Lagos State Climate Risk Assessment

February 2021

Institutional Framework

The Partners

Geo-Solutions Providers Ltd under contract with the UNDP in 2020 had Lagos State as the scope for the development of Climate Risk Assessment project. The project was implemented by the Government through the Ministry of the Environment and Water Resources while C40 was the technical partner.

Leading/Coordinating Team

Lagos State Ministry of the Environment and Water Resources

Michael Bankole
Afinowi-Subair Azeezat
Seriki Yewande
Abass Muhammed

United Nations Development Programme
Muyiwa Odele

C40 Cities
Maximus Ugwuoke
Lia Nicholson
Paul Jorgensen

Geo-Solution Providers Ltd.
David Adeyemi Ogunsawe
Dr Michael A. Ahove
Prof. Fabiyi Seyi
Dr. Olayemi Soladoye
Chinenye L. Okafor

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ABBREVIATIONS

CAP	Climate Action Plan
CDAs	Community Development Areas
ESS	Environmental and Social Safeguard
DTM	Digital Terrain Model
FGDs	Focus Group Discussions
FMEnv	Federal Ministry of Environment
GHG	GreenHouse Gas
GIS	Geographic Information System
GRA	Government Reserved Area
HH	HouseHold
HHH	Head of HouseHold
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Project
IT	Information Technology
LCDA	Local Council Development Area
LGA	Local Government Area
LSDPC	Lagos State Development and Property Corporation
LAMATA	Lagos Metropolitan Area Transport Authority
LAWMA	Lagos State Waste Management Authority
LASPARK	Lagos State Parks and Gardens Agency
LASURA	Lagos State Urban Renewal Agency
LCDAs	Local Council Development Areas
LGAs	Local Government Areas
LWC	Lagos Water Corporation
MCA	Multi-Criteria Analysis
MDAs	Ministries, Departments and Agencies
MEMR	Ministry of Energy and Mineral Resources
MEPB	Ministry of Economic Planning and Budget
MM	Millimetres
MOA	Lagos State Ministry of Agriculture
MOE & WR	Ministry of the Environment & Water Resources
MPP & UD	Lagos State Ministry of Physical Planning and Urban Development
MRVE	Monitoring, Reporting, Verification and Evaluation

MW	Mega Watt
M&E	Monitoring and Evaluation
NCF	Nigerian Conservation Foundation
NEST	Nigerian Environment Study Group
NPC	National Population Commission
NEMA	National Emergency Management Agency
NGOs	Non-Governmental Organizations
NiMet	Nigerian Meteorological Agency
PAPs	Project Affected Persons
PSP	Private Sector Participation
QA/QC	Quality Assurance/Quality Control
RA	Research Assistants
RFP	Request for Proposal
RH	Relative Humidity
SDGs	Sustainable Development Goals
SLR	Sea Level Rise
SRTM	Shuttle Radar Topography Mission
ToR	Terms of Reference
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organizations
USGS	United States Geological Service
WHO	World Health Organization
^{0}C	Degree Celsius

EXECUTIVE SUMMARY

Coastal cities around the world have consistently experienced sea level rise and its attendant coastal flooding and storms. Thus, global biodiversity loss; floods, heat waves, droughts and desertification; oxygen depletion, forest fires; decreased crop yield; and negative health impacts are some of the negative consequences of climate change identified in literature. The significance and evidence of the threats of climate change to global systems have gone beyond affecting Polar Bears as it was in the 1990s. It has now reached human existential threat; thus, necessitating global, regional, national and sub-national efforts by governments to develop and implement several policies, programs and protocols towards reducing the threats of climate change.

Currently, several African nations are battling with the consequences of climate change such as drought and desertification, erosion, coastal flooding, challenges of water demand and supply as well as unpredictable rainfall patterns leading to poor agricultural yield with very poor coping capacity often resulting in outcry for aids from the developed communities. Lagos state-the commercial nerve centre of Nigeria and the fourth largest economy in Africa has its own fair share of the impact of climate change. However, the recent development of the resultant impacts of climate change, no doubt, portends debilitating threats to the over 25 million populations and the varying multi-billion dollar investments and infrastructures across the State. It is a known fact that several studies have been carried out by successive governments on climate change, therefore the implementation of this Climate Risk Assessment (CRA) project would enable Lagos to have a statewide strategy for resilience in order to ensure sustainable adaptation strategy.

Potential climate futures

The risk assessment of communities in Lagos state to climate change with particular reference to five notable climate change impacts viz: floods and ocean surges, coastal subsidence, heat waves, storms and coastal erosion are reported. However, four major climate change impact scenarios in Lagos state were assessed and their respective impacts in each Local Government Area (LGA) were identified. The extreme climate change impacts evaluated include coastal and urban flooding, coastal subsidence and coastal erosion, extreme heat waves and ecosystem services depreciation.

Spatial assessment of vulnerability

The coastal city of Lagos has had its own fair share of the consequences of global climate change. The impact of the sea level rise has caused extreme ocean surges and the increase intensity of flooding events occurs in most part of the city. Thus, Lagos is the most vulnerable city to the impact of climate change in Nigeria. Today, it is estimated that Lagos is home to more than 25 million people, majority of which are poor and living on the fringes of the society. The large percentage of the population of Lagos is also extremely poor, thereby lacking the required strategies to combat the effects of climate change.

Vulnerability analysis and risk profile

The vulnerability assessment of Lagos communities to climate change with particular reference to impacts such as: floods and ocean surges, landslides and coastal subsidence, heat waves, storms and coastal erosion were assessed during this Climate Risk Assessment (CRA) project. However, based

on the database of vulnerability assessment, a total of 6,983 features were found to be susceptible to climate risk in Lagos state. It is therefore pertinent to mention that the affected features/buildings/infrastructures have varying degrees of exposure based on the proximity, severity and concurrency.

Vulnerability assessment obtained in this study indicates that features located along flood plain, riverbanks and along the Atlantic Ocean, especially the Alfa Beach axis, have the highest degree of vulnerability to the threat of ocean surge. The threat, however, according to interaction with the various stakeholders during the field survey showed that the Eko Atlantic City project has exacerbated the rate of ocean surge; thus, over 350 meters of the community's land, including other infrastructures such as religious, educational, cultural and the main road into the community have been lost to the Atlantic.

Vulnerability of population to the risk of climate change

There is a significant connection between climate vulnerability and human population (UN Habitat, 2019). It is therefore important to evaluate the population distribution of the State in order to enable the government to develop a sound and cost-effective resilient strategy (Lagos State Government, 2020). The demography of the State encompasses all strata of people viz: old, women, youths, men and vulnerable population some of which are also exposed to some of the threats of climate change.

In assessing the vulnerability of the population to the risk of climate change, the demography of the various Local Government Areas (LGAs) as posited in table 1.2 provides a conceptual perspective of the diversity of population that are vulnerable. Thus, an estimated population of about 12,910,948 people is projected to be vulnerable. However, the projected population distribution for the State from 2020 to 2070 is indicated in table E1.

The table shows that the population of Lagos State is projected to be 25,012,637 in the year 2025, 32,332,038 by 2035, 47,516,395 and 79,394,551 between 2050 and 2070 respectively.

Table E1: Projected Population Distribution of Lagos State (2020-2070)

Year	2020	2025	2035	2050	2070
Projected Population	22,000,000	25,012,637	32,332,038	47,516,395	79,394,551

Source: Geo-Solution Providers Limited, December, 2020

The consequence of these future populations explosion on the State despite the limited spatial size can be better imagined than experienced. Therefore, the data would enable current and future governments to evolve climate resilient strategy to safeguard the people toegther with the multi-billion dollar investments across the State.

Vulnerability of the tourism sector

Climate change has emerged as a risk to the tourism industry potentials in the state especially along the coastline (lagoon and Atlantic Ocean) which are constantly threatened by coastal flooding and

ocean surge. It is worrisome to note that the popular Alfa beach that used to play host to varying tourists and events (especially the Lekki Sunsplash) has today been lost to the Atlantic. Interaction with the community members showed that quite a number of the inhabitants are becoming homeless and internally displaced due to the threats of ocean surge which has been exacerbated by the Eko Atlantic City Project. Such threats of perennial flooding, particularly along the coastlines, no doubt constitute a huge hindrance to the up scaling of the tourism potential of the State.

Vulnerability of the agricultural sector

The unpredictable weather pattern, no doubt, creates an albatross to the farmers, including fish farmers not to mention the impact of unfavorable climate patterns including flooding of farms on the agricultural sector. Equally, incidences of coastal flooding and sea level rise constitute a risk to fishermen; thus, depriving them of sources of livelihood.

Vulnerability of infrastructure

Table E2 shows the distribution of infrastructures that are severely impacted by flooding, with Kosofe Local Government Area (LGA) being the most severely affected. Areas such as the entire Isheri (including the LSDPC/Isheri North GRA), Maidan, Agiliti, Owode Elede, Owode Onirin down to Ajegunle (along Lagos-Ikorodu Road) are severely susceptible to the threats of perennial flooding. Also, Eti-Osa, Ikorodu, Amuwo-Odofin, Ojo and Alimosho LGAs are equally vulnerable to the threats of flooding. The distribution of severely affected infrastructures are presented in table E2 while the vulnerability maps are equally presented in the appendix ? (flood risk vulnerability maps) for the affected Local Government Area and for the entire State.

Table E2: Lagos Flood Risk Vulnerability Statistics (Severely Affected)

LGA	IKORODU	KOSOFE	OJO	AMUWO-ODOFIN	ALIMOSHO	ETI-OSA
No. of PAPs	342	2,169	52	218	35	465
Residential	296	1,862	40	197	27	385
Commercial	1	62	2	-	-	25
Mixed	25	110	4	10	5	18
Industrial	2	1	-	-	-	1
Institutional	13	89	5	5	2	18
Roads	5	45	1	5	2	9
Recreational	-	-	-	1	-	9
Estimate (₦)	2,092,930,000.00	34,735,930,000.00	385,150,000.00	6,367,500,000.00	493,000,000.00	29,577,696,008.00

A buffer of 500m was set in order to determine the total number of infrastructures that are moderately affected by flooding. The analysis however revealed that a total of 339 infrastructures (residential, commercial, mixed, industrial) were moderately exposed to the threats of flooding with an estimated value of ₦4, 991,800,000.00 (see table E3).

Table E3: Lagos Flood Risk Vulnerability Statistics (Moderately Affected)

LGA	AMUWO-ODOFIN	ALIMOSHO	ETI-OSA
No. Of PAPs	83	62	25
Residential	67	46	16
Commercial	1	1	-
Mixed	11	4	4
Industrial	-	-	-
Institutional buildings	4	7	3
Roads	-	4	2
Recreational facilities	-	-	-
Estimate (₦)	2,339,500,000.00	1,094,000,000.00	1,558,300,000.00

In determining the estimate of the least affected infrastructures, a buffer of 700m was set along the coast line. Thus, a total of 81 infrastructures of varying landuse with an economic value of ₦6, 276,000,000.00 are exposed to threats of flooding in the State. Table E4 shows the distribution of the least affected infrastructures to flooding in Lagos State.

Table E4: Lagos Flood Risk Vulnerability Statistics (Least Affected)

LGA	AMUWO-ODOFIN	IFAKO IJAYE
No. Of PAPs	33	-
Residential	25	21
Commercial	-	-
Mixed	1	1
Industrial	-	-
Institutional buildings	7	-
Roads	-	-
Recreational facilities	-	-
Estimate (₦)	5,599,000,000.00	677,000,000.00

<u>Topography Analysis</u>

The topography of Lagos was examined using the combination of ARSTER data and SRTM data both obtained from the USGS's site being a globally accepted model. The data obtained were used to perform digital Terrain Model of Lagos state. The Digital Terrain model indicated that significant parts of Lagos State are situated in a low-lying topography some of which are below sea level. The topography ranges from 38 meters above sea level while the higher points are in the northern parts

of the state around the boundary with Ogun state, but majority of the high points are still below 78 meters above sea level. This shows that Lagos state is a low-lying area, and this characteristic makes it susceptible to regular flooding.

Slope Analysis

The slope analysis shows that the nature of slope in Lagos encourages flood water retention as most parts of the State are generally flat. This shows that the storm water will take longer time on the surface before it flows into the water bodies.

Temperature

In the year 2009, the area with low surface temperature has significantly reduced and the areas with extreme surface temperature have increased. The average low temperature has increased to about 29^0C. In the year 2019, the highest surface temperature recorded was 41^0C, and the area with extreme temperature has increased across the State. Moderately high surface temperature has also increased throughout the study area.

Land use analysis of Lagos State

Table E5: Land use Analysis of Lagos State 2006 and 2016

Ecosystem	Area (Hectares)	% Ecosystem	Areas (Hectares)	Areas (Hectares) in 2016	% Ecosystem
Undisturbed forest	2118.42	0.60	119075400	11907.54	3.42
Coastal vegetation	13872.96	3.95	107391600	10739.16	3.09
Freshwater vegetation	49881.15	14.21	307831500	30783.15	8.85
Forest plantation	6565.59	1.87	82873800	8287.38	2.38
Disturbed forest	16007.58	4.56	154041300	15404.13	4.43
Tree crop plantation	40012.29	11.40	279909900	27990.99	8.04
Savannah woodland	5983.29	1.70	198685800	19868.58	5.71
Grassland	712.71	0.20	44461800	4446.18	1.28
Arable land	26740.53	7.62	602654400	60265.44	17.32
Settlements	64650.78	18.41	694539000	69453.9	19.96
Bare surfaces/cleared areas	48377.34	13.78	158738400	15873.84	4.56
Water Body	76159.08	21.69	729315900	72931.59	20.96
Total	**351081.72**	**100.00**		**347951.88**	**100.00**

Table E5 shows that the major ecosystems in the year 2006 are water bodies (21.69%) settlements 18.41%) and freshwater vegetation (14.21%). But in 2016, the major ecosystems have slightly changed and they were water body (20.96%), settlements (19.96%), arable land (17.32%) and freshwater vegetation (8.85%). This shows significant depletion in the freshwater vegetation (from 14.21 to 8. 85%) and slight depletion in the water body from 21.69 to 20.96 %). This is due to an increase in building development projects in the State (Fabiyi, 2018).

Figure E1 shows the projected land use change in the year 2030, it showed that the area where high percentage ecosystem change will be noticed in the project area will be around the upper Ikorodu axis.
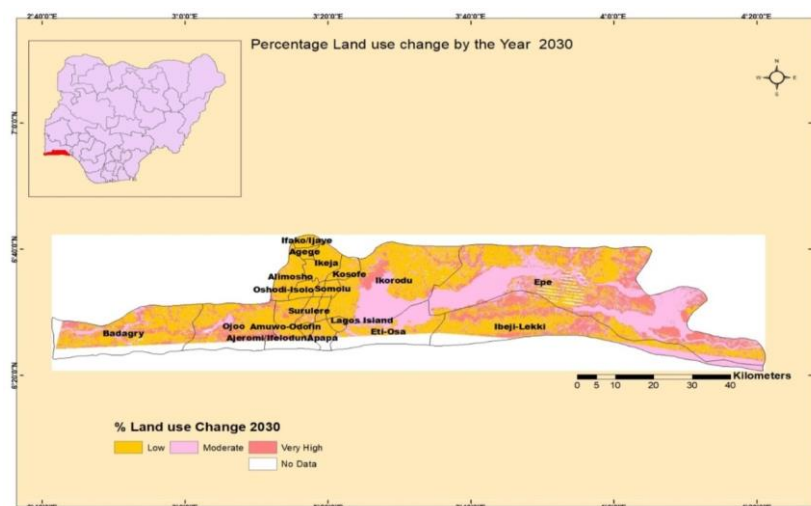
Figure E1: Percentage projected change in Lagos state 2030

Identified hazards

Climate hazards often experienced in Lagos state were identified from a combination of sources; the 3-day capacity building of the Ad-Hoc-Staff/training workshop held on 19th-21st of August 2020, the one-day Stakeholders' sensitization meeting held on 2nd of September, 2020 and the field survey, all organized by Geo-Solution Providers Limited on this project as well as from literature search. The identified hazards include:

1. Heat waves as a result of increase in maximum, average and minimum surface temperature;
2. Inland flooding due to changes in precipitation intensity-duration-frequency),
3. River flooding
4. Flash flooding
5. Erosion
6. Thunder storm
7. Coastal and lagoon flooding (sea level rise).
8. Tropical storms
9. **Urban heat island**

Analysis of Lagos state's meteorological data

The following meteorological data were obtained from the Nigerian Meteorological Agency (NIMET) on Lagos State:

- The periods of drought in Lagos between the years 1990 and 2019 and the five most dry years are presented in table E6.

Table E6: The Most Dry Months in Lagos State (1990 - 2019)

S/No.	Year	Below Average Rainfall (mm)
1.	2007	28.98
2.	2000	26.00
3.	1994	24.90
4.	2002	23.33
5.	2006	22.75

Conversely, the most wet years (heaviest rainfall) in Lagos between the years 1990 and 2019 and the five most wet years are presented in table E7.

Table E7: The Most Wet Months in Lagos State (1990 - 2019)

S/No.	Year	Below Average Rainfall (mm)
1.	2010	255.96
2.	2019	339.76
3.	2004	473.86
4.	1990	543.96
5.	2011	703.16

Periods of hottest years (highest temperatures) in Lagos between the years 1990 and 2019 and the five hottest years are presented in table E8**.**

Table E8: The Hottest Months in Lagos State (1990 - 2019)

S/No.	Year	Average Temperature (^{0}C)
1.	2014	31.85
2.	2018	31.39
3.	2015	31.27
4.	2017	31.25
5.	2019	31.22

Adaptive actions identified by respondents from the climate change community survey.
Flooding
- Pump out water
- Clear drainage
- Stay at home
- Relocate

- Sandbags
- Sand filling
- Raise valuable things
- Raise pavements
- Use Rain boots
- Do nothing

Extreme temperature

- Cooling system
- Sit outside
- Use umbrella
- Bath regularly
- Sleep outside
- Go for a walk
- Proper ventilation
- Wear light clothing

Prioritized actions

The illustration in figure E2 shows a list of actions for a cleaner, greener, healthier, stable and more prosperous Lagos in a changing climate.

Vision

A cleaner, greener, healthier, stable and more prosperous Lagos in a changing climate

	Goals			
	Resilient ecosystems	A flood-proof Lagos	Political flexibility and responsive-ness	Social inclusion of vulnerable groups

Objectives

More greenery	Protected wetlands	Improve drainage	Waste-free Lagos	Local institutional capacity	Evidence-based decision-making	Indigenous adaptation methods	Gender equality

Targets

	Wetlands protected by law						

Priority Actions

Resilient ecosystems	A flood-proof Lagos	Political flexibility and responsive-ness	Social inclusion of vulnerable groups
Integrate green and nature-based ecosystem services into hard engineering solutions Plant more trees for more shade and cooling in public spaces, markets and along streets, and encourage tree planting on private property	Produce a city-wide Flood Risk Map Develop and implement a Storm Water Drainage Master plan Improve, expand and maintain the city-wide drainage network Promote de-paving and encourage the use of permeable surfaces	Institutional frameworks for community involvement in developing climate-resilient guidelines for new city infrastructure Conduct a State-wide sea level rise vulnerability assessment Develop integrated coastal zone management plans that account for community needs	Provision of the basic health-care scheme Strengthening the emergency response and evacuation systems Engage communities in the participatory planning of their settlements in order to reduce their vulnerability to climate change Enhance public awareness and improve adaptive skills and knowledge of indigenous adaptation methods

Figure E 2: Summary of Prioritized Actions

The relevance for the development of a protocol for monitoring, reporting, verification and evaluation system (MRVE) is vital and hereby suggested for the state and has to be kept in focus.The relevance of such quality control mechanism is that it provides a management tool to monitor progress of the implementation plan thus indicates/identifies lacuna between the objectives and the outcomes from the actions (Vulnerability Report, 2015) contained in the adaptation plan. The MRVE protocol of the adaptation plan is a sure bet for the attainment of a Resilient Lagos City State. The

continuous review of this report is encouraged for update, especially because of the dynamic nature of Lagos as a city state. Methods such as cost-benefit analysis could be conducted in the future to inform the cost of adaptation in Lagos state.

CHAPTER ONE

Introduction

The development of a proactive and cost-effective resilient system remains the only antidote to stemming the current tide of the vagary of climate. The avalanche of anthropogenic activities, particularly those emanating from industrial activities over time, have contributed to GreenHouse Gas (GHG) emission which is responsible for the threats of climate change confronting governments and institutions across the world. This is attributable to the wide significant nexus between the consequences of unwholesome anthropogenic activities and the sustainability potential of the environment.Climate change is obviously not far from been being labelled as one of the topmost global challenges confronting humanity (Intergovernmental Panel on Climate Change [IPCC], 2018).Consistent Sea level rise and attendant coastal flooding; global biodiversity loss; heat waves, droughts, and desertification; oxygen depletion, forest fires; decreased crop yield; and negative health impacts such as increased malnutrition, increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts, and increased frequency of cardio-respiratory diseases are some of the negative consequences of climate change identified in literature. The significance and evidence of the treats of climate change to global systems have gone beyond affecting Polar Bears as it in the 1990s. It has now reached human existential threat;thus, necessitating global, regional, national and sub-national efforts by governments over the time to develop and implant several policies, programs and protocols toward reducing the threats of climate change.

Currently, several African nations are battling with the consequences of climate change: such as drought and desertification; erosion, coastal flooding, challenges of water demand and supply as well as unpredictable rainfall pattern leading to poor agricultural yield with very poor coping capacity often resulting in outcry for aid from the developed economies. Lagos State - the fourth largest economy in Africa and the commercial nerve center of Nigeria - has its own fair share of the impact of climate change. However, the recent development of the resultant impacts of climate change, no doubt, portends debilitating threats to the over 25 million populations and to the varying multi-billion dollar investments and infrastructures across the State.

It is a known fact that several studies have been carried out by successive governments on climate change and the implementation of this Climate Risk Assessment (CRA) project would enable Lagos to have a statewide strategy for resilience in order to ensure sustainable adaptation strategy.

The current administration of Lagos State Government is poised to safeguard residence of the state against negative impacts of climate change. This urge was responsible for the award and implementation of the Climate Risk Assessment (CRA) project for the State coupled with the position of the State as the seat of commercial and industrial activities in addition to the feat of Lagos as the foremost State on issues of sustainable development. This has endeared development partners, especially the United Nations Development Programme (UNDP), for the development of the Lagos State Climate Change Policy (2012 – 2014) and Climate Change Action Plan (2014 – 2020), which was endorsed by the Lagos State Executive Council in 2015, before the signing of the Paris Agreement.

In search for an excellent state-level CRA, the state's trajectory indicates that there is a significant body of work on climate change scenarios, coastal risk analysis done on the following subjects by the following consultants;

- Beachland Resources Limited. (2011)
- NEST
- Justice Research Institute (2011)
- Triple "E" Systems Inc. & Pennsylvania State University and Triple "E" Systems Associates Ltd (2010).
- UNIDO (2010).
- HEDA Resource Centre (2011). There is need to indicate the work done by these consultants

These culminated in the adaptation component of the 2014 Lagos State CAP which gave birth to the document "Towards a Lagos State Climate Change Adaptation Strategy" published in February 2012.

The document (Lagos State Government Resilience Strategy) identified some of the dominant shocks and stressors induced by climate change to include: storm surge, building collapse, flooding, including inland flooding, coastal and lagoon flooding, heat stress, urban fires,; thus, there is the need for a concerted effort to develop resilience systems to mitigate and adapt to these stressors in order to ensure sustainable survival of the Lagos social and economic ecosystem for the attainment of the mega city agenda and Sustainable Development Goals (SDG).

In view of the impact of climate change on the State's systems, a state-wide Climate Risk Assessment (CRA) study became crucial to further strengthen the Lagos State Climate Action Plan (CAP) which is very central to achieving more resilient systems across the length and breadth of the State.

Thus, considering the threats of climate change coupled with the need to have a robust scientific assessment of the impact of climate change on the State, the Lagos State Ministry of Environment & Water Resources with the support of the United Nations Development Programme (UNDP) and C40 (technical partner) in July 2020 awarded the contract for the implementation of the state-wide Climate Risk Assessment (CRA) study in Lagos State to Geo-Solution Providers Limited and the report is hereby presented.

1.1 Climate change and coastal cities

The advent of science and technology in our contemporary and globalized world and, especially, our consuming patterns of natural resources, has significantly contributed to major changes in communities and cities.Climate change is currently labelled as one of the most important global challenges confronting humanity (Intergovernmental Panel on Climate Change [IPCC], 2014) and the sustainability of our beautiful blue planet, so far the most favourable home for humanity. It is clear that the current impact of climate change is basically due to anthropogenic activities, thus, human influence on the climate system is clear, as we disrupt our climate; we increase the propensity risk severity, pervasive and irreversible impacts. The fact remains that humanity has the

capacity to limit climate change and build a more prosperous, sustainable future (IPCC, 2020). The vital question is how much political will and team spirit will be deployed by nations of the world to tame this climatic monster creating an existential challenge to humanity?

Climate change has continued to have devastating impacts on communities in several nations around the world, especially in poor communities of Africa and Asia (UNDP- UNEP, 2015). Many of these communities have witnessed increased storm severity and frequency, changing weather patterns and rising sea levels (especially in coastal cities) taking a toll on the fragile economy, political system, all leading to serious humanitarian stresses. Climate change is threatening the stability and productivity of agricultural production in Africa. It is estimated that up to 600 million more people in Africa could face malnutrition as agricultural systems break down due to climate change impacts. An additional 1.8 billion people could face water shortages, especially in Asia (UNDP 2011). Thus, the impacts of climate change on people's livelihoods have been clearly documented (IPCC, 2019).

Cities are striving towards attaining their visions for socio-economic development while addressing the climate challenge, yet achieving such outcomes can be demanding. Climate action planning provides city governments and their partners with strategic direction, new ideas, tools, and a community of practice to address climate change while meeting other long-term goals such as socio-economic development and environmental protection. These local authorities could provide essential support planning that seeks to reduce greenhouse gas emissions and adopt low emission development trajectories (mitigation), and also adapt to the impacts of climate change (adaptation) and build local climate resilience (UNDP- UNEP, 2015).

Cities have vital roles to play in the global action in favour of climate change by reducing their Greenhouse Gas Emissions and adapting to the effects of a changing climate. Grassroots governments are near to the communities and are, therefore, pivotal to making these efforts significantly successful. They lead climate action by framing strategies and programmes, integrating such actions into ongoing urban development, and forging the partnerships necessary for effective climate responses.Coastal cities are particularly vulnerable to flooding and erosion due to climate change impacts. Thus, planning provides many city governments and their partners with the basic principles and framework necessary to attain their potential and to contribute to this global effort (UNDP- UNEP, 2015). Coastal urban cities in low-lying areas especially in developing economies are known for hotspots of climate change related risks and therefore, the assessment of different characteristics of vulnerability, resilience and transformation is an important prerequisite for planning (Birkmann, Agboola, Welle, Ahove, Odunuga, Streit and Pelling, 2016) and especially for climate action decision making.

Coastal megacities in developing economies are becoming susceptible to climate change risk due to a combination of climatic and non-climatic factors. Le, (2019) analysed copious related studies and placed them into three clusters. The first cluster assessed the global warming and rising temperature of a major threat to water supply, food production and security, and human health to many regions across developing countries. The second cluster analysed the impacts of climate change to coastal

cities and low-lying regions, which basically focused on sea-level rise (SLR), flooding, erosion, storm, and typhoon. In view of the scenario of 1metre sea level rise , more than 50 million people in developing countries are likely to become climate change refugees, as well as its economic and ecological damaging consequences. The last cluster examined non-climatic variables, such as urbanization expansion, economic growth and development, and entitlement to resources, which have exacerbated the vulnerability to coastal cities in developing countries.

1.2   Scope of the Work

This project was implemented across the State and the outcomes are disaggregated into clusters viz, statewide, 20 LGAs and the five (5) IBILE/divisional zones of the State, and the analysis was done in 2020 while projections were also made for 2025, 2035, 2050 and 2070.

In line with the Terms of Reference (ToR) for the assignment is to provide robust evidence and projections of localized climate risks and hazards, and prioritize sectors and actions that will meet short, medium and long-term adaptation needs of Lagos State's 2020 Climate Action Plan.

