Impacts of Flood on Ekeki Housing Estate Phase 2, Yenagoa, Bayelsa State, Nigeria.

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Abstract- Flooding Impacts on property are in varying degrees. The aim of this research is to identify the impacts of flood on Ekeki housing Estate phase 2 in Yenagoa, Bayelsa State. The philosophy adopted by the researcher was pragmatism and the research design was case study. The methods of primary data collection were through face-face interview with 2 residents within the study area and Four (4) building professionals. The research made use of purposive sampling technique for the study and the population of the study is two hundred and fifty (250 nos) housing units within the study area. The data analytic technique adopted for the study was analytic induction. The study revealed that there is lack of proper supervision and use of sub-standard building materials and lack of proper drainage system which results to extensive flood damage of water-sensitive building services and destruction of building components, thus, bringing about the deterioration of property value and consequent high cost of maintenance. Thus, the study recommended the adoption of flood resilient technologies (FReT) the construction and use of flood resilient materials. There should be setting, implementation and the use of building codes for building, and the use of building professionals for building construction projects.

Keywords: Building Codes, Flood, Impact, Property, Resilience

INTRODUCTION

Flooding may be considered as either mainstream or storm water flooding, mainstream flooding refers to catchments into streams and rivers continue to rise and overtops the waterway channel. While the storm water flooding refers to the inundating that occurs when run off from the catchments exceeds the capacity of the underground or piped drainage system and passes overland (Melbourne Water, 2007).

Flooding is a natural occurrence. Communities learn to live with rivers, since flooding can only be managed and not prevented. Its effect could be minimised through flood protective measures and forecasting (Bezaleel, 2015). The most common source of flooding is from severe rainfall. This occurs when runoff from intense or extensive rainfall fills drain's channels, depressions and water courses and then continues to rise, inundating neighbouring areas. Flooding is one of the highest orders of risk for the built environment throughout the 21st century. The United Kingdom Climate Change Risk Assessment (CCRA) indicates that the built environment will be affected with extreme weather events, impacts will arise due to increased temperatures and changing rainfall patterns Garvin, 2014).

In Nigeria, more than 850km of coastline and coastal states experience various types of floods. Brisibe and Pepple (2018) posited that, Bayelsa State is subject to perennial flooding as a result of intensive rainfall patterns, low terrain levels, dam failures and overflow of the River Niger and its tributaries. Flooding in Ekeki Housing Estate, Yenagoa is also caused by various factors such as poor planning; the construction of roads, bridge, lack of sustainable drainage system, lack of effective waste management system and the erection of buildings without the use of building professionals. As such, there is enormous flood impact on lives of people and properties. Whenever flooding occurs in Ekeki Housing Estate, people are usually displaced from their accommodation. Moreover, there is enormous flood damage on building components and building service units, which results the deterioration of property value and increase in property maintenance cost. This study is intended to make available the needed knowledge for individuals, property developers/ managers in order to embrace resilience in the construction of buildings.

2 Literature Review

2 .1 Flooding

According to (Doswell, 2003), a flood is defined as water overflowing onto land that is usually dry. The great quantity in terms of river, generates of fluvial flooding is essentially caused by heavy rain that creates significant runoff into streams and a flow that exceeds the capacity of the river, causing water to flood-out over the land i.e., the floodplain. The impacts of flood on housing in urban areas are escalating due to extreme weather events and the development of most properties at vulnerable zones (Golz, Naumann, Garvin and White, 2013). . Golz, Naumann, Garvin, and White (2013), stated that flood impacts on buildings are often enormous and can be described by the degree of damage it caused to its materials and structures and the deterioration of its physical functions. Many items of flood damage loss are a function of the nature and extent of the flooding, including its duration, velocity and the contamination of the flood waters by sewage and other contaminants (Escarameia, Tagg, Walliman, Zevenbergen and Anvarifar 2012). More so, (Escarameia, Tagg, Walliman, Zevenbergen and Anvarifar 2012), averred that resilience at property level can be achieved by the use of standard construction materials and methods of construction, layouts and

flood protection products, combined with careful site consideration that minimize the potential for exposure to flood water. The enhancement of buildings towards flood resilience is generally aimed at: (i) minimising flood damage (ii) decrease direct flood repair costs, (iii) allowing fast re-occupation. The benefits associated with the development of buildings for resilience are fundamentally the avoidance of flood damage by reducing the impact of flooding on the property and economic activities that depend on these buildings. In essence, the economic life of the building is being preserved (Escarameia, Tagg, Walliman, Zevenbergen and Anvarifar 2012).

