British Journal of Environmental Sciences

Vol.10, No.4, pp.,28-46, 2022

ISSN 2054-6351 (print),

ISSN 2054-636X (online)

Resilient Housing Provision for Coastal Settlements in Ondo State, Nigeria

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Citation: Oluwaseun Samuel Apenuwa, Eseroghene Onaopemipo Dafiewhare, Opeyemi Owosho, Oluwadunsin Temidayo Adeyemo, Abisoye Oluwatobiloba Ayeni, Caleb Agoni (2022) Resilient Housing Provision for Coastal Settlements in Ondo State, Nigeria, *British Journal of Environmental Sciences*, Vol.10, No.4, pp.,28-46

ABSTRACT*: The advent of sustainability in housing and shelter is being identified as an important discuss for the coastal settlement. This is no further from the fact that this region is being confronted with series of issues bordering around flooding, prevailing wind action, loss of homes, properties and in extreme cases, 'life(s)'. Moreover, this area has to deal with difficulty in proper disposal of waste among many other problems. The Ilaje community, standing as a perfect study area for this research, evidently reveals the importance of a sustainable, ecofriendly and resilient shelter as a necessity for coastline settlements. The outcome of this study proffers applicable solutions to tackling coastal settlement issues including flooding, loss of life and properties, proper faecal waste management while ensuring that uninterrupted electrical power supply is available for household electronic gadgets like radios, televisions, charging of phones and torchlights. Achieving these solutions and ensuring the longevity of the approach will necessitate the training of residents within the coastal settlement, skilled in technical works within the building industry on the construction method for future maintenance and if need be, in erecting newer shelters. Furthermore, there is need for collaboration between the private and public sector in providing the financial assistance needed to foster the acceptance and implementation of the solutions propounded in this research.*

KEYWORDS: coastal vulnerabilities, coastal settlement, community participation, housing provision, resilient housing, sustainable development.

INTRODUCTION

The impacts of climate change hazards are visible in many coastal areas around the world (Spalding *et al*., 2014) with significant rise in the sea level, while the degree and frequency of change is likely to vary across the board and difficult to identify locally (Cazenave & L lovel, 2010; Han *et al*., 2010). The populations within coastal areas are increasing at a fast rate with about 10% of the world's population living there. (McGranahan, Balk & Anderson, 2007). These coastal communities are likely to be susceptible to climate change risks than inland areas due to an increase in flooding, precipitation and temperature conditions, culminating to a rise in sea level, wave heights, and coastal erosion in such areas. The disadvantaged communities identified are those vulnerable to the physical impacts of climate change and undergo severe level of deprivation and environmental isolation (Zsamboky *et al*., 2011).Consequently, a significant proportion of human settlements in coastal areas are considered to be vulnerable to climate-related impacts, including coastal and riverine flooding, sea-level rise and storm surge (Brooks et al. 2006; Solomon et al. 2007; Hunt and Watkiss 2011). Flooding has become one of the leading disasters worldwide and is predicted to increase in frequency over the coming years as a result of climate change and other human-induced activities (Bich *et al.*, 2011; Ding *et al.*, 2013; Mumuni, 2013; Tempest *et al.*, 2017).

In addition, a number of people have been displaced from their houses, thereby becoming environmental refugees due to climate change (Sarwar, 2005). The coastal states in United States of America have contributed more than $6.6 trillion to her total Gross Domestic Products (GDP) despite being less than 10% of the total land area (NOAA, 2013). Due to climate change, this achievement will soon be translated to heavy financial and social vulnerability and result in an unsustainable coastal development (Spalding *et al*., 2014). The concern is high amongst the poor communities in developing nations, who are directly dependent on coastal ecosystems for basic needs such as livelihoods, where capacity to cope with climate change is far less than developed countries (ISDR, 2009).

Over the last four decades, the notion of resilience has become prominent as a frontier concept in health, engineering, social, ecological, and spatial sciences (Cutter, 2016). As a result, numerous definitions of resilience have been suggested and argued in each science, providing a robust data-framework for future resilient approaches. A typical instance of such definition is in the field of climate change and disaster, where resilience is defined as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner" (UNISDR, 2009). Whereas, the Intergovernmental Panel on Climate Change (IPCC) defines resilience as "the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient

manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions" (IPCC, 2012).

Clearly, shelter is one of the basic needs of human survival (Newaz, 2004). Having a home safe from natural hazards is very important in disaster-prone areas. With the unprecedented rate of climate change, building resilience has been getting wide spread emphasis, including the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC, 2014). Therefore, exploring means to reduce community risk through a resilient housing system is now a vital issue of concern in housing provision for coastal communities. In view of this, the research seeks to provide a resilient housing design for rural coastal settlements in Ilaje communities of Ondo State, Nigeria and proposes an implementation approach through community participation for sustainability.

