



Applicability of Indigenous knowledge and methods in flood risk management in a nigerian city

Adaku Jane Echendu

School of Environmental Studies, Queen's University, Kingston, Ontario, Canada

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ABSTRACT

The incidence of flooding is set to rise due to climate impacts in the coming years. Nigeria is one of the countries increasingly experiencing flooding. Its urban areas are expected to suffer more from the impacts of flooding due to the concentration of economic activities therein and projected population growth. To sustainably manage flood risks, there is a growing call to incorporate indigenous knowledge and practices in contemporary flood risk management. This work engaged with experts working in the field of flood risk management in public institutions to understand if indigenous knowledge and methods could positively inform modern flood risk management in Port Harcourt, a major flood prone Nigerian city. It finds that the applicability of indigenous knowledge in contemporary flood management in the research location is limited given the poorly managed transformation, growth, and evolution the city has experienced over time. However, some practice rooted in Indigenous knowledge and practices like planting of certain trees and mangrove species still have utility today. The government is encouraged to halt reclamations and conversions of wetlands and instead, seek ways of restoring and bringing back these important ecosystems given their natural role in flood mitigation and control. Developing urban forests can also play an integral role in managing rainwater runoff while improving the overall environmental quality.

1. Introduction

Nigeria is predisposed to flooding which has become an annual occurrence in many of its states (Obi et al., 2021). Floods cause extensive damage, disruption, and losses (Parsons and Fisher, 2022; Abdullahi et al., 2022). Its psychological effects are also long lasting and could prove difficult to ascertain or measure. Overall, it is a devastating disaster especially for a country like Nigeria struggling to meet its global development goals (Echendu, 2020). The growing incidence of flooding is connected to the global climate change crisis. Climate change causes warmer atmosphere. A warmer atmosphere causes more intense precipitation as the amount of water evaporating into the air is increased by warmer oceans caused by climate change (Trenberth, 2012). When the moisture-filled air converges into a storm system or moves over land, it yields more precipitation (Trenberth, 2012; Kim et al., 2020). In places like Nigeria with poor stormwater management infrastructure, the resultant effect of increased rainfall is flooding. Climate change is projected to cause even more record-breaking flood disasters in future (Ge and Zhu, 2023). Indeed, in 2022, Nigeria was one of the countries including Pakistan that witnessed record breaking flooding events with devastating impacts. Preliminary reports on Nigeria's flooding indicated

a record 1.4 million people were impacted and more than 600 died (Echendu, 2023). Pakistan's record flooding event displaced 33 million people and killed about 1290 (Nanditha et al., 2023; Ochani et al., 2022).

Given the gravity of the flooding problem in Nigeria over the years, several scholars have sought to understand the core drivers of flooding in the country (Nkwunonwo et al., 2015; AKUKWE THECLA, 2014; Etuonovbe, 2011; Egbinola et al., 2017; Echendu, 2021; Echendu, 2022a; Echendu and Georgeou, 2021; Okoye, 2019). Poor urban planning, unregulated or unplanned urbanization, poor waste management among other factors have been identified as the principal drivers of flooding in Nigeria (Egbinola et al., 2017; Echendu, 2021). Indeed, the poor state of urban planning has been repeatedly flagged for its inability to exert the influence needed to combat climate change related impacts in urban Africa as a whole (Cobbinah et al., 2019). This implies the planning problem is not peculiar to Nigeria. However, the Nigerian urban planning system is particularly characterized by dysfunctionality, weak implementation of planning laws, and poor coordination. The result is a lack of ability to manage urban development leading to indiscriminate developments including even on flood paths and channel that cause or worsen flooding. Poor waste management is another key driver of flooding in Nigeria (Egbinola et al., 2017; Echendu, 2021). Sights of

E-mail address: adaku.chyoma@gmail.com.

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garbage dumped in drains are common in many of its cities (Echendu, 2021; Ukpogon and Udofia, 2011; Sridhar and Hammed, 2014). Lack of adequate storm management infrastructure also cause flooding in Nigeria (Echendu, 2022a; Adedoye and Rustum, 2011). Most of these core drivers of flooding are interrelated and reinforcing for example poor infrastructure and waste management are also urban management, planning and administration issues.

