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Social Impact Assessment of Wetlands Conversion on Wetlands Ecosystem Services in Port Harcourt Municipality, Rivers State, Nigeria.

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Abstract
Continues disappearance of wetland areas in Port Harcourt municipality over the years has telling effects on the services and value provided by wetland ecosystem to the environment. The social environment of man became most heated as the impacts continue to increase in dimensions. This study examine the social impacts of wetland loss on wetland ecosystem services. Purposive sampling technique was used to select four sites out of twenty four reclaimed sites identified within the study area. Objective impact assessment of wetlands conversion on wetland ecosystem services was carried out using the Hazards and Effects Management Process (HEMP). The Leopold Matrix of sensitivities against hazards was used to identify impacts, by noting the nature of interactions between hazards and sensitivities. The Risk Assessment Matrix (RAM) was use to access the extent of risk associated with wetland conversions. Impact qualification was based on the effects of the hazard on the social sensitivities. The assessment revealed that the impacts are both negative (rated as major, moderate and minor impacts) and positive impacts. The negative major and moderate impacts include: destructions of the maintenance of migration and nursery habitats, destructions of natural flood control and flow regulation, removal of erosion control measures; and the positive impacts are the provision of land space for transportation, land space for tourism and recreation and land space for human habitations and settlements. Social impacts mitigation and enhancement framework containing abatement measures to negative impacts and enhancement measures to positive impacts was prepared.
Key Words: Social Impact Assessment, Wetlands Conversion, Ecosystem Services.

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I. Introduction

Wetlands all over the world are very important subsystems of the general ecosystem which play vital roles in the sustenance of both the surface and ground water resources of the earth. They also provide significant social and economic values to the society. The inherent quality and ecological services provided by wetlands varies significantly from one wetland ecosystem to another and from one region of the country to another. Mmom; Mohammed and Kpang (2016) observed that wetlands are among the most productive ecosystems in the world today, comparable to rain forest and coral reefs. This, therefore, implies that an immense variety of microbes, plants, insects, amphibians, reptiles, birds, fish and mammals are part of a wetland ecosystem. Ecologically, the significance of wetland ecosystem cannot be overemphasized. The United States Fish and Wildlife Service (USFWS, 2017) posits that wetlands play important roles in the environment, principally for water purification, flood control, shoreline protection and stability, protection of coastal communities from coastal flooding and erosion, including the prevention of storm water current. Cherry (2011) in evaluating the economic values of wetlands observed that economically important species are found in wetland areas such as commercially important fishes and shell fish, including shrimp, blue crabs, oysters, salmon, and sea trout and that these species rely on, or are associated with, wetland ecosystems.

It is important to note that wetlands possess significant social, economic and environmental values, functions and services. For some localities, publicly owned wetlands are exposed to open access pressures, without any form of enforceable property rights, hence allowing unrestricted depletion of this valuable resource. Furthermore, even where wetlands are privately owned, many of the functions they perform provide benefits, which the resource owner is unable to appropriate. The lack of a market for these wetland functions limits the incentive to maintain the wetland, since the private benefits derived by the owner do not reflect the full benefits to the society (Turner, Den Bergh, Barendregt & Maltby, 2000; Dugan, 1993; Agbasi & Odiaka, 2016).

The physical assessment of the functions and services performed by wetland is an essential prerequisite to any evaluation of a wetland's worth to the society. Wetlands functions such as water retention and purification, flood and erosion control, shoreline stabilization, sediments, nutrients and toxicant retention and food chain support, habitat for wildlife, fisheries, recreation site and most especially the maintenance of environmental quality are essential to both social and economic life of the people (Schuyt & Brander 2004). In urban centres, wetland areas serve as drainage basin where storm water and surface runoff are drained.

The ever increasing demand for land space for physical developments and agricultural uses and other resources to meet the needs of the ever growing population has continued to impact negatively on wetland ecosystems most especially within the built-up environment (Agbasi & Odiaka, 2016). Intense urban population growth in Nigeria, now standing at 6.5% per annum (NPC, 2018) has led to accentuated demand for land space and physical development in the form of housing, road construction, industries, factory development, waste dump sites, etc. This according to Sule (2006) has triggered the incessant conversion of wetland ecosystems in Nigerian urban centres to different uses resulting to the total disappearance and/or loss of wetland ecosystems and its values, functions and services.

From the foregoing, it has been observed that the conversion of wetlands, most especially within the urban environment, has created significant impacts on all aspects of the human environment. Highlighting such impacts will involve a comprehensive impact assessment that will encompass the biophysical, social and health components of the environment. In this case, Environmental Impact Assessment (EIA) is an appropriate tool.

Environmental Impact Assessment (EIA) according to United Nation Environmental Protection (UNEP, 2011) is a systematic framework for identifying, predicting and evaluating the environmental effects of planned actions and projects. The assessment comprises of the Health Impact Assessment, Social Impact Assessment and Assessment of the Biophysical Environment. Social Impact Assessment (SIA) which is the crux of this study deals with the procedure that focuses on analyzing, monitoring and managing the planned and unplanned social consequences, both beneficial and adverse of planned interventions (policies, programmes, plans, projects) and social change processes involved by those interventions (Vanclay, 2002). Social impacts include all social and cultural consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society.

Human action such as the conversion of wetlands simultaneously affects both the natural and social environment, not only altering the natural wetland ecosystem, its functions and services, but also providing land space for various human needs including physical development. The increasing rate of the conversion of wetlands has had telling effects on all aspects of the environmental media. In the quest for sustainable development and the maintenance of environmental quality, an examination of the social impacts of wetlands conversion on wetland ecosystem services is deemed paramount, hence this study.

II. Literature Review

2.1 Ecological Models of Urban Form

The ecological models of urban form describe and explain the spatial patterns taken by the distribution of people, buildings and activities across a city's terrains. This orderly set of spatial arrangements is known as the city's land use pattern or spatial form. Over the years, ecological researchers have identified four major models of the geometry of city form, which include the concentric zone model, the sector model, the multiple nuclei model and the urban realms theory (Sule, 2006). While these four models are conceptually distinct in the actual development of most cities, various elements from the four models become uniquely combine in to a spatial pattern that gives each city its own individual spatial geometry, Port Harcourt is not an exception. Each of the four models was developed to explain urban morphology in industrial cities of the twentieth century.

