

Trend of rainfall in Nigeria

The result of rainfall trend is presented in figure 2. Rainfall was increasing between 1990 and 1991 and experienced a sharp decrease in 1992. Another decrease was noticed in 2005 and a steady increase noticed in 2006. However, the rainfall pattern had continued to fluctuate tremendously from 1990 till 2019. This is similar to the findings of Elisha *et al.* (2017) who reported that climate change in Nigeria is evident in the varying rainfall, rise in sea level, drought and flooding.

This implies that the varying water volume and availability limits biological activities on which aquaculture depend. Any small variation in the amount, frequency and intensity of water availability may have important consequence for the dynamics of aquaculture systems. This variation could be as a result of human activities such as industrial emission of greenhouse gases, deforestation etc., that affect the atmospheric condition of the country.

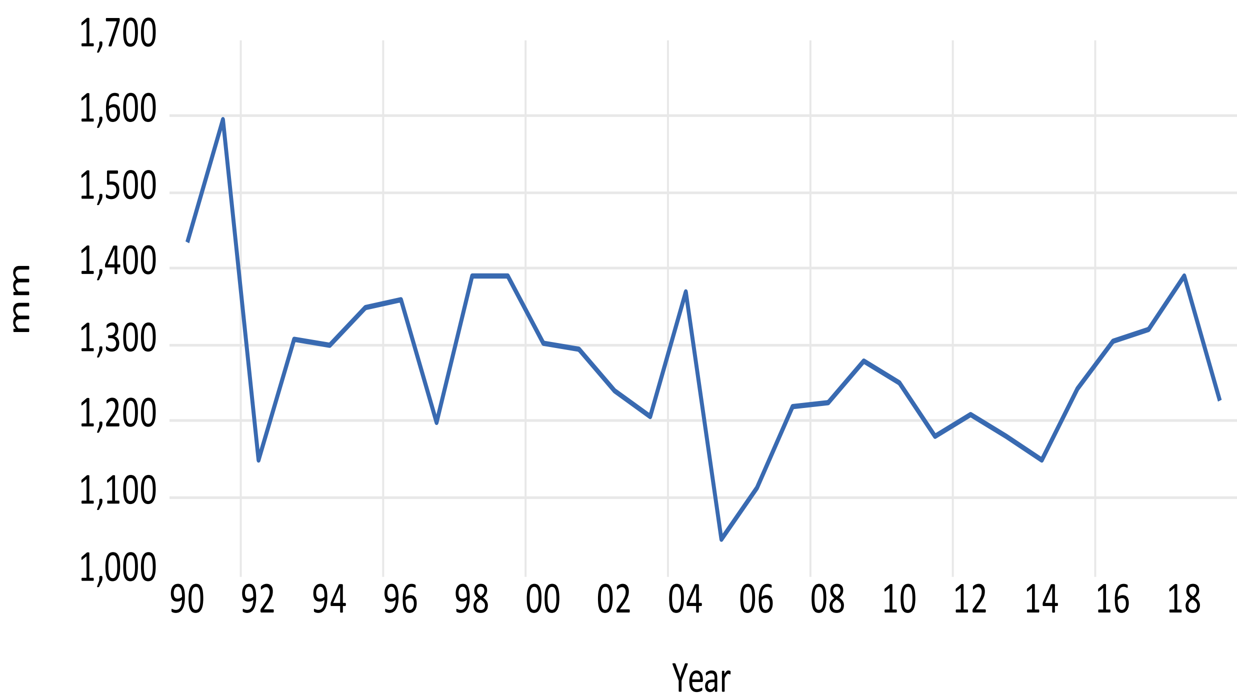

Figure 2: Trend of Rainfall in Nigeria
Source: Data Analysis, 2021.

Trend of temperature in Nigeria

The trend in temperature is presented in figure 3. Temperature fluctuates but a noticeable sharp decrease is recorded in 1993 and an increase in 2009. A steady decline occurred between 2015 and 2018 and started rising from 2019. This could be as a result of global warming effect of greenhouse gases occasioned by emission of effluents to the atmosphere by industries. This finding is similar to the findings of Jones (2003) and Alam and Rabbani (2007) who reported that the earth temperature has been rising since the 20th century. It is also closely related to the findings of Folland *et al.* (1999) and Salman *et al*. (2017) who also posited that rise in temperature is expected in order of 1.4^{o}C to 5.8^{o}C over the 21st century.