The project was implemented by carefully assessing the physical climate risks to Lagos State across the 20 Local Government Areas (LGA) and spanning the five (5) divisions of the state viz-a-viz; Ikeja, Badagry, Ikorodu, Lagos Island and Epe divisions.

The objectives of the project include:

- *Risk assessment:* Conduct a Climate Risk Assessment for Lagos State and prioritize hazards based on impacts to city inhabitants and vital infrastructures;

- *Data:* To use existing data and compile spatial datasets (in particular) in order to analyze and deliver the outputs. In achieving this, data (spatial and non-spatial data) were sought by the Consulting team from Ministry, Departments and Agencies (MDAs) including the satellite imagery of the State while open data sources were also sought;

- *Stakeholder engagement:* Stakeholders were engaged including support of the Climate Change and Environmental Planning Department of Lagos State Government to undertake consultation with key stakeholders.

- *Decision support:* To provide top-down risk reduction insights and recommendations for actions that would deliver the greatest risk reduction potential.

In order to produce the evidence basis to support the climate change adaptation strategy for Lagos, the following were also considered:

1. **Exposure to climate hazards**: risk level (probability x impact) and timescale of the key hazards on potential human and financial resources in the city were taken into account, including the historic trends, current situation, and future scenarios to 2025, 2035 and 2050. The project undertook an assessment of the potential impacts of extreme events on relevant systems, sectors and vulnerable communities/populations. Analyze the potential impact (e.g. number of people affected, cost of damage, days of service lost) of potential damages, avoided economic and societal costs and the value of city systems at risk (value-at-risk

assessment). This serves as a business-as-usual baseline, showing what's at stake if no adaptive actions are taken.

2. **Adaptive capacity to climate hazards**: through a systematic analysis approach, identification and description of factors as it relates to the adaptive capacity of essential urban systems (e.g. food systems, infrastructure services (energy, potable water, drainage, transportation), physical assets and natural systems (e.g. forestry, coastal areas, ocean productivity and other relevant ecosystem services). Adaptive capacity to absorb shocks and stresses from climate hazards, and the degree to which these factors challenge or support recovery, transformation or resilient building were also analysed.

3. **Prioritize sectors and actions:** using scenario analysis, prioritize sectors and actions to arrive at top-down insights and recommendations for actions that will deliver the most impactful climate risk reduction outcomes in 2025, 2035 and 2050.

Specific activities that took place under this consultancy include:

- Review of all existing climate risk studies developed for Lagos State and the Federal Government of Nigeria

- Refin the methodology for the study

- Compared climate projections applicable to Lagos State to identify significant differences or areas where there is uncertainty in the climate models

- Prepare data collection sheets and compile existing spatial datasets, including:

    o topography (scale 1:25,000)

    o recent satellite imagery to assess the urban occupation/land use patterns

    o existing rainfall intensity duration curves and the period of data use in its development

    o socio-economic spatial data (buildings, settlement areas)

    o infrastructure spatial data (electricity, water, waste, transport, health, emergency response)

    o flood lines and coastal erosion / flood zones

    o heat maps

- Meteorological data were collected from the Nigerian Meteorological Agency (NiMet) in Abuja.

- Conducted spatial modeling and hazard analysis:

    o Separated and combined multi-hazard maps

    o Built-up areas exposed to climate risks

    o Non-built-up areas exposed to climate risks

o   Exposure maps and information related to areas of population growth (past and projected), including informal settlements

o   Hotspots maps identifying interdependencies across sectors, areas and communities of high risk and exposure (land value, critical infrastructure, population and climate risks)

o   Projected risks considering climate change scenarios, population growth projections and interdependencies

- Developed a database of the historic costs of climate hazards (number of people affected, cost of damage, days of service lost), by magnitude of hazard, to inform future impact projections

- Estimate the cost of assets and livelihoods at risk for the various hazards

- Prioritize climate hazards using the evidence basis

- Recommend climate risk mitigation strategies and assess and quantify residual risk where possible.

1.3   Lagos city state profile

Created on 27th of May 1967, Lagos State is located in the Southwest region of Nigeria (see Fig. 1.1) and it is often referred to as the commercial and industrial hob of Nigeria. It is located by latitudes 6^0 22'N and 6^0 42'N and straddles longitudes 2^0 42'E to 4^0 20'E. Lagos State occupies about 3,577sq kilometres which is about 0.4% of the Country's (Nigeria) landmass and it controls over 70 percent of the economic activities of the country despite being the smallest State in Nigeria by landmass
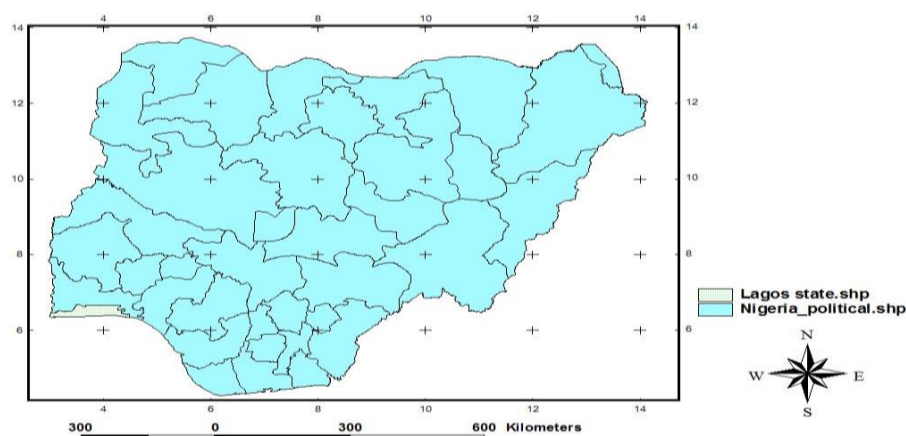
Figure 1.1:   Map of Nigeria Showing Lagos State

The State is bounded in the North and East by Ogun State. It however shares an international boundary on the West of about 45 kilometres with the Republic of Benin while the vast deep blue

Atlantic Ocean constitutes the approximately 180 kilometres long Southern limit. Though founded by one Ogunfuminire who initially settled at Isheri Osun near the Ogun River according to the Yoruba-Awori version by the early migrants from Ile-Ife. Having dispersed southward from Isheri to Yaba where they further moved to Ebute-Metta and later moved to modern Iddo Island (formerly Ile-Olofin). It was from this Ile-Olofin that one Aromire led a migration across the Lagoon to the present Lagos Island.

Irrespective of the version, it is generally known that what constitutes the present-day Lagos was established by the Awori people of the Yoruba race and Lagos has over the time grown to be one of the tenth most populous cities in the world, with people of diverse ethnic backgrounds. Going by the above, it can be deduced that the original owners of the area and Lagos in general are the Awori people of the Yoruba race. Like every other State in Nigeria, Lagos State is divided into administrative units (see Fig. 1.2) otherwise known as Local Government Areas but Lagos has twenty (20) LGAs and thirty-seven (37) Local Council Development Areas (LCDAs) in accordance with the nation's (Nigeria) federal structure together with the need for governance, development and participatory democracy at the grassroots (Lagos State Government, 2019).
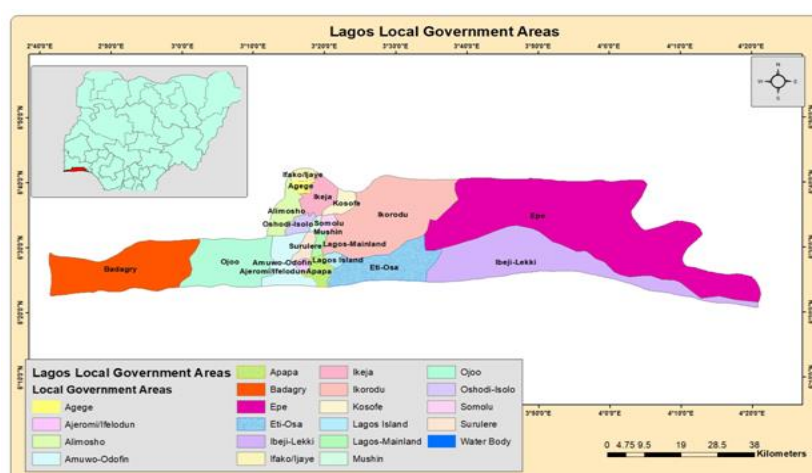
Figure 1.2:   Administrative Map of Lagos State

However, its location coupled with the socio-economic opportunities has over the time culminated into exponential population growth. Though, the result of the 1991 National Population Census conducted by the National Population Commission (NPC) gave a population of over 9 million people (see table 1.1), the census (NPC) population figure for the State no doubt became a subject of controversy and was rejected in its entirety by the then government of the State. Consequently, the State Government conducted its own census which emerged with a total of 17,552,942 inhabitants in 2006 based on records taken from Lagos State Government during the 2006 Population Census Exercise (Lagos State Government, 2019).

Table 1.1: Population of Lagos State (NPC 2006) and Projected 2020 Population

S/No.	Local Government	Population	Projected Population 2020
1.	Apapa	217,362	311348
2.	Lagos Island	209,437	299996
3.	Ajeromi-Ifelodun	684,105	979909
4.	Lagos Mainland	317,720	455100
5.	Badagry	241,093	345340
6.	Ojo	598,071	856674
7.	Amuwo-Odofin	318,166	455739
8.	Shomolu	402673	576787
9.	Kosofe	665,393	953106
10.	Ikorodu	535,619	767218
11.	Eti-Osa	287,785	412222
12.	Ibeju/Lekki	117,481	168279
13.	Epe	181,409	259849
14.	Surulere	503,975	721891
15.	Mushin	633,009	906718
16.	Oshodi-Isolo	621,509	890247
17.	Ikeja	313,196	448621
18.	Ifako-Ijaye	427,878	612891
19.	Agege	459,939	658815
20.	Alimosho	1,277,714	1830192
	Total	**9,013,534**	**12910948**

This study decided to consider the last detailed census in Nigeria of 2006 reported to be a population figure of 9,013,534 to project the 2020 population of the State based on the 2.6% growth rate (World Bank, 2019) as shown above. However, it can be posited that the above population projection (2020) of 12,910948 based on the NPC 2006 population figure, is a far cry from the current population of the State, thus further validating the earlier position of the Lagos State government on the NPC figure, not a true representation of the State's population. The location of Lagos as well as the socio-economic opportunities has attracted immigrants not only from the nation but across the globe especially from Africa, culminating into a population bulge, now the most densely in Nigeria.

Suffice to mention that the attained urban trend coupled with uncontrolled population surge in the State remains a topical challenge confronting the State, Local and of course the Federal Government. This has resulted in the astronomical population growth of the State and; hence, the most densely populated in Nigeria with an estimated population of over 10 million people in 2000; thus, acquiring the mega city status, and 25 million in 2019 as estimated by the Lagos state Bureau of Statistics (see Table 1.2). Lagos State therefore is adjudged one of the fastest growing States of the World. The continuous population surge of Lagos State is however not surprising since literature (Ahove, 2018; Adeosun and Popogbe, 2020) has over the time established the causal nexus between urbanization and population explosion with its attendant consequences on natural resource utilization, over-

stretching of available infrastructure, destruction of the ecosystem for housing and infrastructural development, energy consumption, increased emission, waste generation and amongst other forms of environmental degradation.

Table 1.2: Population Distribution of Local Government Areas in Lagos State

S/N	Local Government	Population
1.	Agege	1,507,591
2.	Ajeromi-Ifelodun	2,094,583
3.	Alimosho	2,987,306
4.	Amuwo-Odofin	766,111
5.	Apapa	762,336
6.	Badagry	555,162
7.	Epe	472,292
8.	Eti-Osa	1,435, 282
9.	Ibeju-Lekki	145,263
10.	Ifako-Ijaiye	1,086,220
11.	Ikeja	946,703
12.	Ikorodu	1,005,551
13.	Kosofe	1,363,919
14.	Lagos Island	1,254,812
15.	Lagos Mainland	918,609
16.	Mushin	1,928,542
17.	Ojo	1,374,002
18.	Oshodi-Isolo	1,655,691
19.	Shomolu	1,496,003
20.	Surulere	1,859,727
Total		**25,615,703**

Source: Lagos Bureau of Statistics (2019)

These myriad of anthropogenic activities over the time have the propensity to trigger global warming with its attendant consequences of climate change which ultimately pose an unfavourable dimension to population, property, and future investments in the State.

1.4   Lagos Development Goals

The current administration of Lagos State Government has identified six pillars of development, for which there are prioritized actions. These pillars, known as "THEMES," resonate with the SDGs and the most urgent challenges of Lagos State. The focal areas of the pillars are as listed below:

Traffic Management and Transportation: Public transport system, Rail infrastructure, Water transports Expand and improve bus network.

Health and Environment: Health and wellbeing, Water, Waste management, Air pollution and Climate change.

Education and Technology: Basic education, Technology and E-governance.

Making Lagos A 21st Century Economy: Conducive business environment, Citizen participation, Opportunities for the workforce for job and wealth creation, Youth development, Reposition Lagos as an ultimate investment destination, Support for key economic sectors and Energy efficiency.

Entertainment and Tourism: Tourism and culture, Creative, Arts and Sports.

Security and Governance: Community surveillance and intelligence gathering, CCTV coverage, Partner with private sector to co-locate surveillance cameras and power streetlights, Civic engagement and community participation,integrate all emergency handling agencies.

The vision and goals for a Resilient Lagos was developed from these THEMES (see Lagos Resilient Strategy, 2020) through a systematic and detailed process involving concepts and views of several stakeholders, including academia, civil society, government, local communities, and business organisations. The realisation of this vision and goals will require the continued partnership of all of these stakeholders. These goals are as follows:

Table 1.3: Lagos Development Goals

S/N	Goals	Three Clustered Pillars
1	Develop a robust, multimodal, and integrated transportation system.	EFFICIENT CITY
2	Improve access to clean water and sanitation.	
3	Enhance the provision of affordable and reliable energy.	
4	Enhance the city's resilience through land-use planning.	
5	Support individual and collective entrepreneurship as a driving force for innovation and development.	ENTERPRISE CITY
6	Position Lagos as an attractive and open city, valuing cultural and environmental assets.	
7	Prepare youth for a changing economy.	
8	Create an inclusive environment for all city residents.	INCLUSIVE CITY
9	Strengthen information management and disaster preparedness	
10	Improve the health system to support Lagos residents in times of shock.	

These goals are further broken into 31 initiatives for ease of implementation within a short, medium and long time range.

1.5 Lagos Socio-economic Statistics

The tables below portray the demographic and socio-economic characteristics of the state through the existing infrastructure and other livelihood amenities as at the year 2018.

Table 1.4: Number of Bore-Holes Sunk by Government/Assisting Agency According to LGA/LCDA in Year 2018

S/N	LGA/LCDA		By LGA	By State Government	By Federal Government	By Multilateral & Donor Partners	NGOs&others
1	Agege	Agege	11	0	0	0	0
2		OrileAgege	6	0	0	0	0
3	Ajeromi/	Ajeromi	0	0	0	0	0
4	Ifelodun	Ifelodun	0	0	0	0	0
5		Alimosho	0	0	0	0	0
6		Agbado/ Oke-Odo	3	21	0	0	0
7		Ayobo-Ipaja	7	0	0	0	0
8	Alimosho	Egbe-Idimu	0	0	0	0	0
9		Igando-Ikotun	0	0	0	0	0
10		Mosan-Okunola	0	0	0	0	1
11	AmuwoOdofin	Amuwo-Odofin	6	0	0	0	0
12		Oriade	0	0	0	0	0
13	Apapa	Apapa	2	0	0	0	0
14		Apapa Iganmu	0	0	0	0	0
15		Badagry	2	0	0	0	0
16	Badagry	Badagry West	2	0	0	0	0
17		Olorunda			NO RESPONSE		
18		Epe	1	0	0	1	0
19	Epe	Eredo	0	0	0	0	0
20		Ikosi-Ejinrin	8	0	1	0	0
21		Eti-Osa East	0	0	0	0	0
22	Eti-Osa	Eti-Osa	0	0	0	0	0
23		Iru Victoria Island	0	0	0	0	0
24		Ikoyi-Obalende	0	0	0	0	0
25	IbejuLekki	Ibeju	0	0	0	0	0
26		Lekki	0	0	0	0	1
27	IfakoIjaiye	Ifako-Ijaiye	0	0	0	0	0
28		Ojokoro	0	7	0	0	0
29		Ikeja	0	0	0	0	0
30	Ikeja	Ojodu	6	0	0	0	0
31		Onigbongbo	0	0	0	0	0
32		Ikorodu	0	0	0	0	0
33		Ikorodu North	3	0	0	0	0
34		Ikorodu West	2	0	0	0	0
35	Ikorodu	Imota	1	0	0	0	0
36		Ijede	4	0	0	0	0
37		Igbogbo-Baiyeku	0	0	1	0	0
38		Kosofe	0	0	0	0	0
39	Kosofe	Ikosi-Isheri	0	0	0	0	0
40		Agboyi-Ketu	0	0	0	0	0
41	Lagos Island	Lagos Island	0	0	0	0	0
42		Lagos Island East	0	0	0	0	0
43	Lagos Mainland	Lagos Mainland	3	0	0	0	0
44		Yaba	0	0	0	0	0
45	Mushin	Mushin	0	0	0	0	0
46		Odi-Olowo	2	0	0	0	0
47		Ojo	25	0	0	0	0
48	Ojo	Oto-Awori	6	1	0	0	0
49		Iba	0	0	0	0	0
50	Shomolu	Somolu	0	0	0	0	0
51		Bariga	2	0	0	0	0
52		Ejigbo	0	0	0	0	0
53	Oshodi Isolo	Isolo	2	0	0	0	0
54		Oshodi	0	0	0	0	0
55		Surulere	1	0	0	0	0
56	Surulere	CokerAguda	1	0	0	0	0
57		Itire-Ikate	0	0	0	0	0
	GRAND TOTAL		**106**	**29**	**2**	**1**	**2**

Source: Lagos State Government (2019)

Table 1.5: Number of Housing Estates by LGA/LCDA YEAR 2018

S/N	LOCAL GOVERNMENT		LGA NUMBER OF HOUSING ESTATES	STATE GOVERNMENT NUMBER OF HOUSING ESTATES	FEDERAL GOVERNMENT NUMBER OF HOUSING ESTATES
1		AGEGE	0	0	0
2	AGEGE	ORILE AGEGE		2	0
3	AJEROMI/	AJEROMI	0	0	0
4	IFELODUN	IFELODUN	NO RESPONSE		
5		ALIMOSHO			
6		AGBADO/OKE-ODO	0	1	0
7		AYOBO-IPAJA	0	0	0
8		EGBE-IDIMU			
9		IGANDO-IKOTUN	0	`2	1
10	ALIMOSHO	MOSAN-OKUNOLA	1	1	2
11	AMUWOODOF	AMUWO-ODOFIN	18	0	0
12	IN	ORIADE	0	0	0
13		APAPA	1	1	2
14	APAPA	APAPA-IGANMU	0	0	0
15		BADAGRY	1	1	1
16		BADAGRY-WEST	0	0	0
17	BADAGRY	OLORUNDA	NO RESPONSE		
18		EPE	1	0	1
19	EPE	EREDO			
20		IKOSIEJINRIN	1	4	0
21		ETI-OSA EAST	0	0	0
22		ETI-OSA	NO RESPONSE		
23	ETIOSA	IRU—VICTORIA ISLAND	0	0	0
24		IKOYI-OBALENDE	1	0	0
25		IBEJU			
26	IBEJU LEKKI	LEKKI	0	0	0
27		IFAKO-IJAIYE	0	4	0
28	IFAKO-IJAIYE	OJOKORO	0	29	0
29		IKEJA	0	6	0
30		OJODU	3	5	2
31	IKEJA	ONIGBONGBO			
32		IKORODU	0	0	0
33		IKORODU NORTH	0	0	0
34		IKORODU WEST	0	1	0
35		IMOTA	NO RESPONSE		
36		IJEDE	NO RESPONSE		
37	IKORODU	IGBOGBO-BAIYEKU	0	0	0
38		KOSOFE	0	0	0
39		IKOS-IISHERI			
40	KOSOFE	AGBOYI-KETU	NO RESPONSE		
41		LAGOS ISLAND	0	4	1
42	LAGOS ISLAND	LAGOS ISLAND EAST	NO RESPONSE		
43	LAGOS	LAGOS MAINLAND	0	2	0
44	MAINLAND	YABA	0	0	0
45		MUSHIN	1	1	
46	MUSHIN	ODI-OLOWO	NO RESPONSE		
47		OJO	NO RESPONSE		
48		OTO-AWORI	0	0	0
49	OJO	IBA	0	0	0
50		SOMOLU	0	0	0
51	SHOMOLU	BARIGA	0	0	0
52		EJIGBO	0	1	0
53		ISOLO	0	1	0
54	OSHODI ISOLO	OSHODI	1	1	0
55		SURULERE	5	0	0
56		COKER-AGUDA	0	0	0
57	SURULERE	ITIRE-IKATE	0	0	0
	GRAND TOTAL		34	11	10

Source: Lagos State Government (2019)

Table 1.6: Number of Public Toilet Constructed by LGA/LCDA: YEAR 2018

S/N	LGA	LCDA	NUMBER OF PUBLIC TOILET
1	AGEGE	AGEGE	0
2		ORILE AGEGE	6
3	AJEROMI/IFELODUN	AJEROMI	13
4		IFELODUN	0
5		EGBEDA AKOWONJO	0
6	ALIMOSHO	ALIMOSHO	8
7		AGBADO/OKE-ODO	0
8		AYOBO-IPAJA	0
8		EGBE-IDIMU	3
9		IGANDO-IKOTUN	9
10		MOSAN OKUNOLA	5
11	AMUWO ODOFIN	AMUWO ODOFIN	2
12		ORIADE	4
13	APAPA	APAPA	9
14		APAPA IGANMU	5
15	BADAGRY	BADAGRY	13
16		BADAGRY WEST	0
17		OLORUNDA	NO RESPONSE
18	EPE	EPE	1
19		EREDO	1
20		IKOSI EJINRIN	2
21	ETIOSA	ETI-OSA EAST	3
22		ETI-OSA	0
23		IRU VICTORIA ISLAND	0
24		IKOYI-OBALENDE	2
25	IBEJULEKKI	IBEJU	0
26		LEKKI	3
27	IFAKOIJAIYE	IFAKO-IJAIYE	0
28		OJOKORO	10
29	IKEJA	IKEJA	1
30		OJODU	4
31		ONIGBONGBO	6
32	IKORODU	IKORODU	0
33		IKORODU NORTH	0
34		IKORODU WEST	3
35		IMOTA	2
36		IJEDE	1
37		IGBOGBO-BAIYEKU	3
38	KOSOFE	KOSOFE	0
39		IKOSI	40
40		AGBOYI-KETU	11
41	LAGOSISLAND	LAGO SISLAND	10
42		LAGOS ISLAND EAST	11
43	LAGOSMAINLAND	LAGOS MAINLAND	25
44		YABA	6
45	MUSHIN	MUSHIN	0
46		ODI-OLOWO	1
47	OJO	OJO	1
48		OTOAWORI	0
49		IBA	20
50	SHOMOLU	SOMOLU	8
51		BARIGA	3
52	OSHODIISOLO	EJIGBO	6
53		ISOLO	2
54		OSHODI	14
55	SURULERE	SURULERE	8
56		COKER AGUDA	5
57		ITIRE-IKATE	8
		GRAND TOTAL	298

Source: Lagos State Government (2019)

Table 1.7: Highlights of Income and Expenditure of LGA/LCDA: YEAR 2018
Source: Lagos State Government (2019)

S/N	Local Government		Total Revenue		Total Expenditure	
1	Agege	Agege	2,329,939,491.00	5,321,173,845.94	2,341,355,434.51	5,418,932,371.00
		OrileAgege	2,448,530,168.88	1,767,126,509.11	2,448,530,168.88	1,834,304,866.99
2	Ajeromi/ Ifelodun	Ajeromi	3,513,486,343.00	6,101,963,958.00	3,200,094,429.00	6,248,978,129.00
		Ifelodun	2,667,576,241.55	21,101,134,969.81	2,544,272,488.20	2,146,454,532.50
3	Alimosho	Alimosho	1,742,889,758.94	1,122,696,963.71	1,753,940,338.49	1,122,014,434.36
		Agbado/OkeOdo	1,766,528,699.29	1,137,421,874.05	1,766,528,699.29	1,001,631,827.39
		Ayobo-Ipaja	1,552,114,762.00	916,343,112.64	1,068,797,111.53	873,524,401.42
		Egbe-Idimu	2,183,769,035.42	989,775,483.49	1,560,249,765.21	859,589,682.00
		Igando-Ikotun	1,589,451,651.94	981,079,912.02	1,080,792,472.86	1,045,770,061.80
		Mosan Okunola	No Response	981,677,557.90	No Response	972,958,796.56
4	Amuwo/ Odofin	Amuwo Odofin	2,251,686,833.72	4,829,325,866.22	1,987,979,636.45	4,767,784,592.44
		Oriade	2,384,780,974.11	1,898,144,362.09	2,188,535,272.51	1,478,349,742.88
5	Apapa	Apapa	2,525,631,580.22	4,545,538,123.55	2,559,880,470.71	4,952,286,504.58
		Apapa Iganmu	2,593,384,038.16	1,545,084,645.66	2,023,970,657.75	1,302,413,521.27
6	Badagry	Badagry	1,907,552,849.37	4,770,601,962.93	969,889,099.38	4,746,563,687.73
		Badagry West	1,862,132,455.00	944,798,136.59	1,142,425,817.10	944,448,258.29
		Olorunda	1,409,898,763.08	990,921,564.37	1,244,464,763.08	944,908,081.82
7	Epe	Epe	1,782,291,925.76	3,985,088,219.51	948,991,925.76	2,710,015,673.69
		Eredo	1,531,641,691.74	990,158,701.38	1,531,641,691.74	997,112,061.07
		Ikosi Ejinrin	1,501,901,520.00	934,505,935.85	1,501,901,520.08	909,536,880.96
8	Eti-Osa	Eti-Osa East	1,953,973,724.89	1,955,973,724.89	1,798,097,588.67	1,594,847,588.67
		Eti-Osa	1,243,768,740.11	4,864,929,777.17	405,454,714.74	4,895,303,710.62
		Iru Victoria Island	1,984,194,670.37	1,503,738,486.21	1,834,137,523.88	1,463,631,043.50
		Ikoyi-Obalende	1,720,342,780.00	1,086,967,555.46	1,756,422,770.00	1,015,408,727.85
9	Ibeju- Lekki	Lekki	2,887,360,148.09	4,031,521,127.70	2,798,200,560.51	3,902,415,317.70
		Ibeju Lekki	2,584,268,288.70	1,454,863,334.07	2,603,593,408.39	1,764,507,953.59
10	Ifako/Ijaiye	Ifako-Ijaiye	2,418,525,391.00	5,189,860,234.94	1,368,482,261.65	5,103,447,429.47
		Ojokoro	2,243,149,240.35	1,813,498,784.57	1,480,329,144.56	1,474,701,843.6
11	Ikeja	Ikeja	49,452,569,801.48	633,581,428.08	292,872,731.08	50,648,077,251.41
		Ojodu	1,4187, 86,689.00	1,172,812,289.54	1,136,700,448.19	1,008,592,344.82
		Onigbongbo	1,586,199,733.17	1,036,592,693.80	1,116,454,733.17	885,118,269.31
12	Ikorodu	Ikorodu	1,317,483,792.21	6,419,454,245.25	663,596,747.74	4,623,558,265.18
		Ikorodu North	1,525,304,401.97	712,505,166.86	1,525,304,401.94	666,579,540.64
		Ikorodu West	1,560,621,234.50	409,241,480.88	1,184,883,830.64	404,832,988.81
		Imota	826,444,611.15	536,107,661.38	681,153,595.52	479,577,680.00
		Ijede	1,408,771,815.48	605,472,435.08	1,350,775,057.38	574,904,031.13
		Igbogbo-Bayeku	1,039,774,060.00	647,229,125.99	616,184,256.79	770,508,390.92
13	Kosofe	Kosofe	2,270,435,957.38	6,376,432,070.28	2,270,435,957.42	6,207,613,519.06
		Ikosi-Isheri	2,156,721,837.56	1,454,811,514.72	11,596,915,959.20	1,472,467,303.20
		Agboyi-Ketu	2,357,442,330.95	1,500,622,430.44	1,999,442,330.95	1,360,011,939.21
14	Lagos- Island	Lagos Island	2,496,492,235.50	4,696,018,475.91	2,817,516,134.96	3,460,606,057.24
		Lagos Island East	2,355,945,529.09	1,575,774,743.16	1,765,222,244.61	1,641,217,693.85
15	Lagos- Mainland	Lagos Mainland	881,582,071.05	4,822,732,921.27	1,730,447,063.36	47,131,270,593.36
		Yaba	2,312,616,655.00	1,687,730,886.48	1,536,890,773.52	1,669,781,907.87
16	Mushin	Mushin	2,976,615,955.23	6,019,103,251.76	2,980,920,945.23	4,572,428,724.44
		Odi-Olowo	2,755,395,672.58	2,061,669,729.85	1,879,263,466.66	2,045,010,875.74
17	Ojo	Ojo	1,963,054,952.13	5,722,416,609.20	1,167,500,000.00	3,792,047,959.98
		Oto Awori	1,708,983,626.86	1,278,638,828.83	1,605,425,761.83	1,122,818,350.25
		Iba	1,813,655,864.00	1,366,559,039.51	1,988,568,563.16	1,307,636,344.03
18	Oshodi/ Isolo	Ejigbo	1,679,915,753.88	1,331,050,521.03	1,857,776,971.61	1,059,805,902.25
		Isolo	2,096,957,395.73	1,427,602,567.04	1,518,675,021.83	1,454,445,153.22
		Oshodi	1,953,113,446.67	4,068,598,472.64	1,031,801,409.66	3,964,865,517.40
19	Shomolu	Somolu	3,983,372,355.14	3,748,644,897.21	3,983,006,548.64	3,835,036,611.90
		Bariga	2,582,712,103.86	1,691,459,420.30	1,392,712,103.46	1,392,712,103.46
20	Surulere	Surulere	3,282,380,357.00	5,747,049,419.70	1,590,404,182.00	5,518,722,518.03
		Coker Aguda	1,666,591,615.00	1,367,153,662.36	1,120,506,879.00	1,187,725,199.14
		Itire-Ikate	No Response	1,092,449,364.67	No Response	992,177,420.28

Uncontrolled urbanization and population explosion across the state especially in the urban centres is responsible for the huge infrastructural gap especially in the satellite neighborhoods across the state. This alarming rate of urbanization has over the time been responsible for the acute dearth of infrastructure such as roads, transportation, water supply, education, healthcare delivery, affordable housing, and electricity thus taking a huge toll on the economic status of various local governments in the state (see table 1.7) which consequently cascades to the citizenry, with its attendant poverty when juxtaposed with the global poverty index.