Despite the presence of institutions that work in the area of flood management and acknowledgement by the authorities on the flooding risk Nigeria is exposed to, there are still serious gaps in rolling out effective Flood Risk Management (FRM) strategies. There is also the absence of a comprehensive FRM policy (Okoye, 2019). However, there are policies in place like Nigeria's National Water Policy that acknowledges the threats of flooding and maps out strategies for needed response and intervention, but implementation of such policies in the country remains a nagging problem.

A fundamental aspect of flood management is the deployment of technologies rooted in scientific foundations (Parsons and Fisher, 2022). In addition, there is a growing acknowledgement and understanding that indigenous knowledge and practices can form a crucial component of the FRM toolbox (Cuaton and Su, 2020). Thus, there is a growing demand for incorporation of indigenous knowledge in contemporary FRM and building/enhancing resilience to climate change (Mavhura et al., 2013; Munsaka and Dube, 2018; Neeta, 2016).

Over the years, international organizations have also during summits and in policy documents advocated for the incorporation of indigenous knowledge in research and development programs in responding to environmental challenges and disasters like flooding (Mapedza et al., 2022). This is evident and engendered in international policy documents like the Agenda 21, the Hyogo Framework for Action, the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals to mention but a few (Mapedza et al., 2022). The Sendai Framework being the most current disaster policy document firmly reiterates the need for integrating indigenous knowledge in disaster risk management to enhance effectiveness (UNISDR, 2015). Despite these acknowledgements on the need for indigenous knowledge to be applied in disaster management, scholars have decried the poor integration of Indigenous knowledge in contemporary western based disaster management processes (Šakić Trogrlić et al., 2019; Cuaton and Su, 2020).

In Nigeria specifically, there is a dearth of research on the extent of application of indigenous knowledge and methods in disaster risk reduction (Abdullahi et al., 2022). Given the need to find sustainable solutions to the perennial flooding problem in the country especially in its highly populated urban areas, this work sought to understand if and what indigenous methods of controlling flooding could be applied in its highly populated and most at risk urban areas. As there are different types of flooding viz-coastal, fluvial, and pluvial flooding. Coastal flooding occurs when surrounding land is submerged by seawater while fluvial flooding occurs as a result of a river overflowing its banks into nearby land due to snowmelt of rainfall. Pluvial flooding happens when rainfall intensity exceeds the capacity of drainage systems (Rosenzweig et al., 2018). For this type of flooding, risk is independent of proximity to a waterbody. Pluvial flooding is increasingly being recognized as a serious risk and threat for many cities globally (Bulti and Abebe, 2020) including the study city, Port Harcourt. It is the class of flooding under focus in this work.

Port Harcourt city provided a suitable case study to understand what methods can help sustainably reduce flood risk and enhance urban communities' resilience to flooding disasters. This is because of its susceptibility to flooding and fast urbanizing rate whereby the city grew over fivefold in both land mass and population in five decades (Brown and Wachukwu, 2015). Findings from this study would contribute to knowledge in flood risk management and highlight contextual factors that can influence the applicability of indigenous knowledge in contemporary FRM. This work thereby brings novelty and contributes to knowledge by ascertaining the applicability and feasibility of integrating

indigenous knowledge in FRM in a particularly flood prone and high-risk city. This knowledge can also have wider application in other flood prone cities that has significantly grown in population, urbanized or evolved from their traditional and historical characters as well as physical geographical forms. It can also guide other cities by serving as a cautionary tale on what to avoid in urban management and expansion given the shortcomings that have been highlighted in this work as will be seen in subsequent sections. Experts in flood risk management working in relevant public institutions were engaged with to seek answers on the applicability of Indigenous knowledge in a city that has significantly evolved from its traditional form. This introduction section is followed by an overview of indigenous knowledge and practices in FRM. The research background and location are discussed next followed by the research methodology adopted in this work. The findings are presented and discussed next. The conclusion section wraps up the key arguments in this paper and proffers relevant recommendations.

2. Indigenous knowledge in flood risk management

The need for incorporating not just scientific knowledge but other forms of knowledge including indigenous knowledge is increasingly being recognized (Wang et al., 2019). For the purposes of this work, indigenous knowledge is defined as the sum total and wide array of skills and knowledge curated, acquired and accumulated over generations that is possessed by people in a specific geographical area that enables them manage and co-exist in their natural environment (Ringo et al., 2016; Bwambale et al., 2020). It is dynamic, constantly evolving (Hooli, 2016), built upon, and passed on from one generation to generation via word of mouth and related socialization channels and practices (Mapedza et al., 2022). Indigenous knowledge in traditional communities form part of quotidian interactions with the local environment, with human and non-human elements intertwining to become key components of the native ecosystem (Bwambale et al., 2020). The fact that indigenous or local knowledge is a product of past encounters/experiences of natural hazards has led to its recognition as a resource in resilience building not only in practice, but also theory (Hooli, 2016). Indigenous knowledge exists within a local context and is anchored within a specific social group in a unique setting at a specific time (Bongo et al., 2017). There is the conviction and growing recognition that indigenous practices can form an integral part of the resources and knowledge for managing and controlling flooding (Obi et al., 2021; Abdullahi et al., 2022; Mapedza et al., 2022; Bongo et al., 2017).

Indigenous knowledge is valuable in comprehending past hazard occurrences while scientific knowledge is valuable when faced with unprecedented disaster events (Mercer et al., 2012). Therefore, scientific and indigenous knowledge could complement each other and be seen as two sides of a coin in various aspects of modern disaster management (Mavhura et al., 2013; Bongo et al., 2017). However, there is still limited application of indigenous knowledge in disaster management (Membele Garikai et al., 2022). This is despite the fact that in some communities, more trust is placed on indigenous knowledge in weather forecasts in comparison to western scientific methods (Mahoo et al., 2015).

Flood risk management (FRM) encompasses measures geared towards reducing the chances and effects of flood. It comprises the prediction of flooding, tools and measures for reducing flood risk as well as considerations of socio-economic consequences and factors (Echendu, 2020). FRM is dynamic given that it is not a one size fits all approach but changes to suit local circumstances. The choice of a specific strategy is dependent on numerous factors ranging from environmental (eg geographical features, type of flooding) to socio-economic (ibid). Both non-structural and structural measures also form components of modern FRM with various strategies deployed globally to manage flooding. Fabiyi and Oloukoi (2013) group these approaches into three viz: Scientific, Engineering and Traditional (Indigenous) approaches. They posit that the scientific and engineering approaches are highly technical and elitist which often renders them beyond the reach or applicability of local

communities who must now depend on state agencies, central governments or development partners to have these approaches deployed in FRM.

With respect to flooding, local communities have over the years applied indigenous knowledge in flood response and management (Ringo et al., 2016; Danladi et al., 2020). It is applied in predicting the occurrence of floods, responding to and recovering from floods. Across Africa, communities are known to have a good understanding of weather patterns and employ this knowledge in predicting impending flooding. For instance, the study of clouds and trees and the behaviour of some animal species help in predicting floods (Munsaka and Dube, 2018). Predictions are also made based on the behaviour of local flora (Hooli, 2016). Local elders serve as repertoires of meteorological knowledge and use this knowledge acquired over the years in making flood predictions (Hooli, 2016; Yoshizumi et al., 2012). Other widely deployed indigenous knowledge in flood risk management include monitoring of the degree of rainfall in upper catchments, lunar observations, behaviour of aquatic animals and birds, observing the colour of waterbodies, identifying cloud position, analyzing the magnitude of wind and thunderstorms, monitoring sounds from rivers and torrents, studying the mobilization of ants, etc (Devkota et al., 2013; Fabiyi and Oloukoi, 2013; Mapedza et al., 2022; Mahoo et al., 2015). Ecological indicators like scarcity of certain vegetation also serve as indicators of impending floods (Fabiyi and Oloukoi, 2013). Predictions or forecasts based on indigenous knowledge have also been proven to be fairly accurate (Mahoo et al., 2015).

Indigenous communities are also known to deploy available local materials and resources to put up structural barriers as flood interventions (Munsaka and Dube, 2018; Mavhura et al., 2013). These include levees, sandbags, digging of channels for waters, building embankments with local materials like mud, construction of earth drains (Kometa, 2019; Hooli, 2016). Some agrarian communities also adapt and cope with flooding by farming early maturing varieties of crops, early harvesting of crops and relocating to higher grounds (Obi et al., 2021; Echendu, 2022b).

Many Nigerian communities have also coped with and managed disaster conditions over years by relying only on indigenous knowledge (Abdullahi et al., 2022) highlighting its relevance in FRM. Fabiyi and Oloukoi (2013) find that the Itshekiris, Ilajes and Ijaws of Nigeria who inhabit rural coastal communities have unique local meteorological knowledge that enable them predict flooding in real time, seasonal and even long-term basis. These highlight the utility of indigenous methods in FRM. The knowledge of elders has also been formally incorporated in town planning in some places. For example, in Namibia, the government made it mandatory for regional planners to consult traditional authorities during any significant public land-use decision in their localities which was previously not the practice (Hooli, 2016).

However, studies acknowledge that most of these indigenous strategies are unsustainable amid the increasing occurrence of disasters. This is because they only help in the short-term and often fail in the face of serious events (Mavhura et al., 2013). A combination of scientific and indigenous methods dependent on context could prove a more sustainable approach due to the opportunity to leverage on the key features and benefits of both methods. This assertion/position is brought to the test in this research where the participants share their expert opinion on the feasibility of incorporating the two domains in addressing the real time flood challenges in the study city of Port Harcourt, Nigeria.

3. Research background and location

This research was undertaken in Rivers State, one of Nigeria's 36 states. Given the demography of participants (experts knowledgeable in FRM) required for this study, the capital city, Port Harcourt was the most ideal location (see Fig. 1). This is because it is where the relevant government ministries, parastatals and other relevant public institutions involved in flood control and management are located. The choice of Port Harcourt thus made it most convenient and practical for recruitment of

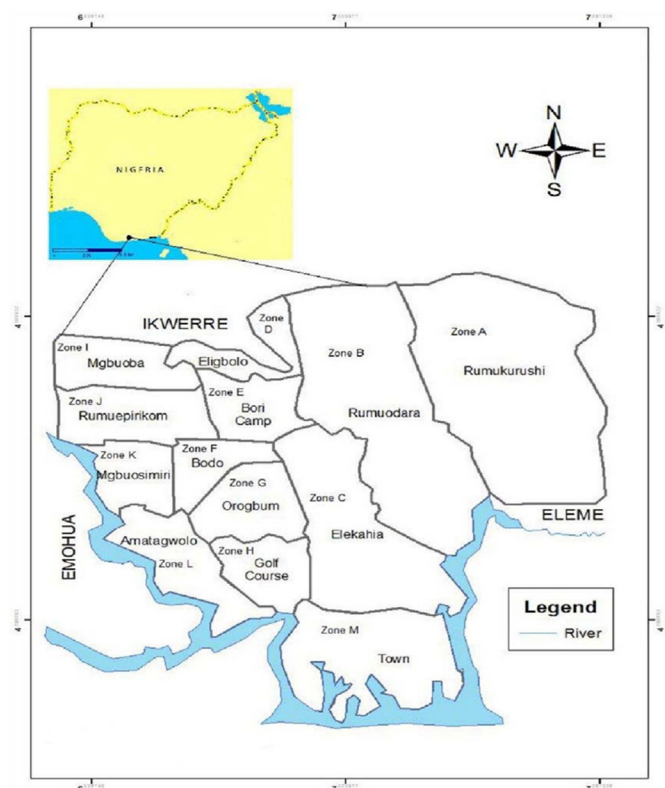


Fig. 1. Map of port hacourt. Source (Akukwe and Ogbodo, 2015).

the expert participants. Also, the incidence of flooding in the city has steadily risen over the years with areas not historically known to flood beginning to experience flooding on a growing basis (Echendu, 2019). It is a major coastal city located in Nigeria's Niger Delta region. This region is prone to a lot of environmental and climate issues. Port Harcourt is also one of the cities where urban flooding is prevalent (Egbinola et al., 2017). Given the growing recognition of the incorporation of indigenous practices in FRM, experts in the field of FRM in Rivers State across various government ministries and research institutions were engaged with to understand the feasibility of incorporating indigenous flood control practices in controlling rising flood occurrences in the city.

4. Research method

Given the growing call for the adoption and integration of indigenous knowledge in flood risk management, this paper sought to investigate indigenous practices that have traditionally been used to manage flooding and to what extent these practices are relevant or can help in FRM practices in order to sustainably address the worsening perennial flooding in Rivers State. This is thus a primary qualitative case study whereby experts working in various relevant institutions concerned with flood management in the state were engaged with.

Semi-structured one-on-one interviews formed the basis of primary data collection. Referral sampling or snowball sampling whereby an initial contact makes the first referral and subsequent referrals follow was the recruitment method. A total of eighteen experts knowledgeable in FRM were engaged with in this research. Seventeen of the eighteen participants were male reflecting male dominance in the urban/environmental management and planning profession in Nigeria. They were asked the feasibility of incorporating indigenous flood control practices in contemporary flood management in the city. The interviews were conducted between April and May 2022 and lasted between 60 and 90 min. Four of the participants were employed at the Rivers State Ministry of Environment; another four worked with the Rivers State Ministry of

Development and Planning; two participants were employed at the Rivers State Ministry of Works; and three worked with the Rivers State University of Science and Technology. One participant worked with the Nigeria Meteorological Agency; two with the Niger Delta River Basin Authority; and the final two participants worked with the Center for Disaster Risk Management and Development Studies situated at the University of Port Harcourt. The interviews were conducted in English, recorded and transcribed verbatim in Microsoft word. QSR NVIVO, a qualitative analysis software was then used to code the data into themes for final analysis. This followed an inductive approach whereby data is analyzed without preconceived theories or categories. This enables the data to guide analysis and the emergence of themes, patterns or concepts providing a straightforward and simple approach for deriving results within the context of research questions (Thomas, 2006). The experts were asked what indigenous or traditional practices they have knowledge of that has been historically used in managing flooding. They were then asked if these practices can help in managing the contemporary flooding challenge in the city. The participants in this work have been assigned codes EP1 to EP18 to accord then anonymity.

5. Findings and discussion

The findings of this research are presented under two themes in this section.

5.1. Indigenous practices deployed in flood risk management

The experts possessed excellent knowledge of indigenous or local methods that have been used over the years or were used in the past to manage flooding. They also shared what indigenous practices they have witnessed being done either in the past or currently, or what they have knowledge of in a bid to manage flooding. Some of them have also participated in these activities as growing children and youth.

As explained by EP4: *'Most of the times, we cleared the surroundings. Like, I can remember in my village, the youth are normally called upon to clear the water channels because there are traditional water channels where this water flows through. You know how water flows, if it's blocked, it won't flow. So, the youth are called on to clear it so that it can flow naturally into the rivers. This is done to prevent the village from being flooded'*.

Many basic activities as described by EP4 like clearing channels and pathways are activities that have been done in local communities in many parts of the globe historically to ensure solid matter obstructions do not cause or contribute to flooding. In modern time in cities all over the world, similar action is seen in the routine cleaning of drains and removal of obstructions and debris for proper flow of storm or rainwater.

EP7 also shared what he witnessed while growing up as a child that was being carried out to prevent flooding: *'Those days, what I saw being done by our forefathers to prevent flooding was to plant some kind of trees along the banks of the river trees like the Indian bamboo. The roots of the Indian bamboo are strong and sort of holds the soil together to avoid both flooding and erosion. You know when erosions come, it caves in the soil and then flooding goes into the community. But when they plant these Indian bamboos, it makes the soil to be more firm. Recently, I participated in one NGO sensitization and the essence was to encourage the planting of some mangrove species. We planted these species and sensitized the people to engage in the practice of planting of trees'*.

Planting of trees serve to prevent flooding as the fine and large roots of certain species consolidates and binds the soil, stabilizes river banks and thereby reduces erosion (Moore, 2022; Pramova et al., 2012). Trees serve many purposes in managing water related disasters. The mere presence of trees ensures that the quantity of sediments entering waterways is reduced, preventing water downstream from becoming clogged with silt and muddied (Moore, 2022). Bigger trees can also protect smaller shrubs and vegetation from the forceful speed of floodwaters by serving as a physical barrier (ibid). Trees also slow the force of floodwaters as its parts such as roots and trunks block and deflect water, and

even changes the direction of flow. Trees can also help prevent landslides (Hawley and Dymond, 1988; Spiekermann et al., 2021).

EP7 mentions a recent sensitization program by an NGO he participated in that was geared towards encouraging the planting of mangrove species as a flood mitigation measure. The utility of mangroves in mitigating flooding is supported by empirical evidence (Menéndez et al., 2020; Soanes et al., 2021; Hoang Tri et al., 1998). Mangroves serve as a primary line of defence against both erosion and flooding. It has been calculated that the loss of mangroves would cause 15 million more people to be flooded on an annual basis across the globe (Menéndez et al., 2020). They are thus invaluable in the climate adaptation discourse and disaster risk reduction (ibid). Most parts of present-day Port Harcourt city were previously mangrove forests and wetlands which have now been converted to make room for the astronomical population growth (Echendu, 2023). The Rivers State government have also been named the key actor in the reclamation of these ecosystems (Dapa and Brown, 2020) which provide invaluable ecosystems services (Echendu et al., 2022).

EP 8 stated he had no personal experience of what was done in the past but goes on to share what he has knowledge of, saying: *'I grew up in the city and I've been in the city all my life. While I was staying with my grandparents, I was too young to know how they were going about it[managing flooding]. I believe generally that human sanitation was taken seriously or doing pathways, I think that was serious then. You know one of the problems we usually have which is also natural is that even our waterways most times, apart from the human devils[who block them], sand and silt block them. Sometimes, you see water hyacinth and plants grow on them. There are some places that are water channels, and you might not even know because grasses have grown all around them. Thank God for the Niger Delta Development Authority.¹ From time to time, they give out contracts to clear this. And maybe during the time of our parents they were doing it naturally maybe using boats they will go and clean but now they[the agency] use swamp buggies'*.

His expression captures natural factors that may obstruct waterways like silt and invasive plants like Water Hyacinth and how that is being addressed today via contracts awarded by a government agency where contractors use Swamp Buggy (a heavy-duty amphibious vehicle) to routinely remove these invasive plants. He believes that this may also have been done in the past with access to the channels achieved using traditional boats or canoes at the epoch.

Other participants discussed structural measures undertaken by locals to manage flooding like building levees and ridges to serve as flood deterrents, building embankments and relocating from lower grounds. Some of their submissions aligned with the findings of the literature review on traditional practices that are used in managing flooding. The participants also stated that these practices are no longer widely practiced in contemporary times. The only practice that may be akin to or reflective of traditional practices is environmental sanitation whereby certain hours in a chosen day of the month say 7am till 10am in the morning is set aside for cleaning the environment. Residents except for essential workers are expected to stay home and join community efforts to clean up the environment.

EP10 elaborates more on the present-day practice of environmental sanitation: *'The only thing they do in the city of Port Harcourt presently is this idea of Environmental sanitation on the last Saturday of the month. Majorly, people clean the environment, they clean the drains, that's what they do in the city of PH. But in the villages, all they do is to dig gutter and where is the water flowing to? Nowhere. They just dig gutter so that part of the flood water will enter that gutter. Except where they have stream close by, they can now channel the water to the river through manual labor. In Port Harcourt, what they do majorly is the cleaning, this environmental sanitation'*.

He laments that even in the rural areas that still bear some semblance of traditional societies, what is being done today is limited in comparison to the past. This is apparent on his rhetorical question regarding where

¹ This Agency was set up in the year 2000 by the federal government with the sole mandate to develop Nigeria's oil Niger Delta region.

the water goes to. In the city however, environmental sanitation is all that could be deemed reflective of indigenous practices that is still in practice today and which could be deemed relevant in modern day flood control especially given how poor waste management worsens the flooding in the city.

5.2. Effectiveness of indigenous practices in flood risk management in Port Harcourt

Having elicited from the expert participants the Indigenous practices in flood management they have knowledge of, they were asked the feasibility of these methods in contemporary times.

According to EP2, the historical indigenous or traditional methods deployed in managing flooding would not be effective in the face of the city's contemporary flooding dilemma. He says:

'The challenge is that the problems of Port Harcourt have grown beyond traditional flood management methods. The reason being that what are the traditional ways of flood management? You build small, small ridges and then try to create artificial channels for water to go away. Or you leave the environment and go to higher grounds. Where will people go to? We can't relocate, we can't build small ridges or channels. It is a bigger scenario, and the traditional methods won't apply here. I may be pessimistic, but I think it won't work.'

EP2 expresses pessimism with regards to the applicability of indigenous methods and presents a much narrower view of indigenous practices and limits it to the building of small ridges and widening of channels to enhance water flow. To him, the city has grown beyond the extent that the traditional practices he mentions would have any significant impact in managing the scale of flooding being experienced in the city.

EP6 and EP8 views aligns with the EP2's opinions on the limited applicability of indigenous methods in addressing the city's current flooding challenges. They lament how the arbitrary development of natural drainage areas have rendered the applicability of indigenous methods null in relation to the city's flooding problem.

'This city is no longer a traditional community. This is a cosmopolitan city where even the foreigners outnumber the indigenes. You know you have people of various interest groups living here, so on what basis will you begin to apply traditional knowledge. For instance, again, the government has gone to reclaim same swamp forests around the Amadi area. I am sure they didn't make preparations to compensate for the excess water that that swamp forest used to collect. Where will that water go into now? The water will end up in people's houses' ... EP6

'Well, before now the city has not been developed like this. We had Indigenous enclaves scattered in the city and then the development was not like this. They have not developed these natural bodies that takes in water when rain falls. But today, those areas have been built up, so it [these building or development modifications] has started defeating the indigenous knowledge of the people on how to respond to flooding' ... EP8

They also note that the city has experienced significant growth in population and development of areas that served as natural drainage basins. They also cited recent examples of the government reclaiming wetlands. Conversion of wetlands has also been cited a major factor that has exacerbated flooding in another flood prone Nigerian city, Ibadan (Egbinola et al., 2017). Some other participants detailed how even road construction that is meant to be a development project becomes a nightmare in some places due to poor design and lack of provision for drainage during road construction. This is another example of poor urban planning and management as there ought to be provisions for adequate drainage in such road construction projects. Also, the traditional methods like clearing the waterways are no longer effective because the places that were historically waterways have been covered with buildings.

This is seen in EP12's words: *'You know the NDDC² constructed road for us[talking about his community]. The height of the road now is higher than the other areas. There's tendency of water from the roads to flow into communities and cause flooding because they didn't put any drainage on both sides. That's why the youth are asked to clear the waterways so that it can naturally flow. We have tried to mitigate the flooding traditionally through human efforts. We help ourselves and clear whatever blockages because water doesn't like to be blocked. It loves to flow through its channels. This flooding is more in the urbanized areas than in the villages because that's where people build anyhow'.*

The poor oversight by town planning authorities is evident in EP 12's assertion where he states, 'people build anyhow'. This exemplifies the failure of urban planning authorities to effectively regulate or manage urban development. Poor urban planning is a problem in the city that has been revealed to be a causative factor in the flooding being experienced on an increasing basis (Echendu and Georgeou, 2021; Echendu, 2021).

For EP 10, the level of development which he terms 'civilization' the city has experienced has meant that traditional methods are no longer applicable. He surmises: *'Due to civilization, most of these traditional practices or processes that were used are almost done with. You know civilization has brought in technological know-how which can be used to manage the floods. Now this is where the government really need to come in'.* He believes the deployment of western flood control practices falls under the purview of the government and called on them to act in this regard.

EP 13 goes into more details and like other experts in this study, thinks indigenous practices would be ineffective. He states that this is due urban growth and development which did not consider the natural water canals. In his words: *'Like I mentioned, historically and originally, we have natural right of way of canals. But, because of civilization the canals ought to have been expanded because of increase in population and urbanization. You know here in Africa, we welcome western ideas, western knowledge. There is a paradigm shift now and the historical measures cannot serve today's needs. So, the innovations that come in today, we have to embrace them. Within this innovation may lie our needed solutions to the flooding problem'.*

EP13 strongly believes that it is western/scientific based ideas that can adequately address the city's flooding problem. Despite his strong views regarding what would work in the local scenario, strong evidence exists that a merging of traditional and western flood control measures which mainly borders on structural modifications may be a better holistic approach in flood management (Šakić Trogrlić et al., 2019; Wang et al., 2019). A mix of such approaches could involve striving to ensure any new development considers the natural features of the land and the development practices of locals who have historically inhabited an area for a long time. Some local communities are known to reserve some low-lying lands as drainage basins of the community. Leaving such areas as is even when undertaking more modern developments could be an example of integration of traditional and modern practices.

EP 15 also believes that the population growth the city has experienced over the years means that the traditional Indigenous practices are no longer sufficient to manage contemporary flooding. To that effect, he says: *'When you talk about our forefathers' practices, at the epoch Port Harcourt wasn't up to a million residents, everywhere was still bush'.* To him, those practices would no longer meet today's flood management needs given the level of growth the city has experienced. This growth has largely occurred in an unregulated manner contributing to the myriad of environmental problems including flooding that plague the city today.

6. Recommendations and conclusion

This work set out to determine the effectiveness or applicability of indigenous practices in a major Nigerian city, Port Harcourt increasingly facing flooding on a yearly basis. The participants in this work who are experts in the field of Flood Risk Management employed in the public

² NDDC is an acronym for the Niger Delta Development Commission.

sector shared their knowledge on indigenous methods that have been historically applied in managing flooding in the locality. However, there is a largely unanimous view of the participants in this research that the effectiveness and relevance or applicability of traditional or indigenous methods in managing flooding is limited. They attribute this to the level of growth and physical changes that has occurred in the city. Those traditional features or characteristics which make indigenous knowledge and methods effective are no longer in existence in the contemporary Port Harcourt urban environment. The research findings suggest that the degree of relevance of indigenous practices especially the types that have been elucidated in this work in flood risk management is influenced by urban development and growth. Indigenous knowledge has been applied for centuries in observing flood early warning signs and flood forecasting, coping and adaptation to flooding across the globe. However, based on the research findings, Indigenous knowledge and methods as was practiced in the locality would no longer contribute substantially to managing flooding in the city given the evolution of the city over the years. However, some practice rooted in Indigenous knowledge and practices like planting of certain trees and mangrove species still have utility today. In Port Harcourt, mangrove forests and wetlands are becoming rarer and rarer due to their incessant reclamation and development. The state government is encouraged to halt these reclamations and conversions and instead, seek ways of restoring and bringing back these important ecosystems. This is especially advised in those areas they naturally existed given their natural role in flood mitigation and control. The government is also encouraged to plant urban forests as they can play a key role in managing rainwater runoff while improving the overall environmental quality. This would also help in giving the city a more natural look given the changes that have taken place over the years. FRM practices need to be designed and implemented according to context, and in the case of Port Harcourt, sustainable stormwater infrastructure is essential especially in regard to pluvial flooding. The findings of this research are limited by the type of flooding (pluvial/rainfall) under study being the predominant type of flooding being experienced Port Harcourt city and its environs. The position of the experts on the applicability of indigenous methods in managing flooding in the city is also limited by the type of flooding under focus in this research. Certainly, indigenous knowledge has relevance in flood risk management and needs be curated and streamlined into modern FRM where possible. This research presents opportunities for further research on indigenous methods in urban flood risk management and exploring the subject further with other types of flooding. The findings also serve as a cautionary tale especially around arbitrary transformation of natural landscape forms to such extents that the ecological value of these ecosystems is lost thereby losing natural landscape resilience features and rendering urban areas more exposed to disasters.

Declaration of competing interest

There is no conflict of interest in this research.

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