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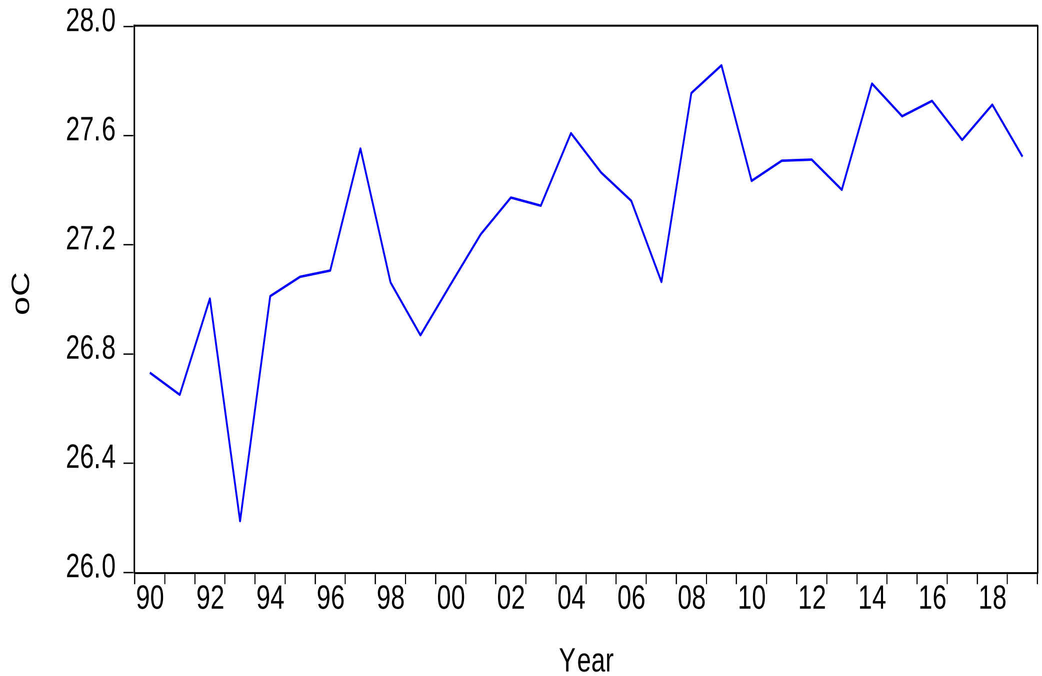

Figure 3: Trend of Temperature in Nigeria
Source: Data Analysis, 2021.

Trend of humidity in Nigeria

The trend in humidity is shown in figure 4. The result indicates that humidity decreased between 1990 and 1991 but rise and witnessed a sharp fall in 2003. It however fluctuates between 2004 and 2017 and started increasing from 2017 to 2019. This is line with the findings of the National Oceanic and Administration; NOAA (2010) of Pakistan that mean humidity has been increasing since 1950.

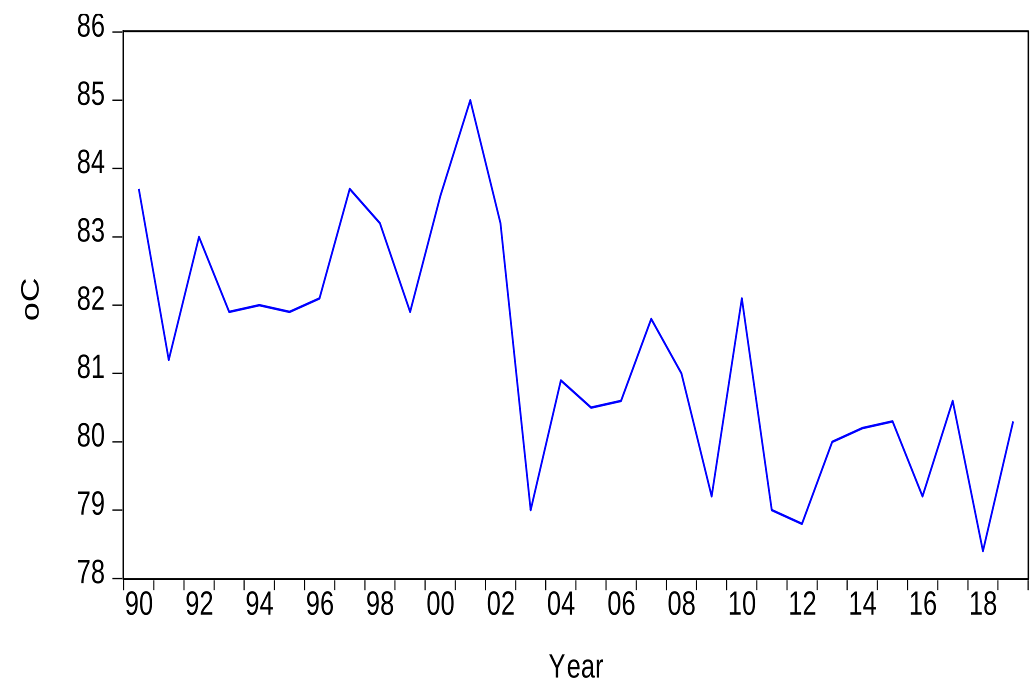

Figure 4: Trend of Humidity in Nigeria
Source: Data Analysis, 2021.