LITERATURE REVIEW

In recent times, with prevailing disaster occurrences, it is obvious that the effects of climate change are inevitable and will only get worse in the near future giving rise to even frequent natural hazards. The government's lack of sufficient disaster-preparation efforts will result to more calamity-related deaths, while people will continue to be entangled in the vicious cycle of poverty, rebuilding their lives only for them to be destroyed again by the next calamity (IPCC, 2007; ADPC, 2011). Predominantly, housing is the sector severely impacted by these natural disasters. Damage to housing sector includes damages both on private and government properties, and in most cases, the government have to provide assistance for the damages attributed to the private housing sector (ADPC, 2011).

The impact to disaster is further exacerbated due to location. The poor tend to locate their houses in areas with less resistant to the impact of weather and climate change. The sites are cheap and less attractive due to its location along flood plains, unstable hills and most times the structures are poorly built which further increases sensitivity to climate change and broaden their vulnerability as recovery becomes more difficult (Wisner, 2001; Hallegatte, 2012). For example, after Hurricane Andrew in the United States, the poor residents were not only impacted but also received less relocation assistance because it was difficult getting transportation, childcare and to take time off their work to make claims (Dash, Peacock, & Morrow, 1997). With limited resources and options, recovery processes of individual households are contingent upon their coping capacity and the external support (ADPC, 2011; Fothergill & Peek, 2004).

Consequently, the community as a whole suffers as the local economy is hit hard and the responsibility to support those made homeless by the natural disasters can place extra burden on the dwindling economy (ADPC, 2011). For this reason, disasters have adverse

impact on housing as the financial inadequacy of the marginalized community makes the community members incapable of building back better by themselves.

Vulnerabilities of Housing to Disasters

Truly, hazards in nature do not constitute disaster risk, however, the underlying vulnerabilities to hazards and external drivers constitute disaster risk and resulting losses. Such factors contributing to the vulnerabilities of housing as stated in ADPC (2011) includes:

- Poor land use planning, poor understanding on hazards or without risk-based planning
- Lack of knowledge and incorporation of appropriate disaster resistant features during planning and construction process
- Lack of regulatory mechanism to enforce land use/building regulations
- Limited or no mechanism for accountability in case of violation of regulations
- Lack of skilled human resources in planning and execution
- Poor quality and sub-standard building materials
- Poor maintenance of structures
- Poor governance-corruption

Furthermore, a variety of factors can be attributed to the vulnerability of the housing stock. Such determining features comprises of not having systems in place for proper settlement planning, inappropriate technical guidance in forms of building codes, lack of suitable enforcement mechanisms, incapacity for implementation, and lack of skilled labor as well as enabling factors such as good governance.

Inappropriate housing solutions together with poorly constructed houses have been known as one of the main sources of risks to climate hazards (Tran et al., 2012). If the houses are not well built using appropriate structures, materials, proper design and construction methods catering to the need to reduce disaster risk then, the houses will be highly vulnerable to adverse impacts of natural hazards.

Moreover, the socio-economic situation of households translates to differing levels of housing vulnerability (Tran et al., 2012). To demonstrate, high income households can afford to buy expensive land in the urban areas with adequate basic services and infrastructures, also their houses are constructed with skilled professionals, therefore, they are situated in safe and less vulnerable places. However, low-income households are the most vulnerable because they cannot afford such provisions and tend to locate themselves in the disaster-prone areas without any construction assistance.

Additionally, Lack of knowledge and awareness of the local people regarding climate risk and disaster risk reduction is another underlying cause of vulnerability (Tran and Tran, 2013). Due to this ignorance, they are not integrating the concept of resilience in their housing practices or giving due importance to it.

Concept of Resilience

The term resilience is often used in the same manner as the notion of -bouncing back that reflects its Latin root – *"resiliere"* which means - to jump back (Klien et al., 2003; Paton & Johnston, 2006). Different authors (scholars and organizations) have defined resilience by different perspective. Here, resilience is considered with the perspective of disaster or hazard event. The International Strategy for Disaster Reduction (ISDR) defines resilience as - the capacity of a system, community or society that is potentially exposed to a hazard, to adapt to it by resisting changing so that it reaches and maintain an acceptable level of functioning and structure (Sadeka et al., 2011). Also, the United Nations International Strategy for Disaster Reduction (UNISDR) defines resilience as the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of such hazard in a timely and efficient manner (UNISDR, 2007).

'Resilience' is generally seen as a broader concept than 'capacity' because it goes beyond the specific behavior, strategies and measures for risk reduction and management that are normally understood as capacities. However, it is difficult to separate the concepts clearly. In everyday usage, 'capacity' and 'coping capacity' often mean the same as 'resilience'. A focus on resilience means putting greater emphasis on what communities can do for themselves and how to strengthen their capacities, rather than concentrating on their vulnerability to disaster or their needs in an emergency. The terms 'resilience' and 'vulnerability' are opposite sides of the same coin, but both are relative terms as argued by **Manyena (2006**). One has to ask what individuals, communities and systems are vulnerable or resilient to, and to what extent. Like vulnerability, resilience is complex and multifaceted. Different features or layers of resilience are needed to deal with different kinds and severity of stress.

