Original Research Article

Resilient responses to urban wetland loss: experiences from Port Harcourt Municipality

Abstract

Wetlands globally contribute to~~to~~ valuable ecosystem services to both natural species habitat and human tourist attractions in any location ~~they are~~including those found in~~cluding~~ Port Harcourt Municipality. Wetlands are also beneficial and significant ~~as they~~ serving~~e~~ as breeding regions for wildlife and safe spaces for sea creatures, support a diversity of species and provide some climate restraining components, characteristic of any natural habitat. This study highlights some resilient responses~~, which~~ residents put up in the aftermath of wetland reclamation and conversion in neighbourhoods. The study aims to ascertain the environmental and physical challenges of wetland loss on the wetland dwellers and subsequently identify resilient paradigms adopted to cope with such~~the~~ associated stress. Forty-one wetland settlements were identified within the Port Harcourt municipality and three out of those settlements were chosen purposively. A total of 293 questionnaires were distributed and SPSS was used to analyse the data. ERDAS Imagine 2014 version was used to show spatial changes between the years 1986 to 2000, and 2000 to 2016. The study shows that from 1986 to 2000, Port Harcourt municipality lost a total of 1,255,500m^2. This translates to a 5% loss with an average rate of 89,678.57m2 per annum. Between 2000 and 2016, the rate of loss was 108,956.25m^2 per annum, and approximately 7.69% of wetlands totalling 1,743,300m^2 were lost to urbanisation and other activities. The result indicates that some of the challenges of wetland loss include flooding, poor refuse disposal system, and unplanned settlements. Indigenous knowledge, social capital and symbolic power are some of the resilient responses displayed by the vulnerable population to build ~~their~~ resilience capacities. The study recommends periodic mapping of all wetlands and an effective development control framework to monitor incursions into existing wetlands.

Keywords: Biodiversity, Port Harcourt municipality, resilience, responses, wetlands loss

1. Introduction

Wetlands are best designated as the intermediate lands located between marine ecosystems and terrene, often characterised by a shallow water table. The global significance of wetlands is gaining momentum and progressively receiving appropriate attention because it adds to the~~y~~ scenic ~~add to a~~ loveable and healthy environment ~~in several ways~~ (Cohen *et al.,* 2016; Richardson *et al.,* 2016). During the dry season, wetlands tend to retain high water ~~as they~~due to its moderately stable~~ilise the~~ water table. Besides, in any scenario, wetlands play a significant role in mitigating flood because it has ~~they~~ some entrap suspended solids and ~~some of~~other ~~the~~ accompanying nutrients. As such, rivulets emptying into lakes through wetlands often carry along with it less suspended solid nutrients to the lakes than when such rivulets flow directly into the lakes as fish species and planktons feed on those nutrients (Cronk and Fennessy, 2016: Knight *et al.*,2001). Wetlands are vital resources to the natural ecosystem due to its importance ~~as they~~ serving~~e~~ as feeding regions and breeding grounds for wildlife protection and the creation of shelters for sea creatures.

As obtainable in every natural habitat, wetlands are very significant in the preservation of the diversity of species and serve as tourist and recreation attraction that contributes to the economy of wherever ~~they are~~it is located ~~found~~. Consequently, the act of eliminating such viable wetland systems due to industrial development, urbanisation and other related factors means a gradual extinction of sea animals and eventual deterioration of water quality (Bassi *et al.,* 2014; Garg, 2015). Some of these wetland-subordinate animals exist in several local inhabitants and are supported by the occasional change. Preservation of minutest wetland densities in any human-controlled environment is vital in preserving both flora and fauna as well as other significant environmental benefits derived from wetlands (Bassi *et al.,* 2014).

Biodiversity preservation and natural landscape depletion have shaped a rich biota connected to wetlands. Wetlands typically occur in distinct portions of an upland environment, such that some populations of wetland

diversities are small which sometimes make wetlandsthem susceptible to extinction (Serran and Creed, 2016; Salaria, 2017). Consequently, the reclamation and conversion of wetlands engendered by natural causes and anthropogenic activities require regular spatial assessment and strict regulations as there are prices to pay for such actions. Typically, wetlands are described as 'kidney of the landscape' (Amani *et al.*, 2017; Talukdar, 2017). Marine biodiversity is often reliant on factors such as the hydrologic regime and geological conditions. Diverse efforts are being made to enable the conservation of the biodiversity that exists in swamps, marshes, streams, wetlands and waterways. The reason for this intricate biodiversity is to reduce its loss through safeguard and practicable management practices (Miller *et al.*, 2016; Talukdar, 2017).

Therefore, this study is aimed at ascertaining the physical environmental challenges experienced by wetland dwellers within Port Harcourt municipality and proffer effective physical planning and other measures to mitigate the challenges associated problems with urbanisation and wetland conversion within Port Harcourt municipality.

2. Port Harcourt municipality

Port Harcourt is a creation of the British colonial masters as the capital city of Rivers State in 1912 due to its proximity to the coast to ease the exportation of agricultural products and other mineral resources such as groundnut, palm produce and coal from the hinterland (Oyegun 1994). It was named after Lewis Viscount Harcourt and had 30,000 acres as its initial landmass before crude oil was discovered in Oloibiri in 1956 and the city began to experience rapid expansion beyond its original boundaries. As of 1997, Port Harcourt was approximately 470km on latitudes $6^0$59' to $7^0$6 N of the equator and longitude $4^0$40' E to $4^0$55 E of the Greenwich meridian. It is in the Niger Delta and lies along the Bonny River an eastern distributary of River Niger which is 66km upstream of the Gulf of Guinea (Oyegun, 1997). Port Harcourt is within the sub-equatorial climate as 70% of the annual rainfall occurs between April and August, while 22% is spread through September to November (Ayotamuno and Gobo, 2004). Port Harcourt as a region has a unique surface characteristic because it falls within the coastal belt surrounded by low-lying coastal plains enmeshed in physically sedimentary formation predominant in the Niger Delta (Belgam *et al.*, 2004).

