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A Comparative Review of the Implications of Flooding on Architecture and Planning Policies in the UK and Nigeria

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Abstract

Since signing the Kyoto protocol and the Paris accord, several countries have already enacted policies to reduce activities that have contributed to global warming and ultimately climate change. However, some levels of damage has already been done resulting in the manifestation of certain adverse effects such as, increased flooding due to more frequent and continuous rainfall, melting of ice caps and rise in sea level amongst others. With these adverse effects on the increase, buildings and infrastructure have become more vulnerable to enhanced degeneration and possible destruction globally, especially along coastal and low lying communities. As a result of this, some countries have developed policies directly related to architecture, planning and construction, in a bid to save more lives and property in the event of extreme weather conditions such as floods. Some of these policies have been translated into building codes and planning regulations that govern the design and construction of buildings and infrastructure in flood-prone areas while others are still at report briefing stage. This study reviews policies enacted by the UK and compares it to what exists in Nigeria so far. It focuses on three key areas in which climate change impacts directly on the built environment. Data for this study was obtained from secondary sources such as policy documents, briefing papers, and reports, Acts, building codes and planning regulations from print and online media.

Keywords: Climate change; Policy; Architecture; Planning; Built environment; Flooding

Introduction

Climate change is a change in global weather patterns. The long-term alteration in global weather patterns especially increases in temperature and storm activities are regarded as potential consequences of the greenhouse effect. The weight of scientific evidence indicates that human-induced global climate change is occurring and is having environmental, biophysical, social and economic impacts at local, national and global scales. It was Roaf et al [1] that suggested that from the rather nonchalant way the built environment is being developed; government as well as ordinary people do not understand the import of a rapidly changing climate and the need to redesign our buildings and cities to adapt to cope with this change to insure future generations.

Responding to climate change as it affects the built environment from both mitigation and adaptation angles require strategic approaches from policy, regulatory and institutional frameworks and capacities. The effectiveness of the environmental and other policies and their potential to support adaptation and mitigation measures in three key areas of the built environment is the focus of this study. Although climate change has been mentioned in some key policies in most countries that are signatories to the Kyoto protocol and the Paris agreement, yet some of these policies are simply too generic and are not in position to provide the required focused response to certain adverse effects of climate change in the built environment.

This paper focuses on the adverse effect of flooding. Flooding occurs as a result of incessant rainfall, overflowing of rivers, storms and hurricane, sea level rise and increased groundwater. The four main sources of flood risk include:

Fluvial or River flooding

Coastal flooding

Surface water flooding

Groundwater flooding

The UK Climate Change Risk assessment Report (2017) puts flooding and coastal change risk to communities, businesses and infrastructure as the top amongst six areas of climate change risks for the UK. Priestly [2] states that, in England alone around 5.4 million properties are at risk of flooding from rivers and the sea, which is 1 in every 6 properties. It puts the annual flood damage costs at £ 1.1billion for the whole of the UK. In Nigeria, the comprehensive Post Disaster Needs Assessment conducted from November 2012 to March 2013 on the flood induced damage in Nigeria's Niger Delta with the support of the World Bank, United Nations and other agencies estimated the total value of infrastructure, physical and durable assets loss at $ 9.6bn [3]. Priestly further states that although it may not yet be possible to prevent all flooding and coastal erosion from taking place but with effective adaptation, mitigation and risk management methods, it can help reduce the impact. Flooding as stated earlier is one adverse effect of climate change that directly impacts the built environment and for which adaption for resilience is crucial.

This study focuses on the various interventional actions of government agencies saddled with the responsibility for protecting both the built and natural environment from flooding. Normally, government standards and regulations as depicted in building codes and planning laws mainly focus on more general issues related to building designs. These include the maintaining of standards in the

area of Health, Safety and Environment (HSE) as depicted in planning regulations, building codes and environmental impact guidelines. However, with increased flooding issues due to climate change, responsible authorities have had to be more concerned with certain specifics in the area of architectural design, planning and landscape and the use of building materials to increase resilience to flooding. Within the past two decades, more responsible government agencies have developed specific policies or strategies that target building adaptation or align property and infrastructural development to climate change management. This paper highlights some of those examples and focuses on their relevance to three key areas in the built environment. These include policies affecting architectural design, policies affecting building material specification and usage and policies affecting urban planning.