Over several decades, the definition of community resilience has been expanded to include a range of concepts related to the community's ability to deal with disasters including community planning, mitigation, recovery, the development of networks, and the ability of a community to learn from prior events (Plodinec, 2013). With these concepts taken together, community resilience focuses on developing new capabilities among emergency planners, urban planners, community leaders, and public health providers to leverage community assets and integrate community resources into preparedness planning and response to address a range of shocks and stresses (Chandra et al. 2013). The 'disaster-resilient community' is an ideal. Communities can never be completely safe from natural

and man-made hazards. It may be helpful to think of a disaster-resilient community or a disaster-resistant community as 'the safest possible community that will have the knowledge to design and build in a natural hazard context, minimizing its vulnerability by maximizing the application of Disaster Risk Reduction (DRR) measures.' DRR is therefore the collection of actions, or process, undertaken towards achieving resilience (Geis DE, 2000). The component of resilience is a broad concept and hence is divided into five thematic areas relating to resilience and DRR. The five thematic areas are based on those in the Hyogo Framework for Action and are intended to cover all aspects of resilience **(Twigg, 2007**).

Table 1: The five thematic areas relating to resilience and DRR

Thematic Area	**Components of Resilience**
Governance	• Policy, planning, priorities and political commitment. • Legal and regulatory systems • Integration with development policies and planning • Integration with emergency response and recovery • Institutional mechanisms, capacities and structures; allocation of responsibilities • Partnerships • Accountability and community participation
Risk Assessment	• Hazards/risk data and assessment • Vulnerability and impact data and assessment • Scientific and technical capacities and innovation
Knowledge and Education	• Public awareness, knowledge and skills • Information management and sharing • Education and training • Cultures, attitudes, motivation • Learning and research
Risk management and Vulnerability reduction	• Environmental and natural resource management • Health and well being • Sustainable livelihoods • Social protection • Financial instruments • Physical protection; structural and technical measures • Planning regimes
Disaster preparedness and response	• Organizational capacities and coordination • Early warning systems • Preparedness and contingency planning • Emergency resources and infrastructure • Emergency response and recovery • Participation, voluntarism, accountability

Source: Twigg, 2007

Disaster Resilient Housing

Shelter is one of the basic needs for human survival besides food and clothing. Everyone has the right to adequate housing for health and well-being. Housing has close relationship to a person's life, livelihood, health and overall well-being and therefore directly includes the social themes of vulnerability, social protection and livelihoods (Newaz, 2004). Adequate housing is not just limited to physical structure. Adequate housing means adequate privacy; adequate space; physical accessibility; adequate security; security of tenure; structural stability and durability; adequate lighting, heating and ventilation; adequate basic infrastructure, such as water-supply, sanitation and waste-management facilities; suitable environmental quality and health-related factors; and adequate and accessible location with regard to work and basic facilities: all of which should be available at an affordable cost. Adequacy should be determined together with the people concerned, bearing in mind the prospect for gradual development (UNCHS, 1997).

Housing is often the most valuable and important asset for many people, and its principal role is to provide protection from the elements of nature. Disasters throughout the world often impact severely on housing, and it is usually the most visible element that is damaged or destroyed. Rapid onset disasters such as earthquakes and cyclones cause significant devastation to housing, often leading to loss of this valuable asset; slow onset disasters such as floods and bushfires often displace people from their homes and can also cause destruction (CMC, 2015). Developing countries tend to bear the brunt of disaster impacts, with the poor there often being the most severely affected; the impact of disasters on the built environment is much higher than in developed countries, estimated at more than 20 times in magnitude (Barakat, 2003 and Hillier & Nightingale, 2013)

Disaster resilient housing refers to those structures that is expected to not collapse or be destroyed, but may still suffer some damage which however, can be repaired. In detail, disaster resilient housing means to build structures and a community that incorporates disaster resilient strategies and disaster risk reduction measures so that the houses can withstand the impact of any natural hazards such as, cyclones, floods, earthquakes, landslides etc. A disaster resilient housing does not only depend on the structure, material, design and construction of the houses but also depends on the socio-economic conditions, administrative and local governance of the community (Saira 2015).

METHODOLOGY (STUDY AREA)

Study Area - Ilaje Local Government Area of Ondo State, Nigeria

Ilaje LGA was carved out of the former Ilaje/Ese- Odo LGA on 1st October 1996. The total land area of the LGA is 2,300 square kilometres. It lies within $5°45^{1}$ - $6°15^{1}$N and $4°30^{1}$ - $5°00^{1}$' E while the headquarters is located at Igbokoda town. Ilaje LGA has a projected

population of 397,442 from 2006 population census figure of 290,615 using a growth rate of 3.18 (NPC 2006). The major tribe is Ilaje while the dominant occupation of the people is fishing and major festivals are Malokun and Ere. The coastal environment offers not only an excellent location for fishing but also boating, swimming, sport fishing, picnic, boat regatta, diving and many more. Major settlements include Igbokoda, Ode-Ugbo, Ugbonla, Ayetoro, Ode-Mahin and Ode-Etikan. The study area is bounded in the North by Okitipupa Local Government, in the East by Ese Odo Local Government, in the West by Ogun State and in the South by Atlantic Ocean.