Although, the sector model, the multiple nuclei models and the urban realm theory were presented as alternative to the concentric zone model, through time, the four models have become intellectually connected and widely considered as the classical models of urban land use. However, it is observed that the four models shares common assumptions of urban growth and land uses, which include:

i. That the city is growing in population and expanding in economic activities;

ii. That a relatively free land market that is responsive to the economic principles of supply and demand with little in the way of government regulations;

iii. An economic base that is mainly a mix of industrial and commercial activities;

iv. Private ownership of property;

v. Specializations in land use;

vi. A transportation system that is fairly rapid and efficient and is generally available in terms of cost to the majority of the population; and

vii. Freedom of residential choice at least for the higher socio-economic strata (Sule,2006)

Meanwhile in sharing these assumptions, the four models predict different spatial patterns of urban structure and morphology, they are fundamental to all forms of urban growth. In practical terms and observation, Port Harcourt municipality in its growth patterns exhibit these forms of spatial urban morphology where the city has experienced a great deal of spatial expansion from the Central Business Districts (CBD) to the fringes with rapid urbanization, unregulated physical development that shows a clear-cut manifestation of urban sprawl encroaching in wetland areas. The adoptions of these models to this study help to provide the basis to which urban land uses, structure and patterns are arranged.

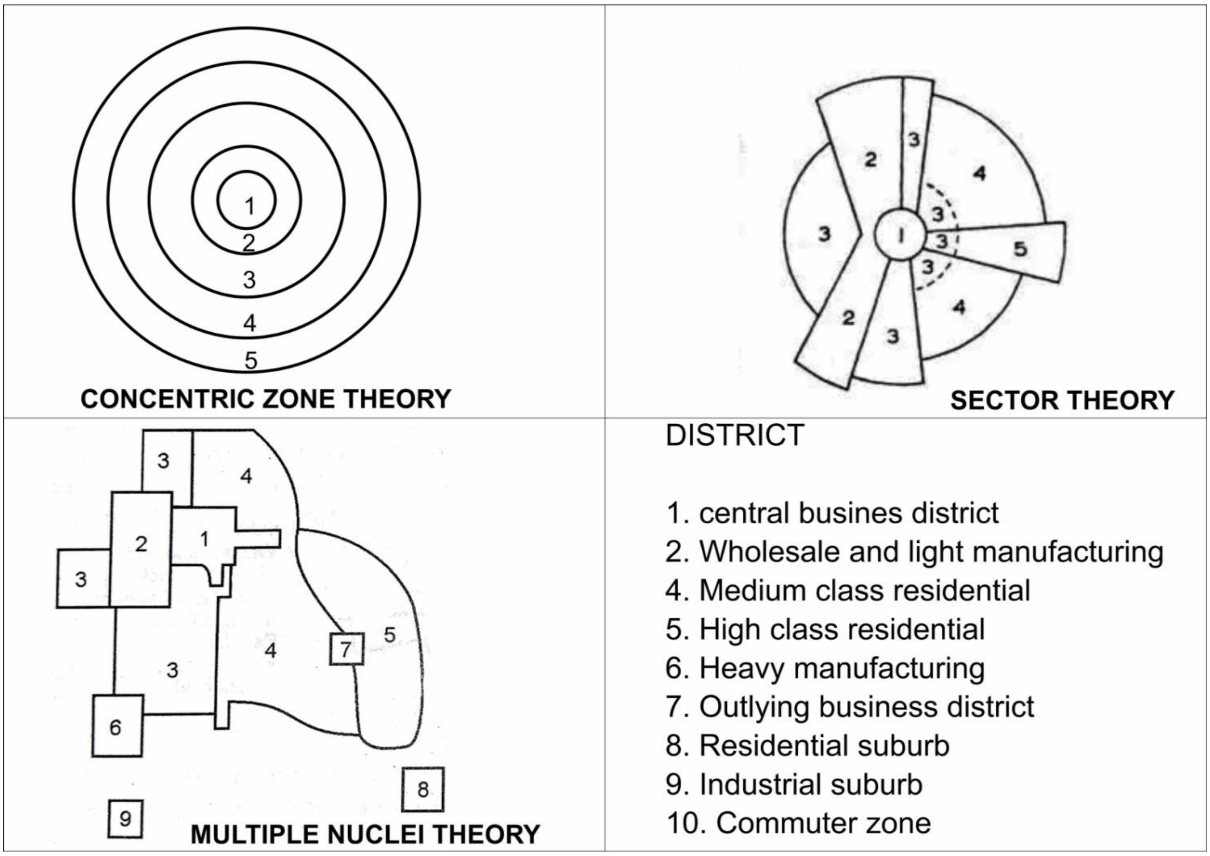


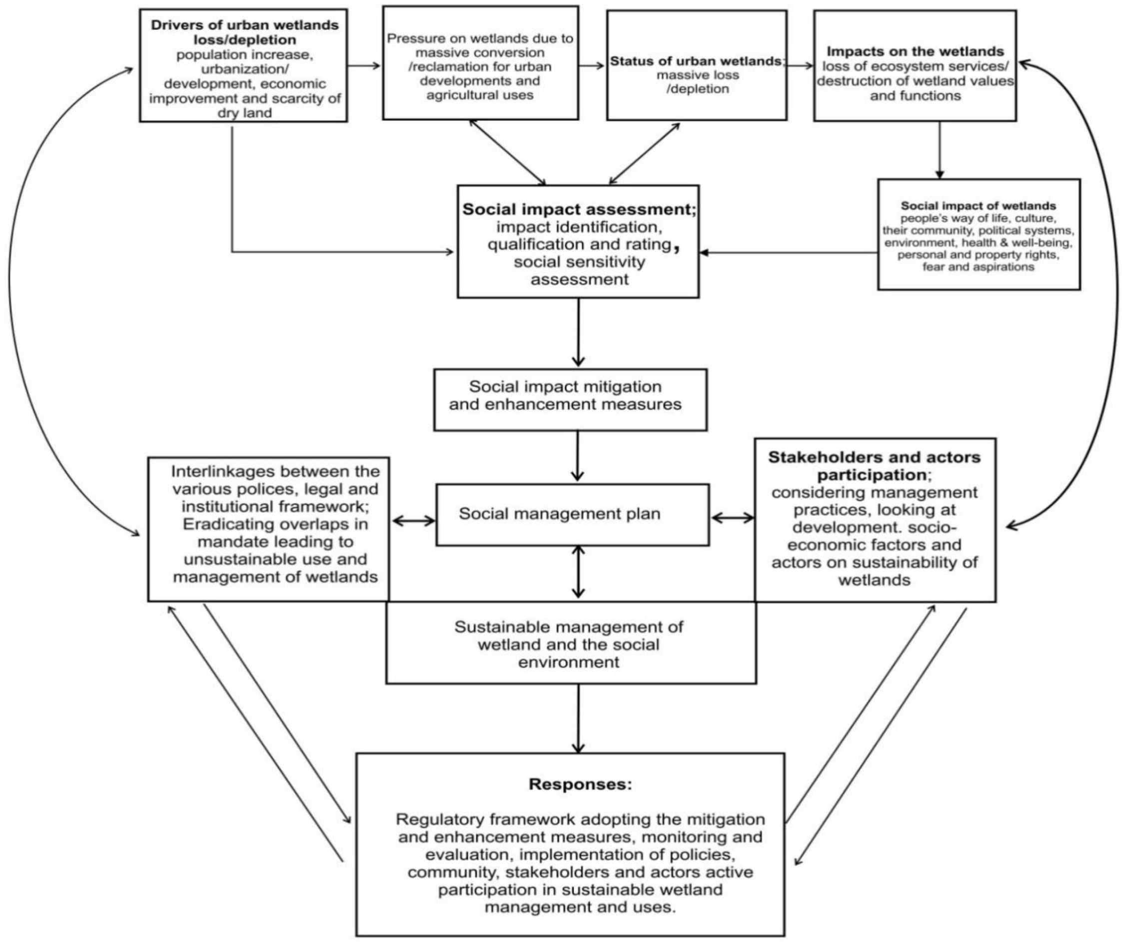
Fig. 2.1: Ecological Models of Urban Form
Source: Sule, 2006

