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ESTIMATION OF SEA LEVEL ANOMALY ACROSS THE NIGERIAN COASTAL REGION USING SATELLITE ALTIMETRY TECHNIQUE

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ABSTRACT

The Sea level anomaly (SLA) phenomenon is one of the important global issues that is slowly threatening human survival and impairing economic development across the Nigerian coastal states. This phenomenon has significant impacts on the social economy, natural environment, and ecosystem of coastal areas. Multi-mission satellite altimeter data, reprocessed by data unification and combination system (DUAC) has offered a great opportunity for adopting active remote sensing technology in studying sea level changes. This study presents the SLA variation across Nigeria's coastal zone using multi-mission satellite altimeter data for the period of fifteen years ((2006-2020) obtained from the Copernicus Marine Environment and Monitoring Services (CMEMS) portal. the monthly trend of the SLA was analysed for the period of study and the rate of SLA per year was determined; in addition, the future trend of the SLA variation along Nigeria's coast was predicted for thirty years at ten years intervals using a simple least square regression model. the results revealed a sharp high and low value of SLA from the year 2014 to 2017. This could be attributed to the effect of El-Nino and la-Nina effect. The estimated SLA value was validated using in-situ tide gauge stations located at Que Iboe Entrance in Akwa Ibom and Akaasa in Bayelsa States. The result was highly correlated with the in-situ data giving the correlation coefficient (R) of 0.8 at Que Iboe Entrance and 0.77 at Akaasa respectively. The predicted value of SLA presented a trend that indicates a rise of 0.125m in the years 2030, 0.140m in 2040, and 1.501m in 2050 at a 95% confidence level. However, the total area of about 2192 km3 in the coastal area is likely liable to be flooded by the rise in sea level. Therefore, there is a need to conduct more extensive research to ascertain the actual sea level anomaly over Nigeria's coastal water.

KEYWORDS: Climate Change, Satellite Altimetry, Sea Surface Height, Tidal Gauge, Sea Level Anomaly

1.0 INTRODUCTION

Sea level anomaly (SLA) depicts the excess anomaly above the mean sea level or the geoid. However, to determine sea level anomalies, sea surface height (SSH) variation is better referred to as mean sea surface height rather than the geoid (Andersen et al., 2011). The subtraction of the mean sea surface conveniently removes the temporal mean of the dynamic sea surface height and creates sea level anomalies that, in principle, have zero mean. This is so because mean sea surfaces are normally computed by averaging altimetry observations over a long period and preferably combining data from several exact repeat missions (Scharroo et al., 2011).

According to the National Oceanic and Atmospheric Administration (NOAA, 2016), the trend of rising sea levels is directly proportional to the trend of rising global temperatures. Global sea level anomaly has been estimated to rise significantly as a result of changes in atmospheric temperature, sea surface temperature (SST), precipitation characteristics and other climate parameters (Ariana et al., 2017). The coastal areas comprise valuable ecosystems and are typically known for having higher population densities than inland areas (Small & Nicholls, 2003). Additionally, it generates significant amounts of economic resources as it contributes to national wealth (Sachs et al., 2001). The major impacts of sea-level rise include inundation of low-lying areas, shoreline erosion, coastal wetland loss, saltwater intrusion, higher water tables, and higher extreme water levels leading to coastal flooding (Leatherman & Nicholls, 1995). Human-induced pressures on the coastal areas such as growing population, water abstraction, and alteration of the hydrological regime including the damming of sediments will exacerbate the effects of sea-level rise (Nicholls et al., 2007). However, due to uncertainties in future projections and a lack of systematic data, these factors cannot be fully considered in this report. Hence, the main issue addressed in this article is to estimate the rate of sea-level anomalies and their extended effects across Nigeria's coastal areas.

The impacts of sea-level anomalies have been given less consideration in developing countries (Nigeria) when compared to developed countries (Udo-Akuaibit, 2017). Yet poorer countries with dense populations may be worst hit by climate change as they have a lower ability to prepare, adapt, and respond (Nicholls et al., 2007). The entire Barrier Lagoon across coastal areas of the southwestern part of Nigeria is under threat of sea level rise; the situation is more worrisome considering the dense population surrounded by the region. The level of existing infrastructures ongoing developmental infrastructures and proposed developmental activities within the areas is under threat (Musa et al., 2016). Since the launch of the maiden altimetry satellites sometime in the 1970s, the oceanographic communities have enormously made use of altimetric data to better understand the worldwide oceanic system and how it evolves at different temporal and spatial scales (Cazenave et al., 2006). With the successful launch of the JASON 1-3 satellite in January 2016, the quality of altimetry data available can only get better. The development of satellite altimeters to adequately sense ocean dynamics has been one of the primary objectives of the National Aeronautics and Space Administration (NASA).

Long-term sea level change is important for a variety of environmental and socio-economic reasons, especially for the large portion of the world's population living in the coastal zone (Fu et al., 2000). This technique provided access to the geographical variations of the sea level changes which might certainly not be uniform over the world (Cazenave et al., 2002). The geographical position of countries relative to the equator and the poles, as the rotation and revolution of the earth, have reduced the accuracy of global sea level anomaly data to be used as measures for each country. Regional estimation of sea level will post more accurate results than global due to its continental characteristics.

However, the global models have covered loops where regional data are not available and it has given room for the most probable approximation of other regions.

Generally, radar altimetry is among the simplest geodetic remote sensing techniques, two basic geometric measurements are involved in this technique. Firstly, the distance between the satellite and the sea surface is determined from the round-trip travel time of microwave pulses emitted downward by the satellite's radar, reflected from the ocean, and received again on board. Secondly, independent tracking systems are used to compute the satellite's three-dimensional position relative to a fixed earth coordinate system. Then, combining these two measurements yields profiles of sea surface topography, or sea level Anomaly, to the reference ellipsoid (Abazu et al., 2018).

The Niger Delta region of Nigeria has the highest sensitivity to climate change in Nigeria, and its adaptive capacity is the second lowest in terms of socio-economic development of the country (FME, 2010). It is one of the most vulnerable coastal areas in the world due to its natural properties, very low elevation (relief), and gentle slope. With an anticipated rise in sea levels of 0.6-1m for the Nigerian coast by 2100 (FME, 2010), large parts of the delta could be affected with huge costs in both lives and property. Based on physical properties and human population to be displaced, studies by (Ericson, et al., 2006), ranked the Niger Delta among the vulnerable coasts of the world. However, the objectives of the research are to present the sea level anomalies across the Nigerian coastal states in view to suggest the best adaptive measures to minimize the loss of lives and properties.

2.0 Study Area

Nigeria's coastline cut across a total of eight states, which are estimated to account for 25% of the national population (Nenibarini et al., 2019). Based on the morphological, vegetational, and beach-type characteristics, the coastal zone is classified into four broad regions namely, from west to east, the barrier lagoon coast, the transgressive mud coast, the Niger Delta, and the strand coast. The coastline lies between latitude 40 10' to 60 20' N and longitude 2045' and 80 35' E, it runs across seven states of the federation, namely Lagos, Ondo, Delta, Bayelsa, River, Akwa Ibom, and Cross River (Nwilo et al., 2015).

The coastline consists of inshore waters, coastal lagoons, estuaries, and mangroves, especially in the Niger Delta area. The major economic activities in the coastal zone are oil and gas and exploitation, fishing, shipping, agriculture, sand mining, and tourism. The coastal area is dotted by ports and large metropolitan and urban centres including Lagos. However, coastal zones in Nigeria face a range of challenges, such as coastal erosion, flooding, overexploitation of natural resources, marine and coastal pollution, mangrove depletion, and Nypa palm invasion. All these are negatively impacting the people's livelihood and climate change and sea level rise are exacerbating them.

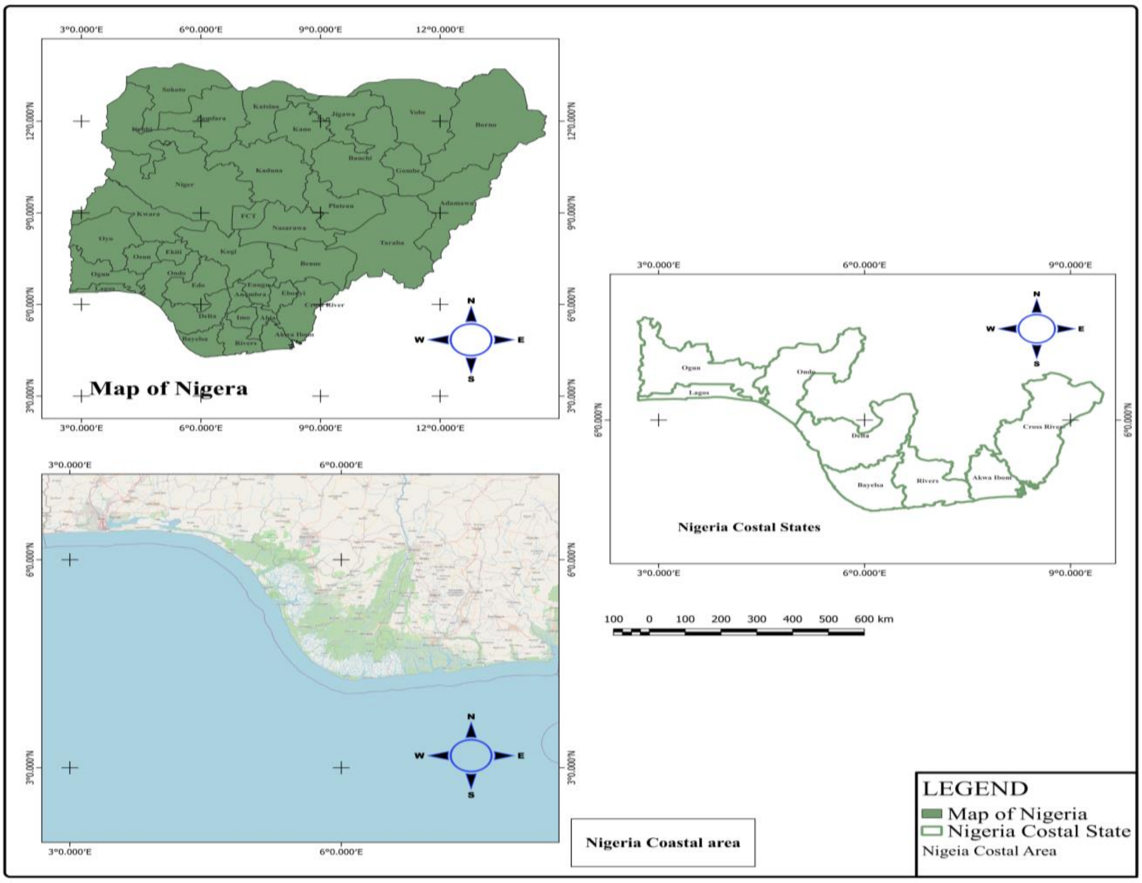


Figure 1. Study Area

3.0 METHOD

3.1. Data Acquisition

The (SLA) data was downloaded from the Copernicus Marine Environment Monitoring Services (CMEMS) site via aviso, and data from a multi-mission altimeter satellite system was utilized. Hence, fifteen (15) years (2006-2020) merged maps of SLA (MSLA) covering the whole of Nigeria's coastal zone were extracted from Topex/Poseidon, Jason-1, Jason-2, and Envisat in Netcdf data format. In-situ tidal gauge (TG) data of Akaasa in Bayelsa State and Que Iboe entrance in Akwa Ibom State were acquired from the Nigeria Navy hydrography unit for validation of the study. Table 1. shows the satellite mission used for the research

Table 1. Satellite Altimeter Missions Used

Satellite	**Source**	**Period**	**Cycles**
JASON-1	NASA/CNES	Jan 2011 - June 2013	332 - 425
JASON-2	NASA/CNES	Jan 2011 - Dec 2015	093 - 285
Topex/Poseidon	NASA/CNES	Sept 2002- Jan 2011	184- 254
ENVISAT-1	ESA	Jan 2011 - Apr 2012	098 - 113

Source: CMEMS, 2021

Global gridded Satellite altimetry data of spatial resolution 0.25˚x0.25˚ (Cartesian) SLA maps were adopted spanning from January 2006 to December 2020, which cover a period of fifteen (15) years across Nigeria's coastal areas. The average monthly data was grouped into phases of five (5) years each. Each phase was classified as Q1, Q2, Q3, and Q4 which sum up a total of fifteen years.

3.2.1 Data Processing Using DUAC System

The telemetry data was filtered and reprocessed by data unification and altimeter combination (DUAC) system. Multi-mission mapping procedure in DUAC is achieved based on an optimal interpolation (OI) technique for delay time 2021 (DT2021). The edge of the DT2021 reprocessing framework is it improves global gridded altimetry products in the tropics and coastal areas at the mesoscale. Figure 2, depicts the overview procedure of data processing in the DUAC system. The Input L2p data undergoes a series of corrections. Since Refraction by neutral and charged particles in the atmosphere delays the electromagnetic pulse and by extension lengthens the altimeter range and to create balance in the pulse delay, a range of corrections was applied such as geophysical corrections (wet and dry tropospheric, ionosphere) sea surface bias, inverse barometer, etc. to the uncorrected range (Pujol *et al.,* 2016).

The crossover adjustment is performed by combining the various altimeter data processed concerning the reference mission. This is essential in improving the quality of the altimeter data by leveraging the strengths of each satellite. For example, Topex/Poseidon, Jasons-1&2 have the most accurate orbit and shorter repeat cycle (10 days) but larger spatial variation (315km apart) when compared to Envisat. However, the other groups of satellites have smaller spatial variation (80 km apart) but longer repeat cycles (35 days) and less accurate orbits (Ducet *et al.,* 2000).

Figure 2. Digital Unification and Altimeter Combination (DUAC) Processing Overview

The time frame covered by the individual crossovers was pegged at 18 days to increase the likelihood of capturing all available real oceanic signals and sea level trends. The final correction step includes processing by applying the Orbit Error Reduction (OER) and wavelength error (WLR) algorithm. This process consists of reducing orbit errors through a global minimization of the crossover differences observed for the reference mission, and between the reference and other missions also identified as complementary missions, as presented by (Le-Traon *et al.,* 1998).

3.3 SEA LEVEL ANOMALY (SLA) PREDICTION

The SLA value for the fifteen (15) years period was plotted in a graphical form to reveal the SLA trend over time. The data was fitted with a linear regression line of best fit. This can be represented by the least square regression equation of the form given by Equations $1 - 11$

$$y = b + mx \qquad 1$$

The general expression for predicting the SLA can be written in the form of

$$y_n = b + mx_n + e_n \qquad 2$$

Where e_n is the estimation error, y is the dependent variable, x is the independent variable, m is the slope and n is the number of variables. To solve equation 2 using the least square regression technique, the observation equation for each period of estimation can be written as follows:

$$\left.\begin{aligned} y_1 &= b + mx_1 + e_i \\ y_2 &= b + mx_2 + e_2 \\ y_3 &= b + mx_3 + e_3 \\ &\quad ,, \quad ,, \quad ,, \quad ,, \\ y_n &= b + mx_n + e_n \end{aligned}\right\} \qquad 3$$

Representing equation 3 in matrix form, we have:

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ ,, \\ y_n \end{bmatrix} = A \begin{bmatrix} 1 & x_1 \\ 1 & x_2 \\ & ,, \\ 1 & x_n \end{bmatrix} + X \begin{bmatrix} b \\ m \end{bmatrix} + E \begin{bmatrix} e_1 \\ e_2 \\ ,, \\ e_n \end{bmatrix} \qquad 4$$

Hence, the solution to equation 3.4 can be realized by adopting the least square observation equation technique. Thus, the general model is given (Onuwa and Asuquo, 2012):

$$L^a = f(X^a) \qquad 5$$

$$L^b + v = f\left(X^0 + \overset{\wedge}{\chi}\right) \qquad 6$$

Where

$$L^a = L^b + v$$

$$X^a = X^0 + \overset{\wedge}{\chi}$$

And linearizing using Taylor's series we have:

$$v = A\overset{\wedge}{\chi} - L \qquad 7$$

Minimizing using the Lagrange multiplier yields the solution as:

$$X = (A^T PA)^{-1} A^T PL \qquad 8$$

And the a-posteriori variance is given by:

$$\sigma_0^2 = \frac{v^T Pv}{df} \qquad 9$$

$df = m - n$ (m is the number of observations and n is the number of parameters) defines the degree of freedom. Where, L^a and L^b are the matrices of adjusted and actual observations, v is the matrix of residual, $\overset{\wedge}{\chi}$ is the matrix of estimated model parameters, A is the design (coefficient) matrix and P is the weight matrix. Hence, it can be solved using the least square technique. The R-square and F-test statistical analyses were then performed for the significant test of fit for model 3.8 using the Excel statistical tool. The R^2 – Statistics: This is given by;

$$R^2 = \left[1 - \left(\frac{SSE}{SST}\right)\right] \qquad 10$$

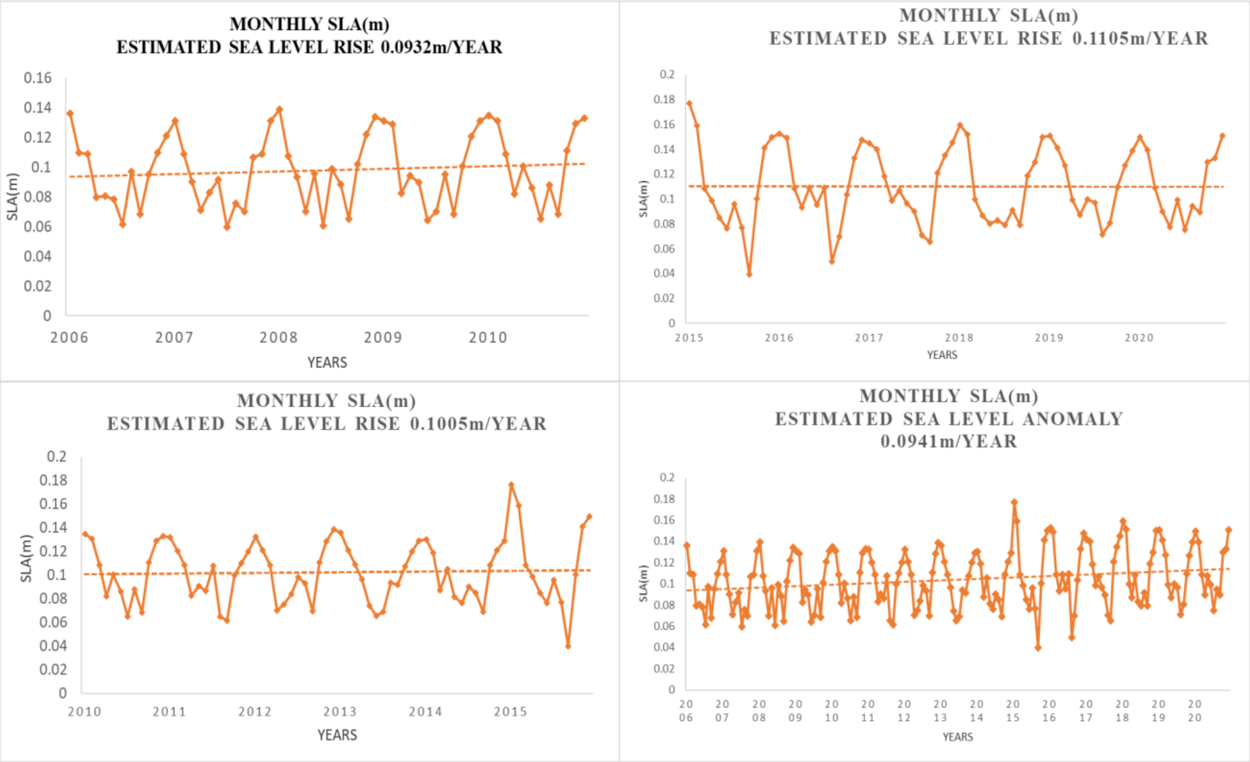
Where SSE: the sum of squares of errors
SST = total sum of squares
***F*– Statistics:** This is given by;

$$F = \frac{\left(R^2/_K\right)}{(1-R^2)/(n-k-1)} \qquad 11$$

Where K= 2 (number of predictors) and n = (sample size).
To solve for thirty (30) years of trend pattern prediction of SLA, equation 3.8 was programmed using the Excel spreadsheet. The model was validated by using excel incorporated statistical tool to run regression analyses using the data, the outcome was the same.

4.0 RESULTS AND DISCUSSION

The estimated trend per year in meters from the satellite altimetry data was illustrated in Figure 3. The line graph was classified into four phases, the phase (Q1) ranges from the year 2006-2010, the second phase (Q2) ranges from the year 2010-2015, the third phase (Q3) is from the year 2015-2020 the last phase (Q4) is the summation of the whole span of the data ranging from the year 2006-2020.



MONTHLY SLA(m)
ESTIMATED SEA LEVEL RISE 0.0932m/YEAR

MONTHLY SLA(m)
ESTIMATED SEA LEVEL RISE 0.1105m/YEAR

MONTHLY SLA(m)
ESTIMATED SEA LEVEL RISE 0.1005m/YEAR

MONTHLY SLA(m)
ESTIMATED SEA LEVEL ANOMALY
0.0941m/YEAR

Figure 3. SLA Trend Pattern of Niger Delta Region for the Year 2006-2020 Using SAT Data

Figure 3. At phase Q1, the total height of SLA recorded at this phase was about 5.8630 m. The average highest monthly SLA value recorded (crest) was 0.1364 m and the lowest (trough) value was 0.0595 m while the computed range was 0.076671m. the upward

movement of SLA begins between the months of October and November while the peak height recorded was between December- January. The downward movement begins from February to April. The movement from April to September is inconsistent as the average SLA for the month range fluctuates the estimated SLA rate per year was computed at 95% significant level to be 0.093 m per year.

At phase Q2, covered range from the year 2010-2015. The average highest SLA height (Crest) value recorded was 0.1768 m and the lowest SLA (trough) value recorded was 0.0396 m. The range computed was 0.1039 m, the values obtained in Q1, it indicates that there is a gradual upward movement of SLA rate from phase Q1 to phase Q2 at 0.48%. The estimated rate of SLA computed at a 95% significant level was 0.1005 m per year at phase Q2. Phase Q3 ranges from 2015 to 2020. The average highest SLA wave (Crest) value recorded was 0.1594 m, the lowest (crest) value recorded at 0.04967 m. The computed range was 0.1575 m. Comparing the SLA trend values from Q2 to Q3, it depicts an increase of about 1.061% which is slightly higher when compared to the trend movement from Q1 to Q2.

The highest wave (Crest) SLA value recorded was between December and January, the SLA values started depreciating (downward movement) from February to April while from April to September remained inconsistent. The estimated rate of SLA computed at a 95% significant level was 0.1105m per year in Q3. It can also be observed that from the time series plots, the sea level trends from the year 2015-2017, recorded a sharp high in SLA value which was above the normal height, and an unusual drop below the normal negative SLA height. El Nino and La Nina may have less effect on SLA in the Nigeria coastal zone due to the position of Nigeria from the equator. The distance of Nigeria from the equator influenced the hot wind coming from the equator. However, the El Niño effect is marked by the decrease of sea surface temperature (SST) in the Nigeria coastal waters, which results in to rise in air pressure, causing the trade wind (conventional air masses) navigating from the northeastern part of the country to weaken, this led to a gradual decrease in rainfall across most of Nigeria coastal areas. This, in turn, could `increase the risks of forest fires and drought. On the other hand, La Niña is a natural phenomenon with dynamics whose impacts are in opposite to El Niño. The La Niña effect is marked by the rise of SST in the Nigeria coastal waters, and the Atlantic trade wind (Maritime Air-masses) becomes more intense, which causes the warm pool to shift to the south compared to normal conditions. This warm pool shifting causes more intense rainfall in Nigeria's coastal states, and therefore increases the dangers of flooding.

Phase Q4 comprises the combination of all satellite altimetry data (SAD) from Q1, Q2, and Q3 making up fifteen years on the graph. The trend rate of SLA from satellite altimeter data for the period of fifteen years (phases Q1, Q2, Q3, and Q4) was computed at a 95% significant level and the result is summarized in Table 4.1.

Table 2. The Estimated Trend/Year

Station	Latitude	Longitude	Phase	Estimated Trend/year
Nigeria Coastal Areas (Niger Delta)	Between 6.33 and 4.166 North of the equator	2.71 and 8.5833 south of the Greenwich meridian	Q1	0.0932
			Q2	0.1005
			Q3	0.1105
			Q4	0.0941

From Table 2, it can be seen that sea level trends exist for the period in review (fifteen (15) years across Nigeria's coastline areas. Positive trends indicate a rise in sea levels while negative trends represent the fall below the computed reference surface around the coast and this corroborates earlier studies Nwilo *et al.,* (2015) carried out within the Nigerian coastline states. It must, however, be stated that a more accurate result will be recorded when satellite altimetry observations are observed at each coastal state tidal station available across the coastline areas. Figure 4. Display the visualization of satellite altimeter data for fifteen years.

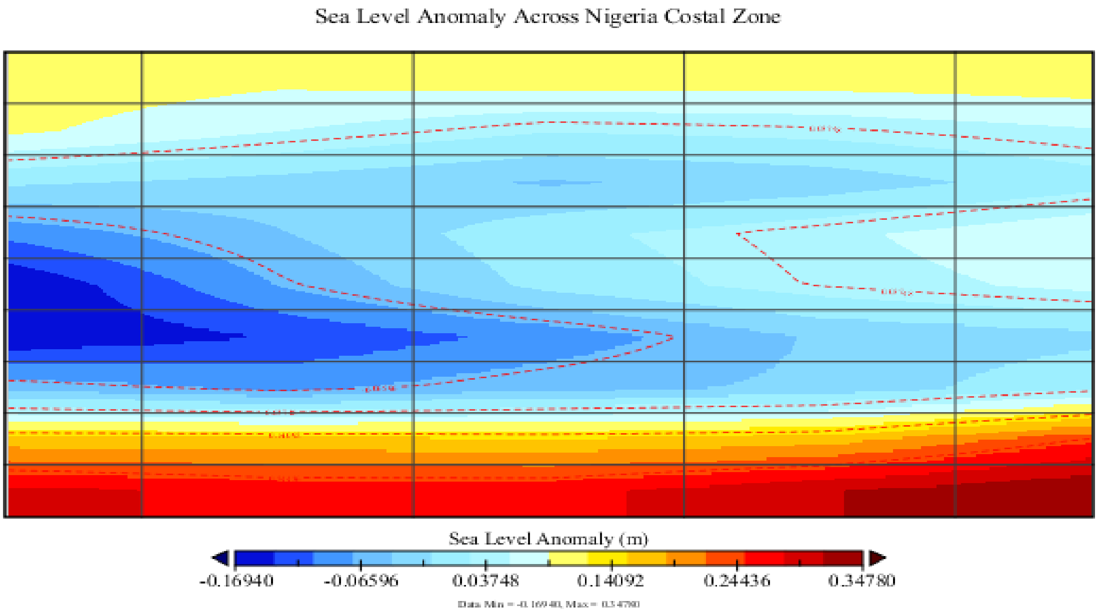


Figure 4. Visualization of sea level anomalies across Nigeria's coastal zone.

Figure 4, reveals the characteristic of the SLA trend, Negative anomaly implies the trend is below the reference point, while positive trend implies that the trend is above the reference point which can be substantiated by the map above. The SLA trend covered from (-0.16940 to 0.34780 m). The sea level increases in the direction of the orange colour region, the darker the reddish region, the higher the SLA height, and the sea level decrease in the blue colour region, the darker the blue colour, the lower the corresponding SLA height. Table 3. Explained the outcome of SLA prediction report. It shows the computed F-statistics, R-statistics, and degree of freedom (DF) for the computed f-statistics.

Table 3. Computed Coefficients and the Significant Statistics of the Regression Model

Model Coefficients	F-Statistics	R-Statistics	Df	P-Value	Standard Error
X_b=0.001734	F-Computed: 43.067	0.7681358	V=1	1.30E-14	0.002403
X_m=0.08975	F-critical:4.195972		V=13		
e_n=0.000254					

From Table 3, the probability value (P-value) is fixed at a 95% confidence level, and the R-statistics, which are the predictors of the model (SLA and time) indicated about 76.8% relationship with the variances of the regression model generated. It shows the percentage of reliability of the dependent and independent variables while the computed F -statistics is almost ten (10) times greater than the f -critical, which is also an indicator of the level of significance of the dependent variable and the generated regression model. Hence, table 4, depicts the sum of errors computed in the equation.

Table 4. Minimization of sum of square of errors

x_1	y_1	$f(x_1)$	$Ei= y_1$-$f(x_1)$
1	0.086819	0.091481	-0.00466
2	0.090502	0.093215	-0.00271
3	0.093848	0.094949	-0.0011
4	0.097036	0.096684	0.000352
5	0.104573	0.098418	0.006155
6	0.108851	0.100153	0.008698
7	0.107775	0.101887	0.005888
8	0.097334	0.103621	-0.00629
9	0.103464	0.105356	-0.00189
10	0.105705	0.10709	-0.00139
11	0.104128	0.108825	-0.0047
12	0.112391	0.110559	0.001832
13	0.112437	0.112293	0.000144
14	0.112266	0.114028	-0.00176
15	0.117193	0.115762	0.001431

Hence, from table 4, the sum of the square of errors (SSE) is solved as: $=E^T E = 0.000254$ However, to determine the model parametersX_b, X_m and e_n, the 15 x 15 matrix equation was solved using the least squares technique; this gives: $X_b = 0.0017344$, $X_m = 0.0897461$ and e_n = 0.000254. Therefore, the least square regression model from equation 12 becomes:

$$f(x) = 0.0017344x + 0.0897461 + 0.000254i \qquad 12$$

This is the derived regression model for the prediction of future trend patterns of (SLA) across the Nigeria coastal region. It is required to predict (SLA) for the next thirty (30) years at ten (10) year intervals.

The satellite altimeter data products (SLA) derived from (DUAC) DT2021 system were compared with SLA derived from two tide gauge stations situated across two states of the Niger Delta region. The choice of the two stations was informed by the non-availability of active tidal gauge stations that correspond to the study area and period of observation for this study. Therefore, the data from these two tidal gauge stations located in Bayelsa State (Akassa) and Awka Ibom State (Que Iboe River Entrance) which covered a period of five (5) years were used to validate the study. Figure 5, depicts the graph showing SLA height and correlation between satellite altimeter data and the Nigeria tide gauge data. It was observed that there was a large gap between the satellite altimetry (SAT) data and the tidal gauge, the difference in density may be a result of the following.

i. The tidal gauge data only define the sea level of a point on the earth's surface.
ii. There are tendencies that the scale graduation which is inscribed on the tidal gauge is not comparable with that used by the altimeter system
iii. Most importantly, most Nigeria marine tide gauge stations are not tied to an established datum as well as the fact that the data used are not subjected to high-quality control (NIOMR, 2006).

Therefore, based on the above, more emphases on the SLA validation will be subjected to the trend pattern of the satellite altimetry data the tidal gauge data, and also, the correlation analysis index.

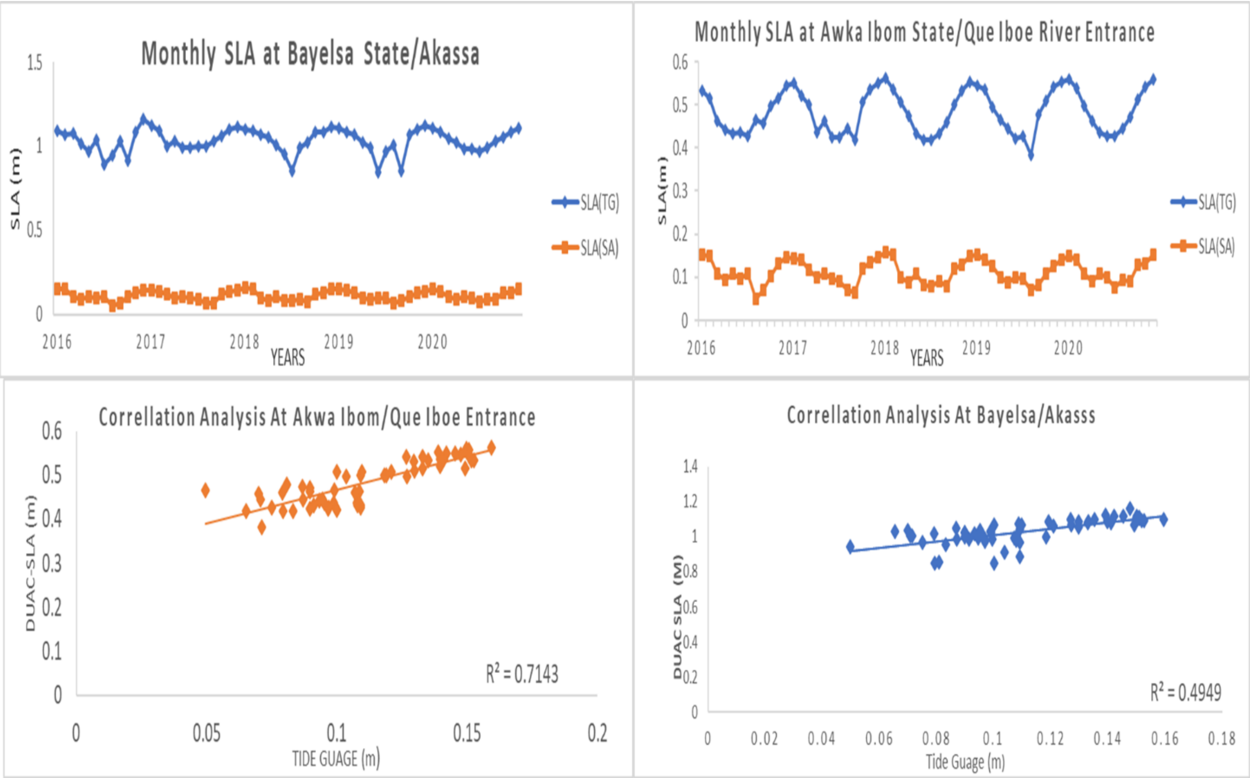


Figure 5, Trend Pattern of SAT Data and Tidal Gauge Data at Bayelsa and Awka Ibom State; Correlation Analyses Index of the SAT Data and Tidal Gauge Data

The similarity in the trend patterns of the SAT data and TG data indicates a good correlation at both stations. At the first station which is located in Akassa of Bayelsa state, the degree of goodness fit is 0.4949 while the correlation index was R = 70.4% while for Que Iboe River Entrance tide station in Akwa Ibom state, the tidal station shows a stronger pattern resemblance having the degree of goodness to be 0.7143 with a correlation index of R = 84.5%, Table 5. Summarize the validation results for both datasets used.

Table 5 Correlation analyses index between satellite altimeter data and tide gauge (Bayelsa/Akassa & Awka Ibom/Que Iboe entrance).

SLA_{SA}	0.845159	1
SLA_{TGQIE}	1	0.845159
SLA_{SA}	0.703525	1
SLA_{TGAK}	1	0.703525

Where:
SLA_{SA}: sea level anomaly from satellite altimetry
SLA_{TGQIE}: sea level anomaly from tidal station at Que Iboe Entrance in Akwa Ibom State
SLA_{TGAK}: sea level anomaly from tidal station at Akaasa in Bayelsa State.

5.1 CONCLUSION

The multi-mission satellite altimetry data was reprocessed using the Digital unification and altimetry combination (DUAC) system, Despite the signal flag-off in the process of streaming from heterogeneous surfaces (water body and land surface), the DUAC system has shown a high level of acceptability and reliability due to its accuracy realized in terms of trend pattern and its degree of closeness when compared with validation data (in-situ tidal gauge data) (correlation analyses index). The mean profile (MP) system was used due to it edge it has over the mean sea level (MSL) system for SLA derivation. MSL is a function of the computed average of the available satellite mission while Mean Profile (MP) is a function of sea surface heights used along the theoretical track of the satellites with a repetitive orbit in the CMEMS products, therefore (MP) gives higher accuracies, especially for global data.

The prediction model was developed taking cognizance of two variables; SLA values which are the dependent and period (T) which are the independent variables, The SLA trend was predicted for the next thirty (30) years at ten (10) intervals. At the first epoch (2030) the estimated SLA value recorded was 0.1084m, at 95% significant level. At the second epoch 2040, the estimated value recorded was 0.1284 m at a 95% significant level. At the third epoch 2050, the SLA value recorded was 0. 1501m, at a 95% Significant Level. The sequence of the trend from the above depicts a gradual upward movement of SLA values which is an indication of the danger ahead of Nigeria's maritime environment. However, it is expected that Nigeria's coastal areas to lose 2192.843 km^2 of it land mass Awosika *et al.,* (1992). Therefore, to ascertain the claim of this research, there is a need to conduct more extensive research on ocean characteristics across the Nigeria coastal zone.

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