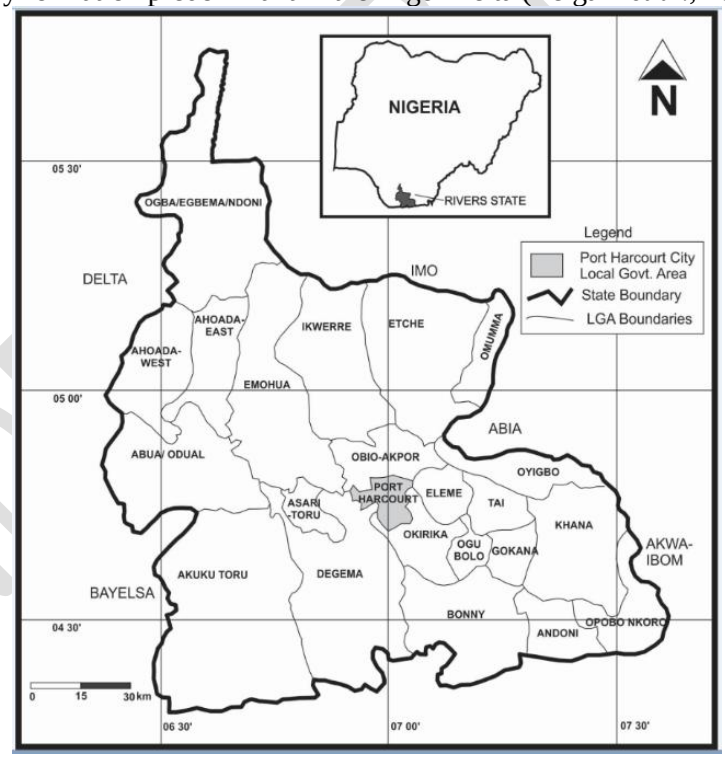

Fig. 1: Map of Rivers State Showing Port Harcourt Municipality.
Source: Deeyah and Akujuru, (2016)

The population of Port Harcourt grew from 7,000 inhabitants as of 1921 to over 800,000 as of 2006 (see table 1). Port Harcourt City Local Government Area serves the heart of the Port Harcourt municipality with about 1,382,592 persons with a combined land and water area of 186km^2 (170km^2 and 16km^2) respectively (National Population Commission, 2006). The municipality is sited along mangrove swamps, marshlands and creeks that make it difficult for effective urban development (Kanu, 2013).

Table 1: Population trend of Port Harcourt from 1921 to 2015

Year	1921	1953	1963	1973	1991	2006	2015

Population	7,000	79,634	179,563	231,600	703,420	1,382,59	2,343,310

Source: Source Rivers State Government, (1975) and Population.city (2015)

3. Wetlands in Port Harcourt

Previous studies have identified and delineated forty-one wetland settlements within the Port Harcourt municipality. These include the waterfront settlements of Port Harcourt municipality starting from Abuja, Afikpo/Abba, Andoni, Awkuzu. Others are located in Bishop Johnson, Bundu, Baptist, Captain Amangala, Cemetery, Egede/Akokwa, Emenike, Egbema, Enugu/Aggrey, while the rest are situated in Eastern By-Pass, Elechi Beach, Ibadan/Yam zone, Igbukulu, Marine Base, Ndoki, NEPA, Nanka, Nembe/Bonny, Orupolo, Ogu/Okujagu, Okrika, Ojike/Urualla, Prison, Rex Lawson/ Etche, Timber/Okwelle, Tourist Beach, Udi, Witt and Bush (Reclamation Drive) (Theis *et al.*, 2009; Kio-Lawson, 2014). These wetlands have been existing since the inception of the 1975 Port Harcourt Masterplan. With time, some of these have been reclaimed and converted to other land uses engendered by community annexation and the continuous negligence of successive governments in Rivers State to address rapid uncontrolled urbanisation and its attendant growing demand for land used for economic prosperity and unplanned city expansion. Urban growth within the Port Harcourt metropolis is moving towards the southward direction and occurs through reclamation, conversion, and the occupation of unoccupied wetlands for other land uses that is convenient for the occupier(s) (Brown and Wachukwu, 2015).

4. Threats to wetlands

According to Olusola *et al.* (2016), there is a difference between wetland degradation and wetland loss because wetland loss is the consequence of converting wetland areas to non-wetland areas, as caused by human activities. These activities include the building of factories, agriculture, dredging and boating, industrial activities like mining, oil and gas exploration, lumbering, construction of marinas and urbanisation (Olalekan and Gordon, 2011; Turner and Gannon, 2017). Urbanisation has been one of the major threats to wetlands because as cities develop, rural areas in the urban fringes experience urban influences with an increased demand for land to meet the growing demand.

Wetlands usually serve as habitats for biodiversity. Studies have indicated that ~~they~~ wetlands are continually being lost to urbanisation and species that use wetlands as their habitats have become endangered as foreign species are introduced into the environment (Hardman, 2011). Wetlands are not only being threatened, but ~~they~~ have also become a threat to urban security in Port Harcourt municipality. It is such that the reclamation and conversion of these wetlands are being undertaken and controlled by community groups and rival urban gangs, in addition to forced economic migrants who see these wetlands as an opportunity for territorial expansion. Thus, residents and visitors alike have become so careful around those reclaimed and converted wetland settlements.