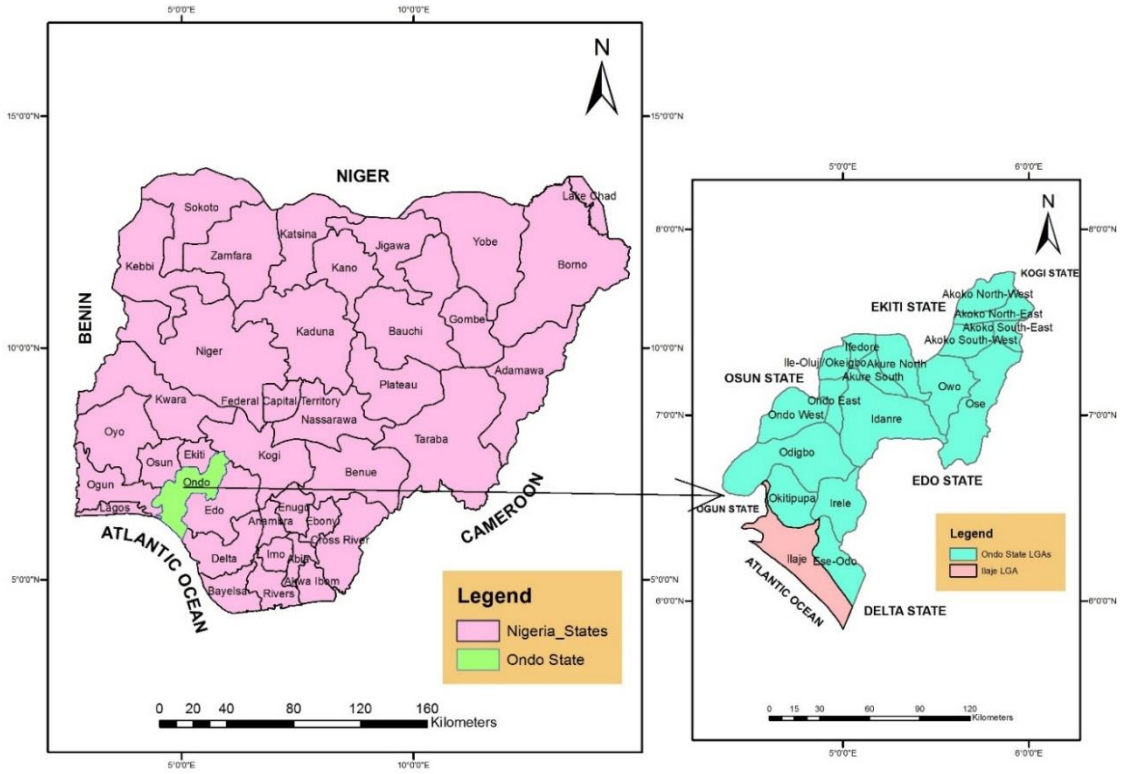

Figure 1: Map of Nigeria Showing Ondo State and Ondo State Showing the Study Area (Ilaje LGA)

RESULTS / FINDINGS

Resilient Housing Provision for Coastal Settlements in Nigeria, (The Design Concept)

The building design is expected to be able to conform to existing wind and flooding conditions per time within the coastal settlement in view. Simplified, as the water level

within the coastal settlement rises above its normal height, the building is designed to be able to float and shelter the dwellers without causing any displacement of the settlement.

Predominantly, it is expected for the design to be durable, spanning a considerable measure of time before maintenance is required. Moreover, underlining characteristics that makes the design suitable for adoption within the region includes eco-friendly building material, culturally acceptable structure imbibing the community's lifestyle, locally sustainable choice of building materials and ease of design adoption by the locals.

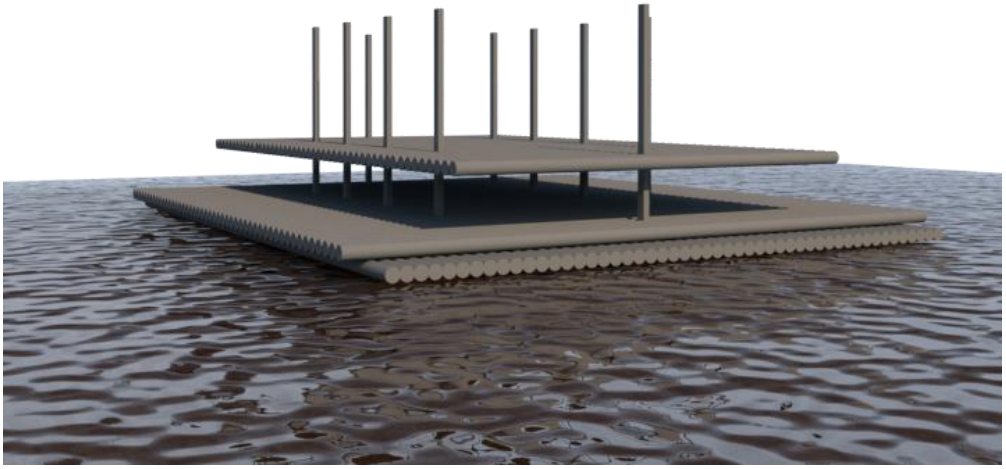

Plate 1: The Design Concept, A Floatable Structure.

