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WORLD MARITIME UNIVERSITY
Malmö, Sweden

RESILIENCE OF THE NIGERIAN COASTAL SOCIO-ECOLOGICAL SYSTEM: CASE STUDY OF THE NIGER DELTA REGION

By
IJIOMAH CHINENYE JOY
Nigeria

A dissertation submitted to the World Maritime University in partial Fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE
In
MARITIME AFFAIRS
(OCEAN SUSTAINABILITY, GOVERNANCE AND MANAGEMENT)

2018

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DECLARATION
I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

Signature: ______________________
Date: ________________

18th September, 2018

Supervised by: Professor Ronan Long
Supervisor’s affiliation: Director, WMU-Sasakawa Global Ocean Institute/Ocean Sustainability, Governance and Management Specialization
World Maritime University
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Thank you, Professor Ronan Long, for guiding and encouraging me to push through this dissertation.
To my loving family, I am thankful for your prayers and encouragement during the period of my study.
ABSTRACT

Title of Dissertation: Resilience of the Nigerian Coastal Socio-Ecological System: Case Study of the Niger Delta Region
Degree: Master of Science

This dissertation is a study of the resilience of the Nigeria coastal socio-ecological system with focus on the Niger Delta region. Given the unpredictability of climate change, looming sea level rise, increased flooding incidences and the current gross environmental degradation resulting from oil pollution, the ability of the Niger Delta’s coastal socio-ecological system to anticipate, absorb, and recover from disturbances or shocks was investigated. The socio-ecological system framework was used to describe and analyze the Niger Delta coastal system and the social, environmental, governance and economic systems were evaluated using Bhamra (2015) resilience framework for measuring sustainable development and Nemec et al, (2013) methodology which is based on Walker and Salt (2006) resilience indicators to identify inherent vulnerabilities, gaps and resilience level. The research reveals that the Niger Delta coastal socio-ecological system has low resilience. Even though some policies that can address these gaps are in place, implementation is the problem.
In concluding the research, steps taken by other countries to build resilience are examined and discussed and some recommendations are made towards building socio-ecological resilience in the coastal region.

KEYWORDS: Assessment, Environment, Ecosystem, Niger Delta, Resilience, Socio-ecological System, Sustainable Development, Vulnerability
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<tr>
<td>CBN</td>
<td>Central bank of Nigeria</td>
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<tr>
<td>CBOs</td>
<td>Community Based Organizations</td>
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<td>CESifo</td>
<td>Center for Economic Studies</td>
</tr>
<tr>
<td>CMSEs</td>
<td>Coastal and Marine Socio-ecological Systems</td>
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<td>CO2</td>
<td>Carbon dioxide</td>
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<td>DPR</td>
<td>Department of Petroleum Resources</td>
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<td>DYNTRA</td>
<td>Dynamic Transparency</td>
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<td>EF</td>
<td>Ecological Footprint</td>
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<td>EFInA</td>
<td>Enhancing Financial Innovation and Access</td>
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<td>EGASPIN</td>
<td>Environmental guidelines and Standards for the Petroleum Industry in Nigeria</td>
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<td>FGN</td>
<td>Federal Government of Nigeria</td>
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<td>Fifth NBR</td>
<td>Fifth National Biodiversity Report 2013</td>
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<td>FMEenv</td>
<td>Federal Ministry of Environment</td>
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<td>GCLME</td>
<td>Guinea Current Large Marine Ecosystem</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>HDI</td>
<td>Human Development index</td>
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<td>HYPREP</td>
<td>Hydrocarbon Pollution Restoration Project</td>
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<td>ICZM</td>
<td>Integrated Coastal Zone Management</td>
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<td>IMO</td>
<td>International Maritime Organization</td>
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<td>MNDA</td>
<td>Ministry of Niger Delta</td>
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<td>MSP</td>
<td>Marine Spatial Planning</td>
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<td>NASPA-CCN</td>
<td>National Adaptation Strategy and Plan of Action for Climate Change Nigeria</td>
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<td>NBP</td>
<td>National Biofuel Policy</td>
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<td>NBS</td>
<td>National Bureau of Statistics</td>
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<td>NBSAP</td>
<td>National Biodiversity Strategy and Action Plan</td>
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<td>ND</td>
<td>Niger Delta</td>
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<td>Acronym</td>
<td>Description</td>
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<td>NDCC</td>
<td>Niger Delta Development Commission</td>
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<td>NDES</td>
<td>Niger Delta Environmental Survey</td>
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<td>NEMA</td>
<td>National Emergency Management Agency</td>
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<td>NEMP</td>
<td>National Energy Master Plan</td>
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<td>NEP</td>
<td>National Energy Policy 2006,</td>
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<td>NESREA</td>
<td>National Environmental Standards and Regulations Enforcement Agency</td>
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<td>NEVIN</td>
<td>New Vision for the Niger Delta</td>
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<td>NGOs</td>
<td>Non-Governmental Organizations</td>
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<td>NHSA</td>
<td>Nigerian Hydrological Services Agency</td>
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<td>Nigeria INDC</td>
<td>Nigeria Intended Nationally Determined Contribution</td>
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<td>Nigeria PDNA</td>
<td>Nigeria Post-Disaster Needs Assessment 2013</td>
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<td>Nigeria SDGs IBR</td>
<td>Sustainable Development Goals Indicators Baseline Report 2016</td>
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<td>NIMASA</td>
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<td>NiMet</td>
<td>Nigerian Meteorological Agency</td>
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<td>NIWA</td>
<td>National Inland Waterways Authority</td>
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<td>NNPC</td>
<td>Nigerian National Petroleum Corporation</td>
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<tr>
<td>NOA</td>
<td>National Orientation Agency</td>
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<tr>
<td>NOSCP</td>
<td>National Oil Spill Contingency Plan</td>
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<td>NOSDRA</td>
<td>National Oil Spill Detection and Response Agency</td>
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<tr>
<td>NOx</td>
<td>Nitrogen Oxides</td>
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<td>NPC</td>
<td>National Population Commission</td>
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<tr>
<td>NRC</td>
<td>National Research Council – United States</td>
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<tr>
<td>NRC</td>
<td>Nigerian Railway Corporation</td>
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<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
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<tr>
<td>PAH</td>
<td>Polycyclic Aromatic Hydrocarbon</td>
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<tr>
<td>PES</td>
<td>Payment of Ecosystem Services</td>
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<td>PIB</td>
<td>Petroleum Industry Bill</td>
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<td>REMP</td>
<td>Renewable Energy Master Plan</td>
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<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>SCP</td>
<td>Sustainable Consumption and Production</td>
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<td>SDGs</td>
<td>Sustainable Development Goals</td>
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<tr>
<td>SDN</td>
<td>Stakeholder Democracy Network</td>
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<tr>
<td>SEMA</td>
<td>State Emergency Management Agency</td>
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<tr>
<td>SESF</td>
<td>Socio Ecological Systems Framework</td>
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<td>SESs</td>
<td>Socio-ecological Systems</td>
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<tr>
<td>SO₂</td>
<td>Sulfur dioxide</td>
</tr>
<tr>
<td>SPDC</td>
<td>Shell Petroleum Development Company</td>
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<tr>
<td>SRC</td>
<td>Stockholm Resilience Center</td>
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<tr>
<td>TEEB</td>
<td>The Economics of Ecosystems and Biodiversity</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<td>UNISDR</td>
<td>United Nations International Strategy for Disaster Reduction</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compound</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>WINET</td>
<td>Women Initiatives Network</td>
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<tr>
<td>WWF</td>
<td>World Wide Fund for nature</td>
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CHAPTER ONE

1 INTRODUCTION

1.1 Background of Study
The ocean which covers over two-thirds of the earth’s surface and their coasts are indispensable constituents of the earth’s ecosystem supporting up to 10 million species that provide diverse ecosystem services, contributes to globalization through the transportation, energy and tourism sectors, boosting the world’s economic well-being. (Georgia Tech, 2018).

According to the United Nations (UN), more than 3 billion people are dependent on resources from the ocean and its coasts for their livelihoods, making the ocean and its resources vital to human survival for food and other necessities, while also serving to regulate global climate, act as a sink for greenhouse gases and habitat for biodiversity (UN-DESA, 2015). Notwithstanding this, for so long, the economic priorities of developed and developing nations are basically on how humans can benefit from the ecosystem without adequate consideration of the impacts caused by humans in exploiting these benefits (Burke et al (PAGE), 2001).

Due to the prevalent human behavior and impacts globally, Coastal and Marine Socio-Ecological Systems (CMSES) are seriously degraded from pollution, destruction of habitats, nutrient enrichment, over exploitation, climate change etc. (Nahuelhual et al, 2016), making, coastal areas more vulnerable to natural hazards,
increasing the risk and resultant impacts not just because of severe climatic events but also due to huge populations living along the coasts and the growing coastal infrastructure to meet their needs (Lozoya et al., 2014). The latter is also very much the case in Nigeria with the rapid expansion of industrial and urban development in the Niger Delta.

Currently, the number of people that coastal flooding and other extreme weather events affects globally is rising, spurring the increasing desire for precautionary and adaptive measures, especially since the increasing impact is exacerbated because the speed of change is not easily known. According to the IPCC, it is therefore very important to develop and implement comprehensive strategic action plans to adaptively manage likely unknown future conditions/occurrences (IPCC 2007).

Socio-ecological systems (SESs) are linked systems of people and nature hence humans are core parts of nature through inter-linkages (Berkes and Folke, 1998). It has been observed through the years that SESs do not generally respond to modification from climate change, in a direct manner but rather changes appear due to cumulative effects after tipping points (attainment of critical thresholds in the system) are reached, resulting in sudden and extreme alterations (Westley et al. 2011). The latter considerations are crucial in designing response systems and improving resilience.

The Nigerian coastal socio-ecological system especially the Niger Delta has been and is still threatened by series of man-made - oil spills, pollution, population increase, dredging (Nwilo and Badejo, 2005), and natural disturbances -floods and coastal erosion which affects the delicate balance, increasing vulnerability. It therefore could be envisaged that the current state in addition to increased use of the maritime space (development of blue economy) and effects of climate change, may cumulatively, drastically alter the structure and function of coastal SESs leading to ecological shift, hence the need to determine, establish and ensure resilience. Addressing such ecological and socio-economic impacts requires holistic, integrated,
participatory ecosystem based and precautionary approaches. Therefore, there is opportunity to advance knowledge by examining how the SES approach could be applied in the Nigerian context to provide perspectives that are necessary for dealing with the complex Nigerian coastal SES.

1.2 Problem statement
Over the years, most developed and even developing nations like the United States, China and Japan have faced and still experience diverse natural and human induced stress/disasters; hurricanes, floods, oil spills etc. and are able to recover because strategic plans and infrastructure have been put in place to help their systems recover (King et al, 2012).

The Niger Delta is faced with increasing human induced hazards from oil spills and is rated as one of the most polluted places globally (Amnesty International, 2018a) and termed the world oil pollution capital (BBC, 2010). These spills have degenerative consequences are impacting negatively on short to long term and cumulatively on human health, the environment and livelihoods of the communities (Albert et al, 2018).

Considering the increasing impacts of human activities and the reality of climate change, this study will look into the current state of Nigeria’s (Niger Delta) coastal social, economic and ecological systems and its ability to absorb and recover from pollution, anthropogenic and natural hazards.

1.3 Significance of study
Considering the magnitude of environmental degradation resulting from oil pollution, the increasing incidences of floods in the Niger Delta region and the slow pace at which efforts are being made towards remedying the situation, this research will review the Nigerian coastal socio-ecological system to find gaps if any and suggest ways of filling the gaps that exist.
The study will further spur the need for policy action to be taken and serve as a foundation for more research on the broad topic on resilience of coastal SESs in Nigeria.

1.4 Aim and Objectives
The aim of this research is to assess the Nigerian coastal socio-ecological system and ascertain to what extent it is resilient. The specific objectives are to undertake the following:
   i. Identify the current vulnerabilities;
   ii. Determine the current resilience level of the coastal socio-ecological system.

1.5 Research Questions
The following research questions are to be answered in this work
   i. What vulnerabilities exist in Nigeria coastal areas?
   ii. Is the coastal socio-ecological system resilient?

1.6 Research Methodology
Qualitative and quantitative methods are employed for this research. The research follows a descriptive analysis of the Nigerian coastal SES using the socio-ecological system framework and resilience indicators to evaluate vulnerabilities, gaps and resilience level based on secondary data extracted from articles, journals, reports, textbooks and related researches from reliable sources. Secondary data was chosen because this research requires a wide range of socio-ecological data for resilience assessment usually derived from workshops at a huge cost, which cannot realistically be obtained within the short time frame given for the research.

