CLIMATE CHANGE AND TROPICAL COASTAL VULNERABILITY IN THE GULF OF GUINEA, NIGERIA

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D) IN INDUSTRIAL CHEMISTRY IN THE DEPARTMENT OF CHEMISTRY, COLLEGE OF SCIENCE AND TECHNOLOGY, COVENANT UNIVERSITY, OTA, OGUN STATE, NIGERIA.

DECEMBER, 2021

ACCEPTANCE

This is to attest that this thesis is accepted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Industrial Chemistry in the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Nigeria

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Prof. Akan B. Williams **…….**

(Dean, School of Postgraduate Studies) **Signature and Date**

DECLARATION

I, OLOYEDE, MARY OMOLARA (13PCC00477) declare that this research was carried out by me under the supervision of Prof. Akan B. Williams and Prof. Nsikak U. Benson of the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Nigeria. I attest that the thesis has not been presented either wholly or partially for the award of any degree elsewhere. All sources of data and scholarly information used in this thesis are duly acknowledged.

OLOYEDE, MARY OMOLARA **…….**

Signature and Date

CERTIFICATION

We certify that the thesis titled **"CLIMATE CHANGE AND TROPICAL COASTAL VULNERABILITY IN THE GULF OF GUINEA, NIGERIA''** is an original research work carried out by **OLOYEDE, MARY OMOLARA (13PCC00477)** in the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria, under the supervision of Prof. Akan B. Williams and Prof. Nsikak U. Benson. We have examined and found the work acceptable as part of the requirements for the award of Doctor of Philosophy (Ph.D) degree in Industrial Chemistry.

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(Dean, School of Postgraduate Studies) Signature and Date

DEDICATION

This work is dedicated to the Almighty God, my help in ages past and my hope for years to come.

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LIST OF ACRONYMS AND ABBREVIATIONS

AOGCMs	Atmospheric and Oceanic General Circulation Models
CC	Climate Change
CFCs	Chlorofluorocarbons
CORDEX	Coordinated Regional Climate Downscaling Experiment
CVI	Coastal Vulnerability Index
DEM	Digital Elevation Model
DESYCO	Decision Support System for Coastal Climate Change Impact Assessment
EEA	European Environmental Agency
GIS	Geographic Information System
GWP	Global Warming Potential
HCFCs	Hydrochlorofluorocarbons
IAMs	Integrated Assessment Models
IPCC	Intergovernmental Panel on Climate Change
LU/LC	Land Use/Land Cover
NIOMR	Institute for Oceanography and Marine Research
NOAA	National Oceanic and Atmospheric Administration
RCP	Representative Concentration Pathway
SimCLIM	Simulator of CLIMate Change Risks and Adaptation Initiatives
SLAMM	Sea Level Affecting Marshes Model
SRES	Special Report on Emission Scenarios
SST	Sea Surface Temperature
UNEP	United Nation Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
USCCSP	United States Climate Change Science Programme
USEPA	United States Environmental Protection Agency
WCRP	World Climate Research Programme

ABSTRACT

Coastal regions are essential spots on earth as they are hosts to various important ecosystems, natural resources, and an increasing population. They are mainly affected by sea-level rise, which is one of the effects of climate change. This study quantifies and classifies the vulnerability of the Nigerian coastline to increase in sea levels. This involved calculating the coastal vulnerability index (CVI) employing physical and geomorphological variables, and socioeconomic indicators that characterized the coastline vulnerability. Two approaches were utilized in this study to obtain the Coastal Vulnerability Index (CVI): an analytical hierarchical process (AHP) based approach to coastal vulnerability studies and the CVI formula proposed by Gornitz (1991). The Nigerian coast was divided into seventeen (17) segments based on geomorphic units. The different vulnerability variables were assigned ranks ranging from 1 to 5, with 1 indicating the lowest and 5 indicating the highest vulnerabilities. The geomorphological and physical parameters include coastal slope, bathymetry, geomorphology, wave height, mean tidal range, shoreline change rate and relative sea-level rise, while the socioeconomic parameters include population, cultural heritage, land use/land cover and road network. Also, the trends and effects of some ocean variables of the Nigerian coastline were analysed, with the aim of identifying the potential drivers of sea level changes. This was achieved by the analysis of tide and oceanographic data obtained from both local and international agencies. Statistical analysis was carried out using MATLAB and XLSTAT. Sea level change projection was carried out using simCLIM. A comparison of CVI values was carried out and the AHP based approach appeared to be a more realistic approach in assessing coastal vulnerability as it is systematic and stepwise. The calculated CVI values (AHP method) ranged from 11.25 to 41.66 with a median value of 23.60. Based on Gornitz approach, the calculated values ranged between 3.51–4.77 and 3.08–5.00 for PVI and SoVI, respectively. However, the aggregated coastal vulnerability index computed using this approach ranged from 3.29 to 4.70. The results obtained from both approaches showed that 59–65% of the entire Nigerian coastline is under moderate to high vulnerability to sea-level rise. These data indicated how the coastal populations are highly vulnerable to both physical–geomorphological and socioeconomic stressors. Coastal vulnerability maps, highlighting the various ranking regions with low, moderate, and high vulnerability were generated in this study. The median projected sea-level rise values using simCLIM ranged from 11.86 cm to 49.22 cm for RCP 2.6; 11.73 cm to 58.91 cm for RCP 4.5; 11.28 cm to 62.28 cm for RCP 6.0; 11.92 cm to 84.25 cm for RCP 8.0, respectively. From the results of this study, there is evidence of rise in sea level occurring in the Nigerian coastline. The projections also predict a continuous increase in sea level in the coming years. Therefore, the results obtained from this study would assist coastal planners in the identification of vulnerable regions along the Nigerian coastline and subsequently influence decisions that would mitigate the predicted impacts of the associated hazards of climate change in the regions.

Keywords: Climate change, sea level change, coastal vulnerability, analytical hierarchical process, coastal vulnerability index