Prototype

The design is a two-bedroom bungalow which has a living Space, kitchen, a sit-out, toilet and bathroom. The toilet and bathroom spaces are accessed from the exterior for the purpose of adopting the way of life of the locals within the coastal settlement in view.

It is a timber frame structure having its longitudinal ends curved in a triangular manner like the ends of the boat to aid the movement of wind current around the building. The structure is expected to be oriented in the direction of the prevalent wind present within the coastal area in view so as to ensure that the building design is not overcome by wind movement.

Furthermore, the design has solar panels installed on the roof to generate electricity and collects water from the gutter to a water storage vessel for consumption within the dwelling. Last but not least, the fecal waste is stored up in a vessel within the dwelling and is disposed intermittently at a stipulated period for biogas production. This will also aid healthy sanitation within the community.

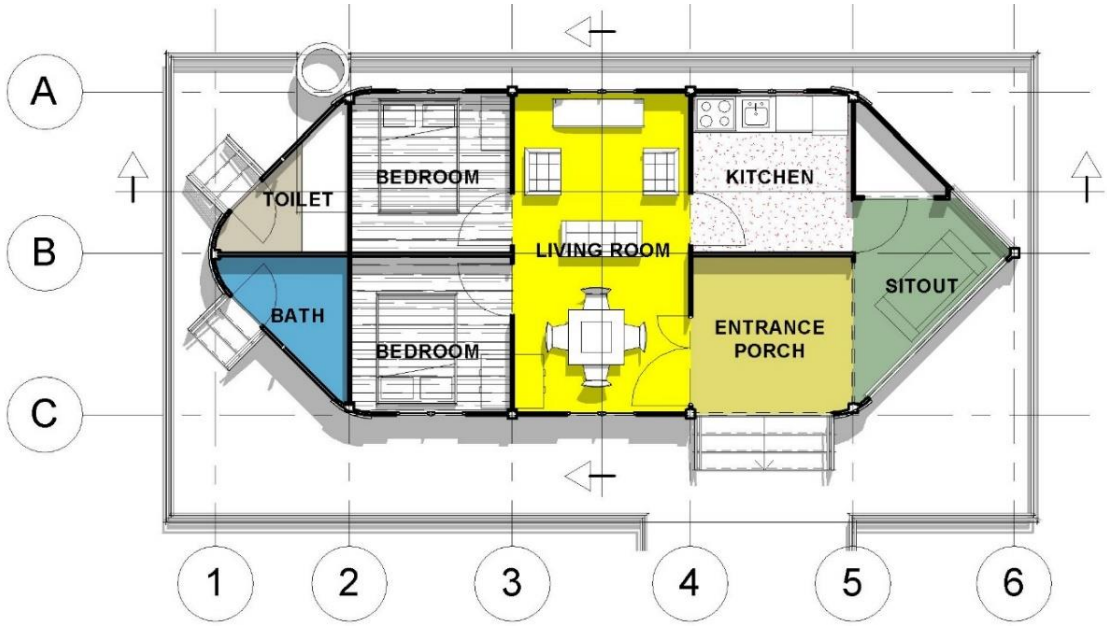

Plate 2: Prototype floor plan.

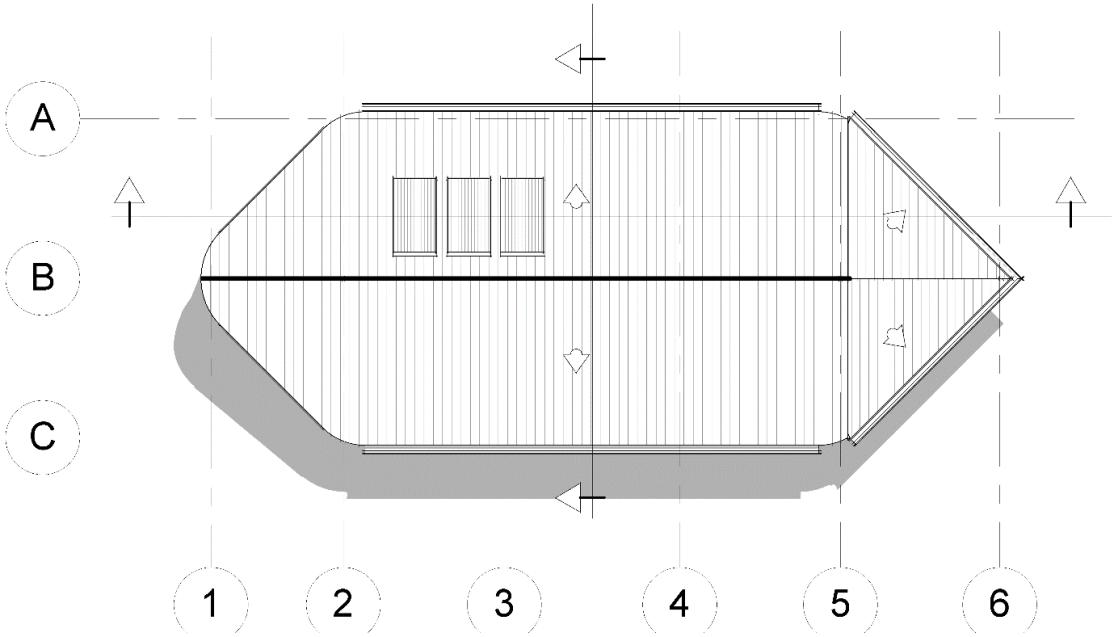

Plate 3: Prototype roof plan.