A fundamental technique deployed in the conservation of biodiversity is the appraisal of the diversity of natural resources accessible and the identification of those that are important and very critical (Knight, 1997; Miller *et al.*, 2016). The knowledge of the uniqueness of biodiversity contributes significantly to the management of the available quality and habitat species population in the wetland zones (Orimoloye *et al.*, 2020).

Wetlands, when effectively managed, most times provide services and commodities to humanity. For instance, wetlands serve as core components of the larger natural landscapes within the environment because their functions and values to humans who depend on them are very significant. Each wetland is unique ecological features and serves several useful purposes including the recycling of nutrients, urban climate change moderation, water filtering, the sustainability of streamflow, groundwater replenishment, floods attenuation and also providing wildlife habitat and potable water (Bassi *et al.*, 2014; Richardson *et al.*, 2016).

In the last few decades, the interface between man and wetlands has become phenomenal due to the unprecedented surges in the population and its concomitant urbanisation with reinforced industrial, residential, and commercial developments. This has led to the pollution of wetlands by industrial and some agricultural practices, insecticides, fertilizers, domestic sewage, and feedlot wastes (Brown and Dapa, 2020)

The gradual depletion of a wetland makes it become a source of concern for every stakeholder within the region of loss. It is such that in some scenarios, wetland loss indicates the conversion of a wetland to a non-

wetland related land use consequent upon human activities. Besides, intense human activities make it lose its functions as a wetland (Moser *et al.*, 1998).

According to Alexandar and Mclnnes (2012), the obligations and commitments under the Ramsar Convention advocate the wise use of wetlands to avoid the degradation and subsequent loss of such wetlands. The Ramsar Convention was set up to handle matters relating to the loss and degradation of wetlands globally, such that wetlands could also contribute towards the achievement of sustainable development. The loss of wetlands in Port Harcourt municipality has led to residents becoming vulnerable to the vagaries of wetland loss and other attendant challenges within the region of loss.

5. Resilience

Resilience and vulnerability are two different yet related concepts that represent the response of actors and social systems to change occasioned by surprises and shocks in the environment (Chacowry *et al.*, 2018). Vulnerability expresses the state of an individual and a group susceptibility to danger and utmost powerlessness to social and environmental changes occasioned by exposure to external disturbances and the ability to adapt and to build resilience capacities (Adger, 2006). Contextually, vulnerable communities have incrementally built their resilience capacities by adopting indigenous knowledge and/or indigenous techniques to combat the menace associated with natural disasters such as wetland and biodiversity loss (Whatmore, 2009). Resilience as a notion is a function of resistance, coping, adaptation, and recovery (Zhou *et al.*, 2010) which has over time gained several connotations based on the contextual application of the notion (Manyena 2006; Rose 2007).

As a concept, resilience stems from the field of ecology and gained prominence in several fields like psychology and sociology. Resilience has been one of the main drivers in social sciences discourses such as environmental planning, economic geography, psychology, and disaster studies which have been using the concept prominently (Davoudi *et al.*, 2012). The usage of the term resilience across various research fields has caused its definition to become indistinct (Pickett *et al.*, 2004; Manyena, 2006; Wreathall, 2006; Cote and Nightingale, 2012). Resilience generally, but not exclusively attributes its focus on the need to reduce damage in the eventuality of unexpected natural or anthropogenic distortions in the physical environment (Zolli and Healy, 2012; Park *et al.*, 2013).

The concept of resilience has had a number of connotations depending on the intention and context of the researcher. Matyas and Pelling (2015) assert that resilience to natural threats involves the capability of vulnerable populations to shape their adaptation, coping, and recovery strategies from the consequences of a natural disaster. Timmerman (1981) identified the need for designing a framework on how to cope, adapt, accommodate, and recover from disasters. Such a framework witnessed incremental evolution over the years primarily in the global north with recorded achievements in science and technology. However, in the global south, there have been little improvements regarding the building of disaster resilience capacities due to the prevalence of the application of indigenous knowledge to build resilience capacities during and after any natural disaster, which indicates the need for some form of external assistance (Chacowry *et al.*, 2018).

In the opinion of Ungar (2008, p225) resilience represent:

> *the context of exposure to significant adversity, whether psychological, environmental, or both, resilience is both the capacity of individuals to navigate their way to health-sustaining resources, including opportunities to experience feelings of well-being, and a condition of the individual family, community and culture to provide these health resources and experiences in culturally meaningful ways.*

Resilience underpins the ability of the affected population to recover to a near-normal state of being after any disturbances. The social environment which encompasses culture, personal characteristics and family contributes significantly to the building of resilience (Ungar, 2008). Researchers have established a commonality in the building of resilience capacities in any disaster scenario which involves the mobilisation of resources, in addition to human adaptation structures that reflect the capacity to withstand and/or recover

from any disaster or stress scenario (Chaskin 2008; Coleman and Hagell 2007; Wreathall 2006; Pickett *et al.*, 2004; Kendra and Wachtendorf 2003).

As the concept of resilience gains momentum globally, researchers are beginning to identify the importance of the connection between the individual, community, and institutions in building resilience during and after a disaster (Rodima-Taylor *et al.*, 2012; Wilson, 2012; Chaskin, 2008; Doron, 2005). For instance, Doron (2005) established that the best treatment for acute stress and trauma is individual resilience, but for long-standing stress occasioned by a disaster, community resilience aids recovery faster. Besides, people tend to develop meaningful relationships in an attempt to build personal resilience, while the supports that aid such relationships are provided by the institutions and the communities provide the platform for such relationships to thrive and encourage the building of resilience (Dolan, 2008). Resilience as a holistic and multifaceted paradigm encompasses the individual, community, and the institution. To research the resilience level of an individual, researchers have made three distinct stages of resilience represented as the child, adolescent, and adult (Coleman and Hagell 2007; Cairns, 2002; Paton and Johnson, 2017; Mallak 1998).

