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APPLICATION OF K- CLUSTER ANALYSIS ON REGIONAL TEMPERATURE IN NIGERIA

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Abstract

Nigeria is located in a tropical region with a latitude 4^0 to 14^0 North of the equator and longitude 3^0 to 15^0 East of GMT and its extends to the western coast of Africa. Nigeria is dividing into four regions namely: Coaster region, Guinea savanna, Mid-land region and Sahel savanna. These regions were heterogeneous in nature; the distance between the Sahel to Coaster regions is 690km at latitude of 120^0N; from Sahel region to Mid-land (Eastern) region is 570km at latitude 120^0N. Also the average distance between Sahel regions to Guinea savanna is 350km at latitude 120^0N. The nearest neighbor analysis signal out twenty one (21) clustering points as extreme temperature from Sahel savanna at 34.4% and thirty two (32) clustering points for the three regions at 65.6%.The hierarchical clustering show that the average temperature in each region was not same, due to heterogeneous nature of average temperature experience in each region. The clustering process as help to determine the geometry angle between $0^0 \leq \theta \leq 360$. But frequency domain in the regions forms an angle between 0^0 and 120^0, the Sahel savanna and Coaster region having the more relative frequency domain.

***Keyword*: Cluster, Neighbor analysis, Latitude, Geometry, heterogeneous, temperature**

1.0 INTRODUCTION

The regional climate change in Nigeria is heterogeneous in nature and its level of persistence varies from one region to another. The average global surface temperature in each region lies between 0.6^0c to 0.8^0c [1]. The Inter-government Panel on Climate Change [2] has projected that the average global temperature for each region will increase due to persistence; it will increase from 1.40c to 5.8^0c by the end of the 21^{st} century.

This increase will contribute negatively to ecosystem and biodiversity in Africa. In the 20^{th} century the African regions experience perennial flooding and outbreak of some epidemic diseases during or after each flooding due to increase in temperature level annually. We observed that spatial variation in regional climate also contributes to scenario on climatic variation. This major challenger that attributed to increase in human activities which often lead to degeneration in ecosystem is increase in average global temperature and low precipitation. The human activities also contribute to region spatial variation through emit of large amounts of greenhouse gases include industrialization burning of fossil fuel, gas urbanization and agriculture [3]. The emitted greenhouse gases are carbon-dioxide (CO_2) and nitrous oxide (NO_2), this affect agricultural developing in Nigeria.

2.0 STUDY AREA

Nigeria is located in a tropical region between latitude 4^0 to 14^0 North of the equator and longitude 3^0 to 15^0 East of GMT and its extend to the West coast of Africa between the Bright of Benin to the Sahara desert between Benin Republic and Cameroon. Nigeria is divided into four regions with land area of 923768 km with a coastline of 853km. Nigeria has two season, dry and rainy seasons. The dry season is accompanied by a dust –laden wind from the Sahara desert. The Sahara region is most extreme in the northern regions. While the rainy season is heavily from tropical region to Atlantic Ocean. The climate change in the North central region is influenced by the high elevation in the region, this contribute to a severe flooding during the rainy season.[9]

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The tropical rainforest comprises the tropical wet and dry climate [9]. All the region has average temperature throughout the year, with a little thunderstorm. The tropical savanna vegetation comprises the guinea Sudan and Sahel savanna .The tropical savanna climate exhibit a single peak, rainy season and a dry season with temperature mean exceed 18^0c through the year. The dry season occurs from December to March with dusty. The Mid-land region in Nigeria has 1520m above the sea level. This region is located in the tropical elevation which settles on the mountains and plateau, above height level with cool temperature and humidity. The population of Nigeria was projected to 192 million peoples in the year 2017, which spread over an area of 923,800 square kilometers [6]. This population comprises urban and rural population with 59% of the total population for urban settlement and 41% for rural settlement [10].