However, the neglect of the public infrastructure most especially prior to the present democratic era has culminated in the inability to sustain them. This has resulted in the destruction of public water supply infrastructure. The prevailing conditions of the public water supply in Lagos State is extremely worrisome as indicated in table 1.4. This is due to the poor condition of the distribution network with its resultant impact on the revenue loss of the Lagos Water Corporation (LWC) and the health of people who depend largely on public water supply. The poor state of public water supply has greatly contributed to the poor sanitary and general environmental condition of the people, the spread of water-related diseases such as cholera, typhoid and many other ailments. However, the population surge has created huge gap in public water supply infrastructure despite several efforts of successive governments in the state at revamping public water supply. Thus, aside from few areas that has supply, major part of the areas rely on supply from   private boreholes and artisanal supply.

Also in terms of electricity, as the economic, commercial and industrial heart-beat of Nigeria with an estimated population of over 25 million people, the demand for energy across the strata of the sectors in Lagos state is far-fetched from the supply (see table 1.8), thus making industrial, commercial and domestic demands to rely on the alternative source of energy (power generating sets) which has debilitating consequences on the environment and sustainable development.

Table 1.8 Electric supply gap in Lagos state between 2015 and 2019

Year	Electricity Demand Ikeja (Disco MW)	Electricity Demand Eko (Disco MW)	Total Estimated (Discos)	Total Supply Ikeja + Eko Doscos (MS)	Electricity Gap/Crisis (MW)
2015	1335	1105	2440	1650	790
2016	1335	1105	2440	1650	790
2017	1335	1105	2440	1650	790
2018	1335	1105	2440	1650	790
2019	1335	1105	2440	1650	790

Source: Lai *et al.*, (2018)

However, taking into cognizance the above, successive administrations in Lagos state has developed and implemented varying programmes and investments toward developing critical infrastructures and services in order to ensure inclusive growth and shared prosperity across the length and breadth of Lagos State. The Lagos blue and red rail project, Bus Rapid Transport (BRT), as well as massive investments in education, health, security, roads, water supply and

sanitation (see table 1.6), housing (see table 1.5), several Independent Power Plants-IPPs (with installed capacity of 32.55MW) and solar energy projects together with other laudable projects are varying attempts by the Lagos state government to ensure sustainable economic prosperity in the state.

Future trends (e.g. emerging technologies; innovations and disruptors enabling transformational action)

No doubt, successive administrations in Lagos State since 1999 have become the frame of reference in Nigeria for innovation, transformational leadership and inclusive growth through the deployment of technologies for shared prosperity. The huge investment in technology to drive governance through the deployment of e-platforms, partnerships with multilateral bodies, the private sector and the creation of special desks such as the Office of Transformation, the development of the Lagos Resilience Strategy as well as the development and implementation of varying climate change adaptation programs including the Lagos Climate Risk Assessment Project is a disruptor for an enduring and transformational Lagos.

The investments and partnerships in emerging technologies (spatial and non-spatial) has enabled and improved governance and business thereby enabling business to be transacted on various e-platforms for transportation, e-payments, e-governance and a host of others. However, the signing of agreement by the Lagos State Government with a Chinese company CIG Motors Limited) to produce cars in the state remains an innovative idea for the transfer of technology as well as creating employing for the teeming youths together with the potential to reduce carbon emission with the deployment of such brand new cars.

1.6   Methodology

Methodology of implementation of climate risk assessment

In line with the ToR, the methodology of implementation for the assignment took into cognizance the industry's best practice in all facets of implementation. Suffice to mention that the experience of the consulting team in project implementation was brought to fore in order to ensure conformity with the client's expectations in terms of Quality Assurance and Quality control (QA/QC), environmental and safeguards-ESS and above, all Covid19 protocols. So for ease of understanding, the methodology of implementation for the conduct of the Climate Risk Assessment (CRA) study for Lagos State, are broken down into project phases and activity types and are discussed extensively below.

Project Phase 1: Inventory Phase

As the name implies, this phase is very crucial and central to the overall success of the assignment. Thus, two (2) major activities that featured prominently under this phase were; the inventorization of the available infrastructure, spatial data assessment and the assessment of human capital for the end-user department of the Client. The assessment however, afforded the consulting team the opportunity to identify the staff strength and proficiency in geospatial technologies and practices.Technical (geospatial techniques) and infrastructural support gaps were found; thus a 3-

day in-house capacity building programme was organized between 19th – 21st of August, 2020 for staff of the Client (Ministry of Environment & Water Resources) in order to build their skills in the areas of climate change assessment and geo-information processing deploying GIS. The attendance register for the 3-day capacity building has been presented in the inception report of the project.

Plate 1.1: Cross-section of participants at the 3-day capacity building programme

User's Need Assessment and Stakeholders' Sensitization Workshop

In line with global best practice, a user's need assessment training was done in-house for the would-be users while stakeholders from MDAs and LGAs/LCDAs were invited for a stakeholders' sensitization workshop on 2nd of September, 2020 in order to ensure full participation and cooperation of stakeholders particularly during the field work. It is sufficing to mention that presentations were made by Mr. Bankole (the Lagos State Ministry of Environment & Water Resources) on the efforts of the State government at combating the menace of climate change while Mr. Ogunsawe, David (CEO/Principal Consultant, Geo-Solution Providers Ltd) made presentation on the CRA project to the stakeholders. The Permanent Secretary, Mrs. Odeneye Belinda and other officials of the State government and LGAs/LCDAs were also present.

Plate 1.2: Cross-section of participants during the CRA stakeholders' sensitization workshop

Spatial and Bibliographic Data Review

After the completion of the user's need assessment forum, the various contact personnel within the user's Department that will assist in the project implementation were identified. The staff constantly interacted with the consulting team to identify the various sources of data that would provide significant inputs into the project.

Project Phase 2: Spatial Data Acquisition, Scanning and Data Conversion

This involved the scanning and digitizing of available topographical maps while all the features (road, drainage pattern and other significant features) were converted to digital format in the ESRI environment. Also, satellite imagery of the entire State was acquired from secondary source (Archive of Geo-Solution Providers Ltd). and the digital footprints of affected buildings were equally extracted as well as the drainage pattern of the State.

However, the attribute of the information about the spatial information contained in maps and satellite imagery were processed and extracted into the database and linked as appropriate while raster dataset arising from the satellite imagery interpretation (for the determination of land use and land cover for the entire state) was processed and analyzed accordingly. The results of the analysis are, however, presented in Chapter four of this report.

Project Phase 3: Project Implementation

Field Data Acquisition

Prior to the deployment of the field data collection team, a mobile app was developed in-house (using the **Epicollect 5** platform) in lieu of the traditional paper/Global Positioning System (GPS) method. It is however important to mention that the developed mobile app has a wide significant edge over the traditional method in terms of accuracy, data collection, integrity of instrument, devoid of illegibility, and above all the collected data were instantly uploaded on the virtual server for integrity checks and simultaneous data processing. The field data collection team was also exposed to the mobile app prior to deployment. The mobile app tagged "*Lagos State CRA Mapping Project*" was designed to take inventory of the resources/infrastructures that are at the risks of climate change in the state. It collects and acquires the coordinates of infrastructure as well as such

information as the ownership, address, LGA, land use, nature/type(s) of risk/exposure, class/severity of risk, impact of hazard, monetary value of property/infrastructure, The image or video of the feature are equally taken and stored appropriately.

Plate 1.3: Field data collection activities

Also, a Focus Group Discussion (FGD) guide was developed in order to have a structured and unified FGD instrument. The FGD guide was a socio-economic survey instrument administered to clusters of stakeholders in order to obtain their views on climate change, risk/vulnerabilities and the prevailing or localized adaptation strategies including the provision or suggestion of panaceas or adaptation strategies to stemming the scourge of climate change in Lagos State. Suffice to mention that FGD guide would be used to engage various strata of stakeholders across the state in order to obtain their views on climate change risks/vulnerabilities and strategies of adaptation. Such stakeholders include; government agencies (MDAs), Community Development Associations (CDAs), Resident Associations, Administrative heads of Local Governments and Local Council Development Areas (LCDAs), community heads, youths, farmers (arable and animal), fishing clusters in the riverine communities, and other vulnerable groups.

Database Development

Having fully converted all the datasets into appropriate digital formats including the processing of the acquired satellite imagery for land use/land-cover assessment and feature extraction, coupled with the acquisition and uploading of acquired field data to the virtual server, the data processing team, however, commenced database population and linkages.

Data Analysis and Scenario Modelling

This phase provided the platform for hazard analysis with respect to land-use/land-cover, risk assessment (flash floods, coastal flooding, increase in temperature and others), population, investments, infrastructure such as -airports, farming (arable and fish), tourists centres/parks,

coastal ecosystems etc. This disaggregated across Local Government Areas (LGAs), including IBILE and other social clusters across Lagos State. It also forecast scenarios viz; 2020 to 2025, 2030, 2035 and 2070. Also, impact ranking was equally done in terms of severity into three (3) major categories viz: low, medium and high while necessary thematic maps were produced for different scenarios (see CRA maps -a separate document).

The consulting team performed geo-spatial analysis such as overlay and buffering analysis. Aside using climatic data sets obtained from the NIMET, sea surface temperature was downloaded from the United States Geological Survey (USGS) for temperature analysis, the Digital Terrain Model (DTM) of the State was equally produced amongst others.

Cost Estimation

Having collected and extracted necessary features such as building footprints, facilities/infrastructures, systems etc. together with the development of the backend database in ArcGIS environment, the corresponding database (number of affected people, cost of damage, strata of affected population for the development of cost of assets and livelihood at risks and historic costs of climate hazards for future projections were analyzed in the next chapter (4). No doubt, the output of the valuation would serve as the fulcrum for quantification of the socio-economic projection of the risks of climate change for Lagos State.

Activity Type 4:   Quality Control and Quality Assurance Procedures (QC/QA)

To ensure high degree of accuracy in the database development, appropriate Quality Control and Quality Assurance (QA/QC) procedures have been integrated into every facet of the project. This quality control assisted in up scaling the integrity of the datasets.

Activity Type 5: Project Evaluation Workshop

A project evaluation workshop will be facilitated in collaboration with the Client in order to formally present the outcome of the study to the stakeholders. The evaluation workshop would provide stakeholders the opportunity to make comments on the outcome of the study while concerns would be corrected prior to the submission of the final report. Such a forum would however take into cognizance the prevailing second wave of Covid19 pandemic.

Methodology of implementation of climate hazard assessment for Lagos state

Meteorological Data: This data was obtained from the Nigerian Meteorological Agency (NIMET) Abuja on the Oshodi station with location on Latitude 06.35´N Longitude 03.20´E. The data shows the observed mean monthly rainfall and maximum temperature from 1990 to 2019; a duration of 30 years.

Sample and Sampling Technique on Climate Hazard Assessment

The samples from this study were drawn from the population of Lagos State using the current population estimation from the Lagos Bureau of Statistics (2019) of 25 million people. The stratified systematic random sampling technique was used in extracting the sampled population of the study

from the 20 LGAs in the state. The stratification was based on the natural categorization of the LGAs into 20 LGAs. Table 3.1 shows the details of the population in each of the 20 LGAs of the State with Alimosho LGA having the highest population estimation at 2,987,306 and Epe LGA has a population estimate of 472,292. From the entire population of the State, 0.1% from each LGA was proposed for sample selection as indicated in table 3.1, a total of 2,695 persons consisting of 1495 male (58.2%) and 1074 female (41.8%) were thus selected as samples for the study. Each sampled individual represented a HouseHold.
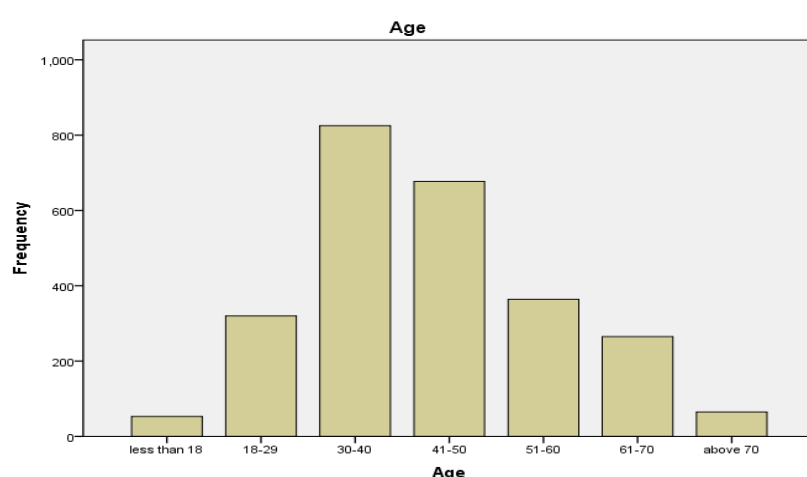
Figure 1.3: Age distribution of the selected samples

The choice of the communities from where the HouseHold (HH) were selected was based on literature citation as well as those identified by stakeholders as communities that have experienced climate change hazards at one time or the other. The selection of the houses were done using systematic random sampling; each house was selected after four others from any street so selected. Any Head of HouseHold (HHH) selected was also based on the participant's willingness to be involved in the interview. HH size ranges between 1-26 peaking at 5 and 6 as indicated by 440 and 429 HHs respectively and HH size of 14 had the least number of HHs.
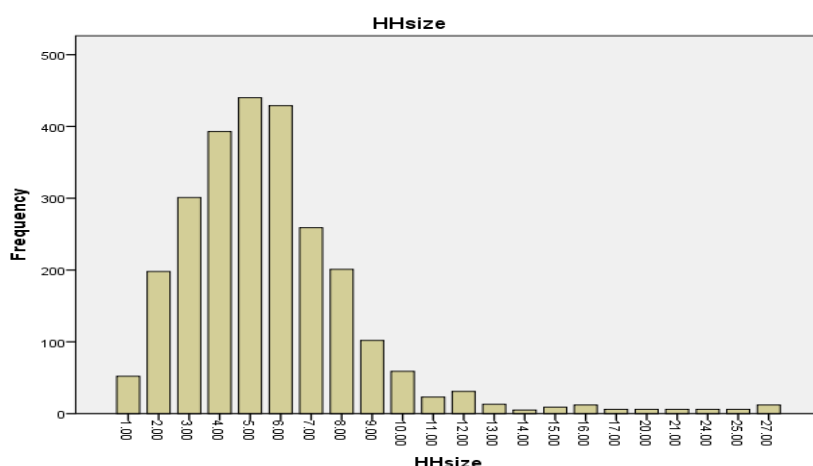
Figure 1.4: HouseHolds showing frequency of number of HouseHold size.

The educational status of Head of HouseHold (HHH) or the representatives involved in this study had 368 (14.3%) persons with primary education, 500 (19.5%) with secondary/technical education; 563 (21.9%) with Diploma/ College of education certificate; 670 (26.1%) with University Bachelor's degree; 282 (11.0%) with University Master's degree; 110 (4.3%) with PhD and 76 (3%) had no formal education.

Instrumentation

The instrument deployed in this study was the 'HouseHold Community Survey Instrument' it has several sections seeking different information from the respondents such as demographic, socio-economic, change hazards awareness, frequency and severity, climate risk assessment and impact on the environment, health, livelihood and housing. Appendix 1 provides the instrument.

This instrument was administered by thirty six (36) trained Research Assistance RAs who are all University graduates from science, technology and social science discipline. They were trained in two groups, a day each on how to administer the instrument and including mannerism of approaching prospective respondents.

Plate 1.4: Training of Some Research Assistants

Each RA administered an average of between 70 and 90 questionnaires to respondents with an average time of 35-45minites spent with each respondent. A total of 2,950 questionnaires were distributed, all were retrieved but 255 and 2695 were found to be inappropriate and appropriate respectively for analysis.

CHAPTER TWO

Climate Change in the City of Lagos

2.1 Climate of Nigeria

Nigeria's climate has been changing, and this can be seen in: increases in temperature; changing rainfall pattern; rise in sea level and flooding events; desertification and drought; land degradation; frequent extreme weather events; affected freshwater resources and biodiversity loss. The length and intensities of rainfall have increased, producing large runoffs and flooding in many places in Nigeria (Enete, 2014). Changes in rainfall pattern are projected to continue to increase. Precipitation in southern areas is expected to rise and rising sea levels are expected to exacerbate flooding and submersion of coastal lands (Akande et al., 2017). Droughts have also become a constant in Nigeria especially in Northern Nigeria, due to a decline in precipitation and rise in temperature (Amanchukwu et al., 2015). Temperature has risen significantly since the 1980s (Enete, 2014), and climate projections for the coming decades reveal a significant increase in temperature over all the ecological zones (Akande et al., 2017).

2.2 Climate change in Lagos State

The geographic position no doubt makes the State to fall in the tropical climate as obtained in Nigeria and other sub-Saharan West Africa. Thus, Lagos State is located within the equatorial climate which is characterized by high temperature, high humidity and heavy rainfall with double maxima (Odewunmi; 2003).The proximity to the equator, the Gulf of Guinea, the influence of the South-West trade wind as well as the North –East trade wind combines to influence Lagos as a rain forest climate. The state has two (2) climatic regimes viz; dry season which spans from November to March and the rainy season which ranges between the months of April to October. In between these two major seasons is a dry spell lasting for a couple of weeks called August break. While there is no month that is totally dry, the mean annual rainfall of Lagos State is 1,620.59, though there are variations due to distances from the coast and topography.

Also, the temperature of Lagos State is constantly high and is constantly narrowed due to the proximity to the sea which mitigates high temperature extremes. Thus, the average daily temperature ranges between 24.5^0C to 29.6^0C.

Plate 2.1: Some incidences of flooding in Lagos State

Generally, relative humidity of Lagos State is high due to the proximity to the Atlantic Ocean. Although there are variations in relative humidity from point to point across the State, the disparities are more significant in respect of the hours of the day. The recorded extremes are for 0700 hours when it is very high and 0130 hours when it is very low, while the Relative Humidity (RH) ranges from 76% to 80.5%.

The above climatic conditions no doubt are responsible for the diverse socio-economic activities and prosperity of Lagos State.
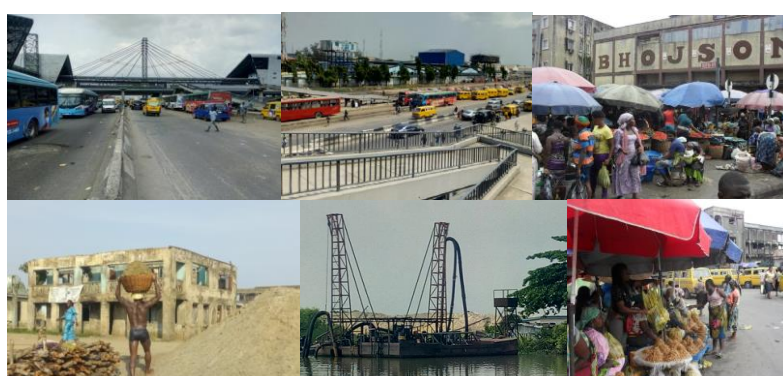
Plate 2.2: Commercial Activities in Lagos State

Despite the rich climatic condition of the state to support agriculture, urban sprawl has reduced the capability of the State in arable farming. Although there are still few agricultural settlements, the vast majority of the population engage in trading together with enormous white and brown collar jobs while artisanal fishing, sand mining (artisanal and industrial) were also common along the coastline. The State has witnessed short-term changes in the patterns of temperature and precipitation that are characteristics of climate change which are expected to shift agricultural production seasons, alter pest and disease patterns, and modify the set of feasible crops; these will affect production, prices, incomes and, ultimately, livelihoods and lives.

Current climate projections for Lagos have high uncertainty, but the scenario they imply is fairly dire. A continuing stream of migrants from other parts of the country may likely lead to population explosion; rising temperatures; more frequent and heavy rainfall; sea-level rise and stronger sea surges; heat risks for the young and elderly. Other climate change induced challenges that may be experienced include displacement of communities as well as poor settlements in high-risk zones at coastal communities, more cases of water-borne diseases; and the potential for increasing deaths.

According to a report on climate change mapping in some constituencies in Lagos State by Oshaniwa and Chikwendu (2013), on the notable percevied evidence of climate change in communities; 90% of the respondents in Badagry indicated high temperature. About 85% of the respondents attested to flooding while 60% of the respondents recorded high storms. In Epe, the most notable changes as attested to by the respondents are high temperature (60%) and high storms

(52%). The notable changes indicated by respondents in Eti-Osa are high temperature with 90% and flooding 80% responses, and in Ibeju-Lekki, it is high temperature with 95.5% and flooding 81% response. In Ikorodu, the most notable changes indicated by the respondents in the communities are high temperature with 90% and irregular rainfall with 30% responses. These data imply that increasing temperature is the most worrisome climate change challenge in most communities in Badagry, Epe, Eti-Osa, Ibeju-Lekki, and Ikorodu. Flooding, storms and irregular rainfall followed in that order. The report also indicated that in Badagry, 50%of the respondents stated that the impact of climate change is high on their environment, while 40% of the respondents indicated that the impact of climate change is high on their Health. 50% of the respondents said that the degree of the impact of climate change is high on their environment, 40% said it is high on Health and 30% indicated that the impact stresses their Livelihood. In Epe 49% of respondents indicated that the impact of climate change is likely to be on their health and another 49% on claims that the impact will negatively affect food security. 50% of the respondents said that the degree of impact is high on health and 45% said it will be on food Security. In Eti-Osa 40% of the respondents indicated that the impact will be on their environment. 30% of the respondents indicated that the degree of climate change impact is high on their health while 29.5% of the respondents say that the degree of impact is high on their environment and 50% on health. In Ibeju-Lekki 35% of the respondents indicated that the impact of climate change is high on the environment and 50% indicated that the degree of climate change impact is high on health. In Ikorodu 35% of the respondents indicated that the impact of climate change is high on the environment and 30% for health. Insummary, the survey showed that the most impactful perceived evidence of climate change is seen on health, food security and the environment.

The State's low-lying coastal location, with an average elevation of less than 1.5 meters, makes its physical exposure quickly apparent. The core areas of the city, where the great majority of the population still resides, are located on the mainland or islands abutting either the Atlantic Ocean or Lagos Lagoon. Floods and storm surges are historically a recurrent phenomena in Lagos, but their effects on human populations have been intensified in recent years by the city's very rapid population growth, accumulating solid waste, and increasingly haphazard and dangerous settlement patterns on wetlands and floodplains. Moreover, the city's commercial and residential development results in the paving of more areas with impermeable, hard surfaces that impede drainage. According to Oshaniwa & Chikwendu (2013), Lagos State has several key climate change vulnerability factors, including:

- Coastal location: the state is exposed to the threat of sea level rise and the risk of storm surges
- Its predominantly low-lying topography makes it susceptible to submerge and experience widespread flooding
- The state possesses fragile ecosystems, such as lagoons, swamps and freshwater bodies
- The water table in large parts of the state is high
- The state has a large and rapidly growing population
- Poverty is pervasive; and because people are poor, they are dependent on the exploitation of natural resources which are under threat from climate change

- A large proportion of the population is living in unplanned settlements in marginal environments
- Women, who are more vulnerable to the adverse impacts of climate change, have less access to climate change information.