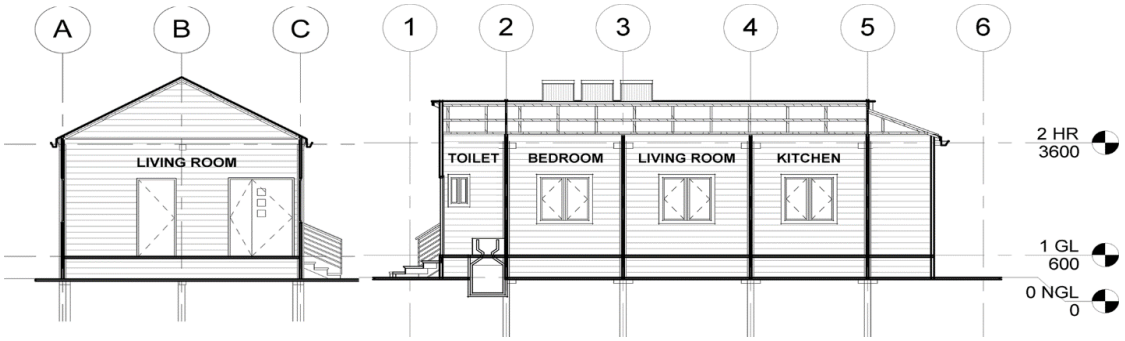

Plate 4: Prototype's Transverse and Longitudinal Sections respectively.

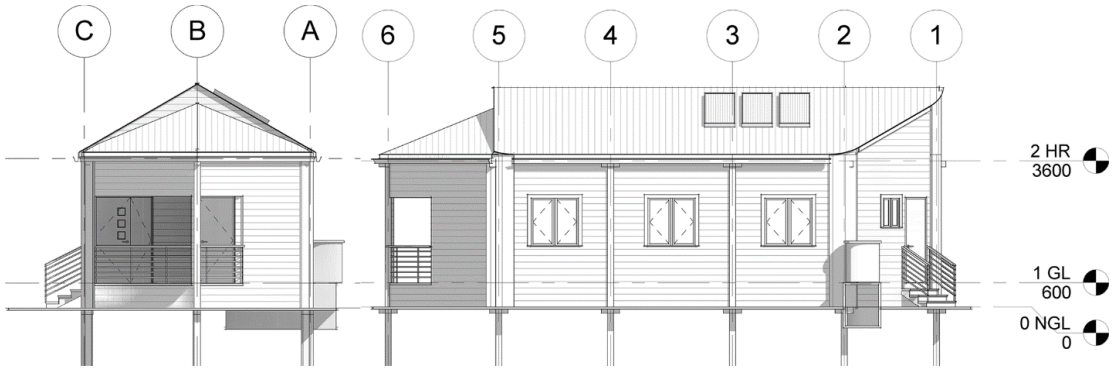

Plate 5: Approach and Left side elevations respectively.

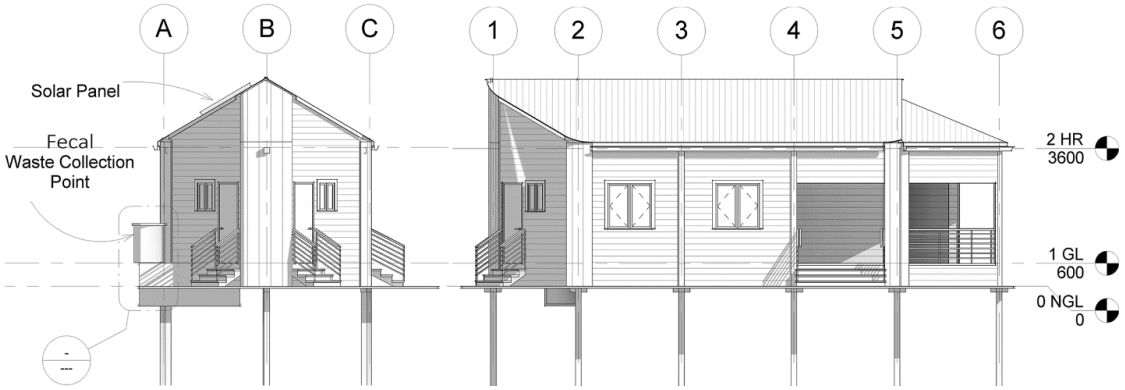

Plate 6: Rear/back, east/right side elevations respectively.

Choice of Material

The choice of material adopted for the floor, walls, and roof is the Bamboo which can be easily sourced locally within the community area. The window is a casement window with the choice of material varying, depending on the income level of the individual. Similarly, the choice of doors would be dependent on the individual as well. However, the choice of materials for the windows and doors will have to be such that their density does not affect the ability of the building structure to float on water.