2.2 The Concept of Sustainable Wetland Management

The concept of sustainable wetlands management takes its root from the principle of sustainable development. Sustainable development according to the World Commission on Environment and Development (WCED) (1987), as reported in the Brundtland Commission report is the development that meets the needs and aspirations of the present generation without compromising the chances of the future generations to meet theirs (Mmom, Ezekwe & Chukwu – Okeah, 2017). Abass (2007) defined sustainable wetlands management as human use of wetlands so that they may yield the greatest benefits to present generations while maintaining its potential to meet the needs and aspirations of future generation. Sustainable management of wetlands implies that there should be wise use of wetland resources to ensure continuous existence of wetlands in their pristine state.

The sustainable management of wetland ecosystems relies on the provisions of the Ramsar Convention on wetlands (Tara & Duggan, 2018), which focuses on the conservation and wise use of all wetlands through local, national and international co-operation as a contribution towards achieving sustainable development throughout the world. The sustainability of wetlands management is about maintaining wetland values, resources and functions while at the same time delivering services and benefits now and in the future for human wellbeing (WWF, 2017).This therefore implies that wise use of wetlands involves protecting, promoting, maintaining and preserving the values and quality of wetlands to achieve environmental, economic and social sustainability.

The framework adopted for this study as presented in fig. 2.1, shows the pertinent issues surrounding wetlands loss, impacts and management programmes. From the model, drivers of urban wetlands loss and depletion are identified to include; population increase, urbanization and development, economic improvement and scarcity of dry land for physical development and expansion. These, ofcourse, put pressure on available wetlands leading to massive conversion and reclamation to accommodate the spatial growth and expansion of urban development. The impacts are loss of ecosystem services/destruction of wetland values and functions. These further create impacts that affect the peoples' way of life, norms, culture, community, political system, environment, health and wellbeing, personal and property rights, fear and aspiration. Assessing these impacts involves impact identification, qualification and rating taking social sensitivities in to account.



CONCEPTUAL FRAMEWORK OF THE STUDY

source; adapted and modified from Njagi, 2006

2.3 **Value and Services of Wetland Ecosystems**

The inherent quality and ecological services provided by wetlands varies significantly from one Wetland ecosystem to another and from one region of the country to another. Mmom, Mohammed & Kpang (2016) observed that wetlands are among the most productive ecosystems in the world today, comparable to rain forest and coral reefs. This, therefore, implies that an immense variety of microbes, plants, insects, amphibians, reptiles, birds, fish and mammals are part of a wetland ecosystem. Ecologically, the significance of wetland ecosystem cannot be overemphasized. The United States Fish and Wildlife Service (USFWS, 2017) reiterated that wetlands play important roles in the environment, principally for water purification, flood control, shoreline protection and stability, protection of coastal communities from coastal flooding and erosion, including the prevention of storm water current.

Cherry (2011) in evaluating the economic values of wetlands observed that economically important species are found in wetland areas such as commercially important fishes and shell fish, including shrimp, blue crabs, oysters, salmon, and sea trout and that these species rely on, or are associated with wetland ecosystems. Cherry (2011) further explained that the economic values of wetlands could be described as a biological supermarket that provides great volumes of food that attract many animal species. Some of the animals use wetlands during part of or all of their life cycle and that dead plant leaves and stems break down in the water to form small particles of organic materials that feed many small aquatic organisms, insects, jelly fish, and small fishes that serve as food for large migratory fishes, reptiles, amphibians, birds and animals, emphasizing that the economic value of wetlands to human society is enormous.

Schuyt (2005) acknowledged the importance of wetlands for the sustenance of rural dwellers in Africa, noting that wetlands in Africa serve as an important source of water and nutrients necessary for biological productivity and often sheer survival of people, thereby making the sustainable management of these ecosystems critical to the long term health, welfare and safety of many African communities. According to Schuyt and Brander (2004), wetlands are ecosystems that provide numerous goods and services that have an economic value, not only to the local population living in its periphery but also to communities living outside the wetland area. They are important sources of food, fresh water and building materials and provide valuable services such as water treatment and erosion control. Schuyt and Brander (2004) summarized the functions and services of wetland ecosystem as shown in Table 2.1.

Table 2.1: Wetland Functions, Value and Services

S/No.	Functions		Value and Services
1	Regulation Functions	i.	Storage and recycling of nutrients
		ii.	Storage and recycling of human wastes
		iii.	Storage and recycling of organic wastes
		iv.	Ground water recharge
		v.	Natural flood control and flow regulation
		vi.	Erosion control
		vii.	Salinity control
		viii.	Water treatment
		ix.	Climate stabilization
		x.	Carbon sequestration
		xi.	Maintenance of migration and nursery habitats
		xii.	Maintenance of ecosystem stability
		xiii.	Maintenance of integrity of the ecosystem
		xiv.	Maintenance of biological and genetic diversity
2	Carrier Functions	xv.	Agriculture
		xvi.	Irrigation
		xvii.	Stock farming (grazing)
		xviii.	Wildlife cropping/resources
		xix.	Transport
		xx.	Energy production
		xxi.	Tourism and recreation
		xxii.	Human habitation and settlements
		xxiii.	Habitat and nursery for plants and animals
3	Productive Functions	xxiv.	Water
		xxv.	Flood
		xxvi.	Fuel wood
		xxvii.	Medicinal resource/value
		xxviii.	Genetic resources
		xxix.	Raw materials for buildings, construction and industrial use
4	Information Functions	xxx.	Research, education and monitoring
		xxxi.	Uniqueness, rarity or naturalness and role in cultural heritage.

Source: Schuyt & Brander, 2004

2.4 Social Impacts of Wetlands Loss and Development

Social impacts include all social and cultural consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society. According to Vanclay (2001), it can refer to quantifiable variables such as numbers of immigrants, but can also refer to qualitative indicators such as cultural impacts involving changes to people's norms, values, beliefs and perceptions about the society in which they live.