Table 2.1: Some flood related incidences between 2011 and 2012

Date	Location	Case	Summary
March 7, 2011	Eti-osa, Ibeju lekki	Ocean surge	NCF raised an alarm over the increasing rate of abandoned vessels along the Lekki Coastline. The Foundation stressed that if urgent attention were not directed towards solving this problem, an imminent catastrophe was waiting to happen.
May 18, 2011	Eti-osa, Ibeju lekki	Coastline erosion, sand filling & dredging	Residents of Alpha Beach in Eti-Osa LG witnessed a massive erosion of the beach coastline by turbulent ocean waves destroying beachfront and endangering the lives of some 5000 residents & properties valued at ₦10bn. Residents claimed the cause of the catastrophe is sand-filling and dredging activities taking place at the Eko Atlantic City
May 29, 2011	Lagos	Heavy rainfall, relocation & resettlement	Lagos State Government directs residents of 10 communities to relocate to other parts of the states ahead of the predicted torrential rains that will fall between June and September. It declared some communities located in the North-eastern parts of the state a "disaster zone".
July, 11 2011	Oshodi-Isolo Apapa, Yaba, Alimosho	Heavy rainfall	The Apapa, Mile-2 Oshodi Expressway succumbed to intense flooding after relentless rainfall. Other areas affected were Herbert Macaulay Way, and Shasha in Akowonjo.
July, 11 2011	Ikoyi, Iru-Victoria Island, Agbado/Oke Odo , Agboyi-Ketu , Apapa.	Rainfall and flooding	The floods in Lagos State have become a nightmare to millions of residents in the state. The heavy downpour over the weekend brought the entire city to a standstill, as roads were virtually un-passable. This year's rainfall is put at 300-1100mm in the north and 1200-2700mm in the south with predictions expected to have impacts on the agriculture, infrastructure, hydrological and health sector of the economy. The parts most hit were the south western parts of Lagos e.g. Victoria Island, Ikoyi, Apapa, Ketu, Abule Egba etc
July 11-12, 2011	Agege, Iru -Victoria Is, Ikorodu, Surulere, Apapa, Badagry, Eti-Osa, Ibeju-Lekki, Oshodi-Isolo, Agboyi-Ketu, Ejigbo	Flooding	The floods that crippled Lagos state over the weekend will leave lasting memories on many for a long time to come. Virtually all parts of Lagos State- Victoria Island, Lekki, Abule Egba, Ikeja, Apapa, Oshodi, Ikorodu, Agege, Okokomaiko, and Ketu were flooded, forcing residents to stay indoors while those on the streets had to battle it out. Areas hit were Festac town, Ejigbo, Jakande Estate, Ago- Palace Way, and Ire-Akari.
February 14, 2012	Oshodi-Isolo,	Rainfall & storms	At Olive Estate in Oke-Afa, the rainstorm destroyed fences and gates while the sewage systems burst out into the streets. A kilometer of the road before Jakande Estate gate cavedin. Also, at Ire-Akari Estate road the rainstorm brought down the roofs of several houses and sacked their occupants of most of the community. School children practically swarm through the floods to find a way home.
February	Iru-Victoria Is,	Wind storms	An early morning storm tore through parts of Lagos, claiming about six

14, 2012	Ikoyi-Obalende, Ejigbo, Oshodi-Isolo, Mushin, Surulere, Ojodu.		lives, destroying properties and highlighting Lagos's vulnerability, as was the case seven months ago when Lagos State coastal regions were virtually submerged. In places like Jakande estate in Ejigbo, lsolo, Surulere, ltire Lawanson, Victoria Island, and Ikoyi – Obalende and Ojodu.
February 19, 2012	Oshodi-Isolo	Rain storms	Among the areas most affected was a low –cost housing building at Jakande Estate, Oke Afa, where over 300 high rise buildings lost their roofs.
Sunday 1 April 2012	Oshodi,Ejigbo, Ibeju, Ikoyi-Lekki,Surulere, Isolo,Yaba, Obalende ,Iru-Victoria Island	Rainfall & flooding	Lagos state experienced an early morning downpour with a fury and accompanying windstorm that ravaged different parts of Lagos, destroying properties and leading to the death of residents in its wake. In areas such as Yaba, Obalende, Ikoyi, Lekki, Ijeshatedo, Ago- Okota, Jakande, Ejigbo and Victoria lsland the rains which caused the floods were quite heavy.
June 22 2012	Orile-Agege Oshodi-Isolo Ibeju-Lekki, Agege	Floods	Flood, gridlock, tears after Wednesday night rain. Lagosians recount woes following hours of rainfall that brought hardship to commuters, families. In areas such as Egbatedo papa, Ashafa Street, Orile, Agege, Okota road and Igbayilola Street were badly flooded.
June 29 2012	Shomolu, Bariga.	Floods & collapse of structure	Tragedy struck in the New Garage area, Bariga and also Shogbamu street Lagos as several building structures and their fences collapsed into other adjoining buildings.
June 29 2012	Oshodi, Apapa	Floods	There were floods on the Oshodi Apapa expressway. Many were left in tears among them a woman who resides in the Kwara bus stop area of Akowonjo on the mainland, whose little boy was allegedly swept away by the floods.
June 30, 2012	Ojodu	Heavy Rain fall	For three consecutive days, the rains fell heavily in Lagos State. The roads in the Ogba area of the state and Ajao Estate Lagos were totally flooded
July 7 2012	Iru-Victoria Island, Ikoyi-Obalende Igando	Rainfall & floods	Disbelief and despondency lived with Lagos families as the flood waters from storms in the past few days recede. Property owners and residents suffered varying degrees of grief trying to put their lives back-together. Areas such as Ikoyi, Victoria Island and Lekki Ajah were all flooded.
July 15th 2012	Ijegun	Flooding	The aftermath of the torrential rains were devastating on the residents of Ijegun community after days of heavy rainfall. Many had to leave their homes for fear of flood, while others sort for higher ground to keep themselves safe from the floods.
July 23rd 2012	Ikosi Isheri	Heavy rainfall & flooding	The Isheri View Estate was badly affected by the heavy rainfalls over the past few days, which caused massive flooding throughout the entire Isheri LG.
Sept. 20, 2012	Ojodu.	Heavy rainfall & flooding	Floods totally brought commercial activity to a standstill at Ogunnusi Road Ogba, Lagos.

Source; Oshaniwa & Chikwendu (2013).

CHAPTER THREE

Risks and Vulnerability Assessment

3.1 Introduction

This section deals with the result of the Risk and Vulnerability Assessment in Lagos State. It describes the impacts of climate change on the strata of infrastructure, resources, population, impact ranking and the vulnerabilities/exposure (in monetary terms) of the Lagos ecosystem to the threats of climate change while also modeling future climate change scenarios and population of the State.

3.2 Spatial Assessment of Vulnerability to Climate Change Stressors in Lagos State

The impacts of climate change are visible and tangible worldwide. It is noted that temperature has generally increased. Since 1970 the global average temperature has been rising at a rate of 1.7°C per century, compared to a long-term decline over the past 7,000 years at a baseline rate of 0.01°C per century (NOAA, 2016; Marcott et al., 2013). Rainfall is becoming erratic and unpredictable and ice cap is melting. There is also notable sea level rise and extreme weather event in diverse areas of the world. Lagos, being a coastal city, has had its own fare share of the global climate change.The impacts of the sea level rise cause extreme ocean surges and increase intensity of flooding events in most part of the city. Lagos remains the most vulnerable city to the impact of flooding due to climate change in Nigeria.

The closeness to the Atlantic and the nature of the terrain with a significant part of the State below sea level and also having large population are important considerations in assessing the susceptibility of the State to flooding. Today, it is estimated that Lagos is home to more than 25 million people, majority of which are poor and living on the fringes of the society thus, a large percentage of the populations of Lagos is also extremely poor and lacking the required strategies to combat the effects of climate change.

The impact of climate change such as floods, heat waves, droughts, landslides, storms, coastal erosion, inundation and sea surges are affecting major parts of the city especially in the shorelines of the lagoons and creeks that characterized the landscape of Lagos State.

Plate 3.1: Threats of flooding in Kosofe and Ikorodu LGAs of Lagos State

Consistent with the international standard, the methodology recommended for the assessment of the vulnerability of communities to climate change have four key components. These are climate hazard characteristics;trends and projections, exposure of people and livelihoods, species or ecosystems sensitivity and the adaptive capacity of people.

3.2.1 Vulnerability Analysis and Risk Profile

This section examined four major climate change impact scenarios in Lagos State and identified their respective impacts in each Local Government Area (LGA). The extreme climate change impacts evaluated include coastal flooding and urban flood, coastal subsidence and coastal erosion, extreme heat waves and ecosystem services depreciation. These extreme weather conditions were evaluated and modeled in line with the guidelines for climate change vulnerability and risk assessment guidelines by UNHabitat. However, the technique of Geographic Information System (GIS) was applied to conduct hazard analysis, level of exposure/sensitivity and the adaptive capacity of the communities to mitigate the effects of climate change impact.

This report presents the vulnerability assessment of Lagos communities to climate change with particular reference to five notable climate change impacts viz: floods and ocean surges, landslides and coastal subsidence, heat waves, storms and coastal erosion. Where possible attempts were made to examine the trends of the impact and project into the future and suggestions were made on the mitigation and remediation measures to combat the effects of climate change.

Plate 3.2: An abandoned building (due to perennial flooding) at Abimbola Taylor Street (Mosan Ipaja LCDA)

Based on the database of vulnerability assessment, a total of 6,983 features were vulnerable to climate risk in Lagos State. However, it is pertinent to mention that the affected features/buildings/infrastructures have varying degrees of exposure based on the proximity, severity and concurrency. Therefore, a lucid analysis and presentation of impact ranking of the study is discussed subsequently. Suffice to mention that features such as (buildings- commercial, residential, institutional), infrastructures (roads, electric, health, religious etc.), commercial (institutional or private) etc. were assessed during the field work and the database containing the geographic coordinates and other metadata of the affected features together with the estimated value, types of threats, impact, and images (photographs) were presented. Vulnerability from field work shows that features located along flood plain, riverbanks and along the Atlantic Ocean especially Alfa Beach have the highest degree of vulnerability to the threats. The threats, however, according to interaction with the various stakeholders during the field survey showed that the Eko Atlantic City project has exacerbated the rate of ocean surge; thus, over 350 meters of the community, including other infrastructures (religious, educational, cultural and the main road into the community, have been lost to the Atlantic.

Plate 3.3: Hon. Balogun, officals of Eti-Osa LGA community members pointing at their houses in the Atlantic

3.2.2   Vulnerability of Population to Risk of Climate Change

Since there exists a significant nexus between climate vulnerability and human population, it is therefore important to evaluate the population distribution of the State in order to enable the government develop sound and cost-effect resilient strategy as the demography of the State (Lagos) encompasses all strata of people viz, old, women, youths, men and vulnerable groups. No doubt various strata of population have been exposed to the threats of flooding, some of which have resulted in the loss of lives including school children and other vulnerable groups of the society. Therefore, to determine the vulnerability of population to the risk of climate change, the demography of the various Local Government Areas (LGAs) as posited in table 1.2 would provide a mental picture of the diversity of population that are vulnerable. Therefore, using the projected 2020 population of the State (despite the controversial nature of the base population), a projected population of about 12,910,948, is expected to be vulnerable.

However, a more acceptable population distribution for the State (2020 to 2070) is hereby presented in table 3.1.

Table 3.1 shows that the population of Lagos State is projected to be 25,012,637 in the year 2025, 32,332,038 by 2035, 47,516,395 and 79,394,551 between 2050 and 2070 respectively.

Table 3.1: Projected Population Distribution of Lagos State (2020-2070)

Year	2020	2025	2035	2050	2070
Population Projection	22,000,000	25,012,637	32,332,038	47,516,395	79,394,551

Source: Geo-Solution Providers Limited, December, 2020

The implication of such rapid population growth in Lagos state despite the limited spatial size can be better imagined. Therefore, the above figure would enable the governments (current and future) to develop a holistic climate resilience strategy in order to safeguard the multi-billion dollar investments across the State.

3.2.3   Vulnerability of the Tourism Sector to Risk of Climate Change

No doubt the tourism potential of Lagos State is underutilized; this is attributable to myriad of untapped tourist opportunities across the State. Like every other city of similar climes, the ability of Lagos State to become the tourist destination of Africa cannot be contested. However, this potential is being hampered by the threats of climate change especially the coastline (lagoon and Atlantic Ocean) which are constantly threatened by coastal flooding and ocean surge. It is worrisome to note that the popular Alfa Beach that used to play host to varying tourists and events (especially the Lekki Sunsplash) have today been lost to the Atlantic. Interaction with the community members however showed that quite a number of the inhabitants are becoming homeless due to threats of ocean surge which has been exacerbated by the Eko Atlantic City Project. Such threats of perennial flooding particularly along the coastlines no doubt constitute a huge hindrance to the up scaling of the tourism potential of the State.

Plate 3.4: Soakaway of a submerged building and a damaged building at Alfa Beach, Eti Osa LGA

3.2.4   Vulnerability of the Agriculture to Risk of Climate Change

The major negative impact of climate change is its capability to create food insecurity, famine and global insecurity. The unpredictable weather pattern, no doubt, creates an albatross to the farmers, including fish farmers not to mention the impact of unfavorable climate pattern which includes flooding of farms on the agricultural sector. Equally, incidences of coastal flooding and sea level rise constitute a risk to fishermen;thus, depriving them of sources of livelihood.

Plate 3.5: Fishermen near Majidun river, Ikorodu LGA

3.2.5   Vulnerability of Infrastructure

Like other physical structures, infrastructural facilities such as schools, hospitals, roads and some others are also vulnerable to flooding. These facilities are so crucial, even in the period of flooding for rescue, support services and could equally provide temporary shelter for flood victims. However, aside from the statutory functions of these infrastructures, the vulnerability also tends to undermine the structural strength of these facilities. Thus, research has shown that infrastrcture vulnerable to flood tends to fail faster. The failure no doubt would deprive the people of the area the opportunity to use the infrastructure while replacing such infrastructure may not be so easy in this period of economic melt-down.

Plate 3.6: Failed access road in Alfa beach, Eti-Osa LGA

The spatial distribution of vulnerable infrastructure and impact ranking together with the cost of exposure (economic value-₦) to flood risk in Lagos State are presented in tables 3.2 to 3.4 below.

Table 3.2 shows the distribution of infrastructures that are severely impacted by flooding, with Kosofe Local Government Area (LGA) being the most severely affected. Areas such as the entire Isheri (including the LSDPC/Isheri North GRA), Maidan, Agiliti, Owode Elede, Owode Onirin down to Ajegunle (along Lagos-Ikorodu Road) are severely susceptible to the threats of perennial

flooding. Also, Eti-Osa, Ikorodu, Amuwo-Odofin, Ojo and Alimosho LGAs are equally vulnerable to the threats of flooding. The distribution of severely affected infrastructures are presented in table 3.2 below while the vulnerability maps are equally presented in the appendix (flood risk vulnerability maps) for the affected Local Government Area and for the entire State.

Table 3.2: Lagos Flood Risk Vulnerability Statistics (Severely Affected)

DESCRIPTION	IKORODU	KOSOFE	OJO	AMUWO-ODOFIN	ALIMOSHO	ETI-OSA
No. of PAPs	342	2,169	52	218	35	465
Residential	296	1,862	40	197	27	385
Commercial	1	62	2	-	-	25
Mixed	25	110	4	10	5	18
Industrial	2	1	-	-	-	1
Institutional buildings	13	89	5	5	2	18
Roads	5	45	1	5	2	9
Recreational	-	-	-	1	-	9
Estimate (₦)	2,092,930,000.00	34,735,930,000.00	385,150,000,00	6,367,500,000.00	493,000,000.00	29,577,696,008.00

A buffer of 500m was set in order to determine the total number of infrastructures that are moderately affected by flooding. The analysis however revealed that a total of 339 infrastructures (residential, commercial, mixed, industrial) were moderately exposed to the threats of flooding with an estimated value of ₦4, 991,800,000.00.

Table 3.3: Lagos Flood Risk Vulnerability Statistics (Moderately Affected)

DESCRIPTION	AMUWO-ODOFIN	ALIMOSHO	ETI-OSA
No. Of PAPs	83	62	25
Residential	67	46	16
Commercial	1	1	-
Mixed	11	4	4
Industrial	-	-	-
Institutional buildings	4	7	3
Roads	-	4	2
Recreational	-	-	-
Estimate (₦)	2,339,500,000.00	1,094,000,000.00	1,558,300,000.00

In determining the estimate of the least affected infrastructures, a buffer of 700m was set along the coast line. Thus, a total of 81 infrastructures of varying landuse with an economic value of ₦6, 276,000,000.00 are exposed to threats of flooding in the State. A table showing the distribution of the least affected infrastructures to flooding in Lagos State is presented below in table 3.4.

Table 3.4: Lagos Flood Risk Vulnerability Statistics (Least Affected)

DESCRIPTION	AMUWO-ODOFIN	IFAKO IJAYE
No. Of PAPs	33	-
Residential	25	21
Commercial	-	-
Mixed	1	1
Industrial	-	-
Institutional buildings	7	-
Roads	-	-
Recreational	-	-
Estimate (₦)	5,599,000,000.00	677,000,000.00

Conversely, the total distribution of infrastructures that are susceptible to the threats of flooding across the State based on the vulnerability mapping of the CRA project for Lagos State is 6,983 with varying degrees of impact ranking viz, severely affected (6563), moderetely affected (339) and least affected (81). However, the estimated value of the exposure of varying infrastructures (public, private, commercial, industrial etc) is eighty four billion, five hundred and thirty four thousand, eight hundred and fifty six thousand and eight kobo (₦84,534,856,008.00) only. This estimates no doubt gives the mental picture of the vulnerabilities/exposure of the Lagos socio-economic ecosystem to the threats of flooding and by extension climate change. Thus, taking into cognizance the socio-economic sensitivity of Lagos State as the commercial and industrial nerve-center of Nigeria, it, therefore, behooves the government to develop a resilient strategy to mitigate the exposure in order to ensure the safety of lives and investments across the State.

Table 3.5: Summary of Flood Vulnerability Analysis for Lagos State

DESCRIPTION	QUANTITY	ESTIMATED COST (₦)
Total number of severely affected infrastructures	6563	73,267,056,008.00
Total number of moderately affected infrastructures	339	4,991,800,000.00
Total number of least affected infrastructures	81	6,276,000,000.00
Total affected infrastructures	**6983**	**84,534,856,008.00**

3.2.6   Topography Analysis and Associated Climate Change Impacts in Lagos

The topography of Lagos was examined using the combination of RASTER data and SRTM data both obtained from the USGS site. The data obtained were used to perform digital Terrain Model of Lagos state. The Digital Terrain model shown in figure 3.1 indicated that significant parts of Lagos State are situated in a low-lying topography some of which are below sea level. The topography ranges from 38 meters above sea level while the higher points are in the northern parts of the state around the boundary with Ogun state, but the majority of the high points are still below 78 meters above sea level. This shows that Lagos state is a low-lying area and this characteristic makes it susceptible to regular flooding. Also, the slope analysis of the state to estimate the potential of free flow of water in the city during prolonged rainfall that can generate large run-off of storm water was also computed (see figure 3.1 below).

Figure 3.1: Digital Terrain Model (DTM) of Lagos State

3.2.7   Slope Analysis of Lagos State

The slope analysis (as presented in figure 3.2) shows that the nature of slope in Lagos will encourage flood water retention as most parts of the State are generally flat. This shows that the storm water will take longer time on the surface before it flows into the water bodies. The flooding potential in Lagos was computed using the Model in HECRAS and the model was used to estimate the area for ten (10) years flooding return period, twenty-five (25) years flooding return period and fifty years (50) years flooding return period. The area to be covered by the projected flooding return period was estimated and overlaid on other resources.
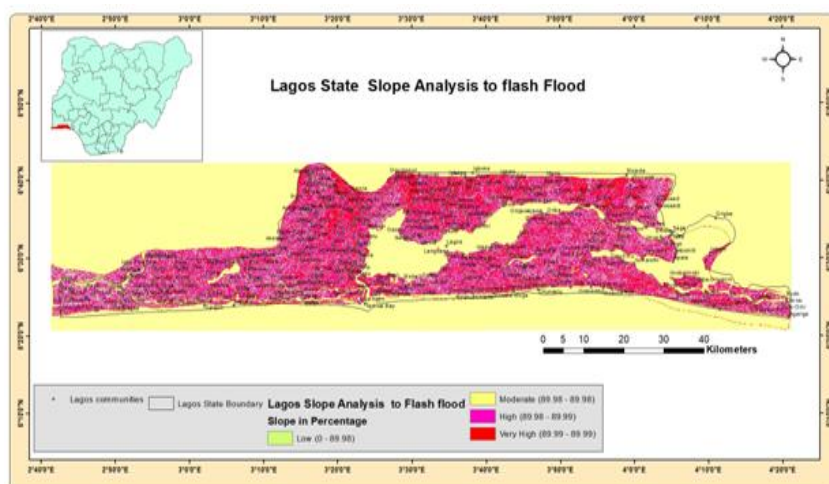
Figure 3.2: Slope analysis of Lagos State to flood

3.2.8   Land Surface Temperature in Lagos State

In order to know the spatial variation in temperature variability, we used the Land Surface Temperature approach of the Landsat data. The data available for the year 1999, 2009 and 2019 were used to evaluate the spatial variability in heat waves and assessment of heat island in Lagos State.
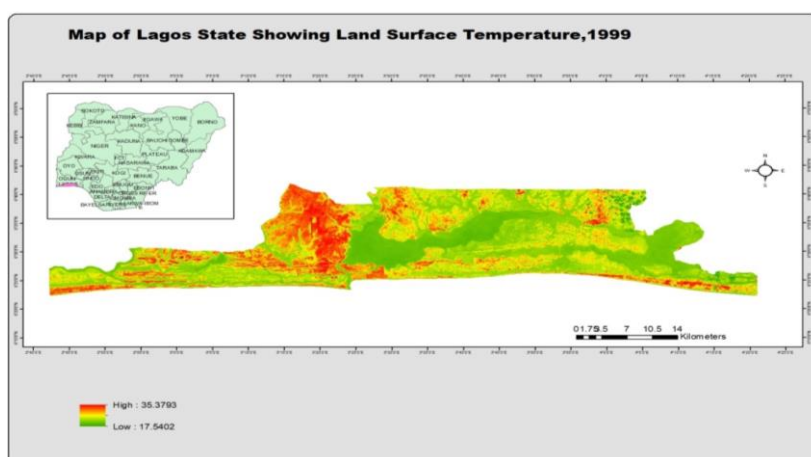
Figure 3.3: Land surface temperature of Lagos State 1999

Figure 3.3 showed that the surface temperature in Lagos state in 1999 is very mild having majority of the space with low temperature ranging between 17^0C to 25^0C. The built-up areas and some parts of the state have temperatures in the range of 35^0C which was very high at that time.
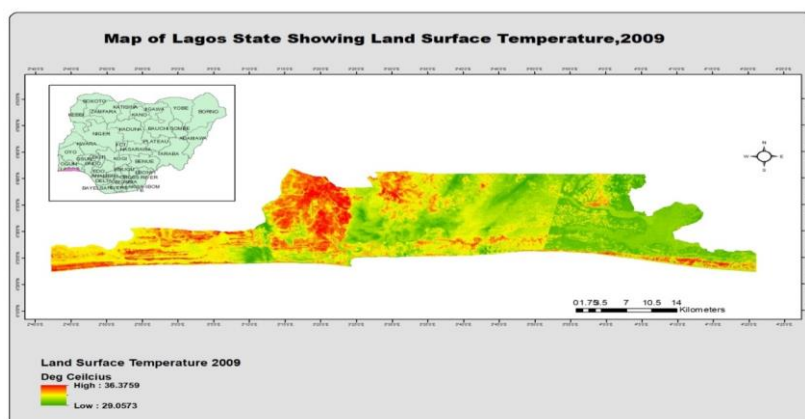
Figure 3.4: Land surface temperature 2009

However, in the year 2009, the area with low surface temperature has significantly reduced and the areas with extreme surface temperature have increased as shown in figure 3.4. The average low temperature has increased to about 29^0C.
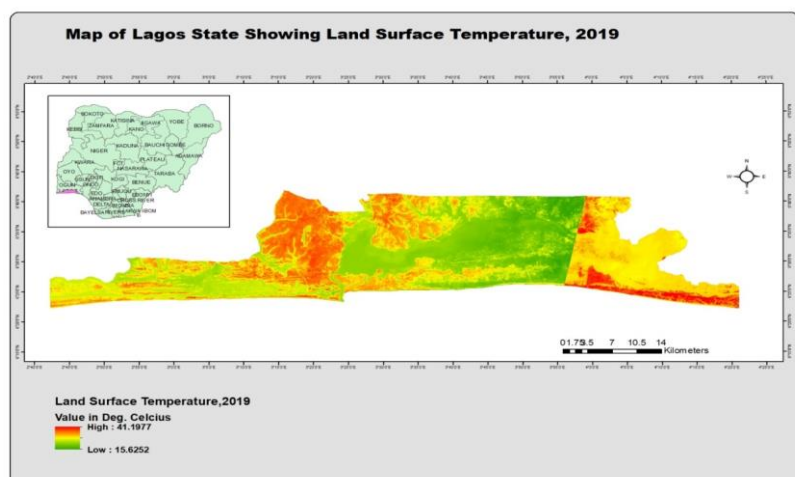
Figure 3.5: Land surface temperature 2019

In the year 2019, the highest surface temperature recorded was 41^0C and the area with extreme temperature has increased across the state. Moderately high surface temperature has also increased throughout the study area such as some communities Epe and Ibeju Lekki.

3.2.9 Trend in Ecosystem Change and Vulnerability to Climate Change Impact and Anthropogenic Activities

The project team evaluated the ecosystem change in Lagos State with the view to identifying the nature of climate change effects on the ecosystem. The study used the Landsat Images of 2006 and 2016 to calculate and identify the depletion rate of ecosystem services of Lagos State and project the depletion rate for the year 2030, 2050 and 2070.

To achieve the above projections, the entire State was classified into 12 major ecosystems for the purpose of this modeling. However, the classification was based on the classification scheme adopted by FORMECU project 1995. Thus, the specific ecosystem used in the analysis and modellings of ecosystem services depletion in Lagos state are as follows:

1. Undisturbed forest
2. Coastal vegetation
3. Freshwater vegetation
4. Planted forest
5. Disturbed forest
6. Tree crop vegetation
7. Wooded savannah
8. Grassland/vegetated bluff
9. Arable land
10. Settlements
11. Bare surfaces and
12. Water body

The 12 major ecosystem classifications were used to identify the changes taking place in the State over a ten (10) year period and then project the ecosystem change for the years 2030, 2050 and 2070.

Satellite imageries (Landsat) of 2006 and 2016 were used to identify ten (10) year depletion of ecosystem services while the results were used to project into the other years based on Markov Chain modeling techniques in IDRISI software. However, the ecosystems were broadly classified into two (2) broad categories viz; forest based ecosystem and non-forest based ecosystem. When forest-based ecosystem reduces, it is classified as reduction in ecosystem based services and this is used to estimate the impacts on the ecosystem based economy and livelihoods. Conversely, when a forest based ecosystem depletes, agricultural based economic activities suffer and the micro climatic condition also is negatively impacted. The first six classes including undisturbed forest, coastal vegetation, freshwater vegetation, planted forest, disturbed forest and tree crop vegetation are all forest based ecosystems while non-forest based ecosystems are wooded savannah, grassland/vegetated bluff, arable land, settlements, bare surfaces and water body.

The Landsat images used were extracted from the USGS site and specifically bands 4,5,6 were used to produce the image composite (See figure 3.6) The image visual interpretation shows that Lagos central is heavily built up while Epe and other areas in the Eastern part of the State are very rich in forest based ecosystem. Water bodies in the State are in the forms of lagoon, creeks, swamps and coasts are the very dominant land use types and cut across the entire State.
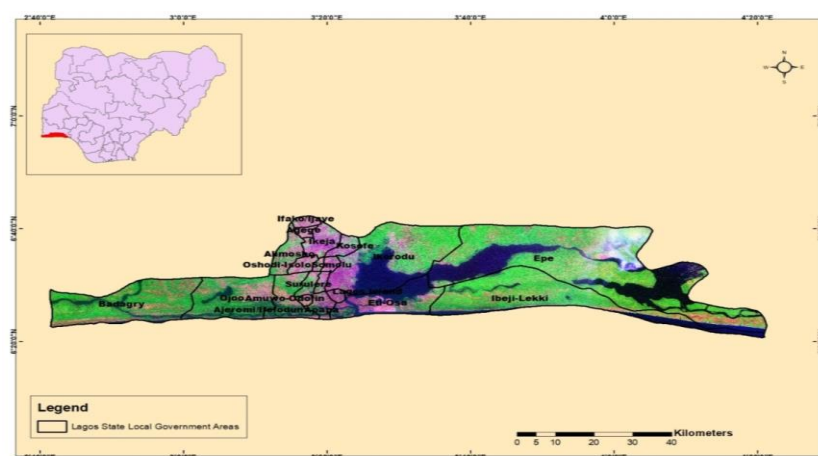

Figure 3.6: False colour image composite image of Lagos state

Ecosystem Analysis 2006

The ecosystem in 2006 showed that the major ecosystem was freshwater vegetation that accounted for more than 49,000 hectares and accounted for 14.2% of the entire project area. Aside from the predominant freshwater vegetation, Lagos, being predominantly urban has settlements accounting for above 64,000 hectares (18.4 %).
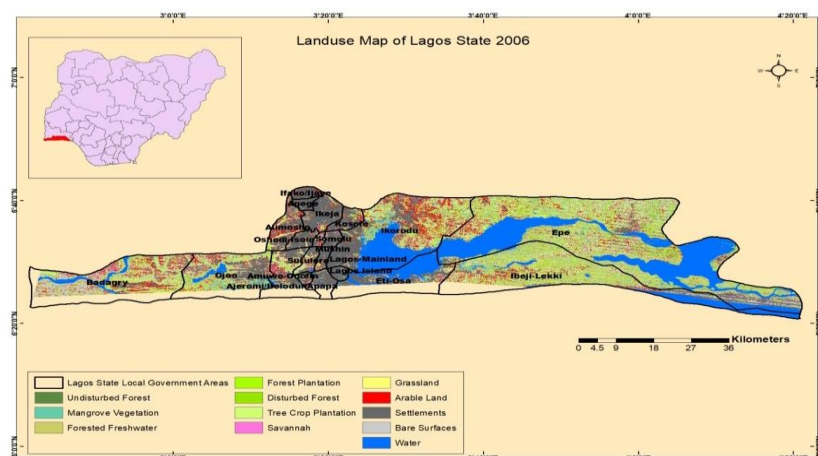
Figure 3.7: Land use analysis in Lagos State in 2006

The analysis of figure 3.7 shows that in 2006, agricultural land use has significantly reduced and there was an upsurge in the urban land use across the State (Lagos).
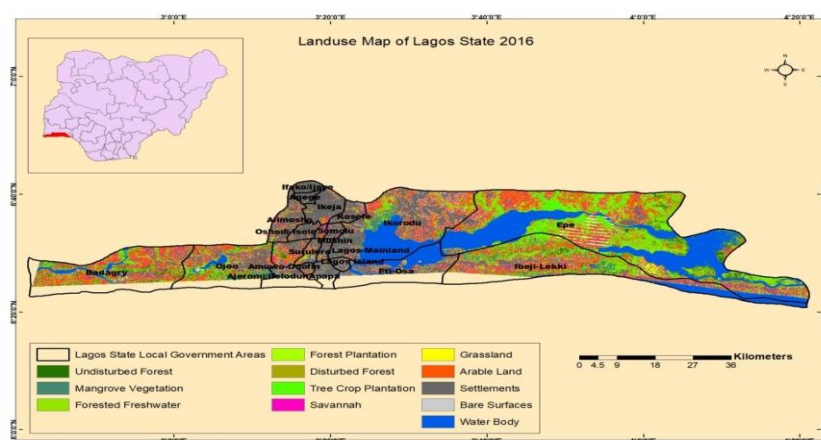
Figure 3.8: Land use analysis in Lagos State in 2016

Figure 3.8 showed also that arable land has taken over most part of the forested freshwater zones of the state while there was a significant increase in the area for urban land use across the state. It was also noticed that the water body also slightly reduced. However, the land use change analyses in the two periods (2006 and 2016) of our analysis are shown in the table 3.6.