Researchers have over the years viewed the community resilience discourse with a perception that resilience in a disaster scenario comes from the individuals within the community. Since resilience comes from the individual within the community, then collective actions among the individuals instinctively translate to community resilience (Cairns, 2002; Mallak, 1998; Jacelon 1997). Community resilience has some underpinning layers of individual activities which is a direct result of collective individual resilience capacities within the community (Doron, 2005; Mallak, 1998). Such underpinning layers revolve around the combination of potential and real resources, possession of durable networks and relationships which Bourdieu (1986) refers to as social capital. It has the potential of enhancing the resilience level of vulnerable communities at risk of any disaster. Community resilience is an indication of the ability of the community not to bounce back, rather, most vulnerable people~~they~~ bounce forward after any disaster episode. This is because *bounce back* indicates the ability of the vulnerable population to return to pre-disaster status. This status by every indication is not achievable, based on the reality of the devastation occasioned by the disaster. As such, *bounce forward* summarises the stability of the community in the context of altered realities occasioned by the disaster scenario (Manyena, 2009).

6. Methods and materials

The study is a passive observational study that adopted mixed method research with no experimental manipulation as participants were in-situ. A multistage sampling technique was adopted. It started with the listing of all forty-one (41) identified existing wetlands. This was closely followed by the identification of those wetlands reclaimed and converted to other land uses. Thereafter, a simple random sampling technique was adopted to allocate the questionnaire based on the population of the settlements and administered same to the heads of households. The sample size was drawn purposively such that Borikiri Sandfilled area, Bundu and Reclamation Drive were selected for ease of access amid growing insecurity in those neighbourhoods. Three (3) key informant interviews were conducted in each of the three sampled communities, and a total of 293 questionnaires was administered based on the population of those neighbourhoods. Secondary data were collected through existing maps from the 1975 Port Harcourt Masterplan and satellite imageries of the study area. While primary data were collected through open-ended questionnaire, personal observation, and key informant interviews. Data were analysed using ERDAS Imagine 14, Lansat interpretations and SPSS. version 22

Table 2: Questionnaire administration schedule

Study Site	No. of questionnaires administered	%
Reclamation Drive	52	17.75
Borikiri Sandfill	118	40.27

Borikiri New Road	123	41.98
Total	**293**	**100**

Source: Authors (2020)

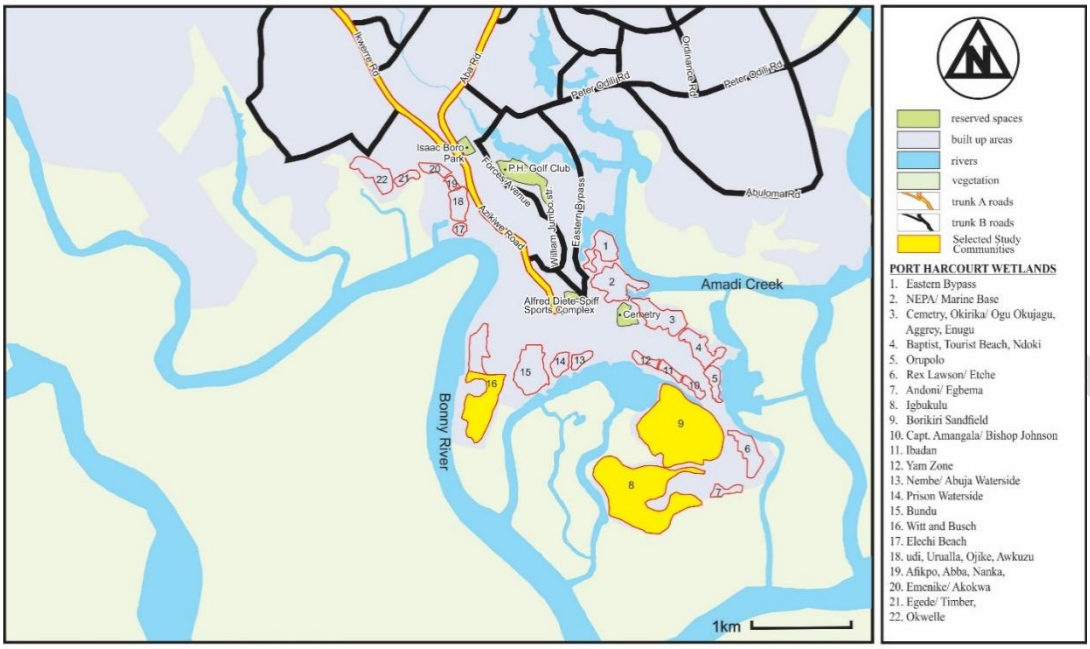

Fig. 2: Map of Port Harcourt Showing Wetlands and the Selected Study Sites
Source: Authors' adaptation (Theis *et al.*, 2009)

7. Results and discussions

7.1 Physical environmental challenges of wetland loss in Port Harcourt municipality

The outcome of the study indicates that there are some physical environmental challenges experienced by the wetland dwellers within Port Harcourt municipality due to the unplanned nature and the palpable lack of basic amenities in these settlements. Some of these physical challenges include flooding, poor sanitary condition, poor waste management system. There has been a continuous depletion of urban wetlands in Port Harcourt municipality through reclamation and conversion of these wetlands for other land uses.