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4. CONCLUSION AND RECOMMENDATION

The study concludes that aquaculture demand supply gap in Nigeria is increasing; rainfall and temperature are decreasing while relative humidity is increasing. Based on the findings of this study, it is recommended that, Government and Non-Governmental Organization stakeholders and individuals in the aquaculture sub-sector should embark on campaign to encourage household production of aquaculture fish to help bridge the obvious gap and consequently reduce animal protein deficiency in the country. It is also recommended that in the face of decreasing rainfall, alternative water source like damn should be provided by government and other stake holders to ensure water availability for aquaculture production. Further, fish species that adapt to the low temperature and high humidity should be made available for mass breeding by the federal department of fisheries and aquaculture society of Nigeria and other stake holders.

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Conflicts of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Abera T. (2022). Evaluating the Performance of 50mm Accumulated Rainfall Threshold for the Determination of the Start of Wet Season over Selected Stations, Ethiopia. *Discovery*, 58(316), 318-339
2. Akinrotimi, O.A., Abu, O.M. and Aranyo, A.A. (2011). Envronmental Friendly Aquaculture Key to Sustainable Fish Farming Development in Nigeria. *Continental J. Fisheries and Aquatic Science*, 5(2): 17-31.
3. Alam, M. and Rabbani, M. (2003). Vunerabilities and Responses to Climate Change for Dhaka. *Environ. Urban*, 19(1):81-97.
4. Barange, M., Bahri, T., Beveridge, M., Conchrane, K., Funge-smith, and Paulain, F. (2018). Impact of climate climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigationoption. *FAO fisheries and aquaculture tectnical paper*, (627):654
5. Cai, J. and Leung, T. (2017). Short Term Prediction of Aquaculture Demand-supply Gap. Rome: *FAO Aquaculture Newsletter* (607):1-47
6. Dangana K, Nwaerema P, Fred-Nwagwu WF. (2022). Climate Parameters and Particulate Matter (PM2.5): Implication for Air Quality Index of Port Harcourt, Minna and Maiduguri of Nigeria. *Discovery*, 58(316), 310-317
7. Dodman, D. (2007). Urban Density and Climate Change: Analytical Review of the relationship between Urban Growthgrowth trends and Environmental Changes. Pakisan Conference for Science and Technology. Pakistan: Science and Technology Pp 160-167.
8. Elisha, E., Emmett J. and Cutler, J. (2008). Ecosystem: Encyclopedia of the Earth. Encyclopedia of the Eath, pp1-3.
9. FAO. (2018). Aquaculture- Meeting the Sustainable Development Goals. Rome: Food and Agricultural Organization Pp 18-20.
10. Folland, C.K., Miller, C.M., Bader, M., Jones, P., Plummer N., Richman, M., Parker D.E., Rogers, J. and Schole, P. (1997). Workshop Indices and Indicators for Climate Change Extremes. *Clim. Change*, 42(1): 31-43.
11. Giwa, E.J., Jim, M., Unah R.L., Waniko S.N., Ogunbadejo H.K. and Alhaji T. (2018). Short Term Prediction of Fish Production in Nigeria; An Empirical study of Nigeria fish demand and supply. *International Journal of Advanced Multidicipliary Research*, 4 (2):29-37.
12. Jonnes, P.D. and Moberg A. (2003). Hemispheric and Large Sclale Surface air Temperature Variations: An extensive Reviision and Update to 2001. *J. Climate*, 16(2):206-223.
13. Onada, O.A. and Ogunola, O.S. (2016). Climate smart aquaculture: a sustainable approach to increasing fish production in the face of climate change in Nigeria. *International Journal of Fisheries and Aquatic Studies*, 8(1):1-13.
14. Otokiti KV, Collins AA, Famewo AS, Raheem RT. (2021). Monitoring Peri-urbanization in Ibadan Region: Case studies of Akinyele, Egbeda, Ido and Oluyole local government areas. *Discovery*, 57(301), 74-85
15. Rosita, H., Azmah, O. and Fatimah K. (2015). Climate Change Effect on Aquaculture Performance in Malaysia: An Environmental Performance Analysis. *International Journal of Business and Society*, 4(1):364-385.
16. Salma, K., Salahuddin, A., Alia, Naziaur, R. and Arshad, L. (2017). Climate change: A Review of the Cureent Trend and Major Environmental Effects. *Science, Tech. and Development*, 36(3):160-176.