The two time results were used for the change projections into the near, medium and distant future.

Table 3.6: Land use Analysis of Lagos State 2006 and 2016

Ecosystem	Area in Hectares (2006)	Percentage (%) Ecosystem (2006)	Areas (Hectares) in 2016	Percentage (%) Ecosystem (2016)
Undisturbed forest	2118.42	0.60	11907.54	3.42
Coastal vegetation	13872.96	3.95	10739.16	3.09
Freshwater vegetation	49881.15	14.21	30783.15	8.85
Forest plantation	6565.59	1.87	8287.38	2.38
Disturbed forest	16007.58	4.56	15404.13	4.43
Tree crop plantation	40012.29	11.40	27990.99	8.04
Savannah woodland	5983.29	1.70	19868.58	5.71
Grassland	712.71	0.20	4446.18	1.28
Arable land	26740.53	7.62	60265.44	17.32
Settlements	64650.78	18.41	69453.9	19.96
Bare Surfaces/cleared areas	48377.34	13.78	15873.84	4.56
Water bodies	76159.08	21.69	72931.59	20.96
Total	**351081.72**	**100.00**	**347951.88**	**100.00**

Table 3.6 shows that the major ecosystems in the year 2006 are waterbodies 21.69%) settlements 18.41%), freshwater vegetation (14.21%). However, in 2016 the major ecosystems have slightly changed and were water body (20.96%), settlements (19.96%), arable land (17.32%) and freshwater vegetation (8.85%). This shows significant depletion in the freshwater vegetation (from 14.21 to 8. 85%) and slight depletion in the water body from 21.69 to 20.96 %) This is due to an increase in building development projects in the State.

Figure 3.9 shows the projected land use change in the year 2030, it showed that the area where high percentage ecosystem change will be noticed in the project area will be around the upper Ikorodu axis.
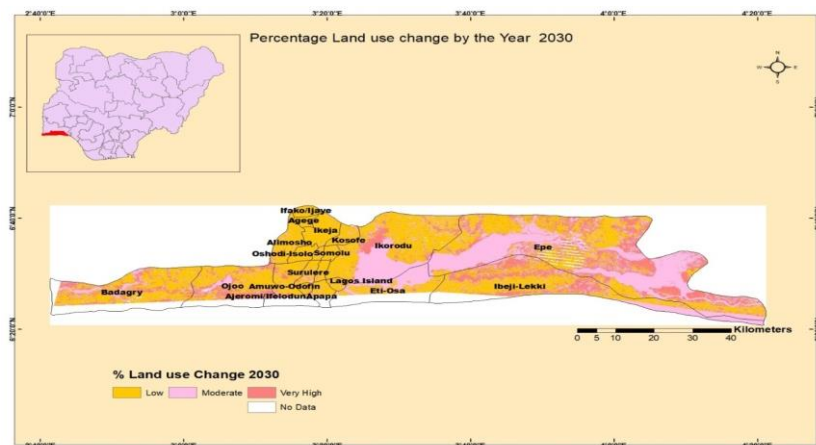
Figure 3.9: Percentage projected change in Lagos state 2030

Percentage Land use change 2050

The ecosystem change will continue till the year 2050 with the majority of change being in the available areas in the rural Lagos particular notice is given to the North eastern part of the state where there are available lands (see Fig 3.10). The areas where low percentage changes were envisaged in the project area are the water body and the already built up area of the state. Growth by attrition was not envisaged in the projected area while the projected percentage land use change in 2070 is also presented Fig 3.11.
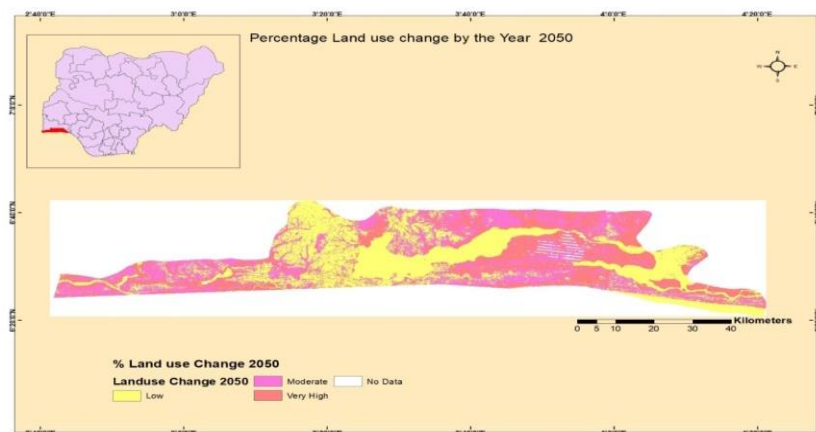
Figure 3.10: Percentage Land Use Change 2050
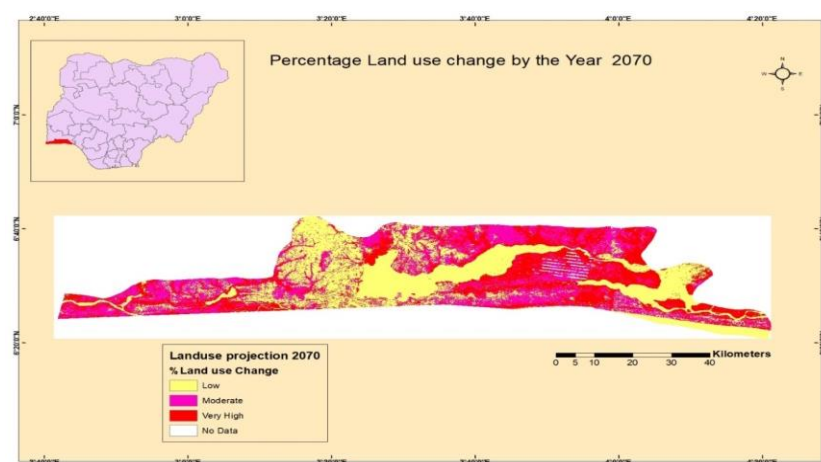
Figure 3.11: Percentage Land Use Change 2070

However, the probability of ecosystem changes from 2016 to 2070 is tabulated below.

Table 3.7: Probability of Ecosystem changing from 2016 to 2070

	Cl. 1	Cl. 2	Cl. 3	Cl. 4	Cl. 5	Cl. 6	Cl. 7	Cl. 8	Cl. 9	Cl. 10	Cl. 11	Cl. 12
Class 1 :	0.0422	0.0300	0.1070	0.0309	0.0597	0.1000	0.0829	0.0178	0.2433	0.2019	0.0611	0.0233
Class 2 :	0.0432	0.0332	0.1086	0.0293	0.0587	0.0998	0.0770	0.0168	0.2260	0.1935	0.0572	0.0567
Class 3 :	0.0414	0.0307	0.1049	0.0299	0.0579	0.0972	0.0807	0.0175	0.2360	0.2051	0.0600	0.0388
Class 4 :	0.0231	0.0190	0.0649	0.0245	0.0378	0.0588	0.0825	0.0190	0.2305	0.3591	0.0699	0.0107
Class 5 :	0.0389	0.0283	0.0998	0.0299	0.0558	0.0927	0.0836	0.0181	0.2430	0.2228	0.0628	0.0242
Class 6 :	0.0302	0.0231	0.0808	0.0271	0.0461	0.0743	0.0838	0.0187	0.2385	0.2934	0.0670	0.0169
Class 7 :	0.0210	0.0179	0.0600	0.0233	0.0353	0.0541	0.0810	0.0190	0.2246	0.3847	0.0703	0.0089
Class 8 :	0.0171	0.0164	0.0505	0.0201	0.0300	0.0449	0.0737	0.0183	0.2013	0.4455	0.0692	0.0130
Class 9 :	0.0228	0.0191	0.0640	0.0238	0.0373	0.0580	0.0803	0.0187	0.2238	0.3722	0.0692	0.0110
Class 10 :	0.0123	0.0141	0.0385	0.0164	0.0236	0.0336	0.0655	0.0175	0.1746	0.5258	0.0685	0.0095
Class 11 :	0.0299	0.0229	0.0800	0.0270	0.0457	0.0735	0.0836	0.0187	0.2379	0.2968	0.0671	0.0170
Class 12 :	0.0129	0.0264	0.0381	0.0047	0.0121	0.0223	0.0108	0.0037	0.0326	0.0272	0.0098	0.7994

The ecosystem projection is very critical to climate change analysis; thus, the vegetation cover is responsible for the carbon sink in many urban Centers. According to the REED+ project, the rate of depletion of the vegetal cover has direct implication on the carbon emission and indirectly affects the ozone layer.

The nature of changes taking place in the different types of ecosystem determines the capacity of the inhabitant to respond and cope with the effects of climate change. It was particularly noted that the urban landscape that dominates the ecosystem in Lagos state constitutes a high emission factor in

the consequential effect on the micro climatic modifications. There are notable impacts of the ecosystem change on Lagos's microclimatic systems which have been succinctly enumerated above.

Also, one of the socio-economic implications of the effects of increase in hard landscape and the decrease in soft landscape in Lagos will lead to slight rise in the outside temperature and this will in a way affect the human conformability and other associated health challenges.

CHAPTER FOUR

Monitoring, Reporting, Verification and Evaluation (MRVE) Framework

Monitoring, reporting, verification and evaluation in climate change adaptation can be for two major reasons:

- To track the progress of the adaptation plan implantation.
- To measure the success of the adaptation plan

It is slightly difficult to measure when a significant change has occurred as a result of implementing an adaptation project, making it difficult to define what adaptation looks like in reality. However, this section highlights the framework and considerations for an MRVE-system proposed as an internal management tool to provide information on the gap between the expectation of the project and the results achieved from the actions contained in an adaptation plan. This is achieved through a Multi-Criteria Analysis (MCA) and a Road-Mapping exercise. The preliminary list of climate-relevant actions was listed for the various climate hazards and participants grouped accordingly.

- Extreme Rainfall (Group 1)
- Surface Erosion (Group 2)
- Flooding (Group 3)
- Temperature Rise (Group 4)
- Sea Level Rise (Group 5)
- Climate Governance (Group 6)

Firstly, the shortlisted actions and any additional actions identified were assessed against the MCA criteria and scored. Options were ranked using a weighting-criteria system, reflecting the relative importance and the local context. The results were reviewed, and the top 1 - 3 preferred actions were identified. Each group then presented the results of the MCA exercise to the rest of the participants and, collectively, it was decided which actions to take forward into the following roadmap session. MCA results for each of the climate hazards are presented in Table 4.2, Table 4.3, Table 4.4, Table 4.5, Table 4.6 and Table 4.7 below. In some cases, where there was considered to be overlap between actions; individual actions have been grouped to create packages of actions.

The criteria are listed as follows:

- A – Adaptation / resilience potential
- B – GHG abatement potential
- C – Level of city power and capacity
- D – Alignment with existing national policies / plans
- E – Social acceptability
- F – Political acceptability
- G – Ease of implementation
- H – Cost (CAPEX & OPEX)
- I – Co-benefits

Table 4.1: MCA criteria and scores

Criteria	Scoring guidance	
	Max (score = 5)	**Min (score = 1)**
Adaptation/resilience potential	Significant benefit for climate change adaptation / resilience.	Negligible / no benefit for climate change adaptation / resilience.
GHG abatement potential	Significant GHG abatement potential – critical to achieving zero emissions by 2050.	Negligible / no GHG abatement potential – not critical to achieving zero emissions by 2050.
Adaptation/resilience potential	Significant benefit for climate change adaptation / resilience.	Negligible / no benefit for climate change adaptation / resilience.
Level of city power and capacity	Directly aligns with policies / plans.	Different, or in contradiction, to existing policies / plans.
Alignment with existing national policies/plans	Directly aligns with national policies / plans.	Different, or in contradiction, to national policies / plans.
Social acceptability	Minimal / no negative societal impacts, and / or significant positive societal impacts, resulting from the implementation of the measure.	Significant negative societal impacts, and no positive societal impacts, resulting from the implementation of the measure.
Political acceptability	Action expected to receive full political support.	Action expected to receive no / minimal political support.
Ease of implementation	The action involves tried and tested processes, technologies, minimal preparation / support and can be implemented immediately.	The action is highly complex, would require support systems that are not currently in place in the city, and would require a significant lead-time.
Cost (CAPEX & OPEX)	The level of required investment is low, and funding requirements can be met by the city.	The action would require significant investment (including capital and operating costs), and is likely to require the sourcing of funds from national government and / or international funding routes.
Co-benefits	The action will have significant co-benefits for residents with immediate effect.	The action will have no / minimal co-benefits for all stakeholders.

4.1 Road-mapping exercise

The adaptation roadmap highlights some actions that the State could undertake in response to the priority risk factors. For each of these projects, the following assessments were done:

- Who is responsible for implementing / overseeing the action?
- How will the action be financed?
- Who are the key stakeholders and what will their roles be?
- What is the current status of the action?
- Sub activities (next steps)
- Link to other actions
- What are the indicators to track success of the action?

- Who will be impacted and who will benefit from the action?
- What are the risks and barriers?

A multi-criteria analysis (MCA) exercise for each of the identified climate hazard was carried out. The implementation considerations for each prioritized action were discussed and assessed, and a roadmap of implementation steps was established. This was followed by a plenary discussion where feedback and comments were shared. The following images and summary paragraphs reflect the key comments / observations from the road-mapping exercise for the prioritized actions.

1: Extreme Rainfall

Table 4.2: MCA Results for Extreme Rainfall

Criteria		A	B	C	D	E	F	G	H	I		
Weighting		1	0.8	0.8	0.8	0.6	0.6	1	1	0.6	Score	Rank
Action 1	Develop and implement a Storm Water Drainage Master plan	4	1	5	1	3	3	4	4	5	24.2	2
Action 2	Rehabilitate waterways across the city including regular desilting and maintenance; Public enlightenment and advocacy to promote depaving and encourage the use of permeable surfaces	5	1	5	3	3	3	4	2	5	24.8	1
Action 3	Encourage communities to build flood defense structures such as ridges, bonds and drains.	4	1	4	1	1	1	1	1	4	14.4	7
Action 4	Provide short term weather forecasting services to farmers to enable them adjust and take advantage of changes in weather pattern	5	2	2	4	5	1	1	2	4	20.4	5
Action 5	Develop an integrated waste management system	3	5	2	1	4	2	3	3	4	21.4	4
Action 6	NEW: Green river banks to serve as artificial floodplain and urban parks	4	4	1	1	3	1	3	3	4	19.6	6
Action 7	NEW: Waterproofing power infrastructure to reduce rainfall-induced blackouts and damage to power distribution infrastructure	2	3	1	1	3	1	1	2	3	13.2	8
Action 8	NEW: Increase flood water management in Lagos to accommodate increased releases in the upstream Oyam dam in Ogun State	5	2	3	2	4	3	2	3	4	22.2	3
Action 9	NEW: Rain water harvesting										0	
Action 10	NEW; Disease/Vector management plan										0	

Action 1:

Develop and implement a Storm Water Drainage Master plan

This action will be the responsibility of the Ministry of Environment & water resources and the office of drainage services. The action will require an injection of investment from the State government and other intervention funds.

The action will require the participation of major stakeholders like LASG, LGAs/LCDAs, traditional rulers, communities, CDAs, NGO/Civil societies, Consultants, Private sectors and the Federal ministry of works. The current status of this action is seen in the current drainage master plan, poorly managed storm water system, built environment blocking water course and improper coordination of drainage plans in isolated estates. This action is linked to vector/disease control, flood control and resilience/smart city. The impacts of this action will be seen in:

- reduction in flooding
- reduction in vector-borne diseases transmission
- high social resilience

Action 2:

Rehabilitate waterways across the city including regular desilting and maintenance; Public enlightenment and advocacy to promote depaving and encourage the use of permeable surfaces
This action will be the responsibility of two ministries (Environment & water resources, Information & strategy) and the local government. The action will require an injection of investment from the State government, other intervention funds and PPP. The action will require the participation of major stakeholders like LASG, LGAs/LCDAs, traditional rulers, communities, CDAs, NGO/Civil societies, market men/women and the media. The current status of this action is seen in the silted and garbage filled waterways, non-sustainable management plan in place, failed drainage system and poor advocacy. This action is linked to vector/diseases control, flood control, proper waste management and awareness of citizenry. The impacts of this action will be:

- free flow of storm water
- reduction in flooding
- reduction in vector-borne diseases transmission
- increase in citizen participation

Next steps for the implementation of this action include; advocacy and awareness (social media, radio, TV & print), civil works, desilting and maintenance. Beneficiaries to this action will be the general public.

Plate 4.1: Summary of actions on rehabilitation of waterways, public enlightenment and storm water drainage development

2. Surface Erosion

Table 4.3: MCA Results for Surface Erosion

Criteria		A	B	C	D	E	F	G	H	I		
Weighting		1	0.8	0.8	0.8	0.6	0.6	1	1	0.6	Score	Rank
Action 1	Reclaim all canal bank roads and coastline areas in the State and where necessary settlements in these areas will be relocated	4	5	5	5	3	2	1	1	5	24	8
Action 2	Encourage communities to build flood defense structures such as ridges, bonds and drains.	5	3	4	4	4	3	2	3	5	26	7
Action 3	Restrict land reclamation activities	5	2	1	5	3	3	1	4	4	22.4	10
Action 4	Develop frameworks for communication with stakeholders and institutions involved in storm water infrastructure management. To develop policy and guidelines on storm water infrastructure management	4	4	5	5	4	4	4	2	4	28.4	4
Action 5	Enforce land use zoning regulations that restrict development on high risk areas such as flood plains and low-lying terrain (wetlands, mangrove forests, flood plains)	5	5	4	4	5	4	3	1	4	27.2	6
Action 6	Maintain and restore mangroves and other coastal wetlands as a relatively cheap form of defense against coastal flooding and coastal erosion to promote livelihoods	5	5	5	4	5	4	3	1	5	28.6	3
Action 7	Develop institutional frameworks for community involvement in developing flood resilient guidelines for new city infrastructure, such as buildings, transportation and drainage systems.	5	4	5	5	3	4	3	3	5	29.4	1
Action 8	Produce and use flood risk maps	5	4	4	4	4	4	4	3	5	29.4	1
Action 9	Raising the building level, building high walls to prevent floods, and repair/replace damaged property	4	3	3	1	1	2	2	1	4	16.8	11
Action 10	The State will maintain reliable information to facilitate proactive flood management and information dissemination to the public	4	3	5	4	4	4	3	3	5	27.4	5
Action 11	Construction of FootBridge to link buildings within communities. Use of sandbags system and sand filling.	3	2	3	3	3	2	4	5	3	23.2	9

Action 1:

Produce and Use Flood Risk Map

The Production and implementation of a flood risk map is a key component of an effective strategy to the management and control of surface erosion in Lagos State. Currently, the State has none and this action has been identified to be solely the responsibility of the State Government but to be financed by donor agencies, counterpart funding alongside the government. The Key stakeholders were identified as: Government, LGAs, LCDAs, Community Leaders, CDAs, CBOs and NGOs.

For the successful implementation of this action, the sub-action and steps to be taken were identified as: Carry out need analysis; produce TOR/RFP; engage consultants; carry out stakeholder engagement; presentation of draft/final reports and assent by Mr. Governor. This action has been linked to other Actions like 1,2,3,4 and 10 identified in Table 4.3.

The indicators to the successful implementation of this action will be seen in evidence based decision making; effective drainage management planning; reduced health bills; reduced flood related emergency disasters as well as preserving infrastructure. Beneficiaries of this action include both the Government and the citizenry. The key risks and barriers to the success of this action will be Finance and community buy-in.

Action 2:

Develop institutional frameworks for community involvement in developing flood resilient guidelines for new city infrastructure, such as buildings, transportation and drainage systems.

The development of institutional frameworks for community involvement in developing flood resilient guidelines for new city infrastructure is a key component of an effective strategy to the management and control of surface erosion in Lagos State. Currently, what the State has is inadequate and this action has been identified to be solely the responsibility of the State Government but to be financed by donor agencies, counterpart funding and developmental partners alongside the government.

The key stakeholders were identified as: government, community leaders, and citizens/residents.

For the successful implementation of this action, the sub-action and steps to be taken were identified as: review existing documents; produce TOR/RFP; and advertised to engage consultants.

This action has been linked to other Actions like 1, 9 and 10 identified in Table 4.3. The indicators to the successful implementation of this action will be seen in evidence based decision making; increased community involvement and reduced conflicts. Beneficiaries of this action include both the Government and the citizenry. The key risks and barriers to the success of this action will be Finance, Implementation and Political will.

Plate 4.2: Summary of actions to produce and use flood risk maps and develop institutional frameworks for community.

3. Flooding
Table 4.4: MCA results for Flooding

Criteria		A	B	C	D	E	F	G	H	I		
Weighting		1	0.8	0.8	0.8	0.6	0.6	1	1	0.6	Score	Rank
Action 1	Improve, expand and maintain the city-wide drainage network, increasing rainwater retention and infiltration for a Sustainable Urban Drainage	5	3	5	5	3	2	4	2	5	27.4	5
Action 2	Effective management of construction and upgrade of drainage channels (primary, secondary and tertiary) to world class standard (conduit drains and lined channels to meet the State needs	5	3	5	5	3	2	4	1	5	26.4	7
Action 3	Sustain the continuous monitoring of flooding problems through the establishment of Flood Disaster Early Warning & Advocacy mechanisms through the Drainage offices within the 20 LGAs and 37 LCDAs	4	2	4	5	3	4	4	4	5	28	4
Action 4	Improve local authorities' adaptive skills and knowledge as well as improve on indigenous adaptation methods.	5	4	5	5	5	4	5	4	5	33.6	2
Action 5	Use of prayers/charms/incantations and consulting the gods (Marine spirits)	1	1	1	1	2	5	5	5	1	18.2	8
Action 6	Consulting the rainmakers	1	1	1	1	1	3	5	5	1	16.4	9
Action 7	Enhance public awareness on the danger of indiscriminate dumping of refuse and obstruction of drainage channels. Local Authorities and communities will be involved in regular work to keep all drainage channels clear of rubbish and other blockages	5	4	5	5	5	5	5	4	5	34.2	1
Action 8	Conduct a baseline study to quantify and qualify waste streams	5	5	5	5	5	4	4	3	5	32.4	3
Action 9	Develop an efficient value chain and circular economy around the waste management system.	5	5	5	5	3	3	2	1	5	26.6	6

Action 1:

Enhance public awareness and Improve local authorities' adaptive skills and knowledge as well as improve on indigenous adaptation methods.

This action is a combination of Actions 4 and 7 and its implementation is linked to all other actions identified in Table 4.4. The state government would be responsible for developing and promoting the action through the Ministry of the Environment and Water Resources. The underlying funding would come from Government, grants, CSR and Green financial instruments. The main risks and barriers will be misconceptions, cultural beliefs and possible resistance from the citizenry. The key steps for implementation of this action will include:

- Stakeholders engagement
- Awareness campaign
- Inclusion of climate change studies in the school curriculum
- The impacts of this action will be:
- Improved response to early warning
- Improved environmental attitude to climate change issues
- Inclusion of climate change studies in the school curriculum

The current status of this action is low and the key stakeholder necessary for the implementation of this action includes; LGAs/LCDAs, civil societies, media, academia, traditional rulers, Ministry of Home Affairs, Ministry of Information, Ministry of local government and community affairs, LAWMA, private sectors and resident associations.

Action 2:

Improve, expand and maintain the city-wide drainage network.

The Ministry of works and infrastructure alongside the Office of Drainage services would be responsible for promoting this action. There would also be an important role for stakeholders like: Ministry of physical planning and urban development, LGAs/LCDAs, Resident Association and the Ministry of local government and community affairs. This action is seen to be Germaine to actions 2 and 3 in Table 4.4.

The key steps for the implementation of this action include: Stakeholder engagement, conduct impact assessment and source for fund.

The impacts of this action will be seen in an improved drainage system, improved surface runoff, reduced water borne diseases and reduced flooding incidences.
Beneficiaries to this action will be the general public while the possible risk/barriers include lack of fund.
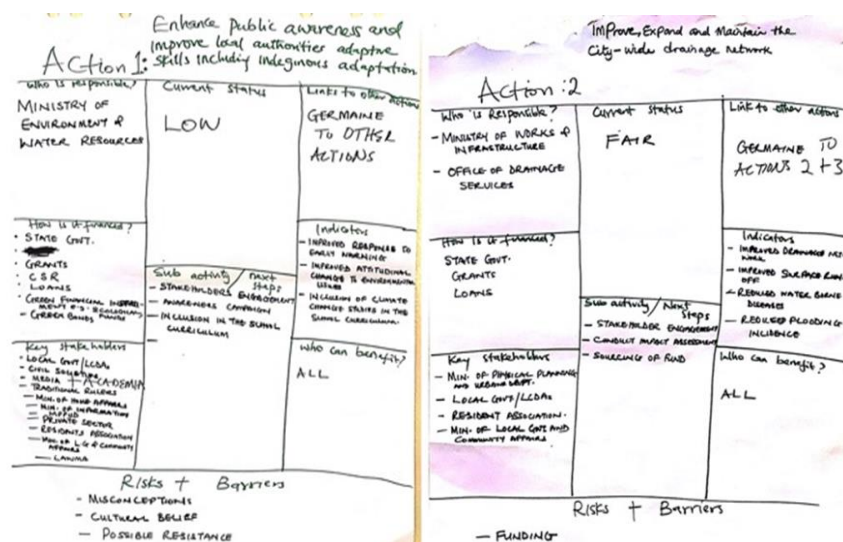
Plate 4.3: Summary of actions on public awareness, local authorities' adaptive skills and maintaining the city-wide drainage network.