For instance, between 1986 to 2016 there has been a phenomenal increase in land-use changes as available satellite imagery indicates that the extent of spatial changes in the study area were both positive and negative changes. Table 3 indicates that the built environment increased from 7,407,000m^2 to 10,577,700m^2 which meant an overall increase of 3,170,700 m^2 representing about 29.98% of the wetlands. Nevertheless, these wetlands were reduced further from 25,649,100m^2 to 22,650,300m^2 representing a depletion rate of 13.24% representing 2,998,800m^2. From the map data analysis, it is evident that within 30-years, these wetlands were being depleted at an average annual rate of 187,425m^2, with a corresponding increase in the built environment at an annual average of 198,168m^2.

Table 3: Changes in wetlands in the study area (1986-2016)

Attributes	**1986 Area (m^2)**	**2016 Area (m^2)**	**Difference (1986-2016) m^2**	**%**	**Annual rate of change (m^2/year)**
Non-Wetland Vegetation	1,854,900	1,988,100	133,600	6.72	8,350
Wetland Vegetation	25,649,100	22,650,300	-2,998,800	-13.24	-187,425
Soil/Bare Ground	2,380,500	1,856,700	-523,800	-28.21	-32737.5
Water Body	11,265,300	11,484,000	218,700	1.90	13668.75
Built Area	7,407,000	10,577,700	3,170,700	29.98	198,168.75
Total	**48,556,800**	**48,556,800**			

Source: Authors' Lansat Image analysis, (2020)

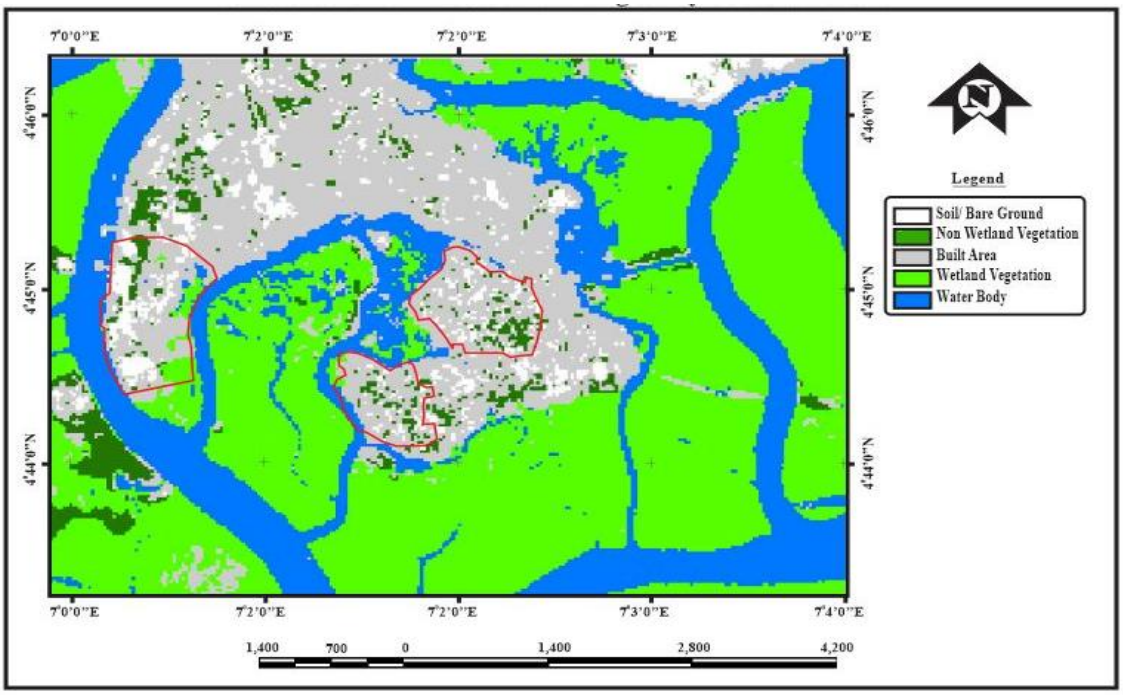

Fig 3: Spatial Changes of Wetlands within the Study Areas for 2016
Source: Authors' interpretation of Lansat Image, (2020)

Changes in wetland patterns over the years have some underlying natural elements like climate change, sediments condition differences and human activities such as city growth, deforestation, and agricultural practices (Grundling *et al.*, 2013). Environmental degradation and man-made activities have a significant impact on natural wetlands by way of altering natural landscapes with several human activities that might have adversative effects on ecological systems. Wetlands can also moderate the water quality and quantity in a watershed, as well as their capability to reduce pollutants as most wetlands, have experienced functional degeneration (Orimoloye *et al.*, 2020).

There is always a price to pay for wetland reclamation and conversion which often result in some form of physical environmental challenges. Flooding was one of the physical environmental challenges noticed in the study area as most of the residents. Responses from Table 4 indicate that 24% from Reclamation Drive, 19% from Borikiri Sandfill and 22% from the Borikiri New Road confirmed that ~~ they~~residents experienced flooding while another 42% from Reclamation Drive, 23% from Borikiri Sandfill and 15% from Borikiri New Road al~~so ffirmed that they~~ experienced periodic flooding in their neighbourhoods.

Table 4: Knowledge of flooding in the settlement

Study area	Yes (%)	No (%)	Sometimes (%)	N/A (%)	Total
Reclamation Drive	24	28	42	6	100
Borikiri Sandfill	19	55	23	3	100
Borikiri New Road	22	54	15	9	100

Source: Fieldtrip (2020)

8. Resilient responses to wetland loss

Building resilience capacities to survive wetland loss in vulnerable communities in the global south encompasses techniques that are unique to such communities. These threads of distinctive procedures are often entrenched in their indigenous knowledge as a people with different connotations such as traditional knowledge, local knowledge and inter-generational knowledge that has been successfully passed on from one generation to another (McEwen *et al.*, 2017; Mavhura *et al.*, 2013).