Study areas

The study examines policies on flooding in the United Kingdom and Nigeria, with specific reference to these three aforementioned areas. A parallel was drawn between both countries because of the similarity in percentage of their high-risk flood zones. Around 10% of England including large parts of some major cities like Hull, Portsmouth and Central London are located in high-risk flood zones (RIBA 2018). Similarly, just around 10% of Nigeria including major cities like Lagos, parts of Port-Harcourt, Asaba, Lokoja, Makurdi and Yenagoa are located within high-risk flood zones [4]. In addition, both countries are at risk of flooding due to sea level rise around their coastal cities as well as flooding due to increased rainfall, all as a result of climate change.

Methodology

A review of policies affecting architectural design

With regards to how climate change induced flooding affects architectural design, Samuels and Prasad [5] best summed it up in this statement:

Since anybody who designs, constructs or commissions a building probably expects it to still be there in 30 or 40 years' time, one of the factors which ought now to be considered is the climate changes which are possible in its lifetime. Thus design should take account of possible rises in temperature, increases in rainfall, changes in sea level and increases in the frequency of extreme events .

This suggests as earlier mentioned that buildings would be required to perform newer functions that they were originally not designed for. The policy makers in London have recognized that warmer, wetter winters and hotter, drier summers are imminent as well as possible natural hazards such as heat waves, flooding and droughts. As such, buildings are expected to take on the new role of catering against these imminent changes and possible hazards. With the expected rise in temperature, designs are expected to increase thermal comfort without over-reliance on mechanical air conditioning. With increase in rainfall and rise in sea levels, buildings are expected to become safety arks because of the resultant flooding. In essence, the resulting weather changes on account of climate change is expected to affect the way we design buildings and transform architecture as a whole.

Unfortunately, this transformation is yet to be fully experienced in the industry or inculcated into the building culture of the general populace. No wonder Roaf et al (2009) suggested that neither the government nor the ordinary people and one might even add most built environment professionals; really understand the import of a rapidly changing climate and the need to redesign our buildings and cities to ensure the survival of our built environment in decades to come. The key area requiring a paradigm shift in architecture as it relates to mitigation of the adverse effects of climate change is how buildings are designed for flood resilience [6]. Observed that people in high flood risk zones were not routinely installing resilient measures in their buildings; the UK Minister Rory Stewart had to initiate a roundtable of all concerned parties in a bid to enhance resilience. The RIBA policy note (2018) suggests the need for a move away from simply managing flood risks by keeping out water, to designing buildings and built environments that are more resilient to flooding. With a projected estimate of 2 in 6 homes in the UK at risk of flooding by 2050, this transformation and its timing becomes crucial.

For this to take effect, it is imperative for architects and other professionals in the building industry to acquire newer forms of training. The Peter Bonfield's [6] which is the result of the roundtable on increasing property flood resilience in the UK, suggests examining the current level of skill required by architects, builders, contractors, and flood surveyors to cope with this rising menace. One of the recommendations of the report is the creation of a certification scheme for such built environment professionals as well as repair technologists, to be linked with the Continuing Professional Development Training of their individual institutes and regulatory bodies.

Concerted efforts to address this flood issue at the design stage has commenced as far back as 2001 in the United Kingdom [7]. There the government published a document "Planning policy guidance note 25: Property development and flood risk. This document which acts as a guide provides information for all parties involved in the planning and development of property in England and how flood risks should be considered in all stages of planning and design. The document goes as far as recommending floor level height design and as well as spatial inclusions or non-inclusions. Proverbs and Soetanto [8] highlight some of the regulations pertaining to design, culled from that document:

- Floor levels of the building should be raised above expected flood levels
- Designs that include basements should be avoided in flood risk areas