2.2 Causes of Flooding

Flooding can result from single event, it preliminary occurs through a combination of events:

- Rainfall fills rivers, streams and ditches beyond their capacity. Flood water overflows river banks and flood defences.
- Coastal storms can lead to over topping and breaching of coastal defences. Properties built behind these defences are therefore still at risk from flooding, although the 'residual' risk is lower. However, the consequences of this type of flood could be high.
- Blocked or overloaded drainage ditches, drains and sewers may overflow across roads, gardens and into property.
- Rainfall can be so intense that is unable to seep into the ground or enter drainage systems. Instead the water flows overland, down hills and slope – properly at the bottom of hills or in low spots may be vulnerable. In urban areas flood water may become contaminated with domestic sewage.
- Prolonged heavy rainfall soaks into the ground and can cause the ground to saturate. The results in rising
- Ground water levels which leads to flooding above the ground.
- Ground water flooding make weeks or months to dissipate.

.2.3 Types of flooding

Each type of flooding brings its own risks and problems and can have many variable – regularly, duration speed and depth. They thus follow:

River flooding: This usually the result of high convective rainfall causing river levels to rise. Rivers vary in the way they cope with the additional water depending on their capacity and access to the flood plain. Floodplains allow the storage of excess water, which reduces water volume and slows down the flow in a river. Development on flood plains can reduce flood storage capacity and have significant effect, creating flooding further down river where it had not previously occurred.

Coastal flood: Coastal flooding is caused by a combination of high tides and wave. High tides usually occur in spring and again in autumn. A build-up of low pressure can coincide with high tides and lead to a tidal surge. The risk of coastal flooding can be made worse by high water in rivers and estuaries that drain into the sea (Pickles, Rhodes, Grooch, Garlick, Kelly, Hadley, and Berry, 2015).Most coastal change occurs rapidly during extreme storm and flood events. Coastal barriers may be breached permanently so that sites that formerly were protected behind barrier beaches, shingle spits or dunes become tidal and subject to marine erosion.

Surface, ground water and sewer flooding: This type of flooding is usually the result of sudden torrential rain, particularly in urban areas, and can be highly unpredictable. Drainage systems are unable to cope with the excess water and overflow. Much damage can occur as a result. Where foul sewers surcharge into the flood, the flood water will be contaminated with sewage. Water companies are responsible for the foul-water and surface water sewerage system if it has been adopted. Contaminated silts left behind when flood waters recede can present significant health risks.

Flash flood: Flash Floods are defined as those flood events where the rise in water is either during or within a few hours of the rainfall that produces the rise. Therefore, flash floods occur within small catchments, where the response time of the drainage basin is short. (Doswell, 2003) posited that most flash flood associated with rainfall are produced by thunderstorms; that is deep moist convection.

2.4 Ways by which Floodwater enter a building

Floodwater will always follow a path of least resistance and will enter a building at the weakest points in the construction, particularly through masonry and construction joints, and any voids and gaps, (Bowker, Escarameia, Euring and Tagg 2007). Current building regulations and traditional construction do not require the use of materials and design details that can withstand long-term immersion in flood water. Water could enter via:

Brickwork and block work.

Party walls of terraced or semi-detached buildings if the attached building is flooded.

Expansion joints between walls where different construction materials meet or between the floor slab and wall. Suspended timber ground floor via the interface between timber and mortar for built-in joints or along the interface between timber and metal plate where joist hanger is used. Water will be absorbed through the exposed end grain of a built-in timber joist. Vents, airbricks. Inadequate seals between windows, doors and frames Door thresholds.