Some of the resilient responses adapted by these vulnerable residents include indigenous knowledge, social capital, and symbolic power.

Researchers have identified indigenous knowledge as a strategy deployed to survive most natural disasters (McEwen and Jones, 2012; Scammell *et al.,* 2009), and it also encourages the building of resilience capacities in the global southern context (Mavhura *et al.,* 2013).

In most circumstances, each of the vulnerable communities exhibits a central idea of seeking ingenious ways to build their resilience capacities with ~~since they have~~ limited access to power structures and other survival kits. Seeking these ingenious ways of building resilience capacities to a natural disaster such as wetland loss in the absence of effective power structures and related resources has over the years become experimental. It had gained currency as an emerging body of knowledge in the global south because it thrives on the evolving repetitive practices of the people (Tharakan 2015; Salick and Byg 2007 Nakata *et al.,* 2005). Besides, such experimental knowledge is contextual and engenders the community or individual to act on impulse when faced with danger occasioned by a disaster (Spiekermann *et al.,* 2015).

For Flavier *et al.,* (1995) indigenous knowledge refers to:

> *Indigenous knowledge (IK) is the local knowledge – knowledge that is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for local-level decision making in agriculture, health care, food preparation, education, natural resource management and a host of other activities in rural communities* (Flavier *et al.,* 1995, p479).

Indigenous knowledge is an indispensable component in the sustainability of natural resources, protection of rural livelihoods and the environment in most rural communities in the global south. These components when effectively coordinated with indigenous knowledge enhance the resilience capacities of any community in a disaster scenario (Murdoch and Clark, 1994; Ulluwishewa *et al*., 2008).

Social capital is another resilient response to build resilience capacity in the event of wetland loss. Social capital (Bourdieu 1993) entails the networks of relationships and the relationships possessed by an individual to highlight the relative strength inherent in families and communities. In context, having relationships and belonging to a network of relationships engender the individual to access resources and further confers a distinct benefit on the individual to accumulate more capital. These relationships and the network of relationships are evident practically fuelled by symbolic and material exchanges that bind the members within the network. These networks are accessed differently based on the status, orientation, disposition, and interest of the members at the point of belonging to the group. These networks of relationships are sometimes socially constructed and assured based on the application of a collective connotation in the form of family, club, school, social class, tribe, profession, and occupation. At the same time, they are also guided by a set of foundational actions which enables them to form a bond that underpins the relationship to establish objective relationships of proximity in the physical, social, and economic space (Bourdieu 1986).
Bourdieu describes social capital as:

> *the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition made up of social obligations ('connections'), which is convertible, in certain conditions, into economic capital and may be institutionalized in the form of a title of nobility* (Bourdieu 1986, p243-49).

Another resilience response to wetland loss is symbolic power. Bourdieu mirrors power relations and power structures in the form of symbolic power, class domination and the reproduction of social hierarchies (Bourdieu (1990), and identifies embedded dispositions displayed by individuals and communities when faced with certain situations (Bourdieu (1992,1990). These concepts also elucidate the description of how actors deploy social positions to access resources in the society that engender differentials in wetland loss disaster resilience and are useful regarding the differentials in disaster resilience in the global southern context.

Symbolic power indicates how those who had the symbolic power within the community used it to influence decisions and control the flow of resources to mitigate the menace associated with wetland loss.

9. Conclusion

The government and residents of these reclaimed and converted wetlands have over the years proposed some mitigation measures that would enhance the quality of urban life and improve the living conditions in those settlements.

Currently, there is no physical planning and development control law(s) in the Rivers State regulating the reclamation, conversion and use of wetlands. However, most of the respondents suggested the enactment of proper statutes and appropriate enforcement framework as such laws would reduce the impact of uncoordinated developments within the study area. Interviews with key informants, also revealed that policy formulation, empowerment of extant regulatory bodies and proper designation of wetlands as areas of natural assets, would also prevent arbitrary incursions into wetland reclamation and development.

The loss of wetland could pose an enormous challenge for many wetland species and the local communities who rely on them as a natural resource to eke out a living. Such important tasks indicate the need for improved management by both the environmental policymakers and the communities. Port Harcourt which started as a city of 7,000 people in 1921 has developed and metamorphosed into a burgeoning millionaire city with a steadily rising population of about a 2.3million residents. The municipality has transited from an administrative centre into a commercial hub and ~~(Obafemi and Odubo, 2013). I~~It has also become a strategic player in the oil and gas industry of the Nigerian economy as it has the capacity to join the global league of megacities. This study has attempted to highlight the physical environmental challenges of wetland dwellers in Port Harcourt municipality and proffer planning, and other mitigation the associated problems of urbanisation and wetland conversion within Port Harcourt municipality.

This study has further that indigenous knowledge, social capital and symbolic power are some of the resilient responses to wetland loss adopted in Port Harcourt municipality. Also, some mitigation measures suggested by residents include the provision of affordable land and the enactment of laws that will deter further incursions into wetlands reclamation and conversion.

10. Recommendations

i. There should be meaningful stakeholder engagement to prevent indiscriminate acquisition, reclamation, and subsequent conversion of wetlands.

ii. The government should conduct periodic geospatial mapping of wetlands to enable the listing of these wetlands and identify the extent of available wetlands; and

iii. There should be a strengthened development control framework to guide and encourage professionally trained and equipped manpower to manage wetlands and ensure acceptable best practices.

iv. There should be a proper Environmental Impact Assessment (EIA) done on any physical development around wetlands so that the impact of wetland loss on species and humans alike would be minimal.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

11. References

Adger, W.N. (2006). Vulnerability. *Global Environmental Change, 16*(3), 268-281.