1.7 Research Outline
This research flows in the following sequence. The opening Chapter gives the background of study, problem statement, significance, aim and objectives of research, research questions, method and outline. The second chapter is a theoretical review of literature on the concepts of resilience, socio-ecological systems and socio-ecological systems framework. Chapter 3 focuses on the Nigerian Coastal Environment, analyzing it using the SES framework. Chapter 4 covers resilience assessment of the Nigerian coastal socio-ecological system. Chapter 5 discusses
results of the assessment and what other countries have done. Chapter 6 concludes the research with some recommendations.
CHAPTER TWO
2 THEORETICAL OVERVIEW

2.1 Introduction
The concepts of resilience and socio-ecological systems are reviewed in this chapter. The literature reviewed was chosen based on originality of the discourse and the suggested improvements on the resilience of socio-ecological systems, as well as the applicability to the study area in Nigeria.

2.2 Concept of Resilience
The concept of resilience was introduced by Hollings (1973) in his paper on ecosystem resilience. Resilience is a term used across diverse fields/disciplines to describe the ability to face stress, bounce back, become strong and continue in existence. In the context of human interactions with the natural environment, it typically means ensuring sustainability (Bhamra, 2015). There is a call to develop resilience as exemplified in the Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction, and the United Nations Framework Convention on Climate Change (Paris Agreement). (Roberts et al, 2015).

In relation to ecosystems/natural resources, the concept applies to ecological resilience, social–ecological system resilience and disaster resilience, which is the response of ecological systems to shocks, response of social–ecological systems to shocks, and response of social structures/relationships to disasters or natural hazards.
respectively. There are however usually overlaps in the perspectives of these concepts (Brown & Williams, 2015). Ecological resilience focuses on continuous functioning of a system even with disturbances (Adger, 2000). Socio-ecological resilience is the ability of systems to adapt to constant changes (Davoudi 2012).

The United Nations office for Disaster Risk Reduction has defined resilience as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions” (UNISDR, 2009).

According to the European Commission resilience is “the ability of an individual, household, community, country or region to withstand, adapt and to quickly recover from stresses and shocks” (EC ECHO, 2016).

Furthermore, Resilience Alliance defines Resilience as the “capacity of a social-ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions”. It describes the degree to which the system is capable of self-organization, learning and adaptation (Holling, 1973; Gunderson & Holling, 2002 and Walker et al. 2004).

Explicitly put, it is “the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events” (NRC, 2011).

Resilience is the “ability of a community to rebound after an extreme or stressful event to either the same condition or to a functional state this applies to either ecological or human communities”. Human communities are able to learn, future events by applying and using lessons learnt from past experiences to adapt to future event/occurrence (Adger, 2000).

This implies anticipating problems, reduction of vulnerabilities, effective response to emergencies, and the ability to recover quickly to a more functional state. To achieve
In plain language, resilience means being able to “spring back from” shocks. The resilience of a system/community to potential hazards is measured by the extent to which the system/community is able to plan, prepare the necessary resources and organize itself both before and during times of adverse events and ability to thrive after (UNISDR, 2009).

Resilience planning is mainly focused on identifying the needs of the concerned system/community and assesses the capacity of provision of essential services during the period of recovery (Brown and William, 2015). It involves being well informed of potential threats, assessing and managing risks and clarifying the roles and responsibilities of the people, communities and organizations involved (NRC, 2012).

Enhanced resilience entails being proactive by anticipating disasters and planning to ensure that losses from disasters are minimal not just waiting for disasters to happen first before trying to manage the outcome. This involves the appropriate allocation of necessary resources within budgetary limits to cover mitigation measures before disasters and recovery measures after disasters. Building resilience is a continuous process rather than a one-off action (NRC 2011; 2012).

According to the literature, the process of developing the practice and culture of resilience is not easy or cheap. It involves making appropriate decisions on how and when to invest time and money, as well as short and long-term planning, beforehand. The ability of individuals and communities to bounce back after an adverse event may be easily acknowledged, it is however not so before a disaster takes place, making the importance/gain of investing to build resilience hard to see and challenging for all concerned (NRC 2012).
In some developed nations, resilience building programs are already being implemented through disaster preparedness. The United States has experienced multiple natural hazards that have cost the country billions of dollars.\footnote{National Research Council (2012) Disaster Resilience: A National Imperative. Washington, DC: The National Academies Press. https://doi.org/10.17226/13457. National Research Council (2014) Reducing Coastal Risk on the East and Gulf Coasts. Washington, DC: The National Academies Press. https://doi.org/10.17226/18811.} However, a 2030 Strategy for Resilience through risk reduction, working with nature and coordinated/collaborative effort of individuals, communities and governments at all levels has been developed by the United States to help reduce social and economic troubles due to natural hazards (NRC, 2012; 2014).

Similarly, Norway has developed emergency electric power source, enhanced transport system and a more sensitive and far-reaching early warning system has been put in place to detect extreme weather events before they occur (O’Brien et al, 2006).

Even though understanding the dynamics of complex system can prove problematic and data limitations make it difficult to advice managers on specific and practical ways to restore/improve the resilience of ecosystem services, resilience as a normative approach gives a conceptual framework of how complex systems can be managed as attention is directed on the dynamics of systems and how these systems are impacted by both short and long term disturbances and stresses (NRC, 2013). Despite the benefits, Lindenmayer and Hunter, (2010) consider it a concept that is “too vague” to be of any use in planning or management of ecosystems.

2.3 Socio-ecological Systems Concept

According to Berkes and Folke (1998) “Social-ecological systems (SES) are linked systems of people and nature, humans must be seen as a part of, not apart from, nature and so SES are nested, multilevel systems that provide essential services to society such as supply of food, fiber, energy, and drinking water”.
The SES approach holds that social and ecological systems are linked through feedback mechanisms and that both display resilience and complexity (Berkes et al, 2003).

**Figure 1: Socio-ecological system at a glance**

The SES concept recognizes the close interactions and connections between society and the natural system as the ecological component provides the necessary services to society and how society modifies the ecological system. SESs are characterized as changing episodically, having different spatial scales and attributes, with multiple equilibria and functional states that cannot be managed by static/fixed policies and programs (Petrosillo et al, 2015).

The SES theory is useful in analyzing complex processes because it takes into account, both human and natural processes and cuts across disciplines and sectors, combining environmental and social sciences approach in solving real life problems (Perez-Soba and Dwyer, 2016; Virapongse et al, 2016).

To understand the human angle to changes within SES, the drivers of human actions need to be understood. Drivers are factors that influence human activities, they can
be direct (social, economic, political, cultural) with immediately recognizable effects or indirect (legislation) less noticeable, which both affects the ecosystems ability to provide its goods and service. (Petrosillo et al, 2015).

Human activities in coastal and marine socio-ecological systems (CMSEs) are on the increase, attracting competing users with frequently conflicting objectives. One of the key challenges in the management of CMSEs is securing their ability to provide ecosystem services - food, regulation of climate, provision of recreation and tourism opportunities, cultural and identity values, all of which influence the livelihoods and wellbeing of coastal communities (Nahuelhual et al, 2016).

2.4 Socio-Ecological System Resilience

SES are active systems that are constantly changing in response to internal or external disturbances (Berkes and Folke, 1998), hence an understanding of their dynamics is necessary in making them adaptable to change and the development of strategies to ensure their sustainability.

CMSEs are exposed to natural hazards like floods, storms and diseases outbreaks and anthropogenic disturbances like oil spills (NRC, 2013). These disturbances in the long term causes stress that impact the ability of such systems to respond to shocks. Building the resilience of SES contributes to sustainable development (Walker et al 2004).

Folke et al. (2010) define resilience of social-ecological systems as the ability “to continually change and adapt yet remain within critical thresholds. The focus of SES resilience is on the variations different from the normal state a system goes through during disturbances (Walker et al 2004).

In establishing resilience, it is necessary to differentiate between the two types of resilience: general and specified resilience (Folke et al, 2010). Specified resilience is the resilience of a specific part of a system to certain known disturbances while general resilience is the ability of the whole system to stand all known and unknown disturbances/stresses and still provide essential services (Walker et al, 2009).
Resilience has four important aspects, **latitude**: the maximum extent a system can get to before it loses the ability to recover; **resistance**: the ease or difficulty at which a system changes; **precariousness**: how close the current state of a system is to the threshold (or tipping point); and **panarchy**: the influence of cross-scale interactions such as politics, biological invasion or climate change (Walker et al, 2004).

Examining the regional development, poverty and sustainability of specific case studies across the United States, Australia, Zimbabwe, Sweden and Thailand, Walker et al (2004) concluded that there are three important attributes that determine the dynamics of SES and its stability through adaptive cycles; resilience, adaptability and transformability.

> “**Adaptability is the ability of actors (humans) in system to influence resilience**”. This is considered as a function of the social component as human actions dominate and determine influence of SES (Berkes et al 2003). This requires changes in some aspects of a system so that the whole system retains its essential properties. For example, a rise in sea level may require shifting the location of coastal marshes and human infrastructure in order to maintain important ecosystem services and avoid future damages resulting from floods (NRC, 2013).

> “**Transformability is the ability to create a fundamentally new system when ecological, economic, or social conditions make the existing system untenable**”. This involves a new way of living or doing things by allowing transformation of SESs through adaptive cycles before it becomes too late, as exemplified in Zimbabwe by transforming the use of depleted rangelands to wildlife conservancy. Similarly the collapse of fishing will make fishermen look for a new source of livelihood (Walker et al, 2004).

Resilience entails envisioning transformation scenarios and planning ahead to minimize the impacts during adjustment periods opening them up to public decision process at the right time to facilitate proper planning and action (Walker et al 2004). The institutional/governance capacity of social-ecological systems is a very
important element in developing the ability to adapt, transform, and innovate (Gunderson and Folke, 2011). In this context, resilience/sustainability, involves adaptive resource management and governance as well as diverse strategies, since there is no one method that can suffice (Walker et al 2004).

According to Walker and Salt (2006) resilient systems should be biologically, socially and economically diverse; ecologically variable-working with natural spatial-temporal changes rather than controlling or reducing it; modular-connected subunits that increase the efficiency/stability of a system; acknowledge slow variables in thresholds; have tight feedbacks; have social capital-leadership and social networks; embrace innovation; overlap in governance and include unpriced ecosystem services in developmental proposals.

Similarly, one of the world’s leading specialist centres, the Stockholm Resilience Center (SRC, n.d) has outlined seven principles be taken into consideration in building resilience in SES, namely; (1) maintaining diversity and redundancy by ensuring that SES have many different components of species, actors, source of livelihood and knowledge to compensate for failure of others in times of disturbances; (2) Maintaining connectivity – the way and manner resources, species or actors disperse, migrate or interact in a social-ecological system by identifying the relevant elements in the system and their interaction, restoring and optimizing their connectivity patterns; (3) Managing slow changing variables and feedbacks to ensure functional and sustained provision of ecosystem service by constant monitoring/taking action to avoid getting to irreversible thresholds; (4) Fostering complex adaptive systems thinking by adopting a holistic system framework, expect change and uncertainties, consider thresholds and match governance institutions to SES processes; (5) Encouraging learning by consulting different sources of knowledge in creating solutions; (6) Broadening participation by engaging all relevant stakeholders; and (7) Promoting polycentric governance to ensure the right people address disturbances at the right time.
Resilience in SESs depends on the feedbacks between ecological and human communities hence an integrated analysis of both nature and people are required. Communities having more diversified economies and social structures are better placed to withstand disturbances to ecosystems that affect the provision of ecosystem services (NRC, 2013)

### 2.5 Socio-Ecological Systems framework

The socio-ecological system framework (SESF) initially proposed by Ostrom (2007; 2009) and modified over the years is still subject to development and testing. SESF was designed to identify essential elements to be considered when studying socio-ecological systems. It gives a multi-tier hierarchy of concepts and variables that can be used to analyze the sustainability of small and large SES (McGinnis and Ostrom, 2014).

**Figure 2: SES framework**

(Modified from McGinnis and Ostrom, 2014)
The SESF first tier includes: four linked subsystems; resource units (RU), resource system (RS), governance system (GS) and actors (A) those extracting or modifying resource units, the interactions (I) between these variables and the outcomes (O) of the entire system processes. Furthermore, the framework also postulates that these components could be affected by external variables, creating feedback from related ecosystems (ECO) or social-economic-political settings (S). These first tier subsystems are further broken down to second, third, fourth, tiers variables depending on what the analyst needs (McGinnis and Ostrom, 2014).

The SESF was chosen for this research because it is policy oriented and conceptualizes the social, ecological and governance systems with human interactions (Binder et al, 2013). This study will focus on the first tier variables, as no clear method of applying the framework is given (Hinkel et al, 2015) however, for the purpose of this study, the framework will be applied by identifying the components/variables and adapting them to suit the Nigerian coastal socio-ecological system as categorized in the next chapter, since there is no one method of conducting SES analysis/assessment (Walker and Salt, 2012; CCRN, 2014).
CHAPTER THREE

3 THE NIGERIAN COASTAL SOCIO-ECOLOGICAL SYSTEM

3.1 Introduction
This chapter describes the state of the Nigerian coastal SES, analyzing it using the socio-ecological system framework.