4. Temperature Rise

Table 4.5: MCA results for Temperature Rise

Criteria		A	B	C	D	E	F	G	H	I		
Weighting		1	0.8	0.8	0.8	0.6	0.6	1	1	0.6	Score	Rank
Action 1	Provide a community-based climate change adaptation support program targeted at crop and livestock agriculture and food security in the State	3	3	4		5	5	3	5	5	25.6	5
Action 2	Plant more trees for more shade and cooling in public spaces, markets and along streets, and encourage tree planting on private property	5	3	4		4	5	5	5	5	29	1
Action 3	Integrate green and nature-based ecosystem services into hard engineering solutions in the city to increase the resilience to heat waves and flooding	4	3	5		5	5	5	4	5	28.4	2
Action 4	Strengthen the Lagos State Government's emergency response system, including developing an E-health system that incorporates disease surveillance	5	3	5		5	5	5	1	5	26.4	4
Action 5	Implement the Lagos State Health Scheme and improve the basic health care system to be able to cope with the health impacts of climate change	4	1	5		5	5	5	4	5	26.8	3
Action 6	Conduct building vulnerability assessments to identify retrofits and improve performance in extreme weather and incorporate thermal comfort, drainage, and water storage considerations into building retrofit designs	4	5	4		2	2	4	2	5	22.6	6
Action 7	Encourage painting of more white roofs and walls, which have a higher albedo and deflect more solar radiation for a cooling effect	2	2	4		2	2	5	4	3	20	9
Action 8	Promote rainwater collection from rooftops and storage for use in buildings to flush toilets or water gardens	3	3	4		3	1	3	5	4	21.4	8
Action 9	Reducing water pipe leakages	3	3	3		5	4	3	3	5	22.2	7
Action 10	Regulate private groundwater extraction to maintain groundwater levels and reduce vulnerability to drought and saltwater intrusion	5	2	3		3	1	2	4	3	19.2	10
Action 11	Reclaim wastewater for agricultural purposes	4	4	2		2	1	4	2	3	18.4	11

Action 1: Integrate green and nature-based ecosystem services into hard engineering solutions including planting trees in public spaces.

This action is a combination of Actions 1 and 2 in Table 4.5 and the objective is to plant more trees in the environment. The MOE & WR would be responsible for promoting this action alongside the Office of Drainage services in the Ministry of works and infrastructure. There would also be an important role for stakeholders like local residents, LASPARK, LAMATA & LASURA. Financing of this action will be a combination of state government, MEBP and NGOs. Likely key barriers include non-acceptance by residents; poor quality infrastructure; lack of technical expertise in nature-based solutions and informal residents in pilot areas.

Pilot schemes are already in place as there are on-going tree planting processes; a lot of livelihood is also generated from planting trees. The linear park in Ojota's design is also in view. The key steps in implementation will be: a consideration of integrated infrastructure to incorporate tree planting and proposed linear park Ojota implementation.

This action will link to new infrastructure projects and beneficiaries include; local residents, tourists and vendors. The impacts of this action will be:

- low emission
- reduced flooding risk
- improved non-motorised transportation

Action 2:

Provision of basic health-care scheme and strengthening of the emergency response system.

This action is a combination of Actions 3 and 4 and the objective is to a provide basic health-care scheme for the citizenry. The ministry of health, LASEMA, NEMA, LASG safety command and NIMET would be responsible for promoting this action. There would also be an important role for stakeholders like local residents, Health insurance providers and Health workers. Financing of this action will be a combination of MEPB, NGOs and intergovernmental/multilateral organizations like WHO & UNICEF.

Currently, basic health care is effective and very accessible but with affordability problems. ERS is good for accidents and security. Temperature and rainfall information is not localized. The key steps in implementing this action will be to implement plans, allocate budget and evaluate impacts.

This action will link to actions 4 & 5 on Table 4.5 and the beneficiaries include vulnerable groups and low income earners. The impacts of this action will be:

- increased number of people served
- increased number of people enrolled in the health insurance scheme
- reduced vector and air borne diseases. Likely key barriers include resistance from citizens, finance, lack of reliable energy/equipment and poor maintenance culture.

Plate 4.4: Summary of actions on health-care and emergency response and nature-based ecosystem services

5. Sea Level Rise
Table 4.6: MCA results for Sea Level Rise

Criteria		A	B	C	D	E	F	G	H	I		
Weighting		1	0.8	0.8	0.8	0.6	0.6	1	1	0.6	Score	Rank
Action 1	Develop a plan for coastal flood defense mechanisms for protection of the shoreline of selected communities.	5	1	5	5	3	4	3	2	4	25.4	4
Action 2	Develop a framework for integrated coastal zone management that accounts for community needs and environmental considerations.	5	5	2	4	4	5	5	4	5	31.2	2
Action 3	Design measures for flood defense improvement and promote increase public awareness	5	1	4	4	5	3	4	3	4	26.4	3
Action 4	Apply strict control over all new land reclamation along the coast, increasing the standard to a minimum 4m above sea level with a requirement for sea defenses against storm surges and reduce the expansion of socio-economic development in areas at high risk from sea level rise	5	1	3	4	3	2	1	1	5	19.4	8
Action 5	Construction of groves and other infrastructure along some sections of coastline, reducing risk from more frequent flooding and erosion	5	1	2	3	4	5	1	1	5	20.2	7
Action 6	Conduct a Statewide sea level rise vulnerability assessment with a view to preparing an inventory of coastal natural and human-made assets that are at risk (including economic valuation)	5	2	5	5	5	5	4	4	5	32.6	1
Action 7	Develop permanent solutions to decrease the erosion of coastline, e.g. building wave breakers farther out at sea and maintaining them.	5	1	3	4	2	2	4	4	5	21.8	5
Action 8	Develop a long term plan for relocating those settlements most vulnerable to sea level rise	5	1	2	5	1	1	4	4	5	20.6	6

Action 1:

Conduct a State-wide sea level rise vulnerability assessment with a view to preparing an inventory of coastal natural and human-made assets that are at risk (including economic valuation).

Two ministries (the MOE & WR and the Ministry of Waterfront and Infrastructural Development) are responsible for this action. The current status of this action is seen in the previous studies on climate change and in the present CRA. This action is proposed to be financed by LASG and the organised private sector. The key stakeholders for the implementation of this action include:

- Government (Federal, State and Local)
- Coastal communities
- Farmers (arable and fish farmers)
- CBOs, CSOs and NGOs

This action is linked to actions 2, 3, 4, 5, and 1 in Table 4.6.

The indicators to monitor the impact of this action include:

- Area inundated by SLR
- Population affected by SLR (M/F)
- Properties (assets affected by SLR)
- Social disruption

Beneficiaries to this action will be all stakeholders while the possible risk/barriers include social resistance, unexpected emergencies and lack of funding.

Action 2:

Develop a framework for integrated coastal zone management that accounts for community needs and environmental considerations.

This action would be the responsibility of MOE & WR, Ministry of waterfront and infrastructural development and the FMEnv. An evaluation of the current status showed recommendations from climate change summits (Lagos) yet to be implemented. The action would lead to the development of a TOR, sourcing for funds and Procurement as its sub-activity. Financing this action will come from the Federal Government, State Government and Development partners

The key stakeholders for the implementation of this action include:

- Sea transporters and farers
- Federal, state and local government
- CBOs, CSOs and NGOs
- Private sector
- Coastal communities

This action is linked to actions 4,5,7,8 and 1 in Table 4.6.

The indicators to monitor the impact of this action include:

- Level of content in coastal management strategy
- Improved livelihoods
- Increased revenue from ecosystem services.

Beneficiaries to this action will be all stakeholders while the possible risk/barriers include lack of political will, lack of funds and intergovernmental/ministerial conflict.

Plate 4.5: Summary of actions on integrated coastal zone management and sea level rise vulnerability assessment.

6. Climate Governance
Table 4.7: MCA Results for Climate Governance

Criteria		A	B	C	D	E	F	G	H	I		
Weighting		1	0.8	0.8	0.8	0.6	0.6	1	1	0.6	Score	Rank
Action 1	Develop an inventory of successful/effective indigenous adaptation technologies for the management of Sea level rise and storm surge challenges.	3	2	4	3	5	4	4	2	5	24.6	10
Action 2	Enhance the capacity of local institutions, including Local Government, Extension workers, Farmers Association and Community Elders to promote the adaptive capacity of indigenous people.	5	5	5	3	5	4	5	2	5	30.8	1
Action 3	Strengthen local administration's financial capacity to invest more in storm surge control and enable them to implement climate related projects	4	1	3	3	5	3	4	2	5	23.4	11
Action 4	Foster partnership among public and private stakeholders in the implementation of flooding and coastal adaptation policies and strategies.	4	1	5	4	4	4	4	4	5	27.8	6
Action 5	Consider project alternatives that can avoid significantly new development in areas that cannot be adequately protected from flooding or erosion due to climate change	3	1	4	3	2	2	2	2	2	17	12
Action 6	Strengthen the implementation of operative physical development plans. The State Government to scale up the code Lagos program and strengthen the State capacity for the collection, analysis and dissemination of data	5	5	4	5	4	4	4	2	4	29.4	4
Action 7	Develop computer-based, flood early warning systems and evacuation plans for the State and enhance the capacity of early warning systems and evacuation including the use of GIS and satellite imagery for coastal zone management.	5	4	5	5	4	4	4	3	4	30.4	2
Action 8	Intensify research to domesticate economically important freshwater fish species.	4	1	4	4	4	4	4	4	5	27	7
Action 9	Promote rural development in order to reduce rural-to-urban migration within Lagos Sate.	4	4	4	4	4	4	4	2	4	26.8	8
Action 10	Engage communities in the participatory planning of their settlements in order to reduce their vulnerability to climate change.	5	5	5	4	4	4	4	2	5	30	3
Action 11	Monitor the activities of businesses in the state to ensure that they are in line with the State's objectives for Climate Change adaptation.	5	5	3	4	3	3	2	3	4	25.6	9
Action 12	Develop and install up-to-date real-time weather monitoring systems for the state	5	4	4	4	4	3	3	4	5	28.8	5

Action 1:

Engage communities in the participatory planning of their settlements in order to reduce their vulnerability to climate change

The Ministry of the Environment is responsible for the implementation of this action. However, there are various other key stakeholders that need to be involved for this action to be a success including: Community Elders, local government and CDA/CDC.

This action will be financed by the State Government, development partners and NGOs. For the successful implementation of this action, the sub-action and steps to be taken was identified as the development of a vulnerability map for the rural communities. This action has been linked to other actions like the strengthening of local administration to make more climate related policies.

The indicators to the successful implementation of this action will be seen in the resilience of communities on climate change risks and the empowerment/increase in their knowledge of climate change risks. Beneficiaries of this action include the rural communities and the local government.

The key risks and barriers to the success of this action will be funding, community buy-in and political instability.

Action 2:

Enhance the capacity of local institutions, including Local Government, Extension workers, Farmers Association and Community Elders to promote the adaptive capacity of indigenous people.

The Ministry of Agriculture is responsible for the implementation of this action. However, there are various other key stakeholders that need to be involved for this action to be a success including:

- Community Leaders
- Farmers Association
- Co-operative groups
- NGOs
- Agro-Allied Companies

The current status is identified as active frontline extension workers and professionals in various field of the agricultural value chain.

This action will be expensive and so significant finance will be needed. The aim will be to source for funding from the Federal Government and the World Bank. For the successful implementation of this action, the sub-action and steps to be taken were identified as: capacity building and advocacy on smart agriculture. This action has been linked to other actions like the establishment of food product centres and the promotion of aquaculture.

The indicators to the successful implementation of this action will be seen as zero hunger and a sustainable healthy diet for citizenry. Beneficiaries of this action include the Government (increase the GDP), stakeholders in Agricultural value chain and the community.

The key risks and barriers to the success of this action will be funding, variability in climate conditions, storage and policy (change in Government).

Plate 4.6: Summary of actions on enhancing local institutions and indigenous people and engaging communities in participatory planning.

4.2: Summary of Prioritized Actions

The illustration below shows a list of actions for a cleaner, greener, healthier, stable and more prosperous Lagos in a changing climate.
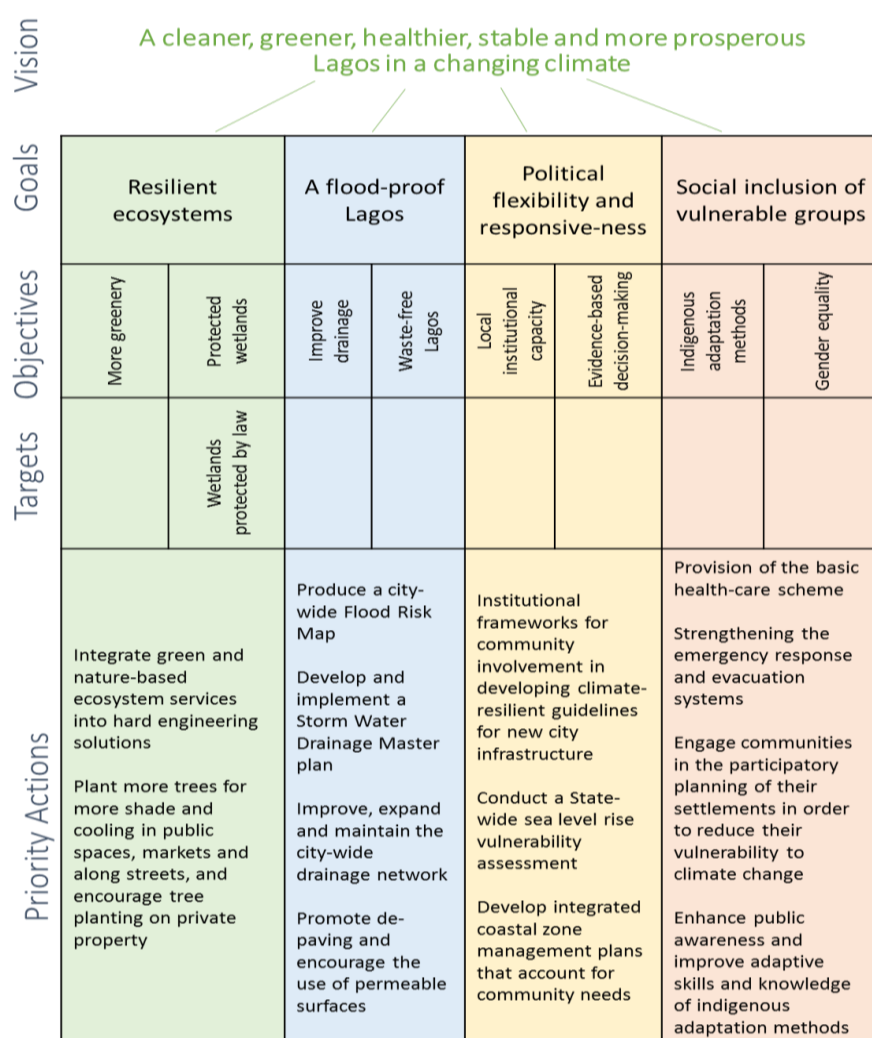
Figure 4.1: Summary of Prioritized Actions

4.3: Next steps

The implementation of these actions include: topographic surveys, Geographic Information System (GIS) mapping of the areas/local communities, hydrological models and Monitoring and Evaluation (M&E). Beneficiaries to this action will be the general public especially vulnerable communities and fragile ecosystems while the risk/barriers include finance, political will, technical capacity and social resistance.

The Climate Action Planning workshop was the third to be held in the city under the CAP Africa programme. C40 will continue to work with key city stakeholders to update the scenarios developed during the workshop with the aim of creating robust adaptation actions for the city.
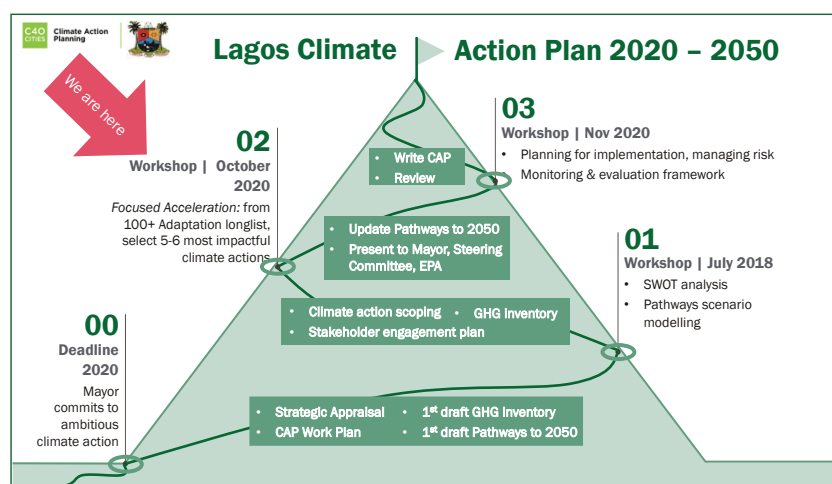
Figure 4.2: Lagos Climate Action Plan 2020-2050

The Lagos Climate Action Planning Workshop aimed to engage stakeholders in the CAP process and to use the local knowledge and experience of the attendees to better understand the opportunities and barriers to climate change actions, confirm and enhance the baseline and assumptions in the Pathways Tool, and develop adaptation scenarios for the city. The outcomes of the workshop will be used to refine the adaptation targets and the climate actions required to meet the objectives of the Paris Climate Agreement by Lagos through its commitment to Deadline 2020.

CHAPTER FIVE

Climate Hazard Assessment

5.1   Introduction

This section describes the overall findings from the climate hazards assessment of the CRA study for Lagos State.

5.2   Identified hazards

Climate hazards often experienced in Lagos State were identified from a combination of sources; the 3-day Capacity Building of Ad-Hoc-Staff/Training Workshop held from 19th to 21st August 2020, the one-day Stakeholders Meeting held on the 2nd September 2020 and field survey. All these were organized by Geo-Solutions Providers Limited on this project as well as from literature search. The hazards identified include:

1. Heat waves as a result of increase in maximum, average and minimum surface temperature;
2. Inland Flooding as a consequence of changes in precipitation (intensity-duration-frequency),
3. River flooding
4. Flash flooding
5. Erosion
6. Thunder Storm
7. Coastal and lagoon flooding (Sea level rise).
8. Tropical storms
9. Urban Heat Island

5.3 Lagos meteorological data analysis

Based on the meteorological data from NIMET on Lagos, the following periods were obtained;

1. Periods of drought in Lagos between 1990 and 2019 are (five driest years); indicating the year and amount of below average rainfall during the dry months;

- 2007 (-28.98mm)
- 2000 (-26.00mm)
- 1994 (-24.90mm)
- 2002 (-23.33mm)
- 2006 (-22.75mm)
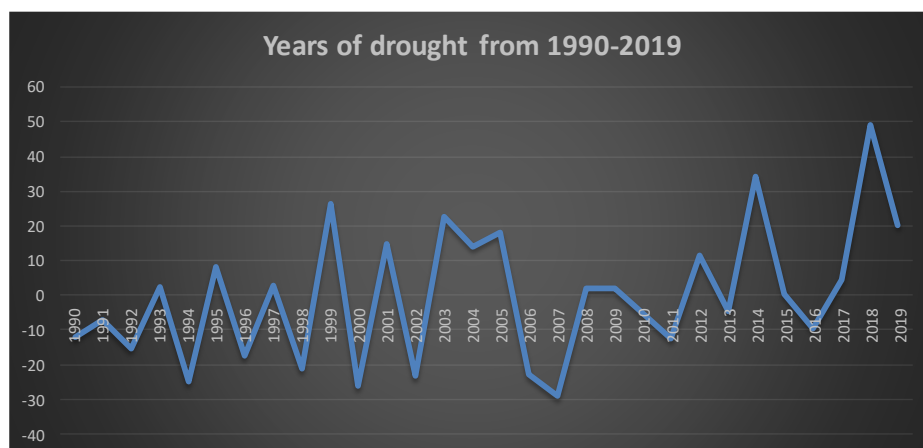
Figure 5.1: Trend of Drought from 1990-2019

2. Periods of Wettest years (heaviest rainfall) in Lagos between 1990 and 2019 are (5 wettest years); indicating the year and amount of above average rainfall during the wet months;

- 2010 (255.96mm)
- 2019 (339.76mm)
- 2004 (473.86mm)
- 1990 (543.96mm)
- 2011 (703.16mm)
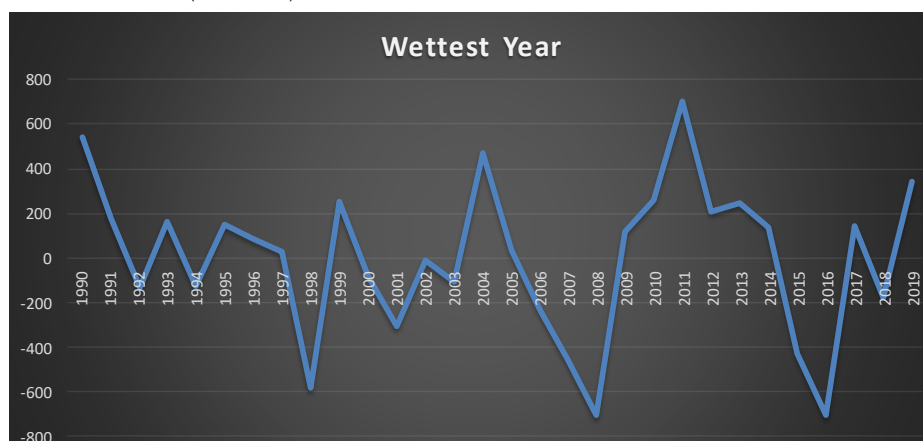
Figure 5.2: Total annual rainfall since 1990
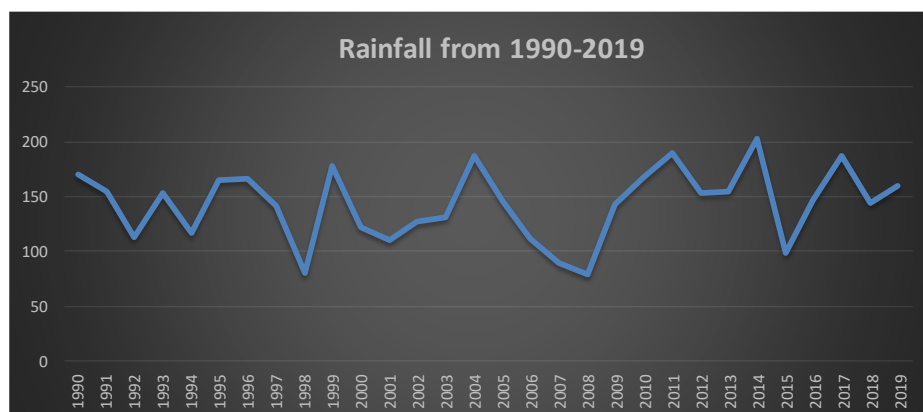
Figure 5.3: Rainfall (mm) in Lagos from 1990-2019
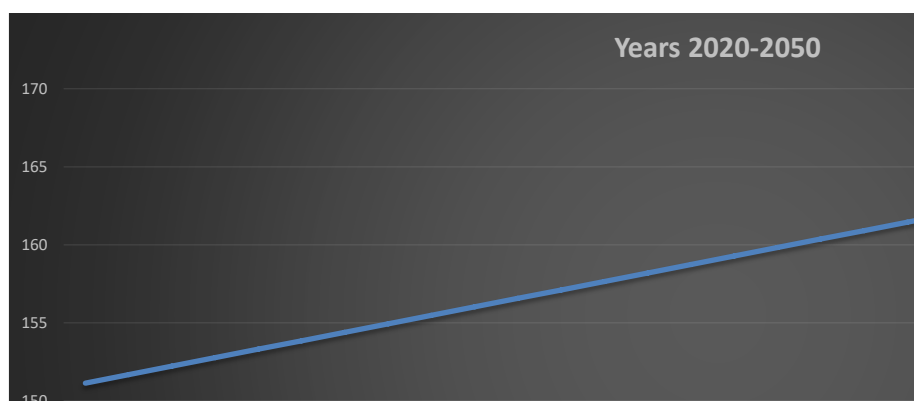
Figure 5.4: Average rainfall (mm) projection in Lagos from 2020-2050 using linear regression

RCP 2.6   RCP 4.5

RCP 6.0   RCP 8.5
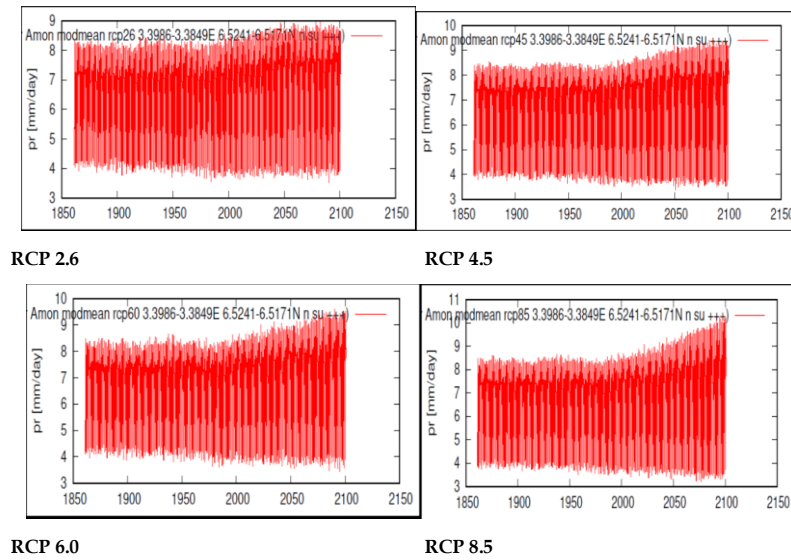
Figure 5.5: Rainfall projection with CMIP5 mean for RCPs 2.6, 4.5, 6.0 and 8.5.
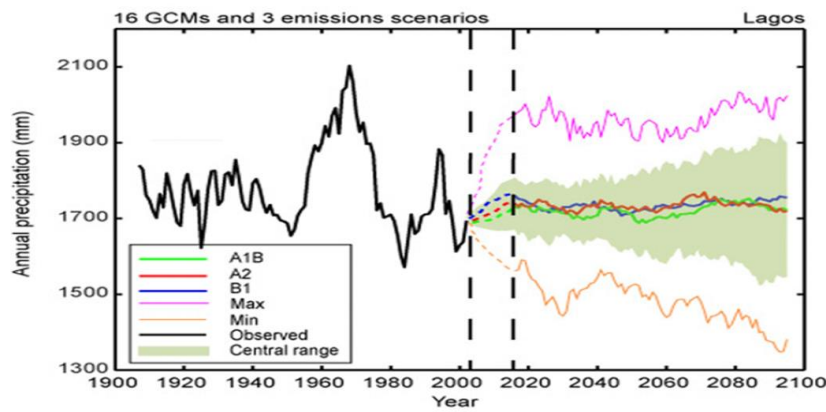
Figure 5.6: Projected Rainfall for Lagos with RCPs 2.6, 4.5, 6.0 and 8.5

3. Periods of hottest years (highest temperatures) in Lagos between 1990 and 2019 are (5 hottest years); indicating the year and above average temperature during the hottest months;

2014 (31.85^{0}C)

2018 (31.39^{0}C)

2015 (31.27^{0}C)

2017 (31.25^0C)
2019 (31.22^0C)
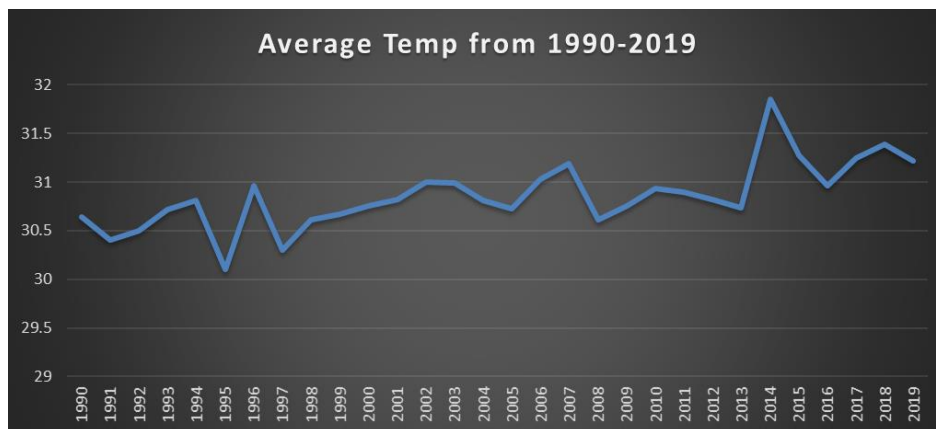
Figure 5.7: Average temperature (°C) in Lagos from 1990-2019
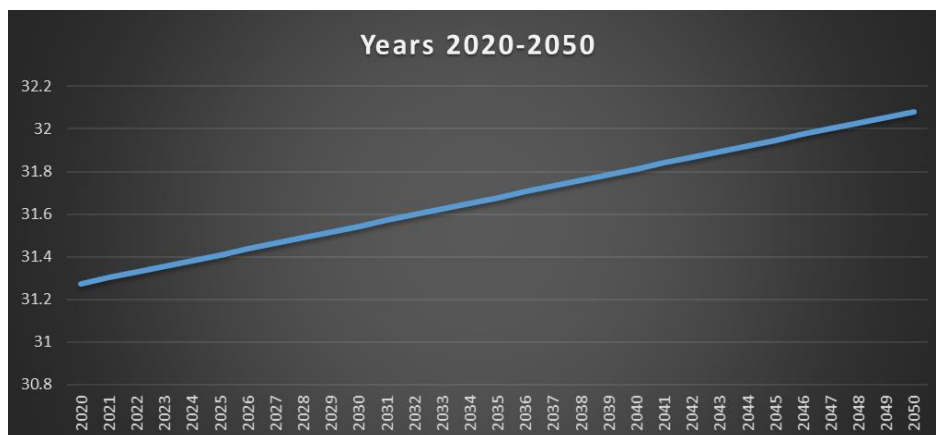
Figure 5.8: Average temperature (°C) projections in Lagos from 2020-2050 using linear regression