Although, Burdge and Vanclay (1995) have observed that most impact specialists have stressed that it is impossible to detail all dimensions of social impacts because social change has a way of creating other changes. Burdge and Vanclay further explained that most of the changes are seen as situation specific, and are therefore dependent on the social, cultural, political, economic and historic context of the community in question, as well as the characteristics of the proposed project and any mitigation measures implemented. However, because of the ambiguity associated with impacts, the lack of operational definition for many constructs, as well as a societal mentality (Burdge and Vanclay, 1995), the focus of investigation has been on measurable impacts such as economic and demographic and politically convenient indicators, such as population change, job creation, or use of services (Gramling & Freudenburg, 1992). Armour (1990) has identified some of the social impacts of development projects to include social change indices such as change in people's way of life, their culture, and their community in terms of its cohesion, stability, character, services and facilities. Vanclay (2002) in his study extended such social change indices to include the people's political systems, their environment, their health and well-being, their personal and property rights and their fear and aspirations, noting that development of any kind poses lots of social impacts on the environment let alone the conversion of wetland ecosystem.

III. Study Area

The study is carried out in Port Harcourt Municipality, Rivers State. The study area lies along the Bonny river, an eastern tributaries of the lower Niger, 41 miles (66km) upstream from the Gulf of Guinea located in Nigeria Niger Delta area (Oyegun, 2007). It is located approximately on latitude 4^0 17' 98" – 4^0 47' 21" E and longitude 6^0 09' 99' – 6^0 59' 55" N of the Greenwich Meridian (Oyegun, 2007). The study area features a tropical monsoon climate with lengthy and heavy rainy season and very short dry season. It has a unique relief. The relief is low – lying and the rivers are influenced by tidal fluctuation. The drainage system of the study area is structurally controlled on the coastal low lands and it is mainly dendritic in pattern on the shore line zone (Umeuduji & Aisuebeogun, 1999).

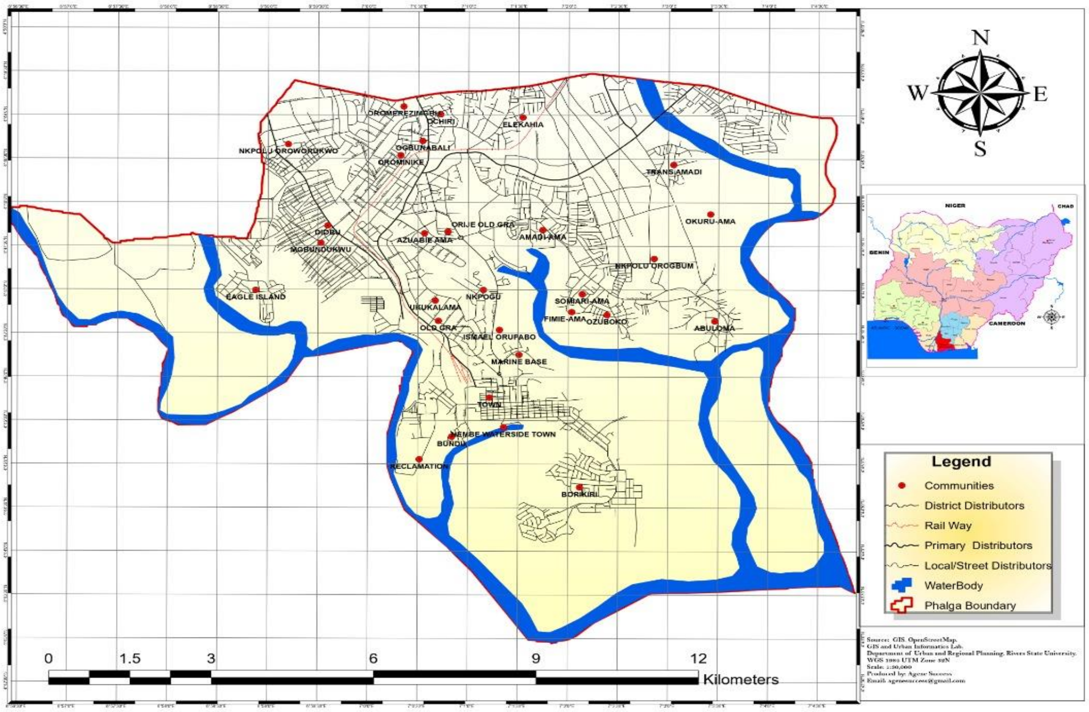


Fig 1.2: Port Harcourt Municipality showing the 25 communities
Source: GIS Lab, Department of Urban and Regional Planning, Rivers State University, 2023

IV. Methodology

The study area has twenty-four (24) reclaimed sites (see Fig. 4.1). Out of which four (4) sites were purposively chosen for sample. The four sites purposively selected for study include; Eastern Bypass, Borikiri Sandfilled, Eagle Island and Ibeto. The four sites chosen for sample are where major and notable reclamation has occurred within the study area.