However, with regards to design, it is the RIBA Policy Note (2018) that contains more practical and innovative examples of flood-resilient architectural designs either developed in the UK or developed elsewhere but adapted in the UK. Their focus lay on multifunctional as well as future adaptable designs such as the flood defense in Katwijk aan Zee, Netherlands that combines parking and hospitality amenities with storm-proofing; the floating settlement in Waterwoningen, Amsterdam and the urban development plan of HafenCity, Hamburg that doubles as its own flood barrier. These designs are worth adapting as they include innovative flood protection methods directly within the building fabric. However, RIBA notes that detailed statutory guidance, building standards and regulations for such new flood resilient developments are still lacking and requires Government intervention. Though some attempt has been made at setting out draft policies to that effect, like those contained in the London Plan.

The London Plan which is a strategic framework of London over the next 20-25 years was developed with several issues in mind including climate change amongst others. The document sets out draft policies that take into account legal requirements, planning laws, sustainability

appraisals and regulation assessments until the year 2031. The UK's climate change projections by 2050 estimate increase in temperatures of over 2.7 degrees amounting to heat waves and increase in mean winter rainfall by 15% that could give rise to floods. Section 5.8 of the plan suggests that the early design stage is the most cost effective time to incorporate relevant design and technological measures to adapt to climate change. However, resilience can also be designed into buildings during repair after flooding (RIBA 2018).

In section 5.12 of the policy, is the planning decision suggesting that building development are required to pass a PPS25 exceptions test for flood resilient design and emergency planning. In this section of the policy it emphasizes the fact that buildings will have to be designed with the ability for quick recovery following a flood (No.4, Paragragh C, Policy 5.12). This will require a design incorporating an effective self-draining system for the water to drain out of a building once flood waters have stopped rising. This regulation was echoed in the RIBA Policy note (2018) through a flood-resilient retrofit design to enable flood victims move back to their property which is expected to become habitable within an hour after flooding following simple disinfection. Pilot projects for this scheme have already been developed in Watford, England.

Furthermore, mitigation initiatives for buildings against climate change have also been proposed in the London Plan policy in the area of sustainable design. Paragraph 7.19 states that "New buildings should achieve the highest standards of environmental, social and economic sustainability by meeting the set standards of sustainable design and construction". But there is also the ominous task of retrofitting and improving the resilience of existing buildings within a 25year insurance window (RIBA Policy Note 2018). Similarly, Peter Bonfield's [6] report, recommends resilient measures in buildings to be installed as either a preparatory measure for properties at risk of flooding or during repair of buildings after flooding. The fact is that flood-resilient architectural design is already being adapted by communities around the world including the UK and contributes to the reduction of loss of lives and property (RIBA 2018).

Although, all these policy notes and guidelines are geared towards achieving complete flood resilience in buildings in the UK, it is worth noting that even the UK is yet to fully incorporate resilient designs into building regulations in flood risk areas. The Royal Institute of British Architects (RIBA) as a body has acknowledged that it will take time to incorporate resilience requirements into Building Regulations for such properties. So in the interim, all agencies like RIBA can do are make recommendations to that effect. Some of the recommendations made so far are:

- The need for a Construction Industry Research and information Association and Better Regulation Executive in developing the Property Flood Resilience Code of Practice and consolidated guidance that provides a standardized approach for the delivery and management of flood resilience measures.
- The giving of licenses for market-driven innovations in flood resilient designs and pilot projects. Where successful pilots would eventually filter into policy reform.
- The Central and Local Government should work with built environment experts and improve infrastructure investment decision-making processes in order to promote multifunctional and adaptable designs that deliver better value for money.
- To ensure that flood-resilient design is more proactively taken up by home and building owners exposed to flood risk.
- Local planning authorities should incorporate plans for improving existing buildings' flood resilience in local plans.
- The MHCLG should amend building regulations to require buildings being rebuilt or renovated to incorporate climate resilient improvements.
- Defra, Environment Agency and Department of Health should incorporate a section on flood resilient design in the next iterations of the National Flood and Coastal erosion Risk Management Strategy and National adaptation Programme.