Cracks and openings due to settlement, poor construction, and services all provide water entry routes, such as:

- Cracks in external wall
- Flaws in construction

Cracks and gaps at the interface between brick, stone and block units and their bedding mortar due to inadequate bonding. These can be as a result of movement caused by thermal expansion/contraction, moisture or settlement,

Damp proof course (d.p.c.), where the lap between the wall damp proof course and floor membrane is inadequate,

Services entries e.g. utility pipes, ventilation ducts, electricity and telephone cables,

Gaps in mortar in masonry, stonework and block work walls, usually at perpends.

Other entry routes include:
Seepage from below ground through floors and basements.

2.5 Types of flood damage on buildings
Flood has the potential to cause damage to the structure of a building. It can also significantly impact the lives of the occupants. Fast flowing water or weakened structures could cause injury or even death. Physical health may suffer if flood water is contaminated or if the building is re occupied before it is allowed to dry effectively. Stress caused by disruption to life style and livelihood both during and after a flood is probably one of the main consequences of a flood. (Bowker, Escarameia, Euring and Tagg 2007). Flood damage on buildings consists of damage to the contents and fittings, disruption and loss of income during the flood and reinstatements (Bezaleel, 2015). As opined by (Golz, Naumann, Garvin and White, 2013), flood damages on buildings are of three types namely;

1. Moisture/Water damage
2. Structural damage
3. Contamination damage

While Brisibe and Pepple (2018) averred that, these damages are seen as;
Saturation of building components, destruction of water-sensitive building components, destruction of building components through hydrostatic pressure and damage to building services.

2.6 Determinants of Building Construction in a Flood Prone Area:

a) Building in a flood prone area must be designed and constructed to the degree necessary to resist floatation, collapse or significant permanent movement resulting from the action of hydrostatic, hydrodynamic, erosion and scour. Wind and other actions during the defined flood event. (Australian Building Codes Board, 2012).
b) The actions and requirements to be considered
i. Flood actions
ii. Elevation requirement
iii. Foundation requirements
iv. Requirements for enclosure below the flood hazard level
v. Requirements for structural connections
vi. Material requirements
vii. Requirements for utilities
viii. Requirements for occupant egress
ix. Impacts to other structures and properties.

The Australian Building Code Board, 2012, highlighted that there are four steps that will minimise the potential water absorption and water damage in a building which are:

1. Choosing materials and construction details that are critical to the minimisation of effects.
2. Choosing materials that are not affected by water.
3. Avoiding moisture traps in house designs and during building by ensuring clean and tidy construction e.g. wall cavities kept free of building debris and waste.
4. Sealing porous materials against water entry. For example, sealing the end grain of timber can significantly decrease water at a very high rate.

2.7 Flood Management Measures
Flood management measures are efforts and attempts to prevent flood hazards from developing into disasters. It is processes that identify the hazards facing a community, assesses the inherent risk, develops and implements strategies or measures to reduce the eminent hazards, counter the risk of flooding and adjust those strategies based on experience and further studies (Owuama, 2014). A wide range of flood management tools exist. These consist of both structural and non-structural, which are complementary in function.

The structural measures include: levees and flood ways, flood resilient building construction, well enforced building codes, retrofitting of existing building and securing right components.

Meanwhile, the non- structural methods include provision of wetlands that act as natural defences, green belts that purify the environment for beauty and flood control, early warning systems, effective land use planning and zoning laws.

Building codes and standards when enforced are effective in reducing property damage, preserving human life and increasing flood resilience building construction.

In the work of (Kakulu and Brisibe, 2014), it was stated there is need to adapt existing buildings to flood resilience through 'best practice' approach to design. Checking site if it is located in an area of high flood risk. This has to be done with the cooperation of planning authorities and survey departments at every governmental level, taking damp proof course (DPC) heights levels from benchmarks and required datum points were available or use the heights of major roads. The use of FReT that is flood resilient construction and materials.