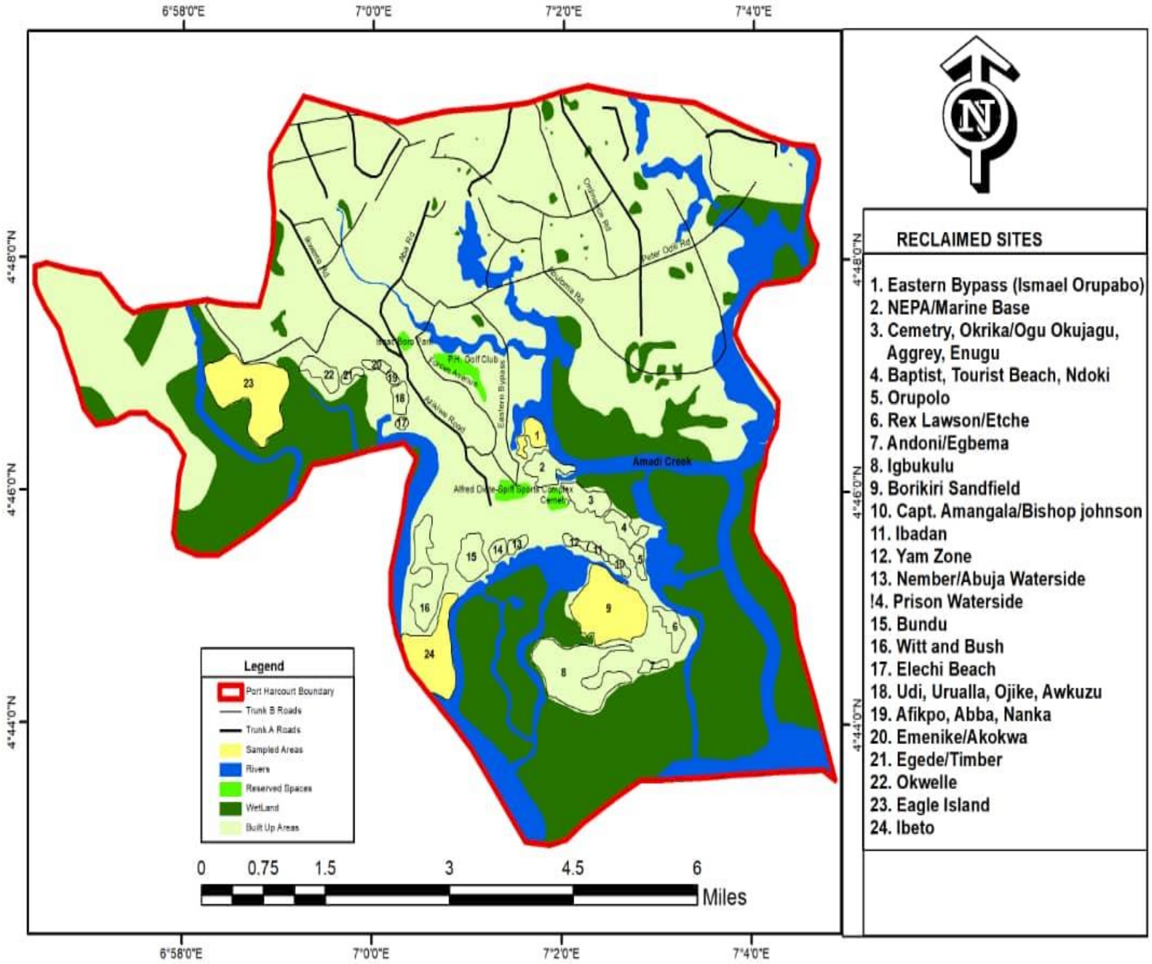


Fig. 3.2: Port Harcourt Municipality Showing Reclaimed Sites and Sampled Locations
Source: GIS Lab. Department of Urban and Regional Planning, Rivers State University, 2023

To obtain the sample population, proximate communities to the four selected sites within the study area was identified as contain in Table 4.1.

Table 4.1 Sample Sites and their Proximate Communities within the Study Area

S/N	Sites	Name of Sites	Proximate Communities	
1	A	Eastern Bypass	1.	Ismael Orupabo
			2.	Ogbunabali
			3.	Amadi-Ama
			4.	Nkpogu
2	B	Borikiri Sandfilled	5.	Borikiri
3	C	Eagle Island	6.	Nkolu Oroworukwo
			7.	Mgbundukwu
4	D	Ibeto	8.	Bundu

Source: Researchers' Computation, 2023

The Hazards and Effects Management Process (HEMP) (Shell, 2005) was used to identify, qualify and rate social impacts and/or effects of wetland conversions on wetland ecosystem services in the sampled communities. However, the Social Impact Assessment in this case is a post impact assessment that employed the Hazard and Effects Management Process methodology. This method entails identifying hazards and sensitivities.

The Leopold Matrix of sensitivities against hazards was used to identify impacts, by noting the nature of interactions between hazards and sensitivities. Impact qualification was carried out by specifying such attributes as positive or negative, direct or indirect; short term and temporary or long-term and permanent, reversible or irreversible for each impact. Rating of impacts was carried out with reference to the probability of their occurrence and their consequences.

Qualitative risk assessment was carried out using the Risk Assessment Matrix (RAM) with *likelihood* plotted on the y-axis and *consequence* on the x-axis. The cells of this matrix, representing possible combinations of *likelihood* and *consequence*, give the levels of impact significance as judged by experts.

4.1 Objective Impact Identification, Qualification and Rating

i. Impact Identification

A matrix table of sensitivities against hazards was used to identify impacts, by noting the nature of interactions between hazards and sensitivities. The number (interaction code) shown at the point of intersection of sensitivity against hazard was used for identification of the impact zone (which was shaded). This code could yield one or more impacts. Thus an interaction code differs from an impact number as is evident in the process.

ii. Qualification and Rating of Impacts

Impact qualification was based on the effects of the hazard on the social sensitivities as was specified, with reference to the already stated attributes such as positive or negative; direct or indirect; short term and temporary or long-term and permanent; reversible or irreversible.

4.2 A social impact mitigation and enhancement management framework which specified the mitigation and enhancement measures to be applied for major and moderate negative impacts and positive impact respectively was prepared; and

4.3 Social Management Plan (SMP) and framework specifying how management of the mitigation and enhancement measures is to be carried out were also prepared. The framework which usually contains the description of mitigation and enhancement, action parties, monitoring parameters, monitoring parties, reporting and timing was specified.

V. Results

5.1 Impacts Identification, Assessment, Qualification and Rating

A matrix of sensitivities against hazards (Fig 4.1) was used to identify impacts, by noting the nature of interactions between hazards and sensitivities. The number (interaction code) shown at the point of intersection of sensitivity against hazard was used for identification of the impact zone (which was shaded)

Hazards of Wetland Conversions	Storage and Recycling of Nutrients	Storage and Recycling of Human Wastes	Storage and Recycling of Organic Wastes	Ground Water Recharge	Natural Flood Control and Flow Regulation.	Erosion Control	Salinity Control	Water Treatment	Climate Stabilization	Carbon Sequestrations	Maintenance of Migration and Nursery Habitats	Maintenance of Ecosystem Stability	Maintenance of the Integrity of the Ecosystem	Maintenance of Biological and Genetic Diversity	Wetland Agricultures	Irrigation Farming	Stock Farming (Grazing)	Wildlife Cropping/Resources	Transport	Energy Production.	Tourism and Recreation	Human Habitations and Settlements	Habitat and Nursery for Plants and Animals	Water Supply	Sources of Fuel Wood	Medicinal Resources/Value	Genetic Ressources	Raw Materials for Buildings, Constructions and Industrial Use	Research, Education and Monitoring	Uniqueness in Cultural Heritage
Westland Take-up											1	2	3	4	5	6	7	8	9		10	11	12							
Westland Végétation Clearance					13	14		15	16	17	18	19	20	21	22					23			24		25	26	27	28	29	30
Sandfilling of Westland	31	32	33	34	35	36		37											38		39	40	41	42						
Wetlands Dredging	43	44	45	46	47	48					49	50	51	52	53	54	55	56	57		58	59	60	61						62
Draining of submerged wetlands	63	64	65	66	67	68							69		70	71			72		73	74	75	76						77
Deep Cement Mixing				78	79	80					81	82	83	84	85	86	87	88	89		90	91	92	93						94
Dumping of solid wastes to reclaim wetlands	95	96	97	98	99	100	101	102			103	104	105	106	107				108		109			110						
Development on wetlands					111	112					113				114	115	116	117	118		119	120	121	122	123			124		125

Fig. 5.1: Interaction of Hazards (Sources of Effects) and Social Sensitivities
Researchers' Field Survey, 2023