In addition to this, the structural members within the dwelling (i.e., the structural framing comprising the stanchion and wedges supporting the structure) is made up of the Iron wood; for its strength and durability in water. Particularly, the choice of the iron wood locally called "Omenghe" is due to the fact that it is locally sourced and can be adopted by the locals within the coastal settlement.

Structural Analysis

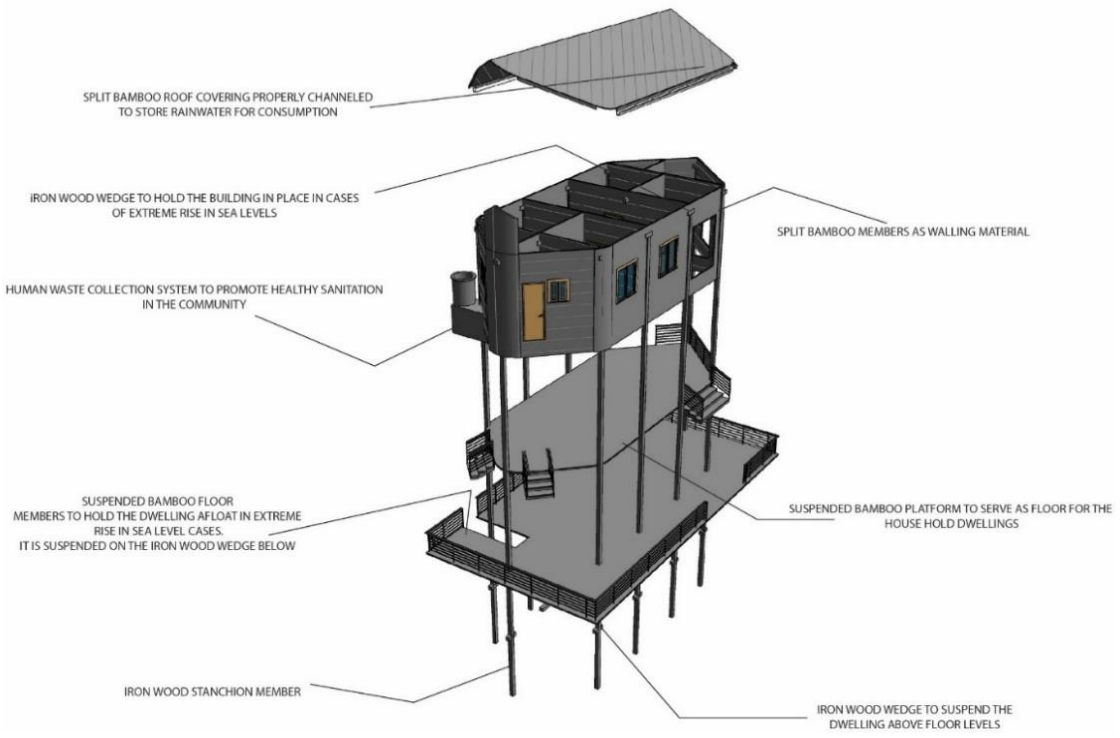

Plate 7: Diagrammatic Prototype Analysis

DISCUSSION (SUSTAINABLE IMPLEMENTATION PLAN)

Planning Phase (Public-Private Partnership)

Partnership has become a center point of discussion in development planning, this is evident in its recognition by the United Nations as one of the goals for sustainable development (Goal 17). Public-private partnership involves long-term collaboration between public and private sectors in which the collaborating actors mutually agree to share risks; despite some academic criticism, the public-private partnership continues to grow as one of the most viable strategies for the provision of public works and services (Hodge & Greve, 2007, Hammami et al. 2006).

The study area is unique being one of the oil producing areas in Nigeria, this therefore makes it suitable to achieve sustainable housing provision. Three government agencies are expected to take a leading role in the partnership, they are the Niger Delta Development Commission (NDDC – Federal Government parastatal), Ondo State Oil Producing Areas Development Commission (OSOPADEC – State Government Agency) and the Ilaje Local Government Authority.

The private sectors partnership should be open to interested private establishment within and outside the country e.g., financial institutions such as the Primary Mortgage Institution (PMI). The community is also expected to be represented, this could be through Non-Governmental Organizations (NGOs), Community Based Organizations (CBOs), private individuals etc.

Materials for construction: The design adopts locally available materials. These materials (basically Ironwood and bamboo) are presently being used by the local residents which is durable. Despite the availability of the materials, embarking on a massive housing provision will deplete the forest resources thereby exposing the area to more effect of climate change. It therefore become imperative to use the services rendered by the terrestrial ecosystem in a sustainable manner. Government should embark on massive afforestation program for these two basic materials (Ironwood and Bamboo). Local residents should be involved as unskilled or semi-skilled labor.

Construction phase

The construction of the design requires new knowledge as its different from the conventional way of design in Ilaje. Ilaje local government has a post-secondary institution (Ayetoro Technical College). Ayetoro Technical College is located at Aiyetoro in Ugbo Ward 2 of the local government. This technical college has been involved in carrying out technical training in areas such as welding, road construction, boat construction, etc.