In Nigeria spatial regional variations were observed in all the regions base on temperature distribution. The temperature trends were heterogeneous in nature, it increased by 1.2^0c in the tropical savanna region [5]. The Mambella, Jos and Obudu experienced lowest mean temperature generally because they experience semi-temperature climatic conditions. The increase in the amount of rainfall in tropical rainforest regions is partially responsible for the increasing in floods devastation in the Coastal states like Calabar, Port-Harcourt, Warri and Lagos observed by [5].In Sahel region of Nigeria we experienced evaporation, drought and desertification which often lead to reduction in water level or total dryness of some rivers, stream, wells and irrigations. [9].The temperature level in Sahel region prevents crops from growing well in a due to extreme flooding and drought which lead to reduction in agricultural production. For example in 2012, the Lido River from Cameroon which flooded the part of Northern part to Coaster region of Nigeria which causes devastation in agriculture production.

The heat wave in tropical savanna region contributes to climate changes which have direct impact to livestock production. Overheating in wave increases vulnerability to disease outbreak, reduce milk production and fertility rate. The climatic variability in temperature contribute to migration of fish and other aquatic animals in the tropical rainforest region. For example the tropical rainforest is characterize with the warmer water temperature and high relative humidity this affects the life cycle of fishes and increases the outbreak of epidemic disease associated to riverside areas. The climate change in this region has direct impacts on agricultural production which lead to decline in fish harvesting in the region. The atmospheric carbon dioxide (Co_2) in the tropical rainforest contributes increase acidity which is very harmful to fish production. The ocean acidification can be a serious threatens to fish adaptation in aquatic due to toxicities of the water level. This toxic in the water level create a biggest effects on agricultural activities in the region. The Coastal region comprises: Abia, Akwa-Ibom, Bayelsa, Cross-River, Rive, Delta, Edo, Imo and Ondo. This region is vulnerable to extreme event, such as storms, this imposes most damage to the coastal region. The exploration in the region has brought environmental degradation which cause enormous effects to ecosystem. The constant gas flaring contributes to increasing of atmospheric temperature of the areas. The impact of maximum temperature in coastal region contribute to increase in the sea level, it cause negative threat to lives and livelihood in the tropical rainforest region.

Fig. 1a: EGIONAL MAP OF NIGERIA

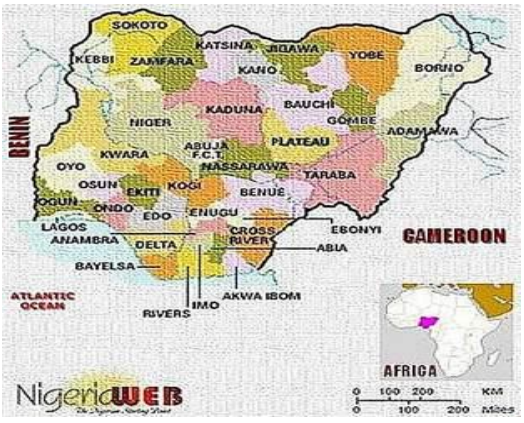

Fig. 1b: THE MAP OF STATES IN NIGERIA

Let X =$[d]_{i=1}^{n}$ be a set of n observations at time (t). A clustering algorithm were taken as input data in form of matrix, we seek to partitions x into k clusters. The partition of

X_{ii} …….. X_{it}; X_{2i} ……X_{2t};

X_{3i} ……..$X_{3t}$and X_{4i}……X_{4t}

Where, X_{it} represent temperature from Coastal region.

X_{2t} represent temperatures from Guinea Savanna region

X_{3t} represent temperatures from Mid-land region

X_{4i} represent temperatures from Sahel Savanna region

Single linkage clustering

In this study a single linkage clustering will be used to cluster the temperatures for the four regions. Single linkage clustering is the oldest and simplest algorithm used to determine the distance between two clusters, considering the minimum distance between an observation in one cluster and another observation in another cluster. [4].

The dissimilarity between two cluster C_1 and C_2 is define by $n(C_1 C_2)$ = min n(i, j) [8]

The single linkage is often called Nearest Neighbor method. Let X_1 and X_2 be a joint cluster that will produce a new cluster $C_1$and C2.