Table 5.1: Impacts Identification, Assessment, Qualification and Rating

Interaction Code	Hazard (source of effect)	Impact Description	Qualification	Likelihood	Consequence	Impact Rating
1.	Westland Take-up	1. Removal of the maintenance of migration and nursery habitats	- Negative - Direct - Long term - Reversible - Incremental - Regional	High	Considerable	Major
2.		2.Removal of the maintenance of ecosystem stability	- Negative - Indirect - Long term - Reversible - Incremental - Regional	Medium	Considerable	Minor
3.		3.Removal of the maintenance of the integrity of the ecosystem	- Negative - Indirect - Long term - Reversible - Incremental - Regional	Medium	Minor	Minor
9.		9.Land space for Transportation	- Positive			
10.		10.Land space for tourism and Recreation	- Positive			
11.		11.Land space for Human Habitations and Settlements	- Positive			
12.		12. Destructions of Habitat and Nursery for Plants and Animals	- Negative - Direct - Long term - Reversible - Incremental - Regional	High	Considerable	Major
13.	Westland Végétation Clearance	13. Destructions of Natural Flood Control and Flow Regulation	- Negative - Direct - Short term - Reversible - Incremental - Regional	High	Considerable	Major
14.		14.Removal of erosion control measures	- Negative - Direct - Short term - Reversible - Incremental - Regional	Medium High	Considerable	Moderate
15.		15. Removal of the role of forest in water treatment	- Negative - Indirect - Long term - Reversible - Incremental - Regional	Minor	Minor	Minor
16.		16. Removal of the role of forests in climate stabilization	- Negative - Indirect - Long term - Reversible - Incremental - Regional	Medium High	Considerable	Moderate

17.		17. Removal of the role of forest in carbon sequestrations	- Negative - Indirect - Long term - Reversible - Incremental - Regional	Medium High	Considerable	Moderate
18.		18.Destructions of maintenance of migration and nursery habitats	- Negative - Direct - Long term - Reversible - Incremental - Regional	Medium high	Considerable	Moderate
19.		19. Destructions of maintenance of ecosystem stability	- Negative - Indirect - Long term - Irreversible - Incremental	Medium	Considerable	Minor
24		24. Destruction of habitat and nursery for plants and animals	- Negative - Direct - Long term - Reversible - Incremental - Regional	High	Considerable	Major
25		25.Destruction of sources of fuel wood	- Negative - Direct - Long term - Reversible - Incremental - Regional	Medium	Moderate	Moderate
26		26.Destruction of sources of médicinal ressources/value	- Negative - Direct - Long term - Reversible - Incremental - Regional	Medium	Moderate	Moderate
28		28.Destruction of raw materials for buildings, constructions and industrial Use	- Negative - Direct - Long term - Reversible - Incremental - Regional	Medium high	Major	Major
29		29.Destruction of source of research, education and monitoring	- Negative - Direct - Long term - Reversible - Incremental - Regional	Medium	Moderate	Moderate
31	Sandfilling of Westland	31. Destruction of storage and recycling of nutrients	- Negative - Indirect - Long term - Reversible - Incremental - Regional	Medium Low	Little	Minor
35		35. Destruction of natural flood control and flow regulation.	- Negative - Direct - Long term - Reversible - Incremental - Regional	High	Considerable	Major
36		36. Removal of erosion control measures	- Negative - Direct - Long term - Reversible	Medium	Considerable	Moderate

			- Incremental - Regional			

Source: Researchers' Field Survey, 2023

Major and Moderate Impacts Identified as shown in table 5.1 include;

i. Destructions of the maintenance of migration and nursery habitats (major)
ii. Destructions of Habitat and Nursery for Plants and Animals (major)
iii. Destructions of Natural Flood Control and Flow Regulation (major)
iv. Removal of Erosion Control measures (moderate)
v. Removal of the role of wetlands in climate stabilization (moderate)
vi. Removal of the role of wetlands in carbon sequestrations (moderate)
vii. Destruction of sources of fuel wood (moderate)
viii. Destruction of sources of medicinal ressources/value (moderate)
ix. Destruction of raw materials for buildings, constructions and industrial use (major)
x. Destruction of source of research, education and monitoring (moderate)

Positive impacts associated with the conversion of wetlands as shown in table 4.1 include;

i. Land space for transportation
ii. Land space for tourism and recreation
iii. Land space for human habitations and settlements

4.7.3 Mitigation and Enhancement Measures

Table 4.2 presents mitigation measures for major and moderate impacts and enhancement measures for positive impacts.

Table 4.2: Social Impacts Mitigation and Enhancement Framework

S/No.	Impact Description	Gross Rating	Mitigation /Enhancement	Net Rating
			Mitigation Measures	
1.	Destructions of the maintenance of migration and nursery habitats	Major	**M1.** Creation of artificial migration and nursery habitats for plants and animals.	Minor
2.	Destructions of Habitat and Nursery for Plants and Animals	Major	**M2**. Provision of designated area for habitat and nursery for plants and animals through forest regime and artificial wetland catchment area	Minor
3.	Destructions of Natural Flood Control and Flow Regulation	Major	**M3.** Provision of retention ponds, drainage channels, levees, flood control dams and reservoirs.	Minor
4.	Removal of Erosion Control measures	Moderate	**M4**. Landscaping and the provision of drainage channels, levees, erosion control dams and reservoirs	Minor
5.	Removal of the role of forests in climate stabilisation	Moderate	**M5**. Designated area for the provision of forest (afforestation and re-afforestation) programme	Minor
6.	Removal of the role of forest in carbon sequestrations	Moderate	**M6.** Designated area for the provision of forest (afforestation and re-afforestation) programme	Minor
7.	Destruction of sources of fuel wood	Moderate	**M7.**Intensify the provision of alternate sources of fuel wood such as cooking gas, kerosene, electricity and coal.	Negligible
8.	Destruction of sources of medicinal ressources/value	Moderate	**M8.** Provision of alternate source of native medical resource/value through the utilization of modern medical therapy and consultants	Negligible
9.	Destruction of raw materials for buildings, constructions and industrial use	Major	**M9.** Provision of alternate source of raw materials for buildings, constructions and industrial use like iron, rods, metals, granite etc.	Negligible

10.	Destruction of source of research, education and monitoring	Moderate	**M10.** Provision of more education and research centres and the improvement in scientific monitoring and satellite orbiting centres	Negligible
		Enhancement Measures		
1.	Land space for transportation		**E.1** More transportation media and facilities should be develop and linked to compliment the already existed ones	
2.	Land space for tourism and recreation		**E.2** Acquire more land space for the development of facilities for tourism and recreation.	
3.	Land space for human habitations and settlements		**E.3** Acquire more land space for human habitations and settlements, discourage rural urban migration, and embark on the development of new towns or satellite towns.	