RCP 2.6   RCP 4.5

RCP 6.0   RCP 8.5
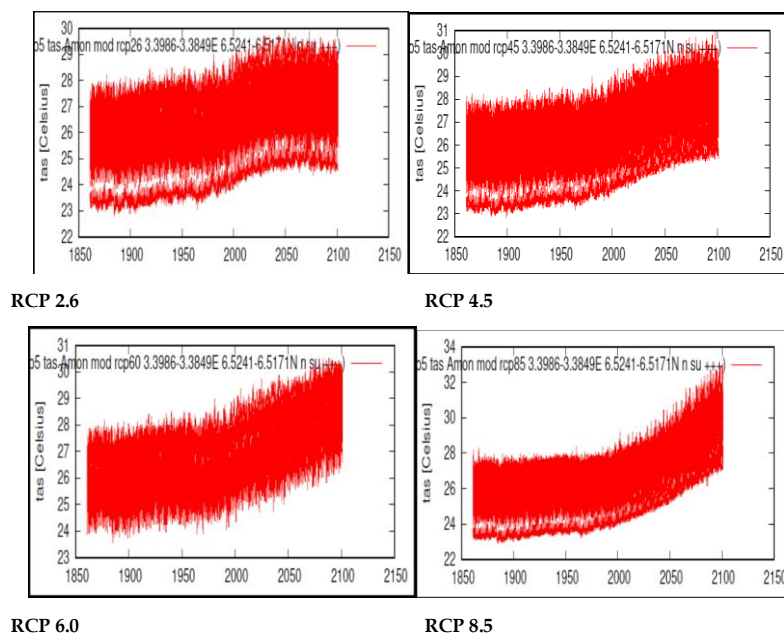
Figure 5.9: Temperature projection with CMIP5 mean for RCPs 2.6, 4.5, 6.0 and 8.5.
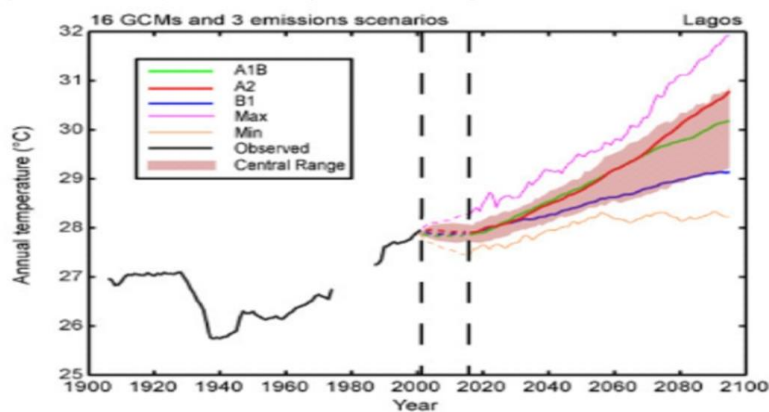
Figure 5.10: Projected Temperature rise for Lagos with RCPs 2.6, 4.5, 6.0 and 8.5

5.4 Current environmental quality in Lagos

Air

The current Air Quality Index in Lagos is 39.3μg/m³ with the particulate matter (PM) 2.5 being the major pollutant (IQAir, 2021). The World Bank (2018) study found that Lagosians are paying a very high price for air pollution inferred from estimates that air pollution is linkable to about 11,200 premature deaths in 2018. Underaged children. about five, are at a higher risk of respiratory infections were the most affected, with about 60% of deaths in 2018. An attempt to quantify these premature deaths in monetary terms, with respect to loss of productivity due to illnesses to the wider population of the city amounts to an estimate of up to $2.1 billion or 2.1% of the state's GDP.

The levels of PM concentration in the air is what poses a major health risk when they are high with an aerodynamic diameter of less than 2.5 micrometers. This size of PM easily passes through the lung through the alveoli to the bloodstream, possibly resulting in respiratory and cardiovascular diseases. This can obviously lead to premature death. The World Bank (2018) study asserts that the levels of PM concentration in Lagos is nearly seven times higher than the recommended limit by the World Health Organization.

Table 5.1: Worst ranked cities for air pollution globally (2018)

|		Annual mean concentration of particulate matter (μg/m³)
1	Delhi, India	143
2	Karachi, Pakistan	99
3	Cairo, Egypt	76
4	Beijing, China	73
5	Lagos, Nigeria	68
6	Mumbai, India	64
7	Dhaka, Bangladesh	57
8	Wuhan, China	57
9	Chongqing, China	54
10	Shanghai, China	45
11	WHO recommendation	10

Source: World Health Organization (2020)

On a global scale, exposure to ambient PM 2.5 caused 2.9 million premature deaths in 2017, or about 9 percent of total deaths in the world. In West Africa, it was responsible for about 80,000 premature deaths the same year. This challenge is particularly acute in Nigeria with the highest number of premature deaths traceable to ambient PM 2.5 in the region.

Road transport is the main source of ambient air pollution. Each day, 227 vehicles clog each kilometer of road. Most vehicles are over 15 years old, using old emission technologies and fuel with high sulfur levels: 200 times higher than U.S. standards for diesel. Industrial emissions are the second source of air pollution. Industrial and commercial zones like Apapa, Idumota, Ikeja and Odogunyan, where cement, chemicals, furniture, refinery, steel industries are concentrated, have

high levels of pollution. In Odogunyan, a PM2.5 concentration of 1 770 µg/m³ was recorded in a period of 24h.

Electricity generating sets supply half of Lagos' total energy demand and are the third source of air pollution. The poor combustion of the gasoline and oil used to operate the generators pollutes the air and causes huge health damage.

Water

The Lagos State Resilience Strategy (2020) reported that 33% of Lagosian have access to pipe-borne water. Lagos supplies just 210 million litres per day, against a requirement for 794 million Liters per day. Water bodies and wetlands cover over 40% of the total land area of Lagos and an additional 12% is subject to seasonal flooding. Lagos has a landmass of approximately 3,577sq km, of which water bodies constitute 22%.

The United Nations in its 2020 report highlighted the lack of clean water and unsanitary conditions as major hindrances to socio-economic development. Lagos Water Corporation covers only 35% of the population of metropolitan Lagos. The corporation is currently facing a water demand of 540 million gallons per day (MGD) but only supplies 210 MGD through 3 major waterworks, 17 mini waterworks, and 31 micro waterworks. While the major waterworks rely on the Ogun and Owo rivers for supply, the others use groundwater pumped from boreholes on site. Excluding unaccountable water losses, this leaves a deficit of 330 MGD (a gap of around 60%).

Over the years, the Lagos State Government has invested heavily in the water sector, focusing on expanding water supply facilities, transmission and distribution systems, rehabilitation of existing facilities and infrastructure, improved administrative infrastructure and institutional support, in addition to improving solid waste management and wastewater management. Part of the State Government's long-term plan is also to encourage private sector participation in the water sector. The initiatives for this are built on existing structures which subsumes the 20 LGAs and the 57 LCDAs,as table 1.5 provides an analysis of public access to water in all theLCDAs in the state, through the bore-hole. This technique incorporates a community-based approach to public access to water, as well as a focus on alternative, inclusive mechanisms for funding public water supply in Lagos.

Biodiversity

According to the Lagos State Government, the biodiversity of the state is being threatened by rapid urbanisation and other factors.

The distribution of mangrove around the Lagos Lagoon attests to the brackish nature of the Lagoon waters and possibly symptomatic of the extent of marine intrusion from the Atlantic Ocean. Conversely its absence around the Lekki lagoon is indicative that the Lagoon is of fresh water. The remnants of mangrove and swamps along Omu creek in Eti osa and Ibeju-Lekki L.G. A. (north of Lekki-Epe expressway) are currently under stress from residential development accelerating in the area. At the Local council level, the surviving mangroves are found in Ikorodu, Etiosa, Kosofe, and

Epe LGA's all on the Lagos Lagoon. Likewise, the remaining swamp wetlands are in order of magnitude also largely in four local councils.

Idiege, Akise, Amadi & Uruku. (2017) stated that mangroves in Lagos decreased by about 77% (from 88.51 to 19.92 km²) at 3.12 km²/yr. deficit while swamps decreased by 52% (from 344.74 to 165.37 km²) at a loss of 8.15 km2/yr. both between 1990 and 2000. They further stated that the mangroves which were widespread in 7 (seven) LGA's in 1990 have dwindled to only four (4) LGAs in 2000 with about 4km² and above. Epe, Etiosa, Ikorodu and Kosofe in that order were the councils with the largest area of mangroves in 1990 of 24.76; 22.65; 19.43 and 17.94 km², respectively.

Similarly, swamps which had sizable presence in five L.G.As. in 1990 had whittled to four councils with about half of their sizes converted in 2000. The relative loss of wetlands (mangrove and swamps) and gains by succeeding land cover mainly bare land and built (Idiege, Akise, Amadi & Uruku 2017).

5.5 Resource Management in Lagos

Resource management requires the maintenance of the integrity of the natural ecosystem. How the resources of Lagos have been managed for environmental quality of life for both present and future generations is essential. Lagos in the 1960s was very aesthetically appealing free from noise or air pollution, secured and with a high tourist value. It was a City with green spaces of Gardens, Race courses, Parks, Cricket grounds and generally famous for its hosting of series of Local and National Flower Competitions. All of these were swallowed by the ardent of the oil boom in the 70's as the state began to experience construction frenzy springing here and there all across the state especially in the city. The construction of highways, flyovers and bridges with weak enforcement of planning regulations and environmental consideration (Anibaba, 2015). Today the city is gradually gaining the aesthetic appeal of the past through improved planning, environmental quality regulations and tree planting.

Tree Planting
Tree planting has been an aggressive and recurrent resource management method deployed by successive governments in Lagos state, involving transplanting seedlings generally for land reclamation, landscaping, carbon sequestration and beautification. Trees eliminate carbon dioxide from the air as they grow through the process of photosynthesis thus purifying the air and at the same time mitigating the consequences of climate change.
The cost of biological mitigation is low compared to many other alternative measures. Anibaba (2015) identified trees planted by state governments of Lagos state since 2008 to include the underlisted.

Open Spaces and Parks:
    [i]   Ashoka Hands up
    [ii]   Ashoka Hands down
    [iii]   Ficus benjamina

[iv]   Bauhinia tomentosa.
Schools:
      [i]   Teak
      [ii]   Terminalia superba
      [iii]   Eucalyptus
      [iv]   Gmelina
      [v]   Sesbania
Residential Streets:
      [i]   Ashoka Hands up
      [ii]   Ashoka hands down
      [iii]   Pride of Barbados
      [iv]   Palms
      [v]   Lagerstroemia
      [vi]   Sesbasania
      [vii]   Bauhinia tomentosa
      [viii] Cassia nemophila
      [ix]   Hibiscus tree
      [x]   Sesbania
      [xi]   Thevetia
Public Walkways:
      [i]   Ashoka Hands up
      [ii]   Palms
      [iii]   Lipia
      [iv]   Lagerstroemia speciosa
      [v]   Nerium oleander
Boulevards:
      [i]   Step tree
      [ii]   Ashoka
      [iii]   Eucalyptus
      [iv]   Neem
      [v]   Palms
      [vi]   Flame of the forest
Medians:
      [i]   Ficus tree
      [ii]   Palms
      [iii]   Eucalyptus
Traffic Islands:
      [i]   Terminalia
      [[ii]   Ashoka

Waste Management in Lagos
Lagos ranks as one of the largest producers of solid waste in Africa generated by the most populated coastal city. Solid waste management is an issue in Lagos state traceable to population explosion,

negative attitude to waste disposal method by the citizenry, inadequate facilities by the responsible actors and some other factors. The responsibility of waste management in the state lies squarely on the shoulders of the Lagos State Waste Management Authority (LAWMA) as well as the PSP partners with a focus to achieve an efficient waste management (LAWMA 2020) in the entire state. It is on record that as at 2014 about 13,000 tonnes of waste were generated daily in Lagos and when extrapolated to the year 2020, this gives over 20,000 tonnes of waste generated daily (Adenaike & Omotosho 2020).

Waste Collection and Disposal

In executing her responsibilities, LAWMA ensures that solid waste is collected from all the LCDAs/CDAs in the state and transported to the various disposal facilities for final disposal at the designated dumpsites. The disposal sites are properly managed for environmental management and ensure that their operation does not have any significant negative impact on the environment especially in terms of soil and groundwater contamination. The major waste dumpsites in the state include:

- Olusosun Dumpsite; situated at the northern part of Lagos within Ikeja local government and receives approximately 40% of the total waste deposit in Lagos. It has a size of about 42.7 hectares in size and has been operational since November 1992.
- Solus 2 and 3 dumpsites are located along Lasu –Isheri road. Solus 2 about is 7.8 hectares while Solus 3 is about 5 hectares. Each site receives an average of about 2,250m^3 of waste per day. These dumpsites have been operational since 2006 and 2009 respectively.
- Temu dumpsite; located in Temu, Epe and has been in use since February 2009.
- Ewu elepe dumpsite, situated in Ewu elepe off Ijede road, Ikorodu is about 8 hectares. The dumpsite has been in operation since November 2008
- Simpson this is located in the Simpson area of Lagos island and it serve as temporary disposal site for waste collected in the Lagos island Lagos mainland/Victoria island axis of Lagos
- Agege TLS: started along Oba Ogunji road collecting waste from Agege, Ipaja/ Ikeja and axes of the state.
- Oshodi TLS: is located in the heart of Oshodi along the Apapa-Oshodi expressway. The station services Oshodi, Apapa, mile 12 axes of Lagos.

Deforestation in Lagos

Over the years, Lagos has lost 96% of its forest due to deforestation. Among the hardest hit indigenous tree species lost to deforestation in Lagos state is mangrove. A "Tree cover threshold" is the term used for defining the tree cover area. For example, 75% includes only areas with about 75% tree cover, whereas 10% includes all areas with about 10% tree cover. 75% tree cover reflects a dense canopy.

Table 5.2: Tree cover data for Lagos State (This data is based on a definition of 30% tree cover. Areas with less than 30% canopy cover are excluded).

Area	Total area (ha)	Tree cover Extent in 2000 (ha)	Tree cover Extent in 2010 (ha)	Tree cover Extent in 2018 (ha)	% cover in 2018	Loss 2001-2018 (ha)	% loss since 2000	Avg loss/year since 2000 (ha)	Loss 2001-2010 (ha)	loss between 2000-2010	Avg loss/year 2001-2010 (ha)	Loss 2011-2018 (ha)	loss from 2011-2018	Avg loss/year 2011-2018 (ha)
Lagos	380570	69746	116791	109068	29%	9983	14%	555	2260	3%	226	7723	7%	965

Ha: hectares

Table 5.3: Carbon dioxide emission data for Lagos. (This data is based on a definition of 30% tree cover. Areas with less than 30% canopy cover are excluded)

Area	Total area (ha)	Tree cover Extent in 2000 (ha)	Tree cover Extent in 2010 (ha)	Carbon biomass (Mt)	Carbon emissions 2001-18 (Mt)	Avg carbon emissions/year 2001-18 (Mt)	Avg carbon emissions/year 2001-10 (Mt)	Avg carbon emissions/year 2011-18 (Mt)
Lagos	380570	69746	116791	15660571	2220952	123386	53011	211356

Ha: hectares

Table 5.4: Biomass data for Lagos (This data is based on a definition of 30% tree cover. Areas with less than 30% canopy cover are excluded)

Area	Total area (ha)	Tree cover Extent in 2000 (ha)	Tree cover Extent in 2010 (ha)	Carbon biomass (Mt)	Avg biomass per ha (Mt)	Carbon emissions 2001-18 (Mt)	Avg annual emissions 2001-18 (Mt)	Avg annual emissions 2001-10 (Mt)	Avg annual emissions 2011-18 (Mt)
Lagos	380570	69746	116791	8542131	123	1211435	67302	28916	115285

Ha: hectares

Table 5.5: Forest cover in Lagos

Area	Total forest area		Dense forest area		Forest gain		Forest loss		Total land area
	>10% tree cover (ha)	% total land cover	>50% tree cover (ha)	% total land cover	2001-2012 (ha)	% total forest cover	2001-2012 (ha)	% total forest cover	(ha)
Lagos	232828	75.6%	10721	3.5%	365	0.2%	7951	3.4%	308003

Ha: hectares

Like every other citiy in the developing world, Lagos is confronted with enormous environmental challenges some of which are pollution (air, noise and water), indiscriminate waste disposal and loss of biodiversity as a result of uncontrolled urbanization.

The over-reliance on land as the major means of transportation is responsible for the avalanche of emissions particularly in the urban centres across the state. Therefore there is the urgent need to fully maximize other modes of transportation (rail, water and cable car) to mitigate trends of emission of pollutants as a result of vehicular transportation.Though the Lagos rail and the ferry transport projects are on-course, the timely completion of this project together with expansion to other heavy transport corridors like Lekki, Ikorodu roads would tremendously support the state in ensuring a more efficient transport system.

Uncontrolled urbanization and timber lumbering are the major threats of biodiversity in Lagos state, available vegetation consists mostly of secondary freshwater swamps regrowth in fallow, undeveloped plots of land, roadsides and ornamental plants in buildings and other public parks. Though the occurrence of wildlife species within metropolitan Lagos are limited to mostly avian (bird) species, a few reptiles such as lizards, crocodiles and monitor lizards while rodents are found mostly in waste bins and failed drainages. However, despite their occurrence in the environment, such rodents have the capability to spread diseases such as lassa fever when in contact with food. However, it is important to note that the availability of very little fauna is primarily due to the competing demand for housing and infrastructure across the state.

Like the air, the Lagos surface water systems cannot be exonerated from the threats of pollution either from industrial activities or indiscriminate dumping of waste particularly during the rainy season. Although concerted efforts have been initiated by the government through relevant MDAs toward monitoring industrial activities and unwholesome dumping of waste in drains, it is however pertinent to commend the efforts of the state at promoting resource utilization through recycling of solid wastes across the state. The judicious utilization of natural resources is the only guarantee for environmental sustainability. Therefore, exploitation and utilization of natural resources must take into cognizance the need of the present and future generation.

The demand of the government for sound environmental practices amongst corporate organizations and citizens remains a sure step toward the environmental sustainability of the state being a coastal environment. Though dredging (commercial and artisanal) activities are carried out in the state especially along the Badagry, Ajah and Ikorodu axis, it is however necessary to audit the activities of these sand miners in order to avert possible future debilitating consequences. More importantly, the need to complement the efforts of the LASPARK by implementing a statewide afforestation programme particularly in the rural areas of Epe, Ikorodu, Lekki and Badagry LGAs.

5.6 Adaptive actions identified by respondents from the climate change community survey.

Flooding
- Pump our water
- Clear drainage
- Stay at home
- Relocate
- Sandbags
- Sand filling

- Raise valuable things
- Raise pavements
- Use Rain boots
- Do nothing

Extreme temperature
- Cooling system
- Sit Outside
- Use Umbrella
- Bath Regularly
- Sleep Outside
- Go for a walk
- Proper ventilation
- Wear light clothing

5.7 Comparing Previous Studies with Updated Study

The world Earth.org(2021) predicted that by the year 2100 major parts of south western Lagos would be inundated by sea water. They also predicted that the inundation of sea water will cover major land use resources and urban infrastructure. The conclusion was similar to the conclusion of Fabiyi (2018) when coastal subsidence was noticed in some parts of Lagos coast. The subsidence was based on the analysis of two radar data on the 853 kilometer stretch in Nigeria.

Gilau, Najjar and Dayo (2010) also analyzed sea level rise in Lagos state. Using Digital Elevation models for potentially exposed areas they projected the sea level rise in Lagos to the year 2100 and concluded that the Badagry and Epe local Government areas will be inundated by the year 2100. They also computed that 28% of the entire Lagos state will be inundated by the year 2100, While the www.Earth.org predicted that 32% of land area in Lagos state will be inundated. This report with a more spatiality specific method shows the different parts of Lagos state that will be severely impacted, moderately impacted and least impacted by the year 2030, 2050 and 2070. The report used two dated digital elevation models with flood prediction modeling in the HECRAS software to predict the sea level rise and the river channel inundation. The analysis predicted generally are indicated in table 5.6.

The inundation will cover significant land use resources and urban infrastructure. The projection shows that the major extreme weather condition in Lagos will be intrusion of sea water and coastal subsidence coupled with sea level rise. This position was corroborated by Fabiyi (2018), where coastal subsidence in Nigerian areas were identified from two dates radar data. Though the study was carried out in the entire 853 kilometers coastline of Nigeria, specifically coastal subsidence was identified mostly in the Lekki section of Lagos state and the transgressive mud beaches of Ondo state in the western coast of Nigeria (See Fig 3.2.) Adelekan (2015) also identified the contribution of coastal subsidence to ocean flood in Lagos state.

Table 5.6: Previous predictions on Sea Level Rise

LGAS	Total Area in Km²	Severely Impacted in Km²	Moderately Impacted in Km²	Least Impacted in Km²	No visible Impact in Km²
Ifako/Ijaye	21.586638	1.08	2.16	5.40	12.95
Ikeja	74.505557	14.90	14.90	11.18	26.08
Alimosho	77.092220	3.85	3.85	23.13	46.26
Ikorodu	515.657917	128.91	103.13	77.35	206.26
Epe	1300.070314	325.02	195.01	260.01	520.03
Agege	15.879690	0.79	2.38	3.97	8.73
Kosofe	37.100292	7.42	5.57	12.99	11.13
Oshodi-Isolo	29.739927	1.49	5.95	7.43	14.87
Somolu	18.328314	1.83	3.67	6.41	6.41
Mushin	10.410956	1.56	2.60	2.60	3.64
Ibeji-Lekki	532.270805	79.84	133.07	159.68	159.68
Lagos-Mainland	18.486326	2.77	3.70	5.55	6.47
Surulere	28.519526	1.43	4.28	8.56	11.41
Amuwo-Odofin	118.168736	11.82	47.27	23.63	35.45
Eti-Osa	220.364875	99.16	55.09	22.04	44.07
Ojoo	273.346148	95.67	41.00	82.00	54.67
Badagry	420.523746	63.08	42.05	168.21	147.18
Lagos Island	16.062526	2.41	3.21	4.02	6.43
Apapa	41.995505	10.50	6.30	12.60	12.60
Ajeromi/Ifelodun	11.870787	1.78	0.59	3.56	5.94
Total	**3781.980805**	**855.32**	**675.78**	**900.31**	**1340.26**

Table 5.6 shows the total area projected to be severely impacted by sea level rise as a result of coastal subsidence in 2050 based on the analysis of 2 dates Digital Elevation data (2005 and 2010) of Lagos state to compute coastal subsidence. The estimated subsidence was projected into the year 2050. The area is estimated to be 855.32 Square Kilometer. The area are likely to be submerged by lagoon or the ocean as a result of submergence of the previously elevated area The areas that will be moderately impacted by the coastal subsidence and sea level rise which mean seasonal overflow is 675.78 Square Kilometer while areas that will be least impacted or no impact at all by the year 2050 was estimated to be 900.31 Square Kilometers.

The Local Government areas that will be mostly affected by coastal subsidence and subsequent ocean surges in the year 2050 are Epe; 325.02 km², Ikorodu 128.91 km², Ojo 95.67 km² Ibeju Lekki 99.16 km², Eti Osa 99.16 km². The projected analysis shows that the Identified Local Government areas need to take extra precaution to prevent future ocean surges and coastal flooding that will continue to increase progressively in the near and distant future. Such measures should include shore protection project along the beaches that are noted to be subjected to subsidence and possible sea level rise.
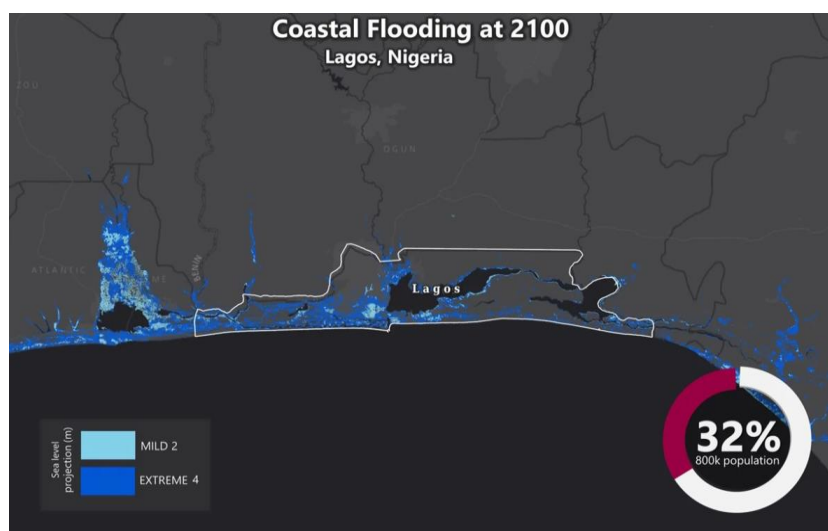
Figure 5.11: Sea Level Rise projection by 2100

Sea level rise projections for Lagos by 2100 for two scenarios with the amount of rise in meters indicated (mild = 2m; extreme = 4m). Population displacement indicated bottom right.

5.8 Priority risks identified based on level of exposure, sensitivity, interdependencies and vulnerability

The main priority risk identified in Lagos state is flood risk and coastal subsidence which are interdependent on each other. The increased coastal subsidence will inadvertently increase the total area inundated and that will be susceptible to inundations. This report also projected terrain changes in 2030, 2050 and 2070 and noted unequal subsidence along the coastal local governments. These subsidence are noted in Etiosa, Ibeju Lekki and Amuwo Odofin. The projected subsidence in Badagry local Government was the least affected for 2030, 2050 and 2070.

The implications of the projection is that the resources in the three Local Government areas are more at risk to ocean surges than other parts of the coastal area. This may not be unconnected with the bearing capacity of the soil formation.

Another area of priority identified during the study is the heat waves. Urban heat island in Lagos keeps expanding and the temperature has been on the increase over the years. It is projected that the average outdoor temperature will increase to 42^0C in 2030, 44^0C in 2050 and hover around 46^0C in 2070. Spatial variation in the urban heat island was also noticed over the years. The local Government with projected extreme temperature include Lagos Island, Lagos Mainland, Agege, Kosofe and Oshodi-isolo Local Government areas.

The level of exposure to the hazard causing event indicates the level of vulnerability. For instance ocean surges are common along the coastline while the heat island is more prominent in the industrial zones of the state. The coastal subsidence which was noticed to be on the average of 0.5 meters in ten years shows grave implication for the future of Lagos State.

CHAPTER SIX

Discussion and Recommendations

6.1   Introduction

This chapter describes the overall findings and recommendations of the Climate Risk Assessment (CRA) study for Lagos State.

6.2   Climate Risk Assessment for Lagos State

Developing a holistic state-wide resilient strategy portends the sustainable strategy in order to strengthen the Lagos State Climate Action Plan (CAP). In view of this, a state-wide Climate Risk Assessment (CRA) study was crucial to afford the State the opportunity to achieve more resilient systems. This project made this a reality for Lagos state as outlined in the findings discussed in this report and recommendations made.