$n(C_1, C_2)$ = min {n ($X_{i,}$ C_2), n ($X_{j\,,}$ C_1)} (1)

= n (X_i, C_1) + n($X_{j,}$ C_2) - $\frac{1}{2}$ (n(X_i, C_1 – n (X_i, C_1) – n (X_j, C_2)) (2)

Average Linkage Method

The average linkage is used to measure the distance between two clusters in a pairs of observations with a distance we obtain the joins clusters based on small variance in each other cluster.

According to Sokal and Michener [11], we defined cluster using combinational formula

$$Djm = \frac{N_{kD_{jk}} + N_{lD_{jl}}}{N_m} \qquad (3)$$

DATA ANALYSIS

In this research three approaches will be use to analysis regional climate change.

Table 1 GEOMETRY ROTATION IN THE REGIONS

	Region 1	**Region 2**	**Region 3**	**Region 4**
CR	**0.713703**	**-0.209068**	**-0.018190**	**0.010544**
GS	**-0.250230**	**0.691697**	**-0.184080**	**0.055197**
ML	**-0.013627**	**-0.0141368**	**0.712511**	**0.004210**
SA	**0.007158**	**0.039710.**	**0.003250**	**0.707736**

SOURCE: NIGERIA METEROLOGICAL CENTER, ABUJA [7]

1.0 Data set

The data sets used for this study were yearly average temperature for 60years (1957 – 2017). Considering dry and harmattan season November – March and April – October rainy season from four climatic vegetation i.e. Coastal region, Genuine savanna region and Mid-land regions and Sahel savanna .The zone has heterogeneous climatic change with regional climatic variables annually.

Research Methodology

The main aim of this study is to cluster regional temperature by partitions it, to determine the pair wise dissimilarities between temperatures from each region by clustering to observe the variation in regional temperatures from different clusters.