Alexander, S. & Mclnnes, R. (2012). *Ramsar Convention on Wetland.* Briefing Note: Scientific and Technical Review Panel. Number 4.

Amani, M., Salehi, B., Mahdavi, S., Granger, J. & Brisco, B. (2017). *Wetland Classification in Newfoundland and Labrador Using Multi-source SAR and Optical Data Integration.* GISci. Remote Sens., 1–18

Ayotamuno, J.M. & Gobo, A.E. (2004). Municipal Solid Waste Management in Port Harcourt, Nigeria: Obstacles and Prospects. *Management of Environmental Quality: An International Journal*, 389-398.

Bassi, N., Kumar, M.D., Sharma, A., Pardha-Saradhi, P. (2014). Status of Wetlands in India: A Review of Extent, Ecosystem Benefits, Threats and Management Strategies. *J. Hydrol. Region. Stud. 2*, 1–19.

Belgam, W.I., Aroyoku, S.B., & Umaiduje, J.E. (2004). *Perspectives on the Human Environment.* Port Harcourt, Nigeria: Dept of Geography and Environmental Management, University of Port Harcourt.

Bourdieu, P. (1986). The Forms of Capital (English Version). *Handbook of Theory and Research for the Sociology of Education*, pp. 241-258.

Bourdieu, P. (1989). Social Space and Symbolic Power. *Sociological Theory, 7*(1), 14-25.

Brown, I., & Wachukwu, F.C. (2015). Settlement Dynamics in the Northern Fringes of Port Harcourt Metropolis. *International Journal of Scientific and Technology Research, 4*(5), 34-43.

Brown, I., & Nengi D.I. (2020). There is a Price to Pay for Every Wetland Reclamation and Conversion: Experiences from Port Harcourt Municipality. *MOJ Eco Environ Sci. 5*(5),221–228.

Cairns, K. (2002). *Attachment, Trauma and Resilience.* London, UK: British Association for Adoption & Fostering.

Chacowry, A., McEwen, L.J. & Lynch, K. (2018). Recovery and Resilience of Communities in Flood Risk Zones in a Small Island Developing State: A Case study from a Suburban Settlement of Port Louis, Mauritius. *International Journal of Disaster Risk Reduction, 28*, 826-838.

Chaskin, R.J. (2008). Resilience, Community, and Resilient Communities: Conditioning Contexts and Collective Action. *Child Care in Practice*, 14(1), 65-74.

Cohen, M.J., Creed, I.F., Alexander, L., Basu, N.B., Calhoun, A.J., Craft, C. & Jawitz, J.W. (2016). Do Geographically Isolated Wetlands Influence Landscape Functions? *Proc. Natl. Acad. Sci. 113*(8), 1978–1986.

Coleman, J. & Hagell, A. (2007). The Nature of Risk and Resilience in Adolescence. *Adolescence, Risk, and Resilience: Against the Odds,* 3, 2-16.

Cronk, J.K. & Fennessy, M.S. (2016). *Wetland Plants: Biology and Ecology.* CRC Press.

Davoudi, S., Shaw, K., Haider, L.J., Quinlan, A.E., Peterson, G.D., Wilkinson, C., Fünfgeld, H., McEvoy, D., Porter, L. & Davoudi, S. (2012). Resilience: A Bridging Concept or a Dead End? "Reframing" Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planning Practice? Resilience as a Useful Concept for Climate Change Adaptation? The Politics of Resilience for Planning: A Cautionary Note: S. Davoudi and L. Porter (Eds), *Planning Theory & Practice, 13*(2), 299-333.

Dolan, P. (2008). Prospective Possibilities for Building Resilience in Children, Their Families and Communities. *Child Care in Practice, 4*(1), 83-91.

Doron, E. (2005). Working with Lebanese refugees in a Community Resilience Model. *Community Development Journal, 40*(2), 182-191.

Garg, J.K., 2015. Wetland assessment, monitoring and management in India using geospatial techniques. J. Environ. Manage. 148, 112–123.

Grundling, A.T., Van den Berg, E.C. & Price, J.S. (2013). Assessing the Distribution of Wetlands Over Wet and Dry Periods and Land-use Change on the Maputaland Coastal Plain, North-eastern KwaZulu-Natal, South Africa. *South Afr. J. Geomat. 2*(2), 120–138.

Hardman, S. (2011). *How Does Urbanization Affect Biodiversity?* Retrieved from Ecological Blog.

Jacelon, C.S. (1997). The Trait and Process of Resilience. *Journal of Advanced Nursing,* 25(1), 123-129.

Kanu, M.C. (2013). *Urban Development Processes and Inequality of the Space Economy of Port Harcourt Metropolis.* Port Harcourt, Nigeria: Unpublished PhD thesis from the University of Port Harcourt.

Kendra, J.M. & Wachtendorf, T. (2003). Elements of Resilience After the World Trade Center Disaster: Reconstituting New York City's Emergency Operations Centre", *Disasters, 27*(1), 37-53.

Kio-Lawson, D. (2014). The Squatters of Port Harcourt, Nigeria: Their Identity, Wants, Characteristics and Policy Options. *Journal of Developing Country Studies, 4*(22), 40-49.

Knight, R.L., 1997. Wildlife Habitat and Public Use Benefits of Treatment Wetlands. *Water Sci. Technol. 35*(5), 35–43.

Knight, R.L., Clarke, R.A. & Bastian, R.K. (2001). Surface Flow (SF) Treatment Wetlands as a Habitat for Wildlife and Humans. *Water Sci. Technol. 44* (11–12), 27–37.

Mallak, L.A. (1998). Measuring Resilience in Health Care Provider Organisations. *Health Manpower Management,* 24(4), 148-152.