3.2 Overview of the Nigerian Coastal Environment
Nigeria has a coastline of about 853 km in length along the Gulf of Guinea in West Africa and lies between latitude 4° 10' to 6° 20'N and longitude 2° 45' to 8° 35' E, bordering the Atlantic Ocean (Nwilo and Badejo, 2018). The coasts are at low lying heights of about 3m above sea level consisting of fresh water and mangrove swamp, lagoon mashes, tidal-channels, beach ridges and sand bars (Dublin-Green et al, 1997).

The Nigerian coast consists of four geomorphological features; the Barrier-Lagoon Complex, the Mud Coast, the Arcuate Niger Delta and the Strand Coast sand bar (Nwilo and Badejo, 2015; Dublin-Green et al, 1997). Out of the 36 states in Nigeria, 9 have a coastline with the Atlantic Ocean, having rich and diverse marine ecosystems and resources and about 25% of the Nigerian population living there (Onyema, 2017).

Nigeria has a current estimated population of 198 million people (NPC, 2018). Over the past 58 years, development of coastal areas in Nigeria has been exponential with expanding cities, industries, tourism and other land-based activities.
This has led to more pressures on the coastal and marine environment caused by man-made as well as natural factors (Famuditi et al., 2014), amongst which are population pressure, coastal erosion and flooding, oil spills, dredging, ports construction and over fishing. It is estimated that 80% of Nigerian lands are affected by coastal erosion (Akegbejo, 2013; Famuditi et al., 2014). According to Danladi et al., (2017), the Nigerian coast has undergone remarkable changes for the past 43 years due to erosion especially the Niger Delta.

In Nigeria, the term resilience is interpreted to suit personal perspectives as different political actors from non-governmental organizations to policy experts use the concept to promote different agendas, ranging from provision of protective infrastructure and enforcement of land use regulations, to changing livelihood sources and resettlement of vulnerable communities (Ajibade, 2017). This is also informed by the complex nature of the law and policy landscape. Thus, for example, Nigeria is party to a number of international agreements aimed at protecting the environment, see Table 1 below.
### Table 1: International Treaties focused on the environment Nigeria is party to

<table>
<thead>
<tr>
<th>Convention/Treaty</th>
<th>Signature</th>
<th>Date of Nigeria’s Ratification or Accession</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kyoto Protocol to the United Nations Framework Convention on Climate Change</td>
<td></td>
<td>10 Dec 2004 a</td>
</tr>
<tr>
<td>Paris Agreement</td>
<td>22 Sept 2016</td>
<td>16 May 2017</td>
</tr>
<tr>
<td>Abidjan Convention</td>
<td>23 March 1981</td>
<td>6 June 1984</td>
</tr>
</tbody>
</table>

(UN, n.d; IMO, n.d)

#### 3.3 Case study: The Niger Delta region (Resource System (RS), focal scale)

The Niger Delta covers an area of approximately 70,000 km² with a population of about 40 million people – 2016 estimate (NPC, 2018; NBS, 2018) and is one of the world’s largest wetlands lying between latitude 4° and 6° North of the equator and longitude 5° and 7° East of Greenwich (Mmom and Aifesehi, 2013). The Niger Delta comprises of Abia, Delta, Bayelsa, Rivers, Akwa-Ibom, Ondo, Imo, Edo and Cross-River states. The focus of this study will however be on states with delta coast, namely: Delta, Bayelsa and Rivers (with a population of over 15million) as they have the highest incidences of oil spills (Amnesty International, 2018b) and their
geomorphology makes them more prone to sea level rise and other stresses (Climate Change vulnerability index, 2015).

**Figure 4: The nine states of the Niger Delta and case study**

The delta was formed by the accumulation of sedimentary deposits transported by rivers Niger and Benue formed the delta. The region experiences very high annual rainfall ranging between **3000 to 4500 mm** with double maxima characteristics of July and September peaks. The Niger Delta has four ecological sub-zones (coastal barrier Islands, mangrove, freshwater swamp forest and the lowland rainforest), however the mangrove is the largest and most dominant (Mmom, 2010). The region is rich in crude oil and natural gas, on which the Nigerian economy is based and bio-resources which serves rural livelihood.
Delta regions are areas of high interdependence between physical, ecological, and social systems interacting at various levels and different spatial-temporal scales (Foufoula-Georgiou et al 2011). The population in the region consists mainly of rural communities depending completely on the natural environment for food and source of livelihood (UNDP, 2006).

About a quarter of the Niger Delta are wetlands - the largest delta in Africa and third largest in the world covering 20,000 to 28,000 km$^2$ of rivers, creeks, estuaries and stagnant swamps (Umoh, 2008) and mangrove swamp spanning approximately 1,900 km$^2$ (Spalding et al, 1997). The Niger Delta wetland system is rich in biological diversity (Ebuku, 2004) and is among the 10 most important wetlands and marine ecosystems in the world (Uluocha and Okeke, 2004).

Presently Nigeria has 11 sites covering a surface area of 1,076,728 hectares designated as Wetlands of International Importance-Ramsar Sites (Ramsar.org). Three (3) of these wetland sites Apoi creek forest, Oguta Lake and Upper Orashi Forests, are located within the Niger Delta.

**Figure 5: Location of Ramsar sites in Nigeria**

(Source: ramsar.org)
These mangrove swamps are located at the centre of a sensitive and complex ecosystem, important for fishing industries and serves as sources of employment/income to the local people. The extensive forests in the Niger Delta have varieties of important economic trees used as timber (Okonkwo *et al.*, 2015; Nwokedi *et al.* 2017). These provide essential ecosystem services like maintenance of biological diversity, production of fish, carbon sequestration, aquifer discharge, flood control and serving as habitat for endangered species (Barbier *et al.*, 1997).

**Table 2: Ecosystem goods and services in the Niger Delta Ecosystem**

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Provisioning</strong></td>
<td><strong>Food</strong>: Fish, periwinkles, barnacles, crabs, snails and other aquatic invertebrates</td>
</tr>
<tr>
<td></td>
<td>Agricultural and tree crops: cocoa, cassava, yam, cocoyam, rice, ogbono, maize etc.</td>
</tr>
<tr>
<td></td>
<td>Bush meat, spices, mangrove salt</td>
</tr>
</tbody>
</table>
**Fuel & fibre:** timber, bamboo, fuel wood, chewing stick, raffia, reeds and sedges etc.

**Genetic and biochemical materials:** aquatic species.

Medicinal species

<table>
<thead>
<tr>
<th><strong>Regulating</strong></th>
<th><strong>Climate regulation:</strong> sink for greenhouse gases of carbon and methane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Hydrological regulation:</strong> provides buffer against natural disaster; coastal erosion and flood attenuation</td>
</tr>
<tr>
<td></td>
<td><strong>Water purification:</strong> fresh water production, quality and volume</td>
</tr>
<tr>
<td></td>
<td><strong>Biological processes:</strong> habitat for pollinators</td>
</tr>
</tbody>
</table>

| **Supporting** | soil formation, rich biodiversity, nutrient cycling, zone of primary production |
| **Cultural**   | Aesthetic: recreational and tourism, fishing festivals |
|                | Spiritual inspiration and sacred sites Educational: Rich biodiversity (indicates potential for tourism), Plant/animal parts for traditional medicine and cultural uses. |

(Adapted from Okonkwo et al, 2015)

### 3.4 Oil pollution in the Niger Delta (Interactions)

Nigeria is the largest producer of oil in Africa and currently the thirteenth largest in the world (CIA world fact book, 2018) having about 606 oil fields in the Niger Delta, 360 on-shore and 246 offshore (Nwilo and Badejo, 2018). The Nigerian economy is hugely dependent on the industry which provides 10% of her GDP and 83% of exports revenue (NBS, 2017; OPEC, 2018).

The discovery of crude oil in the 1950s, rapid growth of the oil industry and lack of enforcement of environmental regulations has caused damage to the region (Nwilo and Badejo, 2018). Catastrophic oil spills resulting from careless operations, old pipelines, marine tankers, oil wells, drilling platforms, tanks and sabotage between 1976 and 2005, caused 9,107 oil spill incidents spilling of 3,121,909.8 barrels of oil.
into swamps, estuaries, inland and coastal waters and land in the Niger Delta (Nwokedi et al, 2017; Egberongbe et al, 2018). About 70% of oil spills in Nigeria results from pipelines (NNPC, 2013) as most 73% of pipelines has exceeded their life span by more than a decade (Amnesty International, 2018).

Also between 2006 to 2015, 9,343 spills occurred, the most notable being the 2011 incident at Shell Bonga facility, which spilled 40,000 barrels of oil into the environment (Kalejaye, 2015) causing severe damage to the coastal environment.

According to the National Bureau for Statistics (NBS), about 6,817 oil spill incidents took place in Nigeria from 1976 to 2001, leading to the loss of about 3 million barrels of oil, of which 69% occurred offshore, 25% and 6% was in swamps and on land. Out of this figure, 70% or more are never recovered even after remediation activities and 2,300 cubic meters of crude are released into the environment yearly (Nwokedi et al, 2017).

**Table 3: Severely polluted places in the study area**

<table>
<thead>
<tr>
<th>Location</th>
<th>Environment</th>
<th>Area impacted (ha)</th>
<th>Incidence type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayelsa State</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biseni</td>
<td>Freshwater swamp forest</td>
<td>20</td>
<td>Oil spill</td>
</tr>
<tr>
<td>Etiama/Nembe ✓</td>
<td>20</td>
<td>Oil spill and fire</td>
<td></td>
</tr>
<tr>
<td>Etelebu ✓</td>
<td>30</td>
<td>Oil spill</td>
<td></td>
</tr>
<tr>
<td>Peremabiri ✓</td>
<td>30</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Adebawa ✓</td>
<td>10</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Diebu ✓</td>
<td>20</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Habitat Description</td>
<td>Distance (km)</td>
<td>Notes</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------</td>
<td>---------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Tebidaba</td>
<td>Freshwater swamp, mangrove</td>
<td>30</td>
<td>✓</td>
</tr>
<tr>
<td>Nembe creek</td>
<td>Mangrove forest</td>
<td>10</td>
<td>✓</td>
</tr>
<tr>
<td>Azuzuama</td>
<td>Mangrove</td>
<td>50</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Delta State</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opuekebe</td>
<td>Barrier forest island</td>
<td>50</td>
<td>Salt water intrusion</td>
</tr>
<tr>
<td>Jones creek</td>
<td>Mangrove forest</td>
<td>35</td>
<td>Spill and fire</td>
</tr>
<tr>
<td>Ugbeji</td>
<td>Mangrove</td>
<td>2</td>
<td>Refinery waste</td>
</tr>
<tr>
<td>Ughelli</td>
<td>Freshwater swamp forest</td>
<td>10</td>
<td>Oil spill-wellhead leak</td>
</tr>
<tr>
<td>Jesse</td>
<td></td>
<td>8</td>
<td>Product leak, burning</td>
</tr>
<tr>
<td>Ajato</td>
<td>Mangrove</td>
<td></td>
<td>Oil spill</td>
</tr>
<tr>
<td>Ajala</td>
<td>Freshwater swamp forest</td>
<td></td>
<td>Oil spill</td>
</tr>
<tr>
<td>Uzere</td>
<td>Freshwater swamp forest</td>
<td></td>
<td>Oil spill</td>
</tr>
<tr>
<td>Afiesere</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Kwale</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Olomoro</td>
<td>✓</td>
<td></td>
<td>OC</td>
</tr>
<tr>
<td>Location</td>
<td>phenomena</td>
<td>Value</td>
<td>Category</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
<td>-------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Ughelli</td>
<td>✓</td>
<td></td>
<td>Oil spill</td>
</tr>
<tr>
<td>Ekakpare</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Ughuvwughe</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Ekerejegbe</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Ozoro</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Odimodi</td>
<td>Mangrove forest</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Ogulagha</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Otorogu</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Macraba</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

**Rivers State**

<table>
<thead>
<tr>
<th>Location</th>
<th>phenomena</th>
<th>Value</th>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumuokwurusi</td>
<td>Freshwater swamp</td>
<td>20</td>
<td>Oil spill</td>
<td></td>
</tr>
<tr>
<td>Rukpoku</td>
<td>Freshwater swamp</td>
<td>10</td>
<td>Oil spill</td>
<td></td>
</tr>
</tbody>
</table>

(FMEnv, NCF, WWF, CEEP-IUCN, 2006 Niger Delta Resource Damage Assessment and Restoration project)
Figure 7: Reported spills by Shell and Eni alone

![Bar chart showing reported spills by Shell and Eni from 2011 to 2017](image)

(Amnesty International, 2018)

Figure 8: Satellite images of oil spills by Shell starting 2011 and Eni (Agip) from 2014 to 2017)

![Satellite image showing oil spills](image)

(Amnesty international, 2018)

3.5 Impacts (Outcome)

According to the Global 200 Ecoregion classification undertaken by the World Wide Fund for Nature (WWF), the mangroves forest located in the Niger Delta are considered critically endangered (World Bank, 1995) is the most exploited in the world, the second most sensitive environment in Africa and a global biodiversity hotspot (FAO, 1997).
Large scale oil spill, dumping of drill cuttings, discharge of effluents into the surrounding environment and gas flaring grossly pollutes the air and water bodies, causing acid rain and soil degradation (Pyagbara, 2007), which have led to low yields and death of crops, destruction of livelihoods for the rural population and increased poverty, (Ibeanu and Luckham, 2006) as farmlands, fish farms and fishing sites are rendered unproductive.