These recommendations and proposals are expected to demonstrate the importance of the design-based approach in flood resilient buildings.

A review of policies affecting building materials

Another area Governments can intervene is in creating policies that ensure the use of building materials that are flood resilient and can help save life and property. Adverse effects like flooding and temperature rise can be mitigated with the use of materials that are resilient. Escamareia et al [10] observed that for an effective uptake of resilience, there should be regulations to that effect backed up by legislation to make them enforceable. As at 2012, only few countries in Europe namely; UK, Czech, Poland and Germany had building regulations covering the use of flood resilient building materials [9,10]. By that time the UK had already suffered three major flood events: 2007, 2009 and 2012. Two others were to follow in quick succession in the space of three years: 2013/14 and 2015 [6].

But in other parts of the world, it is the United States of America and Australia that currently lead in the study of flood-resilient building materials. The USA has standardized building codes updated every 3years that specifically covers the use of flood-damage resistant materials for all structures in flood hazard areas. They have also provided documentation identifying some of such materials based on ability to withstand direct and prolonged contact with water, without sustaining damage that requires more than cosmetic repairs. The USA has also gone further to propose future standards that use certain methods to determine flood damage resistance ratings of materials, as well as materials that can withstand contaminants carried by flood waters [10].

In the UK, one of the few proposed climate adaptive neighbourhood development schemes that have incorporated the use of innovative building materials to enhance flood resilience and minimize the risk of flood damage is the brownfield site redevelopment in Norwich. Although this is a step in the right direction, it is however a singular case which indicates that apparently more thought is been put into planning and design related mitigation measures than the development of flood-resilient building materials in the UK. However, this should not be the case as resilience involves creating buildings, communities and regions that mitigate threats of extreme weather and climate change by engineering buildings for severe wind and wave impacts and using materials that are waterproof or otherwise impermeable to water damage [11]. This means to achieve full resilience, design mitigation must be combined with innovative flood resilient building materials and products. The National Flood Resilience Review (2016) suggested some measures in form of

products and building materials homeowners could use to enhance their building resilience capabilities. These include:

- Installing what is referred to as flood doors
- Installation of water-tight airbrick covers and waterproofing brickwork
- Installation of non-return valves

The Bonfield report [6] also suggested the use of flood resilient building tiles and generally promoting the use of already existing flood proof standard products such as the PAS 1188. The report also recommended the standardization and certification of flood products, components, building materials and services, including smart materials as part of their action plan to increase consumer confidence in innovative flood resilient products.

Unlike the use of design mitigation methods, the use of flood resilient building materials in the UK is only beginning to gain momentum, while in Nigeria; it has barely even sprouted. This may be as a result of cost. In an earlier study on lessons learnt from the 2012 floods in Nigeria, the study revealed that 69.6% of home owners and developers cited the issue of cost as one of the major factors why precautionary measures were not taken to increase building resilience against floods as part of lessons learnt [12].

However, who examined cost-benefit analysis justified the use of flood resilient building materials for the reduction of flood damage [13]. The economic value of flood damage was estimated by rebuilding/replacement costs, while damage reduction assessment or value is estimated by various options such as choice of resilient building materials and construction methods e.g. elevated structures. Rogers et al (2015) in a similar study showed that future damage to buildings could be reduced by adopting appropriate building and foundation construction. However, they observed that the cost of building the recommended liquefaction resilient foundation was more costly than other housing foundation types but has been described as critical to building damage reduction. In essence, even if cost is a factor, the cost-benefit analysis from previous studies have shown that it would be more economical to employ the use of resilient building materials and construction methods at the onset, as rebuilding or replacement costs could prove more expensive in the long run.

A review of policies affecting planning and urban design in the built environment

There has been increased focus on the larger built environment especially in urban areas due in part to climate change induced flooding in Europe, Australia, Asia and other parts of the world. McGranahan et al [14] proposed that urban areas are more prone to flooding because of increased impervious cover and filling of wetlands and other natural flood retention systems. As a result of this, some Government authorities have made recommendations related to planning and environmental issues primarily to help stem the effects of flooding. For instance, contained in the UK's planning policy guidance of 2001 as cited by Proverbs and Soetanto [8]. There are strict regulations on planning and development as it relates to flooding. Such as;

- Development must not affect natural drainage and flood plain
- New developments should be located in zones of little or no flood risk where possible
- New developments within flood risk zones are only permitted where risks are managed with adequate flood defenses.

