DECISION SUPPORT FRAMEWORK DEVELOPMENT FOR FLOOD PLAINS IN NIGERIA (A RISK BASED APPROACH)

Ulasi, C. C. and Ulasi, A. J.
[1]Department of Civil Engineering & Technology, Federal Polytechnic Unwana, Ebonyi State.
[2]Department of Electrical/Electronic Engineering, Chukwuemeka Odumegwu Ojukwu University Uli, Anambra State

Abstract
Water we all know is the most vital and prominent need of man. However, its unbelievable effect in 2012 across the whole of West Africa showed that it can also cause untimely death, havoc, disaster and poverty when in excess. The Nigerian hydrological service Agency (NIHSA) prediction of flooding being the number one natural disaster if global temperature and climate changes continues on the rise came to reality in 2012 where over 23 states of the nation was ravaged by horrendous flooding. This was the worst in the history of the country's existence. This was an eye opener to the African continent towards there planning applications for development of their various cities in flood zones and its degree of practice and effectiveness. SUDS (sustainable drainage system) and rainwater harvesting were aspects that couldn't find its grip in the country's flood management plan. Therefore, this work is focused on addressing those precarious situations by carrying out a risk assessment on Nigerian statessited on flood plains and producing a feasible flood management strategy and guideline to planners and developers using the Wales technical guideline planning policy for development and flooding (TAN 15) and NPPF (technical guidance to help local planning authorities implement national planning policy and framework superseded PPS 25) as guidelines to providing a standard guide for the developers and planners in the African continent. Good design principles and more sustainable drainage systems which are much suitable for the African environment is to be encouraged and adopted into practice by this work and total abolishment of the gutter and tunnel system.

Keywords: Nigeria, Floodplains, Flood Disaster, Suds, Design Framework and Risk Management Strategy

1. Introduction

Water is indispensible to human existence, an essential requirement for the economic development of human societies and preservation of healthy ecosystems. However, as David Grey and Claudia Sadoff assert,*"* it is also a cause of death, devastation and poverty. It is a force for destruction, catastrophically through drought, flood, landslides and epidemic, as well as progressively through erosion, inundation, desertification, contamination and disease". Flooding is a major issue in West Africa. The impact of flooding can be devastating in terms of the cost of repairs, replacement of damaged property and loss of business. In addition, the nuisance and stress caused by a flood event and clean-up operations, use of temporary accommodation and the general disruption, can be just as significant. In the past four decades, economic losses due to natural hazards such as, floods disasters have increased in folds and have also resulted in major loss of human lives and livelihoods, the destruction of economic and social infrastructure, as well as environmental damages during this period (Munich Re, 2002).

The Nigeria Hydrological Services Agency (NIHSA) had claimed that "the year 2009 will be remembered as a year in which floods took the headline news from other natural disasters and if global temperatures continue to rise and climate change accentuates, flooding may soon become the number one natural disaster in the world." For Nigeria, this prediction has come true in 2012 as parts of more than 23 states have become inundated by raging floods in the worst natural disaster that the country has experienced in living memory.Nigeria has seen loads of huge flooding starting from the 80's with the Ogunpa Stream in Ibadan that killed several people and completely grounded socio-economic activities in 1980. Recently (August 2008), the residents of Makurdi were thrown out of their residences and their farmlands left