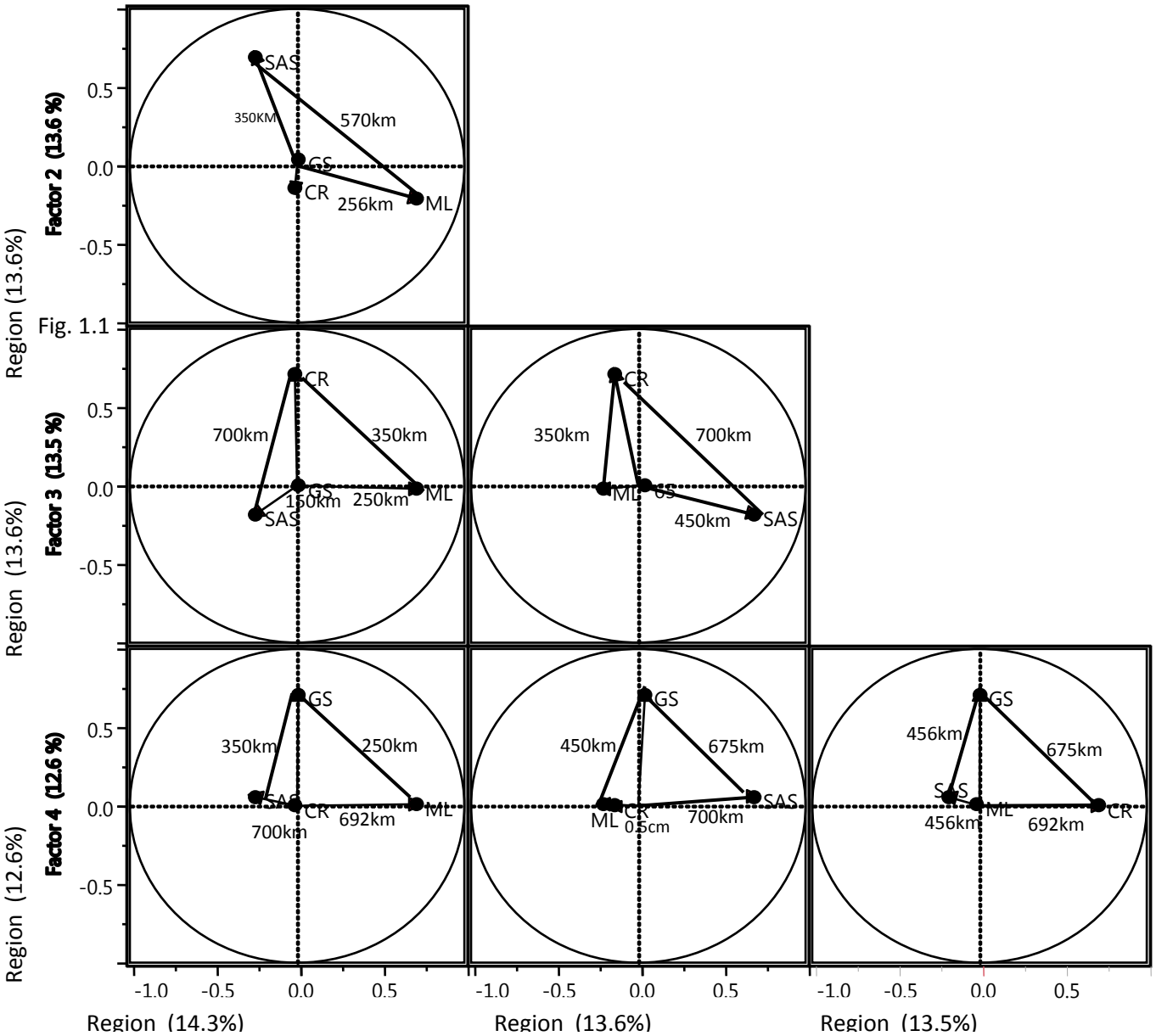

Fig. 2 : Regional Geometry plot

Table 2. The below shows the regional geometry values from plotted plane obtain from K Cluster observations

REGIONS	AVERAGE TEMP.	DISTANCE	LATITUDE
Sahel savanna (SAS)	37.5^0c 36.4^0c	(SAS to GS) 350km SAS to ML 570km	120^0N 120^0N
Guinea Savanna	30.4^0c	(GS to ML) 256km	120^0N
Midland	27.5^0c 25.4^0c	(GS to ML) 250km (CR to ML) 250km	105^0N 105^0E
Coastal Region	19.5^0c	(CR to SAS) 700km	105^0s

The regional geometry chart was plotted from K-cluster observations on temperature. This chart describes the distance and latitude from North to South regions. The temperature in each region depends on the distance; the Sahel savanna region has more extreme temperature than any other region.
We observed that the more the distance; the more extreme the temperature.

Geometry measurement of regional climate change

From Fig2. The geometry plot takes a range between -0.5 < r < +0.5. The regional climate change take an interval lbetween -0.3 < r < 0.5 in fig (1.0) to form antilock wise from Mid-land region (ML) to Sahel Savanna (SAS) at angle 120^0. The angles from one region to another form a triangular shape with 15^0 at ML; 90^0 at GS and 15^0 at SAS. The Euclidean distance within the three regions shows that Sahel Savanna (SAS) is more extreme than other two regions; Sahel Savanna has total degrees in climate change at 120^0. The equidistance between coaster regions (CR). Guinea Savanna (GS) and Sahel Savanna (SAS) has a latitude of 120^0N from SAS to CR with a radius of 0.5. It also form a triangle shape with an equal size.
The equidistance between SAS, CR, and GS form a right triangular shape with 90^0 it has a radius that lies between 0<r<0.5 and the degree of climate change between the three regions is 90^0.
The Euclidean distance in the four regions, Coaster Region (CR), Guinea Savanna (GS), Mid- land (ML) and Sahel Savanna (SAS) are triangular in nature there is no similarity in each region. The Sahel savanna is more extreme than any other regions.