But it is the more recent RIBA recommendations on flood resilient planning citing examples like the floating settlement in Waterwoningen, Amsterdam and the urban development plan of HafenCity, Hamburg that doubles as its own flood barrier that show functionality for the now as well as engaging elements that are easily adaptable in the future. Their recommendations include:

- The use of modular flood defenses that can be increased according to need
- Flood-prone cities with housing shortages should seek to adopt regulations which require all new developments in flood risk areas to demonstrate reduced exposure and vulnerability to flood damage
- For all relevant Ministries in the UK to work with built environment experts to examine the feasibility of introducing Building Regulations, planning regulations and planning guidance for flood resilience and resistance that are linked to Flood Zone Designations

In Australia, the studies done by the Insurance Council of Australia [15] on improving community resilience to extreme weather events resulting from climate change, proposed series of actions by governments on land use planning and zoning across all states to prevent inappropriate development on land subject to inundation. These include:

- No residential or commercial development is to occur on land predicted to be subject to a 1 in 50yr return period of inland flooding or storm surge unless mitigation works have been carried out to reduce the risk to 1 in 100yrs.
- Expand the cyclone and wind storm related building codes to counter the predicted southerly expansion of severe cyclones.

Although the National Planning Policy Framework (NPPF) aids in the control of flood plain development in the UK, it is not empowered to rule out development in flood risk areas. Rather it is the local councils that can redirect development away from areas at highest risk including floodplains.

Climate change policies affecting design, building materials and planning in Nigeria

Climate change is already having an impact in Nigeria, with weather-related disasters and increased temperatures becoming more frequent in the past four decades. As a reactionary measure, the government of Nigeria and a number of civil society organizations embarked on the development of the National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN). The aim was to minimize risks, improve local and national adaptive capacity and resilience to the negative impacts of climate change. Reports from the Nigerian Meteorological Agency (NIMET 2008) from 1941 to 2000 showed evidence of increase of rainfall by 2-4mm in the mangrove swamp and rainforest regions, and an increase in average temperatures by 1.4-1.9˚C in the extreme northeast, northwest and southwest regions of the country [16].

Weather projections as given by the Climate Systems Analysis Group (CSAG) University of Cape Town predict temperature increase by 0.04˚C per annum from now until 2050 and 0.08˚C rise per year after that. It also predicts wetter climate in the south of Nigeria by an average of 15cm annually from 2046-2065. This shows a likely increase

in extreme rainfalls, storms, floods and sea level rise in mangrove swamp and coastal regions of Nigeria.

In response to these looming adverse effects, the Federal government set up climate change units in the Federal Ministry of Environment as well as climate change committee in the National assembly and is still in the process of developing a comprehensive National Climate Change Policy document for Nigeria. But in the interim, NASPA-CCN has developed strategies, policies, programmers and measures to tackle climate change effects in 13 priority sectors. Strategies with planning implications are as follows:

- Assist communities to reduce vulnerability through participatory planning of land use and housing
- Discourage building/urban encroachment into vulnerable areas, high risk zones and low lying areas
- Discourage housing and settlement patterns that are maladaptive in the face of climate change

Unfortunately, none of the policy strategies proposed at that time addressed specific issues on architectural design and building materials as observed in the UK. The three cited above that have planning implications are quite generic but in the years that followed, other documents such as the Federal Ministry of Environment Policy Document (2005) section C, focused on flood prevention, mitigation, control, forecasting and warning, mapping, evaluation, provision of regulations to flood management and zoning. The strategies put forward to achieve its set objectives are flood plain regulations included in the building codes, flood plain zoning and introduction of flood control procedures as part of contract specifications in construction sites. Although, this policy document was released in 2005, the National Building Code released a year later in 2006 which ought to have reflected some of the strategies, had no mention of flood resilient designs, flood resilient materials or flood proofing [17].