impoverished after two days of heavy down pour of rainfall. It was described as very disastrous (Taiwo, 2008). The This day newspaper of (August 18th) has it that "at least five hundred people were rendered homeless and properties worth several millions of Naira were destroyed when a flood, occasioned by torrential rainfall ravaged Babura, a town in Jigawa State in a period of two days". Akani and Bilesanmi (2011) report showed how a Lagos flood forced "Lagosians" to relocate as a result of heavy rain of 7th and 8th of July 2011 not knowing there was going to be a more devastating torrential rain that will result in "more disastrous floods in Lagos Metropolis" in the following week, (Mordi, 2011 and Amaize, (2011). Often, "Send down the rain" is the supplications of Nigerians early in the years in expectation of bountiful harvests. In the recent years, the rains came indeed, but in torrents, giving rise to deadly floods instead, causing harvests of pains. From Lagos, Ibadan, Abeokuta, Calabar, PortHarcourt and Warri in the southern region through Ilorin, Abuja, Lokoja and Mina in the Middle belt to Kano, Kaduna, Jalingo, Maiduguri and Gombe in the North, the rains came down and floods came-up, washing away streets, battering dams, collapsing bridges, submerging buildings, killing people, trapping some in their homes and separating thousands of others from theirs. "Nothing is spared by the marauding floods", (Adedeji, Kuyoro, Adeola and Adeyemi, 2011). The National Emergency Management Agency (NEMA) in October 2012 issued a breakdown of the people affected and displaced by the flood of 2012 which affected the 32 states of the country with 24 states severely affected. A total of 7,705,378 persons were accounted to be affected with about 597,476 houses destroyed or damaged. With all these happening, the question of qualitative urban spacing and sustainable livelihood is put to test.

The quality of the urban space is vital to sustainable livelihood; therefore, it is important to understand the relationship between sustainable development and disaster preparedness and management. Sustainable development is importance and it has come to have an associated meaning (and sub-discipline, 'sustainability science') (Mollinga, 2010) which focuses on the nature of communication and relationships surrounding development and the way in which development can be self-sustaining. The trend in the frequency and intensity of disasters nationally and internationally is due to unpredictable climatic changes, severe flooding, fire, drought, terrorism, epidemics and urbanization especially in developing countries. One very important but frequently ignored aspect in disaster management efforts in Nigeria is risk assessment. Urbanization and lack of good local governance have being regarded as a major creator of urban flood risk (UN-ISDR, 2009, Darteh, 2010). Urbanization exacerbates the damages caused by flooding by restricting where flood or storm waters can go. Large parts of the ground with roofs, roads and pavements are covered, obstructing sections of natural channels and building drains that ensure water moves faster and better than it did under natural conditions. In an urbanizing environment, the infiltration capacity is reduced by the replacement of ground cover with impervious urban surfaces (Odemerho, 1988). In the urban centres, the event of climate change impact the environment either directly or via changes in water flows. Hydrological changes within the river systems are cause for concerns due to the related increase in flooding incidence or significant changes in base flows.

Haven said all these; this work is aimed at investigating on the cause (source), pathway and receptors of the flood at about the urban cities in Nigeria with respect to the African community at large. DPSOR (drivers, pressure, state of system, options and response model) of the foresight future scenario methods would be employed to assess these selected catchment areas of our case study and a view of what the future flood risk scale is deduced with a risk management also provided to curtail it at a temporary scale. This work is aimed at mapping out the areas with the highest flood risk potentiality and developers shunned from building in such environment. An in dept research into the flood and management system of the areas of study will be done and a more viable and sustainable solution from the advanced countries like the UK,USA and Europe at large will be employed to salvage the structural and non- structural problems of the African continent with respect to their flood issues.

2. RESEARCH METHODOLOGY

DATA COLLECTION

Gathering data for this type of work is enormous and it can only be done if the researcher goes down to the grassroots to make proper investigations on issues like the general situation of each of the urban cities at different parts of the country, such as population, land use, the flooding types experienced, the time it mostly occur and the source of the flood. Understanding the people's behaviors and idea about living and how they manage flood when it occurs. Thirdly, to determine the management options streamlined by the government in controlling flood over these cities. After collection of these data, a Questionnaire was built to pass these information around and see how best the people know about their environment and the level of education they have on flood disaster and what are the expectations on their part and that of the government in eradicating flooding. The sample size was 20 people per region of the country. These respondents were selected mostly from 4 categories namely:

Workers with the environmental agency

Nigerian University students (international and locally based)