3 The Study Area
The study area for this research is the Ekeki Housing Estate, Phase 1, in the Yenagoa metropolis of Bayelsa State. It has a latitude of 5.00047 and longitude 6.37785. The Housing Estate is located in the heart of the city between Azikoro Road to the East and the Sanni Abacha Expressway to the West, and bounded by the Melford Okilo Road to the North and the Old Assembly Quarters to the South, it was built as an emergency response to meet the housing needs of the then relatively young State by the first civilian administration in the year 2001, under the auspices of the Bayelsa State Housing and Property Development Authority (BSHPDA). The Ekeki Housing Estate is made up of two hundred and fifty (250) housing units, which consists of two hundred (200) nos 3 bedroom semi-detached bungalows and fifty (50) nos 4 bedroom bungalows. The Estate was said to have been developed from a typical swamp land, with some areas consuming as much as ten (10) to eleven (11) courses of 225mm sandcrete hollow blocks before the damp proof course (dpc). Characteristically, a

major part of the estate is prone to annual flooding, due to intensive rainfalls.

Evidently, the topography of the area is uneven, gently sloping from the Sani Abacha Way axis to the Azikoro Road axis. All houses at the lower end of the gradient are annually threatened or impacted by floods

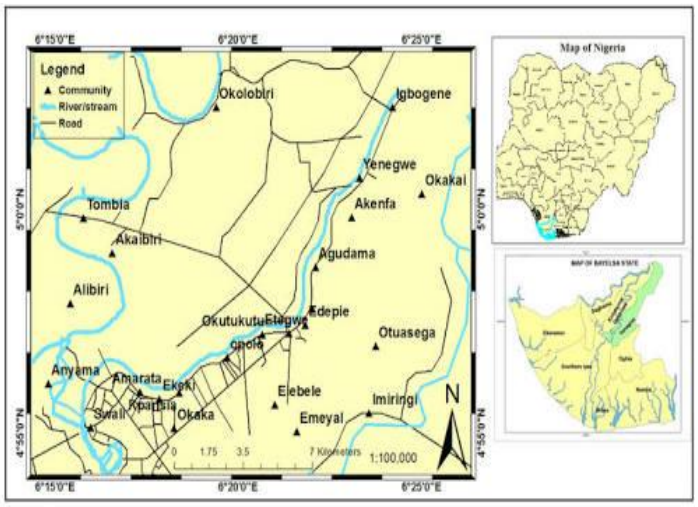

Figure3.1: Yenagoa Map Showing Study Area.

Plate 3.1: Picture showing inundation across street - Southern view of Road 2, Ekeki Housing Estate, Phase 2, Yenagoa (Photo taken on September 10, 2014)

Plate 3.2: Picture showing decaying wooden door due to moisture and flooding on a property in study area.

4 Methodology

The data from this study were derived through primary and secondary sources. While the primary data was obtained through face-to- interview, physical survey, photography and the secondary sources were through published literature.

4.1 Sample size

The sample size was made up of:

- 2 respondents from the study area
- 4 Registered Building Professionals which comprises of a senior Architect, Builder, Estate Surveyor and Electrical Engineer.

4.2 Data Analytic Technique

The data analytic technique adopted for this study was analytic induction. The analysis technique for the qualitative data were known as analytic induction according to Saunders et al; (2009) , analytic induction is defined as the intensive examination of strategically selected number of cases so as to empirically establish the causes of specific phenomenon. It is an explanation building procedure for analyzing qualitative data.

4.3 Data Presentation and Analysis.

Question 1: What are the causes of flooding in Ekeki Housing Estate?

In an interview with residents in the study area, respondent 1responded thus; the causes of flooding in this area could be attributed to poor planning. This estate was constructed on typical swamp, and there was no sand filling done before buildings were constructed, as such, the topography is not even. Also, drainages were constructed after the construction of houses, as such; the water carrying capacities of the available drainages are very poor. Aside, bridge/roads adjoining the estate were constructed, without an Environmental Impact Assessment (EIA). More so, during the construction of the Estate, proper supervision was not done and people involve in the construction tend to compromise the

standard. Another cause of flooding within the area is dumping of refuse on the available drains and this leads to the blocking of drains.

Question 2: What types of problem do you encounter during flood?
Respondent 2 gave the following answers to the above question:
People are being displaced from their accommodation to stay somewhere else. Soak ways filled with water making it difficult for flushing.

Water seepage through underground, water inundation within the surroundings as such making it difficult for movement of people. Dampness of wall as such it results to peeling of paints.

Electrical shocks due to flood soaking electrical sockets and appliances. Decaying/warping of wooden doors as a result of flood soaking them.
Discoloration of tiles through water contamination.
Extensive repair works due to flood damage to building components and service units.

Flood impact and associated maintenance obligation in the aftermath of a typical flood event within the study area could be summed up as follows:

Maintenance Obligation aftermath of flood events:

Washing and repainting of 3Bedroom Bungalow	#200,000.00
Fumigation of surroundings against reptiles'	#10,000.00
Rendering of external & internal walls	#10,000.00
Replacement of 6 nos wooden doors @ #20,000.00 each	#120,000.00
Total costs of maintenance say	**#340,000.00**

Field Work, 2019.

Question 3: How should properties be constructed for them to be sustainable in Bayelsa?

According to an architect there are various parameters that are to be considered in terms of how properties should be constructed for them to be sustainable. In order to carryout construction, a soil test needs to be carried out especially for high rise buildings.
The foundation type needs to be put into consideration. The foundation type depends solely on the number of floors.
The environment has to be put into consideration also. The usual construction methods are always the same. You look for higher ground. You consider elevation of heights of construction for building. The difference is to higher floor level. The types of blocks used should be concrete blocks. Method of construction should be above the flood plain. After digging, foundation and casting is done. Dry casting is usually done in flood prone areas, though this causes differential settlements. This is due to the high-water level. There should be a ground floor slab made up of reinforced concrete with a dam proof membrane round before laying blocks. Concrete is used to cast the foundation, and ground beams are employed in flood prone areas. There is need for a ground floor slab like a table before building on top. For floors, the thickness is 150mm, while it is 225mm for sandcrete blocks for walls. You fill with sand and cast with concrete. In addition, there should be a specified datum level for every building construction. More so, the use of steel construction is advisable in flood prone areas. The use of indigenous technology is preferable. The construction should be in pillars. The design should be that the building is raise with pillars and a space underneath for car park and other recreational activities. Meanwhile, the builder stated that sustainability is dependent on good workmanship and a proper supervision.

The use of professionals for building construction will enhance sustainability.
Also stated by the estate surveyor, good government polices and implementation is needed, policies that will prevent people from building on natural flood plains, dumping of refuse inside drainages. Government funding on drainages is inevitable.
Source: Researcher's Fieldwork (2018)

Question 4: How do you carry out electrical work in buildings in flood prone areas for them to be sustainable?
The height of the dpc determines the placement of every electrical fitting especially in flood prone areas within the state. For flood prone areas, the height of the dpc should be between 1.2m. Socket height for 13amps = 500/600mm from the finished floor level. 15amps sockets (AC sockets and ceiling fans) 1.2m from the finished flood levels. In flood prone areas is usually advisable to use waterproof or watertight sockets.
For already existing buildings before 2012 flood, watertight electrical fittings are advisable. These sockets are usually imported and not locally made. Whenever there is flood, it is always advisable to switch off electrical mains. In the aftermath of flood events, it is always advisable to remove sockets and sun-dry or replace new ones.
Source: Researchers Fieldwork (2018).

5 Findings and Discussions

On Question 1, the respondent attributes the causes of Flooding in Ekeki housing Estate as a result of poor planning before execution of building project. Sand filling was done after constructing buildings as such, there is an uneven topography. Inadequate drainage system and the water carrying capacity of available drainages are poor.
When the bridge adjoining the Estate was constructed, there was no Environmental Impact Assessment (EIA) that was carried out. There was no proper supervision on the construction of buildings and building standards were compromised. Another cause of flooding within the Estate was attributed to dumping of waste into the available drains.

Question 2, the respondent stated the various problems they encounter during flood.

People are being displaced from their accommodation to stay somewhere else. That is people are socially displaced. Soak ways filled with water making it difficult for flushing.
Water seepage through underground water. Water inundation within the surroundings as such making it difficult for movement of people.
Dampness of wall as such it results to peeling of paints.

Electrical shocks due to flood soaking electrical sockets and appliances.
Decaying/warping of wooden doors as a result of flood soaking them. Discoloration of tiles through water contamination. Extensive repair works due to flood damage to building components and service units. Findings revealed an implication on maintenance costs.

On Question 3, building professionals gave their opinions on how properties should be constructed for them to be sustainable. In order to carry out construction, the following considerations have to be in place:

The architect averred that carrying out soil test especially for high rise buildings.
The foundation type needs to be put in place. The environmental conditions are important. Method of construction should be above the flood plain.

After digging foundation, casting is done. Dry casting is done in flood prone areas.
There should be a ground floor slab made up of reinforced concrete with a dam proof membrane round before laying blocks. For flood prone areas, you cast a ground floor slab like a table before building on top. For floor, the thickness should be150mm; while 225mm sandcrete blocks for walls. There should be a specified datum level for every construction. The use of steel is advisable in flood prone areas. The use of indigenous technology is preferable. The construction should be on pillars and a space underneath for car park or recreational activities.

The builder stated that, sustainability is dependent on good workmanship and a proper supervision. The use of professionals for building construction will enhance sustainability.
The Estate Surveyor said, for properties to be sustainable, good government policies and implementation are needed, policies that will prevent people from building on natural flood plains, dumping of refuse inside drainages. Government funding on drainages is inevitable.

On Question 4, *the Electrical Engineer* stipulated that the height of the dpc determines the placement of every electrical fitting especially in flood prone areas within the state. The height of the dpc should be between 1.2m. Socket height for 13amps = 500/600mm from the finished floor level. 15amps sockets (AC sockets and ceiling fans) 1.2m from the finished flood levels. In flood prone areas is usually advisable to use waterproof or watertight sockets.

6 CONCLUSION

In conclusion, the study revealed that there were various causes of flooding in the study area, which has been traced to lack of planning before the execution of building projects, poor topographical settings, inadequate drainage system and lack of proper supervision and building below required standard. In addition, there is an indiscriminate pattern of refuse disposal into available drains. The survey also indicated that there is severe impact of flood on buildings, building components and service units. There is water inundation within surroundings of buildings. Moreover, there is high cost of property maintenance cost in aftermath of flood event. However, for property development to be sustainable the building professionals selected for the study highlighted that soil test should be carried out before any construction work, the foundation type should be considered, and the construction of any building should be above the flood plain. There should be a specified datum level for every construction. The use of indigenous technology is preferable. The construction should be on pillars and a space underneath for car park or recreational activities. Also, based on the findings, sustainability depends solely on proper planning, good workmanship and Professional supervision.

Finally, for properties to be sustainable, good government policies and implementation is inevitable.

Recommendations

Based on the findings of the study the following recommendations are outlined:

1 There should be a synergy among various planning and property development authorities within the state and local government levels. The concept of convergence should be fully exploited from the planning stage to execution stage.
2 The physical planning and development control board should embark on the installation of advisory/prescription signage for reference datum level especially for virgin lands and undeveloped areas.
3 The setting, implementation and the use of specified building codes. 4 When carrying out any building construction, it is important to raise the height of damp roof course (DPC) above flood level and risk allowance should be made available, considering the vagaries of climate change.5) Buildings should be constructed, adopting indigenous technology ie (vernacular architecture). This is a situation whereby buildings are erected on pillars and there is space underneath, to be used as car
4 park and for recreational activities. Property developers should carry out soil test for large projects. Works or structure must not affect floodwater flow capacity.
5 Rendering foundation walls with mortar to increase its resistance to moisture penetration.
6 There should be the use of watertight sockets for electrical installations and placement of sockets must consider the height of damp-roof course (DPC).
7 The government should provide funds for the construction of sustainable drainage system in the state.

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