Artisanal refining sites also contribute to environmental degradation as this led to 10% loss of mangrove vegetation in Bodo west, a community in Ogoniland. The percentage concentration of benzene in the Niger Delta is higher than the WHO standard increasing the risk of cancer (UNEP, 2011).

The Niger Delta region experiences high rainfall, so delays in clean-up results in oil washing into farm lands resulting in death of crops/plants and eventually into the creeks. Disseminated oil also causes persistent contamination long after clean-ups (UNEP, 2011).

As oil settles on the coastal waters, it kills benthic organisms like crabs, poisons algae, disrupts food chains and reduces the yield of edible crustaceans. Oil films coat birds reducing body heat and their ability to fly making them vulnerable to cold and sinking. It also reduces the vitality of fish hatcheries in coastal waters and contaminates commercially valuable fish (Nwilo and Badejo, 2018).

A recent study by CESifo group found out that babies in Nigeria have a double risk of dying if a mother (woman) resides within 10 km of where an oil spill occurs, even (5 years) before she gets pregnant. Neonatal deaths have doubled from 38 to 76 annually for every 1000 births (VOA, 2017; the Guardian, 2017).

Oil spills also negatively impacts local communities directly through the pollution of drinking water sources (Ekundayo and Fodeke, 2000) and the destruction of biodiversity (Phil-Eze and Okoro, 2009). Oil exploitation has led to the destruction
of sacred shrines and forests of cultural value, spills have caused the death/extinction of medicinal herbs used in traditional medicine and spirituality (Pyagbara, 2007).

3.6 **Sea level rise, coastal erosion and flooding** *(Related ecosystem, Interactions, outcomes)*

Nigeria and in particular the Niger Delta region is considered as among the most vulnerable coastal environments to the effects of climate change (Mmom, 2010; Climate Change Vulnerability Index, 2015) See Figure 9. In addition to the anthropogenic threat from unsustainable crude oil exploration and exploitation and population growth, the region is also threatened by flooding and shoreline erosion, which has led to huge loss of lives and properties.

Higher temperatures, prolonged heavy rainfall and poor land use planning have drastically aggravated the impacts from floods and shoreline erosion over the years and increasing severity (Mmom and Aifeshehi, 2013). This may increase with climate change and sea level rise as projections indicate that inundation will be up to 100 km inland. The latter implies the loss of lands, economic activities (livelihoods), biodiversity and even lives (Ogba and Utang, 2007).

It is estimated that coastal erosion affects 80% of coastal lands in Nigeria (Akegbejo, 2013). In 2012, Nigeria experienced the worst and most devastating flood event to have occurred which affected 30 (both inland and coastal) states out 36 states of the federation. Flood hazard in the Niger Delta cost the communities an average of ₦300,000,000 (three hundred million naira) loss (Chukwu-Okeah, 2012). No flood in the history of Nigeria has been so devastating.

The severity of flood impacts are due to inadequate prior knowledge or forewarning, high poverty rates, lack of insurance, weak institutions, the absence/problems with emergency response and early warning systems (Amangabara and Obenade, 2015).

Mmom and Aifeshehi (2013) in their study on Niger Delta identified vulnerability to floods highlighted in particular that communities in the region are vulnerable to flood events because they don’t insure their household due to cost, those living close to
river banks are not willing to relocate, most of them claim to be used to the flood episodes notwithstanding their losses. The Niger Delta communities’ resilience to flood therefore depends on economic, ecological, socio-cultural and political factors.

The United Nations Framework Convention on Climate Change (UNFCCC) Report on impacts, vulnerability and adaptations to climate predict that infrastructure and settlements in the Gulf of Guinea, location of the Niger Delta could likely be inundated due sea level rise (UNEP, 2000). This will only exacerbate the already precarious situation in the region – coastal erosion, massive oil pollution, population pressure, flooding and environmental degradation, increasing the ecological and socio-economic vulnerability and impacts (Ogba and Utang, 2007).

With the estimated sea level rise inundation in the Niger Delta coast, which could reach about 100km (French, et al 1997), exacerbating floods through increased storm waves and salt water intrusion, ecosystems especially the Ramsar wetlands and species of high international interest such as the Delta Red Colobus and Crested Genet could be at risk. In particular, their composition will be affected which could lead to species migration or extinction (Ogba and Utang, 2007). Infrastructure and assets from the crude oil industry are not left out as about 500,000 barrels of crude oil output was lost per day during the 2012 severe flooding (Amangabara and Obenade, 2015).

Furthermore, salt water intrusion could contaminate surface fresh water and even ground water. Inundation by flood water could submerge spawning grounds for fish, shrimps, oysters, causing them to move landwards. It could also affect the few non-oil polluted agricultural lands and fishing grounds which are the main source of livelihood of the local people and displace millions of rural dwellers thus causing increased insecurity, poverty and food shortages (Brooks et al, 2006).
3.7 Governance System (GS and Actors)

The Federal Ministry of Environment is statutorily responsible for ensuring environmental protection, natural resources conservation and sustainable development of the Nigerian environment (FMEnv, n.d a). Table 4 summarizes governance system in the Niger delta.

The Department of Pollution Control and Environmental health oversees cases of pollution and remediation, the National Oil Spill Detection and Response Agency (NOSDRA) an Agency under FMEnv is mandated to respond to oil spill incidences and the Nigerian Maritime Administration and Safety Agency (NIMASA) Act of 2007 also mandates NIMASA to maintain the marine environment from pollution (Nwokedi et al, 2017), including responding to oil spills in the marine environment, albeit in conjunction with other statutory agencies.

The Department of Petroleum Resources (DPR) derives its powers from the Petroleum Act 1969 and is statutorily responsible for ensuring compliance to Environmental Guidelines and Standards for the Petroleum Industry in Nigeria.
The National Environmental Standards Regulatory and Enforcement Agency (NESREA) established in 2007 is responsible for the enforcement of all national environmental laws, guidelines, policies, standards and regulations and also the enforcement and compliance with provisions of international agreements, protocols, conventions and treaties on the environment (NESREA, n.d).

The Petroleum Industry Bill (PIB) is intended to reform the petroleum industry and is comprised of a number of instruments: the Petroleum Fiscal Framework Bill, Petroleum Industry Downstream Administration Bill, Petroleum Industry Revenue Management Framework Bill, Petroleum Host Community Bill and the Petroleum Industry Governance Bill (PIGB) which is the Regulatory framework and the only Bill in the PIB that has been passed by the National Assembly (Senate in 2017 and House Representatives 2018), is currently awaiting Presidential assent (Premium Times, 2018; Petroleum industry bill, n.d).

Climate change is a critical issue globally and in Nigeria, hence, the creation of the Department of Climate Change in the Federal Ministry of Environment in 2011 to drive national climate action efforts/actions and the potential submergence of the coastline as it relates to this study (Department of Climate Change Nigeria, n.d a). In order to properly manage the coastal environment, the Department of Erosion, Flood and Coastal Zone Management was created within the FMEnv to provide policy guidelines and implementation strategies to curtail the menace of erosion, flood and coastal degradation including flood forecasting (FMEnv, n.d b).

In year 2000, the FGN established the Niger Delta Development Commission (NDDC) to bring rapid developmental solutions to the socio–economic, ecological/environmental problems in the region through stakeholder consultation and participation in decision-making (Anietie, 2006) However this approach could not deliver the needed development (Famuditi et al, 2014) necessitating the creation of the Ministry of Niger Delta Affairs (MNDA) in 2008 to formulate, execute and coordinate national plans and programs and international interventions towards the
development of the region (MNDA, 2016). Some of these Federal Ministries/Agencies are replicated at the State and local government level, which is closest to the grassroots.

A lack of clear interpretation of EGASPIN, which serves as the operational basis for the Oil and Gas industry in Nigeria by DPR and NOSDRA, has given oil companies like Shell a leeway to conduct remediation of spill sites that falls short of both national standards and international best practices. Furthermore, NOSDRA lacks the capacity and resources to detect oil spills, eventually relying on the oil companies for support, which is an inappropriate approach according to UNEP (UNEP, 2011). The National Emergency Management Agency (NEMA) established in 1999 amongst other duties carry out research, forecast, prepares for, respond to and manage disasters (NEMA, 2013).

Due to the problems of overlap of responsibilities between Ministries and associated agencies coupled with the lack of resources and poor response in management, there are serious gaps in proper environmental management during incidence of oil spills and enforcement of environmental regulations. Also the lack of trust between actors, politically induced tensions amongst communities, national and regional governments, security issues and technical logistic challenges within the Niger Delta further contributes to the problem in the region (UNEP, 2011).

In June 2016, the FGN launched the implementation of the UNEP Report for the cleanup of Ogoniland and other places in the Niger Delta. The Hydrocarbon Pollution Restoration Project (HYPREP) Gazette which provided the institutional framework for the cleanup was reviewed to make it more inclusive and transparent and then forwarded to the Federal Executive Council for consideration and approval. In March/April, 2018, an invitation for Prequalification of Contractors for Remediation of Hydrocarbon Impacted Sites in Ogoniland/Niger Delta was advertised (FMEnv, n.d c)
In addition to the government owned Nigerian National Petroleum Corporation (NNPC), multinational oil companies involved in oil exploration and exploitation in the region includes Chevron, Shell Petroleum Development Corporation (SPDC), Exxon Mobil, Agip etc. Aside from the formal governance structures, diverse informal structures exist at the local community level including agitation groups.

Notably, trust held in traditional institutions has been destroyed, as community members feel that elders no longer care about the communities’ interest but the largesse they can get from the oil companies (Pyagbara, 2007). A number of local and international non-governmental organizations (NGOs) like Niger Delta Development Forum (NDDF), Environmental Rights Action/Friends of the Earth, Nigeria (ERA/FOEN), Stakeholder Democracy Network (SDN), Niger Delta Wetlands Centre (NDWC), the Niger Delta Focus (NDF), the Women Initiatives Network (WINET), African Environmental Action Network (EANET-Africa), Amnesty International (AI), Partners for Peace (P4P) and Niger Delta Peace Coalition (NDPC) etc. have been at the forefront implementing projects geared towards improving local people’s livelihood, reducing marginalization, eradicating poverty, resolving conflicts, seeking an end to violence and advocating for more transparency and accountability from government institutions (de Visser, 2017). NGOs also seek better governance and the development of multilateral strategies instead of single strategies in solving the problems in the region (Newsom, 2011).