6.3 Inter-Dependencies and Influence Beyond 2050

Ecosystem depletion implication on other hazards

Most of the identified hazards in Lagos are interdependent, when there is increase in urban built up areas, there will be decrease in the delivery of the ecosystem services, which will continue to increase in the next few years in Lagos. This assertion was articulated in the land use change analyses of this report. The increase in hard landscape and displacement of soft landscape to make way for urbanization will increase the run-off and encourage the persistence of storm water on the surface after heavy downpour. The changes in topography as a result of coastal subsidence and the drilling activities in Lagos will further increase the potential for flooding in different parts of the city. The rate of ecosystem depletion due to increased urbanization is also a major contributor to the increase in water run-off and gross reduction in the infiltration capacity of the soil to allow storm water to percolate. The increase in run off will further accentuate the gully erosion in all vulnerable areas in Lagos state.

Increasing rainfall and implications on hazards

The trend in rainfall projected from 2020 to 2050 showed a slight increase in rainfall amount on a continuous basis over the years. The trend will continue to increase beyond 2050 and this has implications in the increasing flood disaster in all the vulnerable areas. The implications of increase in rainfall are the increasing occurrence of flooding and erosion (sheet erosion and gully erosion). The steady increase in rainfall before and after the year 2050 will propel the rate of flooding in all areas that are susceptible to flooding. On the other hand, the increasing rate of flood incidence will inevitably displace some ecosystem and replace other ecosystems. This will be the dynamics of the ecosystem services in Lagos especially post 2050.

Increasing flooding events will also increase the incidences of water borne diseases in most vulnerable parts of Lagos. More population will report incidence of waterborne diseases from the increasing rate of flooding in Lagos as predicted by the RCP 6.5 and 8.5 in line with land use change projections shown in figures 3.9, 3.10 and 3.11. Specific vulnerable areas in Lagos that will be

adversely impacted include Epe, Ikorodu, Ojo, Ibeju Lekki, Eti Osa Badagry and some parts of Kosofe.

Coastal subsidence and implications on other hazards

The coastal local Government areas are in constant threat of subsidence, a consequence of the cumulative effects of drilling activities and the sea level rise. The implication of the observed and projected coastal subsidence in Lagos is that there will be more water on land areas for up to four months during the year. This will result in an increase in the total wetland area in Lagos state. In the distant future beyond 2050, it is estimated that about 1,319 buildings within three Coastal Local Government areas will show signs of unequal settlements and structural failure in the form of cracks and sinking. Most of the current hydraulic infrastructure will be inadequate to contain excess storm water for Lagos state. Some notable inadequate hydraulic structures in the project areas are either inadequate to contain the expected future storm water or have structural limitations for the capacity required in the future. Though the current study is not to test the integrity of hydraulic structures the study team however noted some areas with significant inadequate and defective hydraulic structures. Some examples can be found in Ajegule, Festac and Obalende, Oyingbo and Amuwo Odofin

Specifically, many box culverts and ring culverts found in the residential areas of Ajegunle were found to be inadequate to contain future run –off, examples can be found along Ashanti Close, and Oduola Road Burma road, Forcadoes Road, Hinderer Road and Oranyan road. The drainage channels found in these areas are also narrow or encroached upon by developers. The embankment on the Lagoon in these areas are also undergoing structural defects which will compromise their integrity and the capacity to contain excess water during rain storms in the future. Other examples could be found at Amuwo Odofin area along Folarin Avenue, Abiloye Street and Abule Osun road among others. This will have economic implications as most high-rise buildings currently located in the vulnerable areas will show signs of structural defects beyond the year 2050, even with the most sophisticated structural fortifications will not be able to tame the effects of coastal subsidence and the sea level rise in the identified areas. Some of the buildings in these zones are already showing signs of unequal settlement which include cracks and sinking, while a few others have been abandoned by the residents.

A critical analysis of the past and present disasters and a projection into 2030, 2050 and 2070 in Lagos generally and each local Government specifically showed that the impacts can be very diverse in nature and the approaches to mitigate the effects of the disaster can be diverse also. The spatial scale of the disasters will definitely depend on the time scale. The magnitudes of the economic impact of the disasters in Lagos depend on the management strategies adopted by the stakeholders to mitigate the effects of disasters. Currently there are several measures being undertaken by the public and the private sector to mitigate the effects of climatic hazards identified in Lagos state and most of those identified by the stakeholder have been presented in chapter five of the report, in this section we recommend specific interventions to reduce the effects of climatic hazards on the general populace.

6.4 Reduction and Mitigation of the Impacts of Hazard Risks

Migration/ evacuation of people from vulnerable zones

This is one of the best alternatives if there is adequate land area to resettle the affected persons in Lagos. But land area is constrained in Lagos. The vulnerable zone could be converted to recreational areas and the people currently living in these vulnerable areas be evacuated to relief camps.

Institute early warning system in the flood zones

It is essential to note that some persons irrespective of their negative experiences will still choose to continue to live in the vulnerable areas. Thus, it is necessary to institute a system to warn people in the vulnerable areas before the flooding occurs. The installation of early warning systems in the flood zones in Lagos will help to improve the response and preparedness to flood disasters. A good early warning system will save cost and enable people living in the vulnerable area to relocate before disaster occurs. Mobile information and communication technology is being used to prepare for and respond to flooding in many developed countries. All the people living in the vulnerable areas could receive Short Message Services (SMS).

Reducing Risk

One other method of reducing hazard is to reduce risk for the people of Lagos State. The approaches to reducing risk include engineering/structural solutions and nonstructural solutions. The structural solutions include building resilient hydraulic infrastructure to contain excess storm water. Resilient infrastructure is desired to be resistant to a range of impact and able to function effectively during extreme events. Redundancy must also be built into assets and the service it provides. It is important that the resilient infrastructure must provide a safe operating space for the infrastructure to withstand the impacts of extreme events.

Building flood resilient infrastructure

Building resilient hydraulic infrastructure is very expensive and it is beyond the capacity of the state government alone. To accommodate such a project, it is necessary to approach development partners to assist in developing robust resilient flood resistant infrastructure in Lagos state. Building resilient infrastructure requires robust risk forecasts, understanding of the likely future magnitude and the types of required infrastructure necessary to contain the impacts of the hazards. The private sector has a role to play in developing robust hydraulic infrastructure to stem the rate of flooding and the impact of flood disasters in Lagos state. The private sector would require incentive from the Government in order to invest in hydraulic infrastructure in Lagos.

6.5   Recommendations

Considering the enormous investments in the State and coupled with the threats of climate change on the ecosystem of Lagos State, the following recommendations are hereby made in order to enable the State achieves its desired goal.

1   Implementation of action plan as contained in the Lagos State CAP.

2   There is the need for the State government to carry out a Post Impact Assessment (PIA) of the Eko Atlantic City project (construction and sand dredging activities) in order to provide the platform for first hand impact assessment of the project activities particularly on the Lekki corridor.

3   To urgently initiate a task force specifically to salvage the alarming encroachment of the Atlantic Ocean on the Alfa Beach and its environment.

4   To implement an integrated state-wide drainage desilting/clearing programme through citizen participation approach (where necessary).

5   Carry out the dredging of the Ogun and Majidun rivers and also provide the required embankment for the protection of lives and property of adjourning estates and settlements.

6   An urgent action plan is required to save the Gede gede Tapa and Oniyameta communities from the potential over-flooding of the canal that has been narrowed deliberately and the development of a private estate (by DPKAY Homes & Property).

7   Ensure the procurement and installation of recommended IT/geo-spatial infrastructure (as contained in the inception report of the study) required to house the databank of the CRA project for update and further usage.

8   Ensure periodic training of the user department for proficiency and operational efficiency.

9   The government needs to embark on an enlightenment campaign in order to create awareness of the implications of exposing their assets in harm's way to the climate risks. Structural solutions in the form of a comprehensive drainage master plan should be followed with a phased implementation strategy to stabilize the coastal zones. Stabilization of the coastal areas will tame the coastal subsidence and will further enhance urban resilience to coastal flooding.

10   Urban Heat Island is caused by a number of factors which include global warming but it is substantially aggravated by the replacement of soft landscape by hard landscape. The process of industrialization and urbanization in Lagos state resulted in replacement of trees, shrubs, grasses (soft landscape) with brick, mortal and steel (hard landscape). This process results in creating and aggravating pockets of heat islands and heat waves in Lagos state. The short and medium terms measures to curtail the effects of the Urban Heat Island is to consciously plant trees that will absorb the effect of the heat and moderate the local temperature. Another vital method in tackling urban heat Island is to reduce the amount of hard landscape in private, government and business buildings facilities as well as on walkways on roads sides.

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Appendix 1

Community Survey Instrument

Dear Sir/Ma,

We specially appreciate you very much for supporting this climate change community survey for house hold and facility occupants. Thank you very much for your support.

Section A: Background information

1. Are you the Head of HouseHold? Yes ❑   No ❑
2. Age: Less than 18yrs ❑ 18-29yrs ❑ 30-40yrs ❑ 41-50yrs ❑ 51-60yrs ❑ 61-70yrs ❑ Above 70yrs
3. Gender: Female ❑   Male ❑
4. Length of time in this house: Year………… Months………………
5. Are you a tenant or owner? Tenant ❑   Owner ❑
6. To understand the size of your HouseHold. How many people slept here last night or night within the week? No. of male persons ……. No. of female persons …….. No. of male under 15…… No. of female under 15…… No. of male over 65…… No. of female over 65…….
7. For everyone counted above, kindly estimate the total monthly income.❑< N18,000 ❑ N18,001.00 – N25,000.00 ❑ N25,001.00 – N50,000.00 ❑ N50,001.00 – N100,000.00 ❑ N100,001.00 – N250,000.00 ❑N250,001.00–N500,000.00 ❑ N500,001.00 – Above
8. In your HouseHold, how many people work and earn a living. No. of persons working ……. No. of persons working (under age 15)…….. No. of persons working (age 15 to 65) No. of persons working (age over 65)
9. In your HouseHold, how many people do not work at all, include children?
10. What is the main source of income in your HouseHold? (If more, please tick maximum of 3 sources.)
    ❑ Agriculture   ❑ Petty trading   ❑ Street food (preparation/vending)❑Small-business ❑Large business ❑ Skilled-labor ❑ Unskilled/casual labor ❑ Clerical/professional ❑ Social welfare ❑ Financial ❑ None ❑ Other
11. How many individuals are permanently ill (e.g., disabled) in your HouseHold?   _____
12. Please tell me how strongly you agree or disagree with the following statement: People in our HouseHold frequently go to bed hungry because food is expensive" ❑   very strong ❑ strong ❑   disagree ❑ strong disagree ❑   no response
13. Highest educational attained (Respondent) ❑ Primary Education ❑ Secondary Education/Technical colleges ❑ ND/College of education ❑ University degree (Bachelor) ❑ University degree (Master) ❑ University degree (PhD) ❑ None

2. Personal view regarding the HouseHold: Rank from 0 as very bad to 10 as very good

S/N	Statement	1	2	3	4	5	6	7	8	9	10
2.1	The health status of your HH.										
2.2	Your satisfaction with the quality of your housing (fresh water, sanitation, room size, other facilities for comfort)										
2.3	Personal safety of my residential area. (very unsafe/much crime to very safe/no crime at all)										
2.4	Environmental condition of my residential area.(waste/pollution/no green areas and parks)										

3. **Climate Change Hazards: Awareness and Experience.**

S/N	Climatic Hazards	Awareness	Experienced	When: Year/Month
3.1	Surface flooding	❑Yes ❑ No	❑Yes ❑ No	
3.2	Erosion	❑Yes ❑ No	❑Yes ❑ No	
3.3	River flooding	❑Yes ❑ No	❑Yes ❑ No	
3.4	Flash floods	❑Yes ❑ No	❑Yes ❑ No	
3.5	Coastal flooding	❑Yes ❑ No	❑Yes ❑ No	
3.6	Thunder-storms	❑Yes ❑ No	❑Yes ❑ No	
3.7	Tornados	❑Yes ❑ No	❑Yes ❑ No	
3.8	Tropical storms	❑Yes ❑ No	❑Yes ❑ No	
3.9	Heat Waves	❑Yes ❑ No	❑Yes ❑ No	
3.10	Urban Heat Island	❑Yes ❑ No	❑Yes ❑ No	

3.11. Can you remember any major flood event in your area?......................
3.12. Was your housing/ building prone to this flood event? ………..
3.13. How often was your HH affected by a flood in the last five years?........................
3.14. What were you able to do to protect yourself from the effects of the flood?..
3.15. What factors led to this action, or prevented you from doing something else?

4. **Climate Change Hazards: Frequency and Severity**. In view of your experience, rate these hazards based on:

1. **Frequency**: Never Happened, 1; Some times, 2; Fairly Frequent, 3; Frequent, 4; very Frequent, 5.
2. **Severity**: Never Happened, 1; Not serious,2; Fairly Serious, 3; Serious, 4; and Very Serious, 5.

SN	Climatic Hazards	Frequency					Severity				
		1	2	3	4	5	1	2	3	4	5
4.1	Surface flooding										
4.2	Erosion										
4.3	River flooding										
4.4	Flash floods										
4.5	Coastal flooding										
4.6	Thunder-storms										
4.7	Tornados										
4.8	Tropical storms										

| 4.9 | Heat Waves | | | | | | | | | | |
| 4.10 | Urban Heat Island | | | | | | | | | | |

Ratings regarding exposure to flood events

4.11	How would you rate your exposure to flood events? On a scale between 0 (no exposure, our HouseHold was never flooded) and 10 (very exposed, our house floods very easily)										
0	1	2	3	4	5	6	7	8	9	10	

5.0 High temperatures/heatwaves:

5.1. Can you recall any unusual period of high temperatures (heatwave) in the Lagos?   Year...............

5.2. How did the heat affect you?..

5.3. Where did you suffer most from the heat? Home ❑ Work ❑ On the road ❑

5.4. What were you able to do to protect yourself from the heat?...….

5.5 What factors led to this action, or prevented you from doing something else? …………………………………………..

Ratings regarding exposure to high temperatures

5.6	How would you rate your exposure to high temperatures? On a scale between 0 (no exposure, I am never hot at home or work) and 10 (very exposed, I am very often uncomfortably hot at home and/or work)										
0	1	2	3	4	5	6	7	8	9	10	

6.   Future Risk

Please consider the following scenario: Change in weather and sea-levels means that your house and this neighborhood will regularly be flooded, say every three years.

5.1	Would you wish to continue living here	❑ Yes ❑ No
5.2	What could you do to continue living here?	
5.3	Would you expect help from government?	❑ Yes ❑ No
5.4	Would you expect help from anyone else?	❑ Yes ❑ No
	What kind of help and why?	

5.5	In the scenario above, and assuming you have the same income and family as now please rank (from 1 to 4, where 1 would be your best choice) what you would want to do and what you think you would actually be able to do:

Options	Wish	Reality
Who knows what the future will bring – there are lots of things that could affect us, I'd rather wait and see.		
I would be able to redesign the walls or entrances of the house to make it resistant to the hazard		
There is not much that could be done and it would be better to move to avoid flooding even if this meant moving away from friends, local schools, work and so on.		
I could not change the house, so flooding would happen but I could change the way we live, e.g keep important belongings off the ground flood to avoid damages during floods		

7.   Personal view

7.1 Who should be responsible for direct disaster response in case of a flood? Please rank according to importance: The local government and disaster management agency of the state ❑ Every HouseHold for itself ❑ Local NGOs and other local civil society organizations such as religious groups ❑ Relatives, neighbors and friends ❑ International and foreign Organisations or the governments of other countries) ❑ I do not know. Others: _____

7.2 Do you think that the local government will over the next 10 years maintain, reduce or increase its current level of support in dealing with floods? Maintain ❑ Reduce ❑ Increase ❑ I do not know ❑ others (specify) _____

7.3 Do you think that the local government has improved, maintained, its support in dealing with floods and/or heatwaves?Maintain ❑ Reduce ❑ Increase ❑ I do not know ❑others (specify) _____

7.4 How do you think about the following statements using the scale provided below:

Statements	Strongly Agree	Agree	Strongly Disagree	Disagree	No opinion
The poor and vulnerability are to blame for their own vulnerability.					
The city was a fairer place 10 years ago.					
I am more concerned of flooding today than I was 15-10 years ago.					
I am more concerned of the heat today than I was 15-10 years ago.					

THANK YOU

Appendix 2
Focus Group Discussion (FGD) Guide

1. Name of Community:_____ LGA:_____ Coordinate:_____

2. What is the estimated population of the community? _____

3. What are the frequency and severity of the impact of climate change that are peculiar to your community/neighbourhood?

4. Do you think that the frequency and severity of the impact of climate would result in migration of people from your community? _____ (Yes) _____ (No)

5. Do you think that the frequency and severity of the impact of climate change would make businesses/investments to relocate from your community? _____ (Yes) _____ (No)

6. In what way(s) do you think that the frequency and severity of the impact of climate change would affect your families and community?
    (a) Negatively
    (b) Positively
7. Specifically state how the frequency and severity of the impact of climate change is affecting you, your families and community?

8. What activities in your neighbourhood/community do you think is responsible or contributes to climate change?

9. Is there currently localized mitigation and adaptation measures used in reducing the impact of climate change in your neighborhood or community?

10. What suggestions do you have for reducing the negative impacts?

11. What steps have you taken as a community to continue your normal life style or activities after the negative impact of climate change?

12. Which location or group of people in your neighborhood would you say is/are mostly affected by the negative impact of climate change and why?

13. How does the threat of climate change affect your means of livelihood, health, property and investment and for how long have you been witnessing this?

14. What is the frequency and severity of the impact of climate change on the following sectors?

S/N	Sectors	SEVERITY LEVEL				
		1	2	3	4	5
I.	Investments (commercial activities, manufacturing etc.)					
II.	Property					
III.	Transportation					
IV.	Education					

V.	Fishing				
VI.	Farming				
VII.	Trading				
VIII.	Conflict				
IX.	Health/emergency services				
X.	Involuntary displacement				
XI.	Public infrastructure and services				
XII.	Crime				

Facility Assessment Instrument

Field ID of Staff: ………………………..   **Date: ………………**   **Sheet No: …………**

S/No.	Name of Infrastructure/Features/Services	Land Use	Waypoint ID	Image ID	Valuation/Comments

Appendix 3
Attendance at the 3-Day Capacity Building Workshop

CLIMATE CHANGE RISK ASSESSMENT IN LAGOS STATE

Capacity Building of Lagos State Ministry of Environment & Water Resources Team on Climate Change Risk Assessment (19th -21st of August, 2020)

Venue: Lagos State Ministry of Environment & Water Resources, Alausa-Ikeja, Lagos

Date: 20th August, 2020

ATTENDANCE SHEET

S/N	NAME	ORGANIZATION	PHONE NO.	E-MAIL	SIGNATURE
1	ADEFOLU EMMANUEL	Geosolution	07054475264		
2	Bankole Michael	MOE&WR	08022909780	michael.bankole@lagosstate.gov.ng	
3	Ajilore Temitayo.O	MOE & WR	07037718833	temitayo.O14@gmail.com	
4	Omoseyindemi Omowunmi C	MOE & WR	08166652665	mowunmi.c@gmail.com	
5	Osifeso E Olaoluwa	MOE & WR	08055117301	Osifeso.olaoluwa@yahoo.com	Osifeso
6	AMUSAT AZEEZ D.	MOE & WR	08172147223		
7	Braimah Kehinde Hafis	MOE & WR	07033042994		
8	OYEDEJI ADEOYE	Geo Solutions	08057483235		
9	AKANIHI ADEWUNMI	MOE & WR	08137573456		
10	OGUNSAWE Felix A	Geo-solution Providers Ltd	08022562121	loginbm.1@yaha.com	
11	OGUNSAWE David A		08028285879	davesawe@gmail.com	
12	Michael Ahoue	Geo Solution Provider	08032347047	fjahove@gmail.com	
13	bus Seyi Falayi		08040484463	seyifalayi@yahoo.com	
14	Omotolanle Maybagbeola	ODS&WR/MOE&WR	08099076850	botanng@yahoo.com	
15	AFINOWI-SUBAIR A A	MOE & WR	08023436209	adetaz12@gmail.com	Afino
16					
17					
18					

CLIMATE CHANGE RISK ASSESSMENT IN LAGOS STATE

Capacity Building of Lagos State Ministry of Environment & Water Resources Team on Climate Change Risk Assessment (19th -21st of August, 2020)

Venue: Lagos State Ministry of Environment & Water Resources, Alausa-Ikeja, Lagos

Date: 21st August, 2020

ATTENDANCE SHEET

S/N	NAME	ORGANIZATION	PHONE NO.	E-MAIL	SIGNATURE
1	Osifeso E. Olaoluwa	MOE & WR	08055117301	osifeso.olaoluwa@yahoo.com	Osifeso
2	Omoseyindemi Omowunmi	MOE & WR		omowunmi.c@gmail.com	
3	Ajilore Temitayo.O		07037718833	temitayo.O14@gmail.com	
4	Bankole Michael	MOE&WR	08022909780	michael.bankole@lagosstate.gov.ng	
5	Muhammed Abbas	MOE & WR	08086787454	abbas.muhammedds@gmail.com	
6	AMUSAT AZEEZ O	MOE&WR	08172147223	amusat@yahoo.com	
7	AFINOWI-SUBAIR A.A	MOE & WR	08003430p4	adetaz12@gmail.com	AAfino
8	Braimah Kehinde Hafis	MOE & WR	07033042994	abushaanKir.60@gmail.com	
9	Adeoye Oyedeji	Geo-Solutions	08057483235	adeoye2017@gmail.com	
10	ADEFOLU EMMANUEL	Geosolutions	08036457204	mis06@fmhvi.com	
11	Bab Seyi Falayi		08040850063	seyifalayi@yahoo.com	
12	OGUNSAWE Felix A.	Geo-solution Providers Ltd	08022562121	loginbm.1@yeha.com	
13	Okafor Chinenye. L	Geo-solution	08039162815	chinenyeokafor2017@yahoo.com	
14	Omotolanle Mayobagbeola	ODS&WR /MOE&WR	08099076850	botanng@yahoo.com	
15	Ahove Michael	Geo-solutions	08032347047	fjahove@gmail.com	
16	OGUNSAWE David A		08028285879	davesawe@gmail.com	
17					

CLIMATE CHANGE RISK ASSESSMENT IN LAGOS STATE

Stakeholders' Sensitization Workshop on Climate Change Risk Assessment (2nd September, 2020)

Venue: Adeyemi Bero Hall, Alausa-Ikeja, Lagos

ATTENDANCE SHEET (MDA DELEGATES)

S/N	NAME	ORGANIZATION	PHONE NO.	E-MAIL	SIGNATURE
01	OLANIYE, Samson. O	LASRRA	08051259666		
02	Bandimu Oluwaseyi	MOE & WR	07082561078	shayi-138@yahoo	
03	Omobolanle Magbagbeola	ODS & WR	08099076850	bmagbagbeola@	
04	Wale Ademinafin	MOE	07097237812		
05	Badmus O.T.	LASEMA	09069841195	badmuso@yahoo	
06	Okoro JN	EDUCATION	08023227424	dudulleokoro67@gmail.com	

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MINISTRY OF THE ENVIRONMENT & WATER RESOURCES.

1	Abbas Mohammed	MOE & WR	08056789484	mohammed.88@gmail.com	
2	Olayinka Damilola	"	08033540742	danielolay.k24@	
3	LAWAL Adekunle .M.	MIN OF ENVIRONMENT	08028158081	kunlai2002@yahoo.com	
4	Adeolu O-A	MOE & WR	08056701463	gisfileoffice@gmail.com	
5	Adone T.O	" "	07039181833	temmyayoo74@gmail.com	
6	Omoseyindemi Omokunmi.O	MOE & WR	08166525665	mdrunmic@gmail.com	
7	Ojoye A.L.	MOE & WR.	08055449814	ojoyelatifal@gmail.com	Oluole
8	AMUSAT A.O	MOE & WR	08172147223	Amusat.Aus@lagos.gov.ng	
9	Osipeso E.O	MOE & WR	08055117301	osipeso.olaoluwa@gmail.com	Olapin
10	Akanni A.A	MOE & WR	08132547886	adamanakkani@yahoo.com	
11	Peeyo M.A	MoE & WR	08054165366	mary.adefiom@gmail.com	
12	Bankole M.O	"	08022909780	bkbufs2012@gmail.com	
13	Adedokun Ayodesi	MOE. WR	08109938529	Aadegbgo.01@gmail.com	Ayodasi

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CLIMATE CHANGE RISK ASSESSMENT IN LAGOS STATE

Stakeholders' Sensitization Workshop on Climate Change Risk Assessment (2nd September, 2020)

Venue: Adeyemi Bero Hall, Alausa-Ikeja, Lagos

ATTENDANCE SHEET (LG DELEGATES)

S/N	NAME	ORGANIZATION	PHONE NO.	E-MAIL	SIGNATURE
1	Adera Adeyemi	Itire Ikate Lagos Government	08056174729	Jude pst@fb	
2	Olusegun Akeju	Mainland L.G.	08027516640	entas70@yahoo	
3	Mejo fashmon Olulade	Mainland L.G	09055573677	raluofshred@yahoo	
4	Engr Whesy M.S	IJEDE LCDA	08038883346	fyggywhistopmil	
5	Haruna . S. B	Mushin LG	08033337352	harunaismail20@yahoo	
6	Idowu Quadri Abdullah	Alimosho L.G.	08039129369	quadyla@gmail.com	
7	Agunbiade Selmah	Oriran LCDA	07031285141	tayamchu@Goo	
8	Engr. Olaniyan G.K	Egbe Idimu LCDA	08023770905	kayodeolaniyan@yahoo	
9	QS O.O. Adesanya	Oriade JCDA	08023066353	olufimoh.adesanya62@gmail	
10	Engr. O.A Hassan	Ojo LGA	08034286351	seanhassan@gmail.com	
11	Olukoga Adebayo.8	ETI-OSA L.G	08023535283	Olukoga.bashirk@y	
12	Engr. Mrs.	Somolu L.G	08038276296		
13	Engr. Oke Oluwagbenga	Agboyi-Keta LCDA	08026626920	gbengule2016@gmail	
14	Elder B.O. Fadimu	Ayobo-Ipaja Lcda	09133609217	fadimu@yahoo	

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LG DELEGATES (CONTD.)

S/N	NAME	ORGANIZATION	PHONE NO	E-MAIL	SIGNATURE
15	Engr. Oladapo. O	IFAKO-Ijaiye LG	08073574983	Oluseyi.Oladapo209	
16	Engr. Raphael Mojisola	Oshodi Isolo LG	08029915053	oreoraolapararighedo@gmail.com	
17	Engr. Malodeje N.I	AGEGE LG	08784284794	ulibngr.engineer@yahoo.com	
18	MOGAJI ENIOLA. K	YABA LCDA	08027204770	eniyola02@gmail.com	
19	Engr. Ade Kazeem	OTO-Awori. LCDA	08089497999	Adekazeem847@gmail	
20	Engr. Olowo Mashood	Surulere L.G.	08027611201	mashoodolowo@yahoo	

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Glossary

Adaptive Capacity: Adaptive capacity refers to the ability and willingness of systems to adjust to potential damage, to take advantage of opportunities, or to respond to consequences of climate change. Systems can be natural systems, individuals, or institutions such as governments.

Climate Risk   Climate risk is linked to the probability of adverse impacts from climate change. It is caused by harmful climate events or trends that have negative impacts on cities worldwide. Risk is determined by the interplay of hazards, exposure, vulnerability and sensitivity.

Exposure   The term exposure refers to the presence of people and/or assets that are located in areas that are potentially affected by climate change.

Hazard   Climate hazards are threatening climate events that have the potential to cause damage or harm to humans, assets and natural systems.

Impact The term impact is used to refer to the effect of extreme weather and climatic events on natural and human systems. The impact may be affecting lives, health, the economy, infrastructure and ecosystems. They are often referred to as consequences

Indicator   Indicators are measures used to collect relevant climate related data. They can be climatology information, which provide important evidence of what climate change looks like such as rainfall, hot days or storm intensity. They can also be non-climatic information such as information on sectors, demography, land use, flood damage or critical infrastructure maps.

PAP   Project Affected Persons; a concept used to define people affected by projects or climate disasters

Sensitivity   Sensitivity is the degree to which a system or species is affected, either adversely or beneficially, by climate change.

Vulnerability Vulnerability refers to the extent to which people or assets are susceptible to the adverse impacts of climate change. It relates to the lack of capacity to cope and adapt.