However in 2011, a more comprehensive flood control plan contained in the National Environmental Regulations of the Federal Republic of Nigeria-Official Gazette [18] was drafted. It contained 18 flood control regulations, 3 inspection and enforcement actions, permit obtaining procedures as well as a disclaimer of liability amongst other things. The regulations specified;

- The requirement of special permits for location, planning and property development in areas vulnerable to flood hazards
- Ensuring the incorporation of flood mitigation measures in all infrastructural developments
- Criteria for infrastructural development involving water diversions and other earth intrusive works
- Recommendations for use of flood resistant materials for all new construction
- Recommendations that the national building code incorporates the use of flood resilient electrical, heating, ventilating, plumbing and air conditioning equipment in all new construction in flood prone areas
- The creation of flood elevation data for public use to be ensured by the National Environmental standards and Regulation Agency (NESREA).
- Elimination of flood damage through infiltration of water through sewage and sanitary systems
- Ensuring compliance and investigating all forms of violations

Although this regulation has slightly greater detail and a better spread in terms of scope than the two earlier policies, it apparently leaves the design and implementation of more detailed control/mitigation measures to the various States of the Federation, to be handled on case-specific basis. This was indicated in number 4 of the regulations which states that "applicants are to comply with zoning and building regulations of particular States and Local Governments in which development is to take place" (pg B381). This is because although in Nigeria the Federal Government establishes Acts, State Governments can also enact laws and bye-laws based on their geographical peculiarities as they see fit. As such it absolves the Federal Government of the responsibility of actual design and implementation of these regulations and relinquishes the onus to the States.

Nonetheless, for Federal projects, the conditions for approval of building plans in flood areas in theory, requires an application made to NESREA with the inclusion of:

- Site Plans
- Detail Plans
- Construction Specifications
- Drainage computations (for run-offs etc)
- Flood proofing details
- Flood proofing certification
- Erosion control plans

The purpose was to ensure compliance of regulations across flood prone areas in the country, regardless of what State the project is to be domiciled in, but this is only in theory and not the case *de facto*.

Policies affecting architectural designs, planning and building materials usage in selected flood-prone states in Nigeria

To ascertain the trickle-down effect of the NESREA regulations and adherence to its requirements at the State levels, the environmental, design and planning policy documents of two States in the High-risk flood zones in Nigeria were studied for semblance of regulation standards or if these standards were adopted. The selected States in the southern and coastal regions of Nigeria that are the most prone to flood related disasters due to climate change as revealed in the NIMET and CSAG reports stated earlier. These are Bayelsa and Lagos States respectively. The policies of these two States have also been reviewed to see if there are any direct implications on architectural design, planning and material usage due to flooding as a result of climate change.

Bayelsa state climate change policy (2011)

Bayelsa State being one of the littoral States in Nigeria, with an intricate system of rivers, creeks and streams making up about 45% of its area, experiences the larger impact of the effects of climate change in its hydrology. The policy document drawn up by its Ministry of Environment states the major threats of climate change in the State as Sea level rise, flooding and storms. With storms and floods as a result of increase in frequency and duration of rainfall, while the Sea level rise is a consequence of increase in global temperature. The State-specific policies were geared towards preventing the impacts of climate change, coping with the impacts where they cannot be averted,

responding promptly and adequately to disaster and quick recovery. However, of all 48 strategies in five categories listed to achieve the policy goals, only seven are directly related to planning and none to design of buildings specifically. They include:

- Proper drainage planning and maintenance of existing drainage networks in urban centers
- Construction of by-pass channels in water ways
- Design and construction of embankments and dykes in communities most vulnerable to flooding.
- Maintain vegetation cover along shorelines to prevent erosion.
- Carry out mapping of sensitive and critical habitats to enable planning of development projects in order to reduce damage to critical and sensitive habitats
- Promote the participation of communities in land use planning
- Develop a State wide land use plan

Besides these, other strategies are either very generic or do not directly relate to architectural design or material usage to enhance flood resilience or mitigation in anyway. In addition, this policy document lacks specific strategies that deal with actual flood resilience in the built environment, temperature increase, and a definite time-frame for implementation or even a detailed plan of action. Already reaching its ninth year and after suffering two major flood disasters in 2012 and 2019 respectively, besides the other frequent flooding issues experienced annually, the policy document is yet to be reviewed or expanded to be more case/region-specific and climate change relevant.

Lagos state climate change policy (2012)

Being a major coastal city and a commercial hub in Nigeria, the impact of climate change induced flooding in Lagos State if unchecked will be quite devastating. The projected sea level rise in the coastal areas of Lagos State could reach 1m by 2100 giving rise to; loss of land to the sea; loss of physical infrastructure; displacement of settlements; loss of ecosystems and biodiversity amongst others. Contained in the document, Towards a Lagos State Climate Change Adaptation Strategy (LAS-CCAS) are policies, strategies and measures to providing an integrated and systematic approach to reducing vulnerabilities, increasing resilience and sustainable well-being of the populace.

The document lists about 44 strategies and measures under Coastal zone and marine ecosystems, Energy, Transportation, Human settlement and Health. Of these strategies 14 are directly related to planning and urban design, while just one is directly related to architecture. The planning strategies include:

- Engage communities in the participatory planning of their settlements in order to reduce their vulnerability to climate change
- Enforce land use zoning regulations that restrict building on high risk areas, such as the ocean front, flood plains and low-lying terrain
- Produce land-use maps of the main urban settlements in the State and periodically review them
- Prepare a master plan for urban settlements in the light of the challenge of climate change and implement them
- Integrate the various District and Model City Plans and ensure their implementation
- Complete and ensure regular review of all physical development plans in the State
- Encourage the use of soft landscaping (i.e., grass in external areas of buildings) rather than concrete
- Intensify the process of providing green parks and open spaces in urban areas
- Develop a long-term physical plan for the coastal zone, using the principle of integrated coastal zone management
- Integrate a disaster avoidance policy into the State's land use planning and development control
- Place strict control over all new land reclamation along the coast, increasing standard to 4metres above sea level with a requirement for sea defenses against storm surges
- Create buffer zones in physical planning to accommodate anticipated sea level rise
- Strengthen policies prohibiting building on water course
- Draw up and implement a Lagos State energy policy, integrating climate change considerations

The architectural strategies include:

- Encourage the adoption of green architecture

Although this policy document is richer in content with regards to planning implications, it is however completely lacking in the area of building material policies and could also benefit from more specific architectural design policies. But other added advantages include an implementation time-line and a regular 3-yearly review based on increased impacts and increased knowledge of climate change. Comparatively, Lagos State has enacted policies with more direct implications on planning that are pertinent to its environmental challenges induced by climate change. Although more needs to be done in the area of policies relating to architectural design and building material usage, the LAS-CCAS document can serve as a template for States with similar climate change induced challenges like Bayelsa.

However, the Federal and State policy documents show no interaction or interphase between the two tiers of government. If this is done, it could synergize the efforts aimed at ensuring that climate change policies within Nigeria are consistent at all levels. But as indicated earlier on in the study, the NESREA requirements are essentially *de jure* and not those presented *de facto*, as they are not demanded for by the approval boards at the State level. It indicates that although the Acts exist at the Federal level, there may be no trickle-down effect at the various flood-prone regions in the States where it matters most.

Discussions and recommendations

This review highlights the level of government involvement in adaptation and mitigation strategies on the adverse effects of climate change and its implications on architecture, planning and use of building materials. It shows that the level of government involvement is so far highly commendable in the UK while only gradually gaining ground in Nigeria. The United Kingdom has made great strides in addressing the issues head-on by creating or reviewing policies that have direct bearing on architecture, planning and use of building materials in high-risk flood zones. Nigeria on the other hand, although

still lacking more detailed policies at the Federal level has recorded some progress at State level in one of the highly vulnerable States - Lagos. Yet a lot still needs to be done to prepare vulnerable environments in Nigeria for climate change induced flooding.

One would assume that by now all countries that have signed up for the Kyoto protocol and the Paris accord would have developed comprehensive policies backed up by legislation, especially with the adverse effects of climate change on the increase. But the rather slow pace of government initiatives supports Roaf et al's [1] submission that governments as well as ordinary people seem not to understand the import of a rapidly changing climate and the need to redesign our buildings and cities to adapt to it. Professionals in the built environment like architects and planners had been earlier thought of as part of the elite group with some level of understanding of the impending dangers linked to climate change. But with some recent studies like Bonfirld's recommendation for the need for continuing professional development in flood resilience by building professional institutes (2016) and those on architects' knowledge on flood adaptable designs and resilient buildings in Nigeria, that assumption has been largely disproved [19].

While a continuous awareness campaign, education and information dissemination strategy is required to bring the larger populace up to speed, it will require much more to keep the built environment professionals abreast of the facts. To be technically equipped for flood design, adaptation and mitigation due to climate change, the contemporary architect and planner ought to be adept with information on flood behavior, defensive planning, and energy efficient buildings, flood resilient and smart building materials and above all intelligent buildings. Knowledge of flood resilient and smart building materials is crucial for developing product specifications for buildings in high-risk flood zones.

For the architect especially, intelligent buildings are considered to be the future of climate change adaptation. These are buildings that are transformable, adaptive, movable or interactive in response to environmental conditions. They are adaptive where they can adjust to different functions, users and climates; transformable when they change shape, space, form or appearance; movable when they can relocate from one place to another; and interactive when they respond to user's requirement in automatic or intuitive ways. All these changes are done in a dynamic fashion to constantly changing environmental conditions in energy efficient ways [20,21].

On the issue of flooding, just as all issues regarding climate change, timing and setting time frames is of the essence if major flooding disasters are to be averted or their impact reduced. So, with regards to long-term planning and time-line goals, the UK Government has been the more proactive of the two case studies. In response to climate change issues, the UK Climate Change Act 2008 was formed and requires the Government to compile an assessment of the renewed risks the UK faces as a result of climate change. The Act empowers a committee to advise the UK on preparing for climate change and the resulting recommendations are published in a risk assessment report, the first of which was published in January 2012. The 2017 risk assessment report puts flooding and coastal change risk as the top amongst six areas of climate change risks the UK is exposed to. As a response to the risk assessment study, the UK has developed a flood risk management time-line:

- The first is a 6-year investment plan (2015-2021) on flood risk management and flood defenses with a commitment of £ 2.5 billion
- There is also the UK Government's 25 year environmental plan
- Thirdly is the 100 year plan with an estimated funding of £ 25 billion

The 6-year plan which is already in effect is expected to protect a further 300,000 properties and reduce flood risk by an estimated 5%. Bonfield's [6] roundtable action plan also includes a timeline:

- 1 year – better understanding of property level resilience amaongst the general populace
- 2 years – developing systems with the insurance, building and finance sectors
- 3-5 years – a situation where those at high flood risk areas have knowledge and capability to adapt their properties to limit damage in event of flooding
- 5 years – an environment where it has become standard practice for properties in high risk flood zones to be resilient

In the Nigerian scenario, only the Lagos State Government indicated an implementation time-line and a regular 3-yearly review based on increased impacts and increased knowledge of climate change. Neither the Bayelsa State Government nor the Federal Government has indicated timelines for review of policy documents or implementation of already proposed policies [22].

This study is by no means an exhaustive review of Government policies on flood resilience, adaptation and mitigation strategies. It however highlights key areas where policies have been made or are yet to be made affecting architecture and planning issues as it relates to climate change induced flooding in the UK and Nigeria. In addition, many regional or State Government authorities still rely on the more generic climate change policies enacted years earlier in their attempt to uphold their own end of the bargain of the Kyoto protocol. But in all, it buttresses the fact that while climate change has had some direct implications on architecture and planning, it emphasizes the need for more targeted policies if flood resilience, adaptation and mitigation is to be achieved.

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