In other to ensure resilience, government and institutions need to be adaptive and strong social networks have to be built by encouraging cooperation among stakeholders (Resilience Alliance, 2010). The complexity of the structures and the institutional fragmentation is evident from the information in Table 4 below. The structures for applying SES framework to the Niger Delta coastal SES is shown in Figure 10 below.
### Table 4: Governance in the Niger Delta

<table>
<thead>
<tr>
<th>S/ N</th>
<th>MDA</th>
<th>Responsibility</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Federal Ministry of Environment (FMEnv)</td>
<td>Environmental protection, natural resources conservation and sustainable development of the Nigeria environment.</td>
<td>FMEnv</td>
</tr>
<tr>
<td>a</td>
<td>Department of Pollution Control and Environmental health</td>
<td>Pollution control and remediation</td>
<td>FMEnv</td>
</tr>
<tr>
<td>b</td>
<td>Department of Climate Change</td>
<td>drive national climate action efforts/actions</td>
<td>FMEnv</td>
</tr>
<tr>
<td>c</td>
<td>Department of Erosion, Flood and Coastal Zone</td>
<td>provide policy guidelines and implementation strategies to curtail the menace of erosion, flood and coastal degradation</td>
<td>FMEnv</td>
</tr>
<tr>
<td>d</td>
<td>The Hydrocarbon Pollution Restoration Project (HYPREP)</td>
<td>Institutional framework for the clean-up of the Niger delta region</td>
<td>FMEnv</td>
</tr>
<tr>
<td>2</td>
<td>National Oil Spill Detection and Response Agency (NOSDRA)</td>
<td>respond to oil spill incidents</td>
<td>Agency/FMEnv</td>
</tr>
<tr>
<td>3</td>
<td>Nigeria Maritime Administration and Safety Agency (NIMASA)</td>
<td>maintain the marine environment from pollution</td>
<td>Federal Ministry of Transportation</td>
</tr>
<tr>
<td>4</td>
<td>Department of Petroleum Resources (DPR)</td>
<td>ensuring compliance to EGASPIN and other regulations the Oil and Gas Industry</td>
<td>Technical arm, Ministry of Petroleum Resources</td>
</tr>
<tr>
<td>5</td>
<td>National Environmental Standards Regulatory and Enforcement Agency (NESREA)</td>
<td>enforcement of all national environmental laws, guidelines, policies, standards and regulations and compliance with provisions of international conventions</td>
<td>Agency/FMEnv</td>
</tr>
<tr>
<td></td>
<td>Agency/Group</td>
<td>Role/Function</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Niger Delta Development Commission (NDDC)</td>
<td>Facilitate the rapid and sustainable development of the Niger Delta into an economically prosperous, socially stable, ecologically regenerative and politically peaceful region.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Ministry of Niger Delta Affairs (MNDA)</td>
<td>Formulate, execute and coordinate national plans and program and international interventions towards the development of the region.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Community leadership</td>
<td>Upholding traditions and social value.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>NGOs</td>
<td>Seeking transparency, accountability from government and development for the communities.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Agitation groups</td>
<td>Canvassing for wealth distribution and development for the region.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>State Oil Producing Areas Development Commission (SOPADEC)</td>
<td>Developmental issues.</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Author)
Figure 10: Applying SES framework to the Niger Delta coastal SES

Social, economic political settings (S)
National economy

Governance System
Government MDAs – FMENV, FMPR, DPR, NOSDRA, (Federal, State & local), PIB, EGASPIN, Community

Interactions (I): unsustainable resource use, natural occurrences, weak regulations
Outcome (O): severe (oil) pollution, destruction of livelihood sources, increased vulnerabilities/reducing resilience

Resource System
The Niger Delta coastal SES

Resource unit
Wetlands, Farmlands, Water, rivers, soil, mangroves, crude deposits

Related Ecosystems (ECO)
Erosion, floods, sea level rise

Actors
Government, Multinational Oil companies (SPDC, Chevron, Mobil), NGOs, Farmers, fishermen, pressure groups, local community

(Source: Author – adapted to McGinnis and Ostrom, 2014)
CHAPTER FOUR

4 RESILIENCE ASSESSMENT

4.1 Background

There are many frameworks for assessing the resilience of SESs (Nemec et al, 2013). Schouten et al (2009) rightly asserts that assessing resilience in SESs is constrained by complexity and availability of data, however most literatures use two main approaches for assessing resilience (a) a resilience index to assess resilience at a macro level (b) case study or a series of case studies to assess resilience. This research adopts the first approach.

Resilience of SESs is a fundamental measure of sustainable development, as resilience is the ability of systems to respond to change in way that ensures continuous functioning of the people and ecosystem while sustainable development is the ability of humans to manage their demands on natural resources within ecosystem’ regeneration capacities (Bhamra, 2015) . In assessing resilience, it is important to define the scope: resilience of what system, of who, to what and the time frame. This is given in the figure 11 below.
4.1.1 Assessment Methodology
The resilience assessment will involve the 4 steps contained in Figure 12 below;

Figure 12: Resilience assessment steps

(Adapted from OECD, 2014)
Resilience of the Niger Delta SES will be assessed using two methods;

1. An adaptation of resilience assessment indicators of sustainable development for socio-ecological systems by Bhamra (2015), categorized under social, environmental/ecological, governance and economic systems. The current state of the components in each of the systems is discussed based on available theoretical/scientific information from secondary sources to support arguments and then graded using a scale of 5-1, where 5=Excellent/very high, 4=Good/high, 3=moderate, 2=Poor and 1=Critical.

2. The second assessment is an adaptation of the simplified desktop approach used by Nemec et al., (2013) based on Walker and Salt’s (2006) identification of nine general resilience characteristics, which are focused on adaptive capacity of systems and the seven resilience building attributes outlined by Stockholm Resilience Center (n.d). Scores are based on the descriptive analysis of the social, environmental, governance and economic system from the first assessment. Scoring system used is in line with Nemec et al., (2013) where 5=exhibits resilience, 1=not resilient, 3=neutral condition, not clearly exhibiting or lacking resilience, 2 and 4=intermediate resilience between scores. The mean value of scores is calculated to determine the resilience level appertaining to the research area.

4.2 FIRST ASSESSMENT

4.2.1 Social Systems

4.2.1.1 Vulnerabilities

Vulnerability is the tendency of being prone to adverse effects, not being able to adapt or cope (Department of Climate Change Nigeria, n.d b). Nigeria is a lower middle income developing country, with a GDP per capita (as at 2017) of US$1,968.6 (World Bank, 2018) with 62.5% of the population living below international and national poverty line (Nigeria SDGs IBR, 2016). Nigeria and indeed the Niger Delta are highly vulnerable to climate change impacts due to its
economic situation, geography, population, settlement type, agricultural and energy systems. (Department of Climate Change Nigeria, n.d b). Musa et al., (2014) asserts that 42.6% of the Niger Delta characterized by unconfined aquifer, low slopes and topography and high mean wave heights are highly vulnerable to sea level rise, as well as flood/erosion due to increased rainfall. Moreover, experience has demonstrated that one occurrence of an extreme event is able to destroy developments which were built over the years. The destruction by the 2012 floods amounted to N1.48 trillion (US$9.5 billion) (Nigerian INDC, 2015).

**Figure 13: Geography of the Niger Delta**

(Ezenwaka, 2012)
Figure 14: Spatial Variation in relative climate change vulnerability

(FMEnv, n.d)

Figure 15: Flood prone areas in Nigeria

(FMEnv, n.d)
4.2.1.2 Food

Food insecurity covers accessibility, affordability and availability of food. Environmental degradation in the Niger Delta has led to decrease in food production, poor yield, scarcity and high cost of food. Most rural farmers harvest their crops before maturation due to the risk of floods and oil spills and do not have access to storage facilities and government agricultural facilities. Fishery resources which are source of proteins are also severely depleted from oil pollution (Amnesty International, 2009; Babatunde, 2017).

4.2.1.3 Water and sanitation

About 40% of the Nigerian population does not have access to potable water (Nigeria INDC, 2015), and only about 60% of the total population have access to improved sanitation. As a result, deaths resulting from unsafe water and sanitation/hygiene are 335 per 100,000 male and 382 per 100,000 female (Nigeria SDGs IBR, 2016). Ekong et al (2012) stated that 85.7% of people in the Niger Delta do not have access to good drinking water as sources of water supply are from contaminated rivers, lakes, rain water, unsafe wells, water vendors, untreated boreholes and taps causing ill health. Only about 25% of rural households in the region are estimated to have sanitation facilities (Ugochukwu, 2008).

4.2.1.4 Housing/shelter

Aside major cities and towns like Asaba, Port-Harcourt, Yenegoa, etc. which form just 1% of the 13,329 settlements in the region, settlements in the rural areas are scattered and are poor quality houses made from mud with some in swampy areas (UNDP, 2006; Kimenyi et al 2014). This corroborates the 2013 survey by the National Bureau of Statistics (see Table 5 below). The case study Bayelsa, Delta and Rivers States are in the south-south geopolitical region.

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4.2.1.5 Education

Generally, the illiteracy level is still high in Nigeria, with the total number of out of school children at about 13.2 million and a dearth of educational materials (Vanguard, 2017). According to figures from NBS (2016a) Bayelsa, Delta and Rivers States had 7% of both number of primary schools and pupils compared to the
national figures in 2013 (see Table 6 below). These states also had 10% of tertiary institutions graduates in 2014. The Amnesty program by the Yar’Adua administration briefly boosted education and skill acquisition in the region however the quality of education is still quite low due to poor infrastructure especially in the rural areas (UNDP, 2006) with poverty affecting the level of education.

### Table 6: Number of public and private primary schools and pupils for year 2013 in study area

<table>
<thead>
<tr>
<th>State</th>
<th>No. of public schools</th>
<th>No. of private schools</th>
<th>Total</th>
<th>No. of public schools pupils</th>
<th>No. of private school pupils</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayelsa</td>
<td>545</td>
<td>205</td>
<td>750</td>
<td>218,433</td>
<td>19,019</td>
<td>237,452</td>
</tr>
<tr>
<td>Delta</td>
<td>1,293</td>
<td>1,407</td>
<td>2700</td>
<td>350,539</td>
<td>130,875</td>
<td>481,414</td>
</tr>
<tr>
<td>Rivers</td>
<td>2,273</td>
<td>586</td>
<td>2859</td>
<td>1,037,722</td>
<td>63,625</td>
<td>1,101,347</td>
</tr>
<tr>
<td>Sub total</td>
<td>4,111</td>
<td>2,198</td>
<td>6,309</td>
<td>1,606,694</td>
<td>213,519</td>
<td>1,820,213</td>
</tr>
<tr>
<td>National total</td>
<td>60,064</td>
<td>32,787</td>
<td>92,851</td>
<td>22,281,327</td>
<td>3,886,218</td>
<td>26,167,545</td>
</tr>
</tbody>
</table>

(Extracted from NBS, 2016a)

4.2.1.6 Access to financial resources and decent livelihood
The UNDP HDR (2018) measurement of human development index (HDI), based on longevity and health, access to knowledge and decent standard of living put Nigeria’s value for 2017 at 0.532 which falls within low human development category at 157 out of 189 countries. The gender development index (GDI) reflecting gender
inequalities in Nigeria for female at 0.494 and male at 0.569, resulting in a GDI value of 0.868.

The 2013 survey for multidimensional poverty index (MPI), which is a measure of multiple/overlapping deprivations, provides that 50.9% of Nigerian population are multi-dimensionally poor. Nigeria SDGs IBR (2016) puts the percentage of the population living below the national poverty line at 62.6%, rate of unemployment at 36% and total government spending on social protection and employment at 0.95% of GDP. The Enhancing Financial Innovation and Access (EFInA) Report (2012) shows that 42.7% and 35.8% of the total adult female and male population respectively are financially excluded in Nigeria, the same applies to 47.8% of rural and 24.8% of urban adult population.

According to Central Bank of Nigeria (2005) about 35% of the Nigerian population gets services from the formal financial system while 65% do not have access to formal financial services but source from informal sectors like family, friends, NGOs, money lenders and credit unions. In addition, 80% of micro, small and medium enterprises/agricultural business don’t have access to financial resources due to inadequate information, poor market access and credit worthiness, low human capital development, poor infrastructure, dysfunctional financial infrastructure, not understanding government policies and incoordination across the three tiers of government (Eluhaiwe, 2013), along with short payback time, corruption and nepotism (Obokoh et al, 2016).

This deficit has resulted in heavy reliance on informal financial sector by rural farmers. According to the study by Essien and Arene (2014) access to informal credit by small scale agro-based enterprises in the Niger Delta region is influenced by gender, age and social capital, while formal credit access are influenced by educational level, age, size of enterprise and collateral. There is also a clear gender bias as is evident from Ifere and Okosu (2017), who in their study on poverty reduction through financial inclusion in the region found out that 65% of the female
respondents as against 35% male have never used or accessed finance. The South-South geopolitical zone is 32.7% financially excluded while South-East is 25.4% and South-West 24.8%. Even though a sizeable number of the Niger Delta rural people know about electronic banking most of them have never used it as it has not been made available in the rural areas.

The major sources of livelihood in the Niger Delta are artisanal fishing, farming and trading as evident from a survey by Ifere and Okosu (2017), which shows that 11.08%, 24.53% and 43.16% of the population sampled in the Niger Delta were fishermen, traders and artisanal/commercial farmers. These skills are transferred to the next generation by upbringing (MNDA, 2011) but the environmental degradation in the region have rendered most agricultural lands unproductive and drastically reduced fish stock, increasing poverty and dependence level to 21.23% of the respondents in the survey. The unemployment rate in the region is above 40% contributing to violence. Youths from the region seek employment in informal sector in urban areas not to work as farmers (NDDC, 2005; Francis et al 2011). The percentage of unemployment, poverty and illiteracy in Nigeria is high, causing huge dependence on biodiversity for sustenance as over 70% of Nigerians live in rural areas and depend heavily on agriculture and natural resources causing pressure and overexploitation (Nigeria Fifth NBR, 2015).