Source: Researcher's Field Survey, 2023

4.7.4 Social Management Plan

A social management plan specifies mitigation/enhancement measures, action parties, monitoring parameters, monitoring parties, timing, and reporting, as shown in Table 4.3 below

Table 4.3: Social Management Plan

Mitigation/ Enhancement No.	Description of Mitigation/ Enhancement	Action Party	Monitoring Parameters	Monitoring Party	Reporting	Timing
			Mitigation Measures			
M.1	Creation of artificial migration and nursery habitats for plants and animals.	**RSMEN**VLGC NGOs, COs	• maintenance of migration and nursery habitats	• RSMUDPP • FMENV • RSMLS • LGC • NESREA • COs	• RSG • FMENV • NESREA	Annually
M.2	Provision of designated area for habitat and nursery for plants and animals through forest regime and artificial wetland catchment area	**RSMEN**V LGC NGOs, COs	• Habitat and Nursery for Plants and Animals	• RSMUDPP • FMENV • RSMLS • LGC • NESREA • Cos	• RSG • FMENV • NESREA	Annually
M.3	Provision of retention ponds, drainage channels, levees, flood control dams and reservoirs.	**RSMENV**LGC NGOs, COs	• Natural Flood Control and Flow Regulation	• RSMUDPP • FMENV • RSMLS • LGC • NESREA • COs	• RSG • FMENV • NESREA	Quarterly.
M.4	Landscaping and the provision of drainage channels, levees, erosion control dams and reservoirs	**RSMENV**LGC NGOs, COs	• Erosion Control	• RMUDPP • FMENV • RSMLS • LGC • NESREA • COs	• RSG • FMENV • NESREA	Quarterly

M.5	Designated area for the provision of forest(afforestation and re-afforestation) programme	**RSMENV**LGC NGOs, Cos	• Role of forests in climate stabilisation	• RMUDP P • FMENV • RSMLS • LGC • NESRE A • COs	• RSG • FMENV • LGC • RMUDP P	Annually
M.6	Designated area for the provision of forest(afforestation and re-afforestation) programme.	**RSMENV**LGC NGOs, COs	• Role of forest in carbon sequestrations	• RMUDP P • FMENV • RSMLS • LGC • NESRE A • COs	• RSG • FMENV • LGC • RSMUD PP	Annually
M.7	Intensify the provision of alternate sources of fuel wood such as cooking gas, kerosene, electricity and coal.	**RSMENV**LGC NGOs, COs	Sources of fuel wood	• RMUDP P • FMENV • RSMLS • LGC • NESRE A • COs	• RSG • FMENV • NESRE A	Quarterly
M.8	Provision of alternate source of native medical resource/ value through the utilization of modern medical therapy and consultants	**RSMENV**LGC NGOs, COs	• Sources of medicinal ressources/ value	• RMUDP P • FMENV • RSMLS • LGC • NESRE A • COs	• RSG • FMENV • NESRE A	Quarterly
M.9	Provision of alternate source of raw materials for buildings, constructions and industrial use like iron, rods, metals, granite, etc.	**RSMENV**LGC NGOs, COs	• Raw materials for buildings, constructions and industrial use	• RMUDP P • FMENV • RSMLS • LGC • NESRE A • COs	• RSG • FMENV • NESRE A	Quarterly
M.10	Provision of more education and research centres and scientific monitoring and satellite orbiting centres	**RSMENV**LGC NGOs, COs	Source of research, education and monitoring	• RMUDP P • FMENV • RSMLS • LGC • NESRE A • COs	• RSG • FMENV • NESRE A	Quarterly
			Enhancement Measures			
E.1	More transportation media and facilities should be develop and linked to compliment the already existing ones	**RSMENV**LGC COs	Transportation development	• RMUDP P • LGC • FMENV • RSMLS • NESRE A • COs	• RSG • FMENV • NESRE A	
E.2	Acquire more land space for the development of facilities for	**RSMENV**LGC COs	Development of tourism and recreation	• RMUDP P • LGC • FMENV • RSMLS	• RSG • FMENV • NESRE A	

	tourism and recreation.			• NESREA • COs	
E.3	Acquire more land space for human habitations and settlements, discourage rural urban migration, and embark on the development of new towns or satellite towns.	**RSMENV**LGC COs	Land space for human habitation and settlements	• RMUDPP • LGC • FMENV • RSMLS • NESREA • COs	• RSG • FMENV • NESREA

Source: Researcher's Field Survey, 2023

- **RSMENV** --------- Rivers Ministry of Environment
- **RSMUDPP** --------- Rivers State Ministry of Urban Development and Physical Planning
- **RSMLS** ------------ Rivers State Ministry of Land and Surveying
- **FMENV-** ----------- Federal Ministry of Environment
- **LGC** --------------- Local Government Council
- **NGOs** ------------- Non-Governmental Organisations
- **COs** ---------------- Co-operate Organisations
- **NESREA** ---------- National Environmental Standard and Regulations Enforcement Agency

5.1 Negative Major and Moderate Impacts

i. Destructions of the Maintenance of Migration and Nursery Habitats (Major)

Wetlands are important breeding grounds for migratory plant and animal species. They perform the regulation function of the maintenance of migration and nursery habitat by providing anchorage and niches for migratory species. Wetlands are known for the provisions of nursery and migration habitat for bird and fish species. However, objective assessment of the negative impact of wetland conversion in the study area has shown that it leads to the destruction of this very remarkable function provided by wetland ecosystems in the study area. This of course has further led to the extinction and subsequent disappearance of migratory and nursery habitats for plants and animal species in the study area.

ii. Destructions of Habitat and Nursery for Plants and Animals (Major)

Wetlands provide fertile ground for thousands of species of aquatic and terrestrial plants and animals. They are considered "nature's nurseries" providing critical habitation for fish and wild life. It should be noted that most fresh water fishes are considered wetland dependent. They often support high concentration of animals including mammals, birds, fish and invertebrates and serve as nurseries for many of these species (www.worldwildlife.org). Many plant and animal species live in the wetlands, including a number of rare and endangered species. The plants that grows in wetland provides shelter from predators for prey species and nesting area for birds, while the water gives fish and shell fish a place to spawn (Gambrel, 2019). However, an assessment of the negative impacts of the conversion of wetland ecosystem in the study area has shown that it leads to the destruction of habitat and nursery for plants and animals thereby destroying these services and functions provided by wetlands in the study area.

Destructions of Natural Flood Control and Flow Regulation (Major)

Wetland areas are usually low land areas. In urban areas, it is known to serve as urban drainage basin where storm waters are drained. Wetland acts as holding area for large quantities of surface water which can be slowly released into a watershed. According to (epa.gov/wetlands), wetlands function as natural sponges that trap and slowly release surface water through runoff, groundwater and flood water. Trees, root mats and other wetland vegetation also slow the speed of flood water and distribute them more slowly over the floodplains. This combine water storage and braking actions lower flood heights and reduces erosion severity. However, the findings of this study have shown that the increasing disappearance and apparent loss of wetlands in the study area is responsible for the frequent pace of flooding in the area.