Residents from far and near communities have also benefited from technical trainings which has been a source of employment for them.

Since the construction of the building requires new skill, existing related skilled workers such as carpenters, furniture makers etc., should be further subjected to training through the technical college. Coupled with, more residents interested in this can also enroll since a large skilled work force will be required for construction. This on a long run would provide employment opportunities within the community and a source of income for skilled workers therein and at the same time, increasing their workforce. Above all, the use of locally trained skilled workers will help in future maintenance of the proposed buildings.

Operation phase

Proper documentation is important at every stage of housing provision; it becomes imperative to also keep good records at operational stage. This helps to have an understanding of households involved and their basic socio-economic information. The use of local building materials and local skilled work force for major construction will ensure that the housing units are affordable.

Payment system for the housing unit should allow occupants to pay over a good period of time. When payment for housing unit is spread over a long period of time (e.g., 10-30 years) it reduces the stress associated with paying-off for the property acquired as the residents are low-income earners. The partnership contributions from private individuals, government and other organizations can also assist in further reducing the amount to be paid by residents.

The design is new to the residents, there is therefore the need to educate them about the design and how to make proper use of the facilities within the building. The roof of the building comes with a rain water harvesting design to meet the domestic use of water. Moreover, solar panels are incorporated in the roof design in order to provide solar energy for residents to utilize in powering their electrical appliances such as radio, electrical bulbs for illumination, sockets for charging phones, touch lights etc.

On the whole, architectural design of structures over decades must have the capability to respond to changes from the environment and the people. However, the feature in the design is different from the local design pattern even though the design adopted locally available materials. Consequently, residents need to obtain good knowledge from experts in order to sustainably make use of such features. Residents should be exposed to the use of the modified facilities and newly introduced ones including the functioning of the toilet, bathroom and solar power source as well as learning about proper maintenance culture. The more we know about the importance and functions of a facility the more optimally we put it to use sustainably.

Furthermore, the aquatic environment of the neighborhood must not be compromised as the ecosystem is of great importance to man's existence. Hence, waste management within the neighborhood must be done under best management practices. Feacal waste must be safely transported by residents to a Biogas station situated around the community for processing while the local waste management authority should be available to collect waste from each home as and when due.

Implication to Design and Practice

Factors contributing to housing vulnerability to disaster and/or hazard as propounded by ADPC (2011) has been discussed earlier. Moreover, Tran et al., (2012) stated that inappropriate housing solutions together with poorly constructed houses are known sources of risks to climate hazards. For this reason, this study proposes an integration system whereby residents obtain good knowledge from experts and are exposed to the use of features within the design in order to be able to utilize it optimally and sustainably. This will invariably reduce the vulnerability issues that are prevalent within the housing sector.

In addition, the notion of the 'socio-economic situation of households translating into differing levels of housing vulnerability' (Tran et al., 2012), can be alleviated putatively by the 'payment system' that would be adopted in the operation phase of the design proposal. Thus, availing low-income earners with the opportunity of acquiring shelter on a considerable financial scale.

CONCLUSION

Climate change impact is evident within coastal settlement around the world (Spalding *et al*., 2014). However, the population within such settlement is gradually gaining momentum as development continues (McGranahan, Balk & Anderson, 2007). As a result, a large number of human settlements in coastal areas are considered to be exposed to climate-related impacts, including coastal and riverine flooding, sea-level rise and storm surge (Brooks et al. 2006; Solomon et al. 2007; Hunt and Watkiss 2011)

Clearly, resilience has been defined by different authors (scholars and organizations) in different perspectives. Alternatively, resilience here is considered within the confines of disaster or hazard event. It focuses on putting greater emphasis on what communities can do for themselves and how to strengthen their capacities, rather than concentrating on their vulnerability to disaster or their needs in an emergency.

With this in mind, the study focused on the Ilaje local Government area of Ondo state Nigeria and proposed a residential building design which utilized features different from the local design pattern and adopted locally available building materials within the study area. Modified facilities within the design includes the toilet, bathroom and solar power

sources. It is expected that the design will putatively reduce vulnerabilities within the housing sector and ensure that low-income earners are able to afford durable dwellings.

Finally, residents are encouraged to adopt proper maintenance culture within the building and their environment so as to ensure that they optimally utilize the facilities provided sustainably. Correspondingly, the aquatic environment of the neighbourhood must be maintained as the ecosystem is of great importance to man's existence.

Future Research

In optimally harnessing the potential of the design proposal in this study, further research is needed for Feacal Waste treatment and Biogas processing technology in adopting a healthy maintenance culture within the community.

Acknowledgments: This work was supported through the Climate Research for Development (CR4D) Postdoctoral Fellowship (CR4D-19-03) implemented by the African Academy of Sciences (AAS) in partnership with the United Kingdom's Department for International Development (DfID)Weather and Climate Information Services for Africa (WISER) program and the African Climate Policy Center (ACPC) of the United Nations Economic Commission for Africa (UNECA). Statements made and views expressed in this work are solely the responsibility of the author(s).

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