4.2.1.7 Information technology

The advent of the global system for mobile communication (GSM) in the early 2000s revolutionized ICT as 52% of the Nigerian population is covered by mobile broadband network with 74% urban and 48.3% rural population owning a mobile phone (Nigeria SDGs IBR, 2016). Internet services also grew with mobile telephones usage (IWS, 2018), these services are however still marred by high costs, intermittent services and illiteracy. Local radio stations can be easily accessed. Local television stations are mostly free while cable televisions are subscribed at a monthly rate but access depends on the availability of power.
4.2.1.8  **Transportation**
Aside the major cities, most rural parts in the Niger Delta are not easily accessible by roads because of the difficult terrain but through water transportation (speed boats, ferries and canoes, see Figure 17 below). Most available roads are in poor conditions and require the use of motorcycles, commonly called ‘okada’ to navigate them (Okon, 2011). The Federal Government of Nigeria (FGN) through the Federal Ministry of Transportation (FMT) and the National Inland Waterways Authority (NIWA) work to improve inland waterways navigation by offering ferry services, give information on waterways infrastructure, safety, security and emergencies (NIWA, 2018). Also the FMT through the Nigerian Railway Corporation (NRC) intends to construct coastal railway from Lagos - Port Harcourt – Calabar to ease transportation difficulties.

**Figure 17: Major means of transportation in the Niger Delta**

(Okon, 2011; Akinleye, 2013)
4.2.1.9 Social network/integration
The Niger Delta region comprises of diverse vulnerable and disadvantaged populations that are heterogeneous in culture and ethnicity and this differences are not considered in development strategies and practices which are at best top-down in nature excluding the local communities from decision making that would have ensured the sustainability of development projects. Even though the bulk of the national wealth is derived from the region, it is excluded in terms of the provision of social amenities on a regional basis (Kimenyi et al, 2014).

Social networks/connections in the Niger Delta communities are centered on family, friends, community members/groups and nearby outer communities. The youths have the most access to information within and outside the communities and help transmit it usually through phones. Most communities are overseen by community heads, chiefs or kings who are information brokers/focal points between the community members, government officials, the oil companies and outsiders (Okon, 2011), community head-community members relationship is sometimes threatened by the
quest for personal gain by the community heads. Faith based organizations also play an important role in building social networks and ensuring integration.

Due to the struggle for power and resources, social cohesion across certain ethnic groups are problematic as the Ijaw and the Itsekiri, Itsekiri and the Urhobo and Ilaje and Ijaw tribes have some degree of conflict that on occasion can lead to violence within the region (de Visser, 2017; Folami and Chamberlain, 2017).

4.2.1.10 Local Asset ownership

The people of the Niger Delta like other Africans have strong psychological and spiritual attachment/connection to land recognizing it as a basis of their existence determining livelihoods, traditional religion, and culture. In the same way, forests are regarded as sacred possessions. Due to the topography of the region, land is scarce and particularly fertile land (Emuedo and Abam, 2015).

Nigeria SDGs IBR (2016) has put the statistics of agricultural land ownership by sex and tenure at 71.1% and 78.1% for male and females respectively. The Land Use Act of 1978 vests all lands in the Federal Government however customary land ownership still exists in some parts of the Niger Delta as land owners are at liberty to sell lands to a purchaser.

Before the Land Use Act, multinational oil companies negotiate and pay rent directly to the owners of land where they operate. More recently, the federal and state governments receive oil revenues directly instead of the land-owners who still suffer the loss of their livelihood and the degradation of their property assets from oil operations (Emuedo and Abam, 2015).

The limitation of local communities’ and private property rights results in inefficient and unsustainable resource use. This is compounded by government agencies and oil companies ignoring communal rights. This tenure insecurity in land ownership affects agricultural productivity as farmers may not plant tree crops that take time to mature if the land ownership is not certain (Ugochukwu, 2008). In addition, the
bureaucracy involved in documenting land transactions is crucial to the development of initiatives by the private sector (Udoekanem et al, 2014).

4.2.1.11 Fulfillment of aspirations/fruitful living
Although the Nigerian economy largely depends on the revenue generated from the resources in the Niger Delta, the quality of life of the people haven’t improved (Akinleye, 2013) due to high rate of poverty and underdevelopment even though the region receives the higher proportion from the federation account.

In Nigeria, the current life expectancy for men is 52 years and 54 years for women (BBC, 2018), while in the Niger Delta it was estimated at 32 years in 2016, declining from 45 years in 2011. There is some support for the view that this is not unconnected to oil drilling activities, which exposes the people to gas flares and heavy metals leading to incidences of cancer, gastro-intestinal problems, liver, kidney and lung diseases, neurological and reproductive problems etc. (Binuomoyo and Ogunsola, 2017).

Ezejimofor et al (2018) in their study reports the steady increase in frequency of hypertension in the region “for every 10 years increase in participants’ mean age, the prevalence of hypertension increases by 10.43%”. Moreover, the causative factors are linked to the socio-economic disparity, lifestyle and pollution levels.

4.2.1.12 Spiritual fulfillment
Africans in general and indigenes of the Niger Delta in particular have customs and traditions that are spiritually significant rooted in nature – land, rivers, streams, forests etc., which are sacrosanct. There is a common belief that desecrating them will mean calamities for the communities. Although Christianity is now widely accepted in the region, some still practice the traditional religious activities involving the use of materials from the mangroves e.g. using roots of Rhizophora mangrove species root in beating drums at yearly Masquerade festival in Buguma community. Most of the herbs used in spiritual traditional medicine has been destroyed by oil
spills and gas flares impacting on their cultural and spiritual values (Pyagbara, 2007; James et al, 2013).

**Table 7: Social system assessment**

<table>
<thead>
<tr>
<th>Levels of Resilience</th>
<th>Status</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vulnerabilities</td>
<td>Food (Babatunde, 2017)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water and sanitation (Nigeria INDC, 2015, Nigeria SDGs IBR 2016)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Housing (UNDP 2006; NBS, 2016b)</td>
</tr>
<tr>
<td>2</td>
<td>Human empowerment</td>
<td>Educational level (NBS, 2016b; Vanguard, 2017)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Access to financial resources (Essien and Arene, 2014; EFInA, 2012 and Eluhaiwe, 2013)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decent livelihood (MNDA, 2011; Ifere and Okosu, 2017)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Access to information &amp; communication technology (Okon, 2011; Nigeria SDGs IBR, 2015)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Access to transport (UNDP, 2006; Okon, 2011)</td>
</tr>
<tr>
<td>3</td>
<td>Community empowerment</td>
<td>Social networks (Okon, 2011)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Social integration (Folami and Chamberlain, 2017; de Visser, 2017)</td>
</tr>
</tbody>
</table>
4.2.2 Environmental/Ecological System

4.2.2.1 Frequency of disturbance/disaster
Oil spillages are regarded as human induced disasters. Incidences of spills are a common and continuous occurrence in the Niger Delta. It is estimated that annually, about 240,000 barrels of crude oil are spilled from old pipelines, human errors, third party activities- bunkering and sabotage and mechanical failures (Ordinioha and Brisibe, 2013; Emuedo and Abam, 2015). According to the Leadership Newspaper 11th April, 2018 in year 2009, 849 oil spill incidents occurred releasing 48,935.556 barrels of oil, similarly in 2010, 582; in 2011, 676, 2012, 841, in 2013, 883, 2014, 1,087, in 2015, 753, 2016, 574 and in 2017, 436 releasing 25,383.151, 66, 907.865, 17, 665.03, 3749.21, 10,302.178, 32,756.868, 35,202.9876 and 10,096.08 barrels of crude oil respectively into the region’s environment.

NEMA reports flooding in Nigeria to be perennial. However current events show that the frequency of floods and the degree of severity fluctuates but is a recurring event aggravated by intense rainfall, climate change - sea level rise and rapid urbanization and poor planning (Slaughter and Odume, 2017). Since 2011, Nigeria has experienced flooding across the country every year. This year, 2018 floods have ravaged the country even more than the 2012 floods and the Niger Delta is not exempted (Vanguard, 2018).
Figure 19: Satellite image showing oil spill locations and wetland coverage in the Niger Delta
(oilspillmonitoring.ng (NOSDRA, SDN 2018))

Figure 20: 2012 and 2018 flood episodes in the Niger Delta
(Vanguard 2012; Daily Post 2018)
4.2.2.2 Disaster preparedness
Nigeria has a National Disaster Management Framework and NEMA is the statutorily recognized Agency for disaster prevention, preparedness, mitigation and response. This is replicated at the State (SEMA) and local government levels (LEMA). NEMA works in concert with the police, other para-military organizations, Fire Service, NGOs, and CBOs etc. NEMA in preparing for flood disaster has developed contingency plans, dissemination of early warning messages, mapped areas vulnerable to flood and embarked on grassroots education (NEMA, 2014). This has not resulted in less casualties as response to emergency is still crisis management at best without preventive plans. Furthermore, people still build on floodplains and ignore warnings on floods issued out by NEMA, National Orientation Agency (NOA) Nigeria Hydrological Services Agency (NHSA) and Nigeria Meteorological Agency (NiMet) (Vanguard, 2018).

For oil spill preparedness and response, NOSDRA oversees the implementation of the national oil spill contingency plan (NOSCP) and ensures that oil spillers are penalized. This approach is not successful due to technical incompetence and dependence on resources from oil companies like helicopters and stockpile equipment needed to carry out clean-up duties. This makes the companies bold enough to manipulate data on the volume and cause of spill and also not carry out a proper clean up (UNEP 2011; Akpofure, 2015). The Bill to amend the NOSDRA Act is currently before the National Assembly. It is hoped that when it becomes law it will attract more funding that will help NOSDRA counter its challenges and live up to its responsibility (The Punch Newspaper, 21st April, 2018).

The problem of poverty affects the need for modification of human behavior in preparation for disasters as people find it difficult to relocate or insure their houses against risks. Allocation of insufficient resources towards disaster prevention and management; insufficient rescue equipment e.g. tracking system for SAR operations and land, sea and air ambulatory services (NEMA has only one helicopter stationed in Abuja and mobile clinics at zonal offices); overlaps between various government
agencies and other bodies; duplication of efforts and inefficiency in handling emergencies are some challenges facing the Agency (Essoh and Abutu, 2018).

4.2.2.3 Post disaster loss and damage
The Post Disaster Needs Assessment conducted for the 2012 floods showed that 7 million people were affected, 2.3 million displaced, 363 died and 597,476 houses were destroyed, so were large parcels of farmlands, biodiversity and animals which served as means of livelihood and 500,000 barrels of crude oil output daily was lost. $9.6 billion worth of assets was destroyed and $7.3 billion was lost from economic activities across sectors. The most affected states were Bayelsa and Rivers States, with Bayelsa having the highest per capita damage and loss (Nigeria PDNA, 2013). In 2013, 19 deaths, 8,000 people displaced and 6,500 homes destroyed. In 2015, 53 people died and 100,420 displaced while in 2016, 100 people lost their lives, 9,000 houses destroyed, 26,000 livestock were lost and 92,000 homeless and in 2017 about 90 deaths occurred (Vanguard, 2018).

This year 2018, about 141 persons have died, 5,732 houses have been destroyed displacing 19,369 people. In the Niger Delta, Vanguard (2018) reports that Delta state, 43 houses have been destroyed in Koko, Araya, Jesse, Oghara and Agbarhor and 63 communities affected. In Rivers State, 15 persons severely wounded, 200 houses and 85 electric poles have been damaged and Cross-River State 321 houses have been damaged displacing 500 persons.

The oil spills that have occurred in the Niger Delta is far greater in volume and impact than the Gulf of Mexico spill which attracted the world’s attention. These have destroyed and continue to destroy mangrove forests, farmlands, fishery resources, affect livelihood, contaminate water sources and even cause illness and reduce life expectancy (The Guardian, 2010).
There are more than 123 gas flaring locations which flares 75% of associated gas produced in the region, releasing CO₂, NOx, SO₂, heavy metals, black carbon soot, VOCs (carcinogenic) and PAHs from incomplete combustion of petroleum gases which have reduced air quality (Ite et al., 2013). The Social Democratic Network (SDN, 2018) has reported that gas flared daily in the Niger Delta is equal to quantity consumed daily in Brazil. This huge waste leaves communities without effective energy solutions, and contributes the largest CO₂ emissions in Africa. UNEP, reported high concentrations of benzene (0.155 to 48.2μg/m3) in all air samples tested in Ogoniland which are 10% higher than the WHO acceptable levels. Across the region, high PAHs concentration in groundwater (1.92-40.47 μg l⁻¹) makes water solubility low, with some groundwater having layered oil of 8cm floating on the surface. Drinking water wells and rivers are also grossly polluted (UNEP, 2011; Ite et al., 2013).

Emuedo et al (2013) in their study of water quality in Nembe, Okpare and Okrika in Bayelsa, Delta and Rivers states respectively, discovered that pH of water samples collected was acidic (5.07±0.05-5.43±0.04 rainy season/ 5.00±0.00-5.20±0.14 dry
period) and had high amounts of heavy metals (lead, zinc, chromium, cadmium and copper). Similarly, Nduka and Orisakwe (2010) observed that some the temperature of some water bodies exceeded 30°C across the 3 states and Ozubo river (Rivers state) having the highest level of chloride and Etim et al, (2013) in their assessment across the region for physico-chemical parameters concluded that stream water are unsafe for human consumption. In Ogoniland as with other grossly oil polluted places in the Niger Delta, UNEP (2011) reported hydrocarbons in soil at 5m depth for 49 sites. This has chronic and acute toxic effects on plants, reduces oxygen content in soil, causing death of plants (Ite et al, 2013).