Removal of Erosion Control Measures (Moderate)

Wetlands along lakes and rivers reduce soil erosion by binding and stabilizing the soil in plant roots. As noted by the Agency of Natural Resource, Department of Environmental Conservation, available at https://dec.VerMont.gov/watershed/ wetlands/functions and water-quality, vegetated wetlands along the shores of lakes and rivers can protect against erosion caused by waves along the shorelines during floods and storms. Results from specialists in wetland management also revealed that wetland plants are important because they can absorb much of the energy of the surface waters and bind soil and deposited sediments in their dense root systems. They also protect shorelines, river banks or stream banks from excessive erosion by dissipation of wave and current energy or by binding and stabilizing the soil. Wetlands loss implies total removal of this notable function of wetland ecosystem in the study area.

iii. Removal of the Role of Wetlands in Climate Stabilization (Moderate)

The role of green plants most especially wetlands in climate stabilisation cannot be overemphasized. Wetlands continuously stabilize the climate by removing and storing atmospheric carbon arising from anthropogenic activities. Ramsar (2017) revealed that wetland helps in stabilizing climate and reducing climate change impact by serving as the third largest carbon reservoirs on earth. Green plants in wetlands trap carbon monoxide from the atmosphere and convert it to carbon dioxide during photosynthesis thereby reducing the amount of carbon pollutants available in the atmosphere.

iv. Removal of the Role of Forest in Carbon Sequestrations (Moderate)

Wetlands play significant role in regulating exchange of greenhouse gases to and from the atmosphere, including water vapour, carbon dioxide, methane, nitrous oxide and sulfur dioxide. They provide sinks for carbon and nitrogen and sources for methane and sulfur compounds. All wetlands are capable of sequestering and storing carbon through photosynthesis and accumulation of organic compounds in the soils, sediments and plant biomass. As noted by the commonwealth Australia (2012), water logging of wetland soil limits oxygen diffusion into sediment profiles creating anaerobic conditions. These conditions also slow decomposition rate, leading to the build-up and storage of large amount of organic carbon in wetlands sediments. Hence, the conversion of wetlands implies the removal of wetland forests and its role in carbon sequestrations. This of course has been recognized as one of the contributing cause of climate change.

v. Destruction of Sources of Fuel Wood (Moderate)

The natives usually depend on fuel wood gathering from the forest for their cooking, warming, sales as income generating venture and as a way of life. In most cases these forests are wetland areas. Unfortunately, the removal and subsequent loss of these wetlands means total disappearance of the sources of fuel wood for the native who depend on it for survival. Lacerda (1993) noted that wetland mangrove trees annually produce 7,400m^3 of charcoals and 400 tons of bark for tanning in panama, and 120,000 m^3 of firewood in Hunduras, while 80% of the households in Nicaragua used wetland mangrove woods for cooking. These significantly show the important of fuel wood to the natives and the major source is the wetland forest.

vi. Destruction of Sources of Medicinal Ressources/Value (Moderate)

Information derived from the respondents of the study area, and specialists in wetland ecosystem management has shown that different species of wetland plant and animal are used in treating different kinds of sickness, pains and diseases such as malaria, diarrhea, painful joints, glaucoma, asthma, etc. The total disappearance of these plants, leaves, herbs, root, and bark in the study area is as a result of wetland loss. The study has shown that the treatment of these different sicknesses and diseases using traditional approach has drastically declined in the study area as a result of wetland loss.

vii. Destruction of Raw Materials for Buildings, Constructions and Industrial Use (Major)

Different species of Wetland plants provide raw materials for buildings, constructions and industrial uses. Results derived from the respondents of the study area revealed that wetlands in the study area provide different species of hard wood and soft wood for building purposes, furniture, carving of canoes, and other forms of constructions. Respondents of the study area further explained that wetlands ecosystem provides source of timber logging activities and non-timber forest products in the study area. These are further used as raw material for buildings, construction and industrial activities. The study has revealed that the conversion of wetlands and its subsequent disappearance has led to the destruction of raw materials for buildings, constructions and industrial use in the study area.

viii. Destruction of Source of Research, Education and Monitoring (Moderate)

Diversity of plants and animal species in wetland ecosystems provide both scientific and educational research. Excursion, plant examination, taxonomy and orientation, viewing of animals and birds and the use of sculpture for scientific historical findings are carried out in wetland areas. Hence the loss of this unique ecosystem implies the destruction or total removal of source of research, education and monitoring in the study area. The result of this study has shown that these functions of wetland are totally destroyed in the study area.

5.2 Positive Impacts

i. Land space for Transportation

One major noticeable development on wetland areas across states and regions is the construction of access roads that connects different parts of the country most especially land transportation and its infrastructures. The findings of this study revealed that wetlands in the study area are been converted for the development of transportation and transport infrastructures thereby providing access that linked the neighbourhood.

ii. Land space for tourism and Recreation

Objective assessment of the conversion of wetland areas have shown that such reclaimed area can be used for tourism and recreational purposes. This is a typical situation of the pleasure park in Obio/Akpor local government area of Rivers state.

iii. Land space for Human Habitations and Settlements

One of the drivers of wetland loss in the study area is urbanization. As the area urbanized demographically and structurally, there is the need for land space for human habitation and settlements. Objective assessment of the impact of wetland loss have shown that it provide land space for all forms of physical development including human settlements.

VI. Conclusion and Recommendations

6.1 Conclusion

The pace of wetland conversion and wetland loss in Port Harcourt Municipality Rivers State cannot be overemphasized. The ever increasing rate of urban expansion occasioned by population explosion and physical development in the study area has reduced the available land space for human habitations and structural development, thereby endangering the available wetlands in the study area. Wetland areas became the only available alternative for urban expansion for such growth where land reclamation and conversion becomes the order of the time.

Of course, wetland ecosystems provide countless functions and services as earlier identified in this study to the environment and to the people of the study area who depend on it for survival. The incessant conversion of these unique ecosystems results to its total disappearance and loss, hence its impacts on the ecosystem services to the affected area. Thus, this study assessed the social and economic impacts of wetlands conversion on wetland ecosystem services in the study area using the Hazards and Effects Management Process (HEMP), propose mitigation measures for the identified major and moderate negative impacts and enhancement measures for positive ones, and prepare an Environmental Management Plan (EMP) which include a description of mitigation and enhancement measures, actions to be taken, action parties, monitoring parameters, monitoring parties, reporting and timing.

6.2 Recommendations

i. That Government and its relevant agencies should embark on wetland creation, development and conservation to ensure the continuity in the services, function and value of wetland ecosystems in the study area. The remaining un-reclaimed wetlands in the study area should be properly preserved and protected from further conversion and destruction;

ii. In addressing the negative impacts of wetland conversion and to enhance its positive impacts, the implementation of the proposed **Social Impacts Mitigation and Enhancement Framework** as contained in this report (table 4.2) and the **Social Management Plan** (table 4.3) should be carried out and properly implemented.

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