Manyena, B. (2009). *Disaster resilience in Development and Humanitarian Interventions.* Doctoral Dissertation, Northumbria University.

Manyena, S.B. (2006). The Concept of Resilience Revisited. *Disasters, 30*(4), 434-450.

Matyas, D. & Pelling, M. (2015). Positioning Resilience for 2015: The Role of Resistance, Incremental Adjustment and Transformation in Disaster Risk Management Policy. *Disasters, 39*(s1), s1-s18.

Miller, J.S., Lowry, P.P., Aronson, J., Blackmore, S., Havens, K. & Maschinski, J. (2016). Conserving Biodiversity Through Ecological Restoration: The Potential Contributions of Botanical Gardens and Arboreta. *Candollea 71*(1), 91–98.

Moser M., Prentice C. and Frazier S. (1998). A Global Overview of Wetland Loss and Degradation. *Wetlands International. Volume 10 of the Conference Proceedings.* Technical Session B of the 6th Meeting of the Conference of the Contracting Parties in Brisbane, Australia, March 1996.

National Population Commission. (2006). *Data Sheet for Rivers State.* Abuja, Nigeria: Federal Government of Nigeria.

Obafemi, A.A., & Odubo, T.V. (2013). Waterfronts Redevelopments in Port Harcourt Metropolis: Issues and Socio-Economic Implications for Urban Environmental Management. *The International Journal of Engineering and Science (IJES), 2*(12), 01-14.

Olalekan, A., & Gordon, M. (2011). The Niger Delta Wetlands: Threats to Ecosystem Services, Their Importance to Dependent Communities and Possible Management Measures. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 50-68.

Olusola, A.M., Muyideen, A.A. & Ogungbemi, O.A. (2016). An Assessment of Wetland Loss in Lagos Metropolis, Nigeria. *Developing Country Studies*, 1-7.

Orimoloye, I.R., Kalumba, A.M., Mazinyo, S.P. & Nel, W. (2020). Geospatial Analysis of Wetland Dynamics: Wetland Depletion and Biodiversity Conservation of Isimangaliso Wetland, South Africa. *Journal of King Saud University-science, 32*(1), 90-96

Oyegun, C.U. (1994). *An Overview of Port Harcourt Region.* Port Harcourt, Nigeria: Paragraphics.

Oyegun, C.U. (1997). *The Human Environment: Its Form and Processes.* Port Harcourt, Nigeria: Paragraphics.

Park, J., Seager, T.P., Rao, P.S.C., Convertino, M. & Linkov, I. (2013). Integrating Risk and Resilience Approaches to Catastrophe Management in Engineering Systems. *Risk Analysis, 33*(3), 356-367.

Paton, D. & Johnston, D. (2017). *Disaster Resilience: An Integrated Approach,* Charles C Thomas Publisher.

Pickett, S.T., Cadenasso, M.L. & Grove, J.M. (2004). Resilient Cities: Meaning, Models, and Metaphor for Integrating the Ecological, Socio-economic, and Planning Realms. *Landscape and Urban Planning,* 69(4), 369-384.

Richardson, C.J., Bruland, G.L., Hanchey, M.F., Sutton-Grier, A.E. (2016). Soil Restoration: The Foundation of Successful Wetland Reestablishment. *Wetl. Soil. Gene.Hydrol. Landscap. Classificat.* 469.

Rodima-Taylor, D., Olwig, M.F. & Chhetri, N. (2012). Adaptation as Innovation, Innovation as Adaptation: An Institutional Approach to Climate Change. *Applied Geography*, 33(0), 107-111.

Rose, A. (2007). Economic Resilience to Natural and Man-made Disasters: Multidisciplinary Origins and Contextual Dimensions. Environmental *Hazards,* 7(4), 383-398.

Salaria, S. (2017). *Rate of Vegetation Recovery in Restored Prairie Wetlands.*

Serran, J.N., Creed, I.F. (2016). New Mapping Techniques to Estimate the Preferential Loss of Small Wetlands on Prairie Landscapes. *Hydrol. Process. 30*(3), 396–409.

Talukdar, S. (2017). Diversity indices of aquatic macrophytes in Jharokh Wetland, Assam, India. Int. *J. Adv. Res. Idea. Innov. Technol. 3*(5), 32–35.

Theis, M., Lloyd-Jones, T., Adenekan, S., Gusah, S., Moore, M., Gusah, D. & Mulyawan, B. (2009). *Port Harcourt Urban Regeneration Scoping Study.* Port Harcourt, Nigeria: Max Lock Consultancy Nigeria Ltd.

Timmerman, P. (1981). Vulnerability Resilience and Collapse of Society. *A Review of Models and Possible Climatic Applications. Toronto, Canada. Institute for Environmental Studies, University of Toronto.*

Turner, M. H., & Gannon, R. (2017). *Major Causes of Wetland Loss and Degradation*. Retrieved from Wetlands Loss and Degradation.

Ungar, M. (2008). Resilience Across Cultures. *The British Journal of Social Work, 38*(2), 218-235.

Whatmore, S.J. (2009). Mapping Knowledge Controversies: Science, Democracy and the Redistribution of Expertise. *Progress in Human Geography*, 33(5), 587-598.

Wilson, G. (2012). *Community Resilience and Environmental Transitions,* Oxford, UK: Earthscan

Wreathall, J. (2006). Properties of Resilient Organisations: An Initial View. *Resilience engineering: Concepts and Precepts,* 275-285.

Zhou, H., Wan, J. & Jia, H. (2010). Resilience to Natural Hazards: A Geographic Perspective. *Natural Hazards*, 53(1), 21-41.

Zolli, A. & Healy, A.M. (2012). *Resilience: Why Things Bounce Back. UK:* Simon and Schuster, Hachette.