4.2.2.5 Inclusion of environmental cost in market pricing mechanism
The National Biodiversity Strategy and Action Plan (NBSAP) includes as the second target by 2020 the development and implementation of biodiversity valuation and payment for ecosystem services (PES). This will be achieved by carrying out studies on economic value of biodiversity and the Economics of Ecosystems and Biodiversity (TEEB), which will be integrated into national accounts, strategies and planning process to improve investment by the private sector and corporate social support to biodiversity protection (Nigeria Fifth NBR, 2015). Bassey et al (2013) in their study on the Implementation of Environmental Cost Management Impacts of Oil and Gas Companies Output from 2001 to 2010 reported that Nigeria has no instituted standard for environmental cost management in the oil and gas industries. The UNSD website shows Nigeria does not have any classification for Environmental-Economic Accounting.

4.2.2.6 Maintenance of biodiversity and promotion of local species
Nigeria is rich in biodiversity, having 274 mammals, 941 birds, 135 reptile, 109 amphibians, 145 orchids and 5209 flowering plant species with 91 endemic floras and about 35 faunal species. There are 7 national parks, 27 important bird areas, 11 Ramsar sites (3 in the ND), 2 world heritage sites, 994 forest reserves, 32 game reserves, 1 biosphere reserve and many sacred groves (Nigeria Fifth NBR, 2015). The Niger Delta being the most biologically diverse region have species of local and international importance (Ebeku, 2004) with 314 of the 338 inland fish species
occurring there, serving in the provision ecological services for the populace with opportunities in research and development of scientific of understudied species.

According to IUCN Red list 2013, Nigeria has a total of 309 threatened species. About 70-80% of her forest cover has been lost, reducing to 9.6 million ha in 2011 from 15 million ha in 1995 and 24 million ha in 1976 (Nigeria Fifth NBR, 2015). Biodiversity is threatened by unsustainable agricultural practises, cultural practises which encourage consumption and over exploitation of certain species, environmental degradation from extractive processes, oil spill, gas flares and industrial pollution which is responsible for 10% loss of mangroves in the Niger Delta (UNEP, 2011), as well as illegal logging and high dependence on firewood as 70% of Nigerian population use it. High population growth rate, high poverty rates policy and budgetary constraints, poor implementation, poor land use planning and lack of cohesion amongst institutions, poor governance, corruption and lack of political are major challenges to biodiversity conservation in the country.

The ecological fund (2% of annual budget) was set up to help tackle environmental challenges in the country, but has largely been diverted by the government for other uses. The Niger Delta Environmental Survey (NDES) was conducted in 1997 to assess biodiversity/habitats in the region however gaps still exists in the current scientific state of biodiversity. The Gulf of Guinea Large Marine Ecosystem (GGLME) and 2012 Guinea Current Large Marine Ecosystem (GCLME) ecosystem assessment projects was undertaken to develop strategic action plans for sustainable management of coastal resources in countries in the Gulf of Guinea (GoG) (Nigeria Fifth NBR, 2015). A National Biodiversity Strategy and Action Plan (NBSAP) 2011-2020 of 14 SMART targets akin to the Aichi targets has been adopted to protect biodiversity. There is need to integrate relevant sectoral plans with biodiversity issues and to ensure international /transboundary cooperation (Nigeria 5th NBR, 2015). The problem does not lie entirely in the absence of customary, national or
international frameworks, but in the implementation of existing obligations under national and international law (Ebuku, 2004).

4.2.2.7 Resource efficiency in production and consumption
In Nigeria, consumption level is generally high as population growth, rapid urbanization and affluence drives consumption with the rich consuming more than the poor, who depend on local products (Abd’Razack et al, 2013). Nigeria has a National Action Plan for Sustainable Consumption and Production (SCP) which is incorporated into national policies to ensure reduction of poverty and sustainable development. The material footprint per capita is $1,845.85 and per GDP $3,491.93, while domestic material consumption per GDP is $3,491.39 and per capita is $1,845.57. 73.28% of hazardous waste is generated per capita of which only 0.24% is treated and only 0.24% of materials are recycled (Nigeria SGDs IBR, 2016).

4.2.2.8 Ecological footprint
The ecological footprint (EF) measures sustainability and is the area/size of the environment required to produce the goods and services that can support consumption lifestyle and disposal of waste (WWF, 2017). According to Global Footprint Network (GFN, 2018), the latest EF based on 2014 data shows that world EF is 2.84gha while Nigeria is 1.12gha. This figure does not necessarily show sustainability of the Nigerian environment but may imply gaps in meeting basic housing, energy and transport needs (RusselSmith Innova Magazine, 5th May 2017). Furthermore, there are no statistics on the EF of the Niger Delta, however judging from the level of environmental degradation, limited land and unsustainable resource extraction in the region at present, the EF may be close to, if not higher than the global average.
Figure 22: Latest Nigeria Ecological footprint based on 2014 data

Table 8: Environmental system assessment

<table>
<thead>
<tr>
<th>Levels of Resilience</th>
<th>Concern</th>
<th>Indicators</th>
<th>5 Very high</th>
<th>4 High</th>
<th>3 moderate</th>
<th>2 Poor</th>
<th>1 Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Disaster resilience</td>
<td>Frequency of disturbance/stress (disasters) (oil spill/ flooding) (Ordinioha and Brisibe, 2013; Emuedo and Abam, 2015; (Slaughter and Odume, 2017).</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Disaster preparedness (NEMA 2014; Essoh and Abutu, 2018).</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post disaster loss and damage (Nigeria PDNA, 2013; the Guardian, 2010).</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.2.3 Governance System

4.2.3.1 Accountability and Transparency
A strong nexus exists between governance and development. In the Niger Delta, corruption, political inclinations/power and mismanagement of public funds by office holders are underlying factors responsible for underdevelopment in the region. Even in the current democratic dispensation, transparency and accountability variables for good governance is lacking in leaders and institutions, impinging on the achievement of sustainable development (Arugu and Akpan, 2018). There is no accountability by the federal, state and local governments as to how constitutional and statutory funds are dispensed, low and poor national budget transparency and actual implementation (Ushie, 2012). In addition, appointments to regulatory institutions are politicized making them inefficient, favoritism abound in the granting of exploration and rights and licenses and the existence of bureaucratic bottlenecks and inefficiencies in government (Iledare and Suberu, 2010). This lack of transparency, accountability and corruption transcends to poor delivery of services by private contracting/service providers in contract implementation (SDN, 2018). Years after the establishment of the NDDC, not much has changed in the
region not minding the huge financial resources allocated to them, the State
government and the State Oil producing Areas Development Commissions. The
transparency and accountability ranking of Niger Delta Institutions by Dynamic
Transparency (DYNTRA) as at March 2018 rates the NDDC at 30.61% and MNDA
26.53%, while public access to information is 83.33% and 50% respectively
(DYNTRA, 2018). NGOs and citizens are still making demands for transparency and
accountability notwithstanding the institutionalizing and the results to be derived
from the Nigerian Extractive Industry Transparency Initiative (NEITI).

Figure 23: DNDI chart for NDDC and MNDA

(DYNTRA, 2018)

4.2.3.2 Decentralized power, planning and control
Nigeria is a federal state with a governance layers at the national, state and local
levels. There is a power (political, fiscal and administrative) devolution structure
targeted at enabling accountability, efficiency, inclusive participatory governance
and development to reach the grassroots. In practice however reforms take hold
slowly and development agendas have not been people- centered nor participatory
leading to gross underdevelopment, low quality life, frustration and alienation from
government (Ushie, 2012).
Having stated the above, Nigeria is largely a mono-economic state depending wholly on oil revenues, which is shared between the three tiers of government. Currently control of natural resources in this case oil derived from the Niger Delta is centralized and vested in the federal government on the premise of ensuring macroeconomic growth and equitable distribution of wealth to engender development. However, this is not the case as significant benefits of the oil wealth are absent in the Niger Delta with only environmental degradation to show. Pointedly, it was only with strong agitation and call for resource control by the people of the Niger Delta that the constitutional provision of the 13% derivation fund from natural resources was instituted and shared amongst the oil producing states. Even with that, the people are still living in poverty with high rates of unemployment, pollution and under-development, which has been the bane of conflict in the region (Ayokhai and Bwashi, 2015).

4.2.3.4 Presence of the people's vision in development
Akinola (2010) describes the current governance system in the Niger Delta as highly centralized, excluding the people from the process of decision making and benefiting from it. At best the government, agencies, oil companies and local people work in parallel leading to exclusion and marginalization of the people. This is attributable to the disconnection caused by the absence of motivating mechanisms by the responsible institutions to work with local people. For people to benefit from governance, governance systems have to proceed and be guided by the people to ensure that development programs are suited to meet their needs only then can development be sustainable (Okinono et al, 2015). The FGN in June, 2018 unveiled the New Vision for the Niger Delta (NEVIND) an action plan to ensure development of the region through the active partnership of all levels of government, the private sector and local communities (FGN, 2018).

4.2.3.5 Green Infrastructure
Green infrastructure refers to a resilient way of using natural area -vegetation, soil and other forms to restore natural processes and manage wet weather at lower cost by treating it at source to deliver cleaner air and water, flood protection for
environmental, social and economic benefits (US EPA, 2018). In Nigeria, the importance of green infrastructure is yet to be fully understood (FABE International Foundation, 2016). Apart from well-planned urban areas, oil companies’ residential areas designed with sustainability in mind, and few recreational parks, green infrastructure available in the Niger Delta are traditional rainwater harvesting at individual scales consisting of dug-out concretized wells in upland areas used to collect and store rainwater for later use. The absence of such infrastructure contributes to large quantity of storm water runoff, which results in flooding exacerbated by the clogged drainage systems ‘where available’ (Vanguard, 2018).

4.2.3.6 Resource Efficiency in planning
Resources are the backbone of every economy. Resource efficiency entails being able to produce more economic value and general wellbeing with less resources, while generating less waste, which reduces the impact on human health and the environment and supports green economic targeted at these sectors; transportation, energy, water, land and management, and sustainable buildings. Nigeria’s Sustainable Energy for All Action Agenda (SE4ALL-AA) and Climate Change Adaptation Plan etc. recognizes the need for low carbon technology and resource use efficiency however implementation is a problem as Omuta (2014) highlights that Nigeria set the zero-flare deadlines since the 1980s nonetheless, 75% of associated natural gas is still being flared with only 12% being re-injected. There was also plan to raise earnings from natural gas to half the revenue derived from oil in 2010. The aforementioned coupled with pressure from the overexploitation of biodiversity by the locals who depend on it pushes the environment to the brink of collapse. In this narrative, the focus has been more on economic gains and less on social and environmental well-being (Ugochukwu, 2008). Nigeria recognizes resource efficiency in planning but lacks political will to implement appropriate policies and laws to advance sustainability which may affect attainment of the 2030 Agenda for Sustainable Development.
Table 9: Governance system assessment

<table>
<thead>
<tr>
<th>Levels of Resilience</th>
<th>Concern</th>
<th>Indicators</th>
<th>5 Very high</th>
<th>4 High</th>
<th>3 Moderate</th>
<th>2 Poor</th>
<th>1 Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Resilience governance</td>
<td>Accountability (DYNTRA, 2018; SDN, 2018; Arugu and Akpan, 2018)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transparency (DYNTRA, 2018; SDN, 2018; Arugu and Akpan, 2018)</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decentralized power and control (Ushie, 2012; Ayokhai and Bwashi, 2015).</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Integrated development planning</td>
<td>Presence of the peoples’ vision (Akinola, 2010; Okinono et al, 2015)</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Green Infrastructure</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resource efficiency in planning (Omuta, 2014)</td>
<td></td>
<td></td>
<td>✓</td>
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<td></td>
</tr>
</tbody>
</table>

(Source: Author)

4.2.4 Economic System

4.2.4.1 Use of Green technologies

Green technologies are alternative innovative techniques for creating services/products that are economically viable yet sustainable, taking into consideration the lifecycle of products, and aims at reducing waste at source. It includes renewable energy and energy efficiency, green buildings, environmentally preferred purchasing, green chemistry and nanotechnology.
With regard to energy, Nigeria has abundant supply of renewable energy— an average of 6.25 hours daily sunshine, yielding 49,092,212 kWh of energy from the sun, equivalent to around 1,082 million tonnes of oil; (4,000 and 13,000 times the daily crude oil and natural gas production), hydropower contributing about 29% of total electric-power supply (UNIDO UNU-MERIT, 2014), biomass and wind with average height of 10m and 2–4 m$^2$ yearly. Despite this abundance and the policies/plans in place, SE4ALL-AA containing the National Energy Policy 2006, National Energy Master Plan 2006, Renewable Energy Master Plan (REMP), National Biofuel Policy (NBP) etc., there is still shortage of energy which affects quality of life, livelihoods and the economy mostly due to inadequate funding and lack of coordination amongst government agencies. The use of clean stoves is still being encouraged to counteract the use of firewood by the local population (Mshelia, 2013).

4.2.4.2 Resource efficiency of natural inputs
Natural inputs are those physical inputs that are used in production, they are classified by the UN into the following: natural resources inputs, renewable energy inputs and other natural inputs (UNSD, 2012). In the Niger delta natural inputs consists of metals, minerals, fuels, water, land, timber, fertile soil, clean air and biodiversity etc. the current state shows inefficiency in use as agricultural soils, water sources and air are grossly polluted through the production processes of oil and gas. The forests and biodiversity are also grossly depleted by petroleum industry activities and by the overdependence of local communities Resource efficiency will mean using flared gas to generate power for the citizens and at the same time reduce impacts on the environment. The absence of adequate infrastructure to accomplish that, impacts on the environment and other inputs.
Table 10: Economic system assessment

<table>
<thead>
<tr>
<th>Levels of Resilience</th>
<th>Concern</th>
<th>Indicators</th>
<th>5 Very High</th>
<th>4 High</th>
<th>3 Moderate</th>
<th>2 Poor</th>
<th>1 Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>Sustainable production</td>
<td>Use of Green Technologies (Mshelia, 2013)</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inclusion of environmental costs in market prices. (Nigeria Fifth NBR, 2015; Bassey et al, 2013) (See section 4.2.2.5)</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resource efficiency of natural inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Level 2</td>
<td>Sustainable consumption</td>
<td>Lifestyle patterns &amp; Per capita footprint (Nigeria SDGs IBR, 2016) (see section 4.2.2.7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

4.3 SECOND ASSESSMENT

Table 11: Resilience assessment, adaptation of Nemec et al (2013)

<table>
<thead>
<tr>
<th>Resilience property</th>
<th>Score category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity/redundancy (ecological, socio-economic)</td>
<td>4= Ecological: Niger Delta region is ecologically diverse with heterogeneous habitats-floodplains and wetlands and high number of common species and 126 endemic species. About 309 species are threatened in Nigeria due to habitat destroying activities. (Nigeria Fifth NBR, 2015)</td>
</tr>
<tr>
<td></td>
<td>2=Social: The system lacks diversity of livelihoods which are further affected by affected oil spill incidents (Ifere and Okosu, 2017).</td>
</tr>
<tr>
<td>Modularity/connectivity</td>
<td>Connectivity in a system is a two-way variable that can either enhance resilience or spread disturbance. 3 = Ecologically, high connectivity exists in the region because of land-sea interface which can lead to salt water intrusion. Disturbances are able to impact the systems</td>
</tr>
<tr>
<td></td>
<td>3 = socially, communication avenues and connectivity</td>
</tr>
</tbody>
</table>
exists but are very limited across vertical and/or horizontal scales. Quality of communication may not be equitable.

| Acknowledging and managing slow variables/ Tight feedbacks | 2 = recognition of slow variables is limited, there are no institutional structure in place to periodically investigate, experiment and monitor variables in the system for feedbacks. Even when incorporated into policy, they are not readily implemented. This is attributable to the cost of monitoring and lack of political will to make a difference by successive governments. |
| Social capital/broad participation | 2= The social system has a low level of trust and leadership, social networks are good within communities but are volatile across ethnic groups, community participation in decision making is low, providing limited ability to effectively and collectively respond to change (Kimenyi et al, 2014, Okon, 2011 and Chamberlain, 2017). |
| Innovation/encouraging learning | 2 = Learning and experimentation are not actively incorporated into the decision-making process. No long–term monitoring of social and ecological variables, insufficient resources for learning processes and people do not readily accept change. |
| Overlap/polycentric governance | 3= Overlaps exit in the functions of some institutions that have decision-making power, however policy formulation only takes into account multi-stakeholder and multi-level governance, as most decisions are top-down, not incorporating the community based organizations in the process making governance in the region more centralized than polycentric (Akinola, 2010) |
| Ecosystem services | 3= Ecosystem services are recognized in development proposals and assessments (EIAs) but are yet to be valued (Nigeria Fifth NBR, 2015). |

| Mean | \[ \text{Scores} \frac{4+2+3+3+2+2+3+3}{9} = \frac{24}{9} = 2.6 \text{ (Low)} \] |

(Source: Author)
4.4 Summary of Tables and findings

From the above assessment, the ratings of the resilience of the social, environmental, governance and economic systems contained in Tables 7, 8, 9 and 10 are generally low. This is further confirmed in the second assessment in Table 11, where the mean is 2.6, an intermediate score between 1= not resilient and 3= neutral, not clearly showing resilience signifying that the resilience of Niger Delta coastal socio-ecological system is low and hence not resilient.
CHAPTER FIVE

5 DISCUSSION OF FINDINGS

5.1 Vulnerabilities
The research set out to find the current vulnerabilities that exist in the Niger Delta socio-ecological system and whether it was resilient. From the preceding chapters it is evident that vulnerabilities include sea level rise, floods and erosion, food insecurity, salt water intrusion and threats to biodiversity from anthropogenic impacts. The level of poverty makes them susceptible to hazards including exposure of living in unsafe areas (flood plains, riverbanks, or steep slopes), substandard housing and inability to insure, as well as uncertain land ownership rights and vulnerable livelihoods. In the event of hazards/disturbances, with little savings and no access to credit, individuals and communities become poorer (UNISDR, 2015).

Even though the National Adaptation Strategy and Plan of Action for Climate Change Nigeria (NASPA-CCN) contains the nations strategy on climate change adaptation and mitigation and most sectoral policies like the National Agricultural Resilience Framework (NARF 2014) recognize some of these vulnerabilities and have outlined ways to tackle them, implementation is very slow or never forthcoming.

5.2 Gaps
From the assessment, the social, environmental, governance and economic systems are generally poor. Gaps exist in the provision of adequate social infrastructure (housing, transportation, education, and water), participatory engagement and
inclusion of region in development, protection and diversification of livelihood source, experimentation and monitoring, enforcement of environmental standards, inability to learn from past occurrences, inadequate disaster preparedness and proper environmental management.

5.3 Learning from others
There are many examples of resilience planning worldwide that can be used as best practice models for the future development of resilience planning in Nigeria. For instance, United States has experienced hurricanes that resulted in flooding and damage to the natural and human environments. In response to hurricane Katrina that affected the Gulf coast, the National Research Council (NRC) established the Committee on Increasing National Resilience to Hazards and Disasters in 2011, to review the effects of Hurricane Katrina and other natural and human-induced disasters and increase the nation’s resilience at all levels (federal, state, local and community). Five factors were listed as resilience determinants; (1) strong and diverse regional economy, (2) large shares of skilled and educated workers, (3) wealth that can be deployed in strategic ways to adapt when a shock hits, (4) strong social capital, and (5) community competence (NRC, 2011). Steps taken to ensure resilience post hurricane include:

**Insurance and Real estate:** provision of affordable and quality housing, adoption of building code, approving a city master-plan that aims at modernization while recognizing history and culture, not building in floodplains.

**Critical infrastructure:** upgrading educational facilities, providing diversified primary health care increasing accessibility, rebuilding water and sewerage facilities with resilient materials, partnering with national and international organizations to curb present and future climate change induced challenges, ensuring transport facilities can withstand shocks, having backup energy plans and transmitting using steel in-place of wooden poles, ensuring multiple network providers for communication with backup generators.
Governance: encouraging development of individual resilience by knowing what to do when disaster occurs, enhancing government-community relations and the creation of a Coastal Protection and Restoration Authority.

Social capital: ensuring flexible assistance programs, recognizing the role of CBOs, friends and family, ensuring the decentralization of power across sectors- applying systems thinking, diversifying food sources and understanding the critical roles that NGOs play, thus enhancing NGOs-government relations. The role of responsive institution was acknowledged especially for vulnerable elderly population and the recognition and treatment of mental health impacts resulting from hazards/disaster (NRC, 2011).

The United States ensured the speedy clean-up of the Deepwater Horizon oil spill, instituting new processes against future disasters. Fines from British Petroleum are channeled into developing the Coastal Master Plan for the benefit of the common good.

The Netherlands a country below sea level has developed resilience to flood by ‘building with nature’ and ‘living with water’, as exemplified by the Sandmotor, a sand nourishment project, compensation dune nourished by natural processes in Delfland coast and other flood barriers to protect the hinterland from impending sea level rise and floods (Field study, 2018). The Dutch people have also shown commitment and support for such projects.

Indonesia, a developing country highly vulnerable to sea level rise and floods has instituted a 5-year flood resilience initiative ‘building with nature Indonesia’ in conjunction with the Dutch government to manage and prevent coastal erosion and flooding by integrating the restoration of mangroves to serve as natural barriers, small scale hard engineering of permeable brushwood dams to capture sediments for nourishment to maintain balance and sustainable land use governed by local laws (Wetlands International, n.d).
5.4 Research limitation
This research being the first on coastal socio-ecological resilience in the Niger Delta of Nigeria faced the challenge of limited time and availability of data for certain components of the system, it was however overcome by sourcing data from different reliable sources like national reports, journals, NGOs sites, Newspaper articles etc.
CHAPTER SIX

6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion
The Niger Delta coastal socio-ecological system has very low resilience because adaptive capacity and governance is lacking as evidenced by inability of governance system to provide diversified livelihoods, basic services, corruption free governance, enduring conflict resolution and standard disaster preparedness. Even though certain sectoral policies exist, they are not implemented. Climate change will exacerbate the current situation and bring about unpredictable speed of change. To ensure the resilience of the coasts and people, holistic coordinated action is needed at all levels. In the light of the existing inadequacies, the following recommendations are suggested towards building the resilience of the Niger Delta coastal socio-ecological system, which will go a long way in the achievement of all 17 SDGs.

6.2 Recommendations

6.2.1 Speed up the clean-up of polluted areas
Even though the FGN has taken steps towards the clean-up of Ogoniland and other polluted places in the Niger Delta through the HYREP framework and NEVIND, the dedication of further resources to the clean-up project will be a major step towards building resilience. Remediated areas should be transformed to productive uses (protected areas or agricultural lands).
6.2.2 Develop a Coastal Resilience Plan
As a matter of urgency, the MNDA should form a multi-level, multi-stakeholder committee involving local community representatives that are tasked with drawing up a Coastal Resilience Plan for the region. The plan should be administered by the Environmental Management Department of the MNDA and incorporate the following:

- Build transformative capacity by promoting polycentric/good governance and community participation in development. Promote transparency and accountability, ensure the provision of basic infrastructure (access to health, education, housing, clean water). Consult/engage local communities in planning and the implementation of developmental projects, thereby incorporating local knowledge into government programs.

- Strengthen the implementation of environmental regulations and monitoring to curb pollution. Institute the process of experimentation and monitoring of ecological variables at the local-regional level for feedbacks that are incorporated into decisions.

- Clarify the roles of institutions in the Niger Delta, bearing redundancy in mind and investing in disaster preparedness, planning and recovery.

- Build adaptive capacity by ensuring livelihood protection, promote livelihood diversification by introducing sustainable techniques (integrating fish farming and poultry-animal husbandry), improving women’s access to economic opportunities towards yielding broad productive gains and enabling access to credit for small businesses.

6.2.3 Conduct a comprehensive survey of the Niger Delta
This research has highlighted the inherent vulnerabilities and gaps in the region, and publications abound on the environmental problems in the region, however there is need for an in-depth ecological survey of the entire region like the Ogoniland Environmental Assessment, UNEP (2011) for better planning purposes since the last NDES was conducted in 1997, 2000 and the UNDP Niger Delta HDR in 2006.
6.2.4 Integrated Coastal Zone Management/Marine Spatial Planning

To effectively manage the growing pressures from human activities on the marine and coastal environment, there is need to develop an Integrated Coastal Zone Management (ICZM) plan and a Marine Spatial Plan (MSP) for the country which will go a long way to solving current issues concerning the land-sea interface.

ICZM is “a strategy for an integrated approach to planning in and management of the coastal zone, in which all policies, sectors and to the highest possible extent, individual interests are properly taken into account, with proper consideration given to the full range of temporal and spatial scales, involving all coastal stakeholders in a participative way” (Rupprecht Consult & International Ocean Institute, 2006).

MSP is a “public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process” (UNESCO, 2009). Considering the current state of the environment and the impending development of Blue Economy in Nigeria, which at present is sector based, MSP is required to organize maritime economic sectors to prevent conflict while ensuring protection of the environment. ICZM/MSP will integrate sectors/interests through a participatory process to address sustainability issues and socio-economic viability, manage human activities and resource use through ecosystem based management.
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