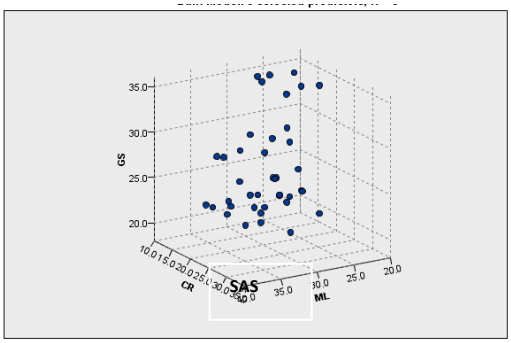

FIG. 3 Nearest Neighbor Analysis on Regional Climate Change

From Fig 3 the cluster chart shows that distance between Sahel Savanna and others regions has a distance of seven (7) co-ordinate points above other regions since Sahel savanna as an extreme temperature than other regions. These points are 35, 35, 35, 34, 33, 33 and 32. See the chart above. Agglomeration schedule was used in this study to determine the distance between the average temperatures in the four regions. The average temperatures were cluster into two stages i.e Cluster I and Cluster II. While Agglomerate schedule was used to combine the two clusters and Dendrogram was used to determine the hierarchy of the average temperature in the four regions. The coefficients values for the two clusters has a domain that start from 0.090 to 295.509 as a results of climate change in average temperatures in the four regions, the minimum temperature takes a coefficients from 0.09 to 20.105 while maximum temperature takes a coefficients 23.255 above.

Table 3 THE AVERAGE CLUSTER CENTER USING K = 4

REGIONS	1	2	3	4	Number of cases in each cluster
CR	14.6	16.5	20.7	20.9	16
GS	22.7	33.1	24.5	23.5	14
ML	26.2	26.4	35.8	27.8	13
SAS	36.5	36.5	36.6	36.9	18

SOURCE: NIGERIA METEROLOGICAL CENTER ABUJA [7]

In this paper we seek to evaluate the distance on the average cluster of each region using Matrix .
Let A: be the average cluster centre
b: number of cases in each cluster

$$14.6x_1 + 16.5x_2 + 20.7x_3 + 20.9x_4 = 16 \quad (4)$$
$$14.7x_1 + 33.1x_2 + 24.5x_3 + 23.5x_4 = 14 \quad (5)$$
$$26.2x_1 + 26.4 + 35.8x_3 + 27.8x_4 = 13 \quad (6)$$
$$36.5x_1 + 36.5x_2\ 36.6x_3 + 36.9x_4 = 18 \quad (7)$$
$$Ax = b$$
$$Let\ A: the\ average\ cluster\ centre \qquad B: Number\ of\ cases\ in\ each\ cluster$$
$$Ax = b$$

$$A = \begin{bmatrix} 14.6 & 16.5 & 20.7 & 20.9 \\ 22.7 & 33.1 & 24.5 & 23.5 \\ 26.2 & 26.4 & 35.8 & 27.8 \\ 36.5 & 36.5 & 36.6 & 36.9 \end{bmatrix} \begin{bmatrix} 16 \\ 14 \\ 13 \\ 18 \end{bmatrix}$$

$find\ the\ inverse\ (A)$

$$A^{-1} = \frac{1}{Det\,(A)} \times A^{T} \quad (8)$$

$$x_i = A^{-1} * b \quad (9)$$

The coefficient of each region can be obtained by multiply

The output of the matrix

$x_1 = CR = -1.10722\,, x_2 = GS = 0.221922$

$x_3 = ML = -0.213353\ and\ x_4 = SAS = 1.57513.$

4.0 Findings and Conclusion

The average regional temperatures in Nigeria were heterogeneous in nature. The only approach that can help to determine the distance between an extreme temperature and low temperature is by using K –cluster process, we discovered that Sahel savanna has more of maximum temperature compare to others regions, the distance between Sahel savanna to others regions is far distance, this make the region more extreme in temperature. The results from Matrix indicate that there is significant different between coefficients obtain from the regions, the coefficient from SAS is 1.57513 has a more extreme temperature than other regions due to the distance between this region to other regions. We seek to conclude that the four regions in Nigeria are heterogeneous in nature, some regions are more extreme to others, cluster analysis is recommended to determine the distance between one region to another using Neighbor analysis at K=4 with Hierarchical analysis. The temperature levels in Sahel region has negative impact on climate change due to the maximum temperature experience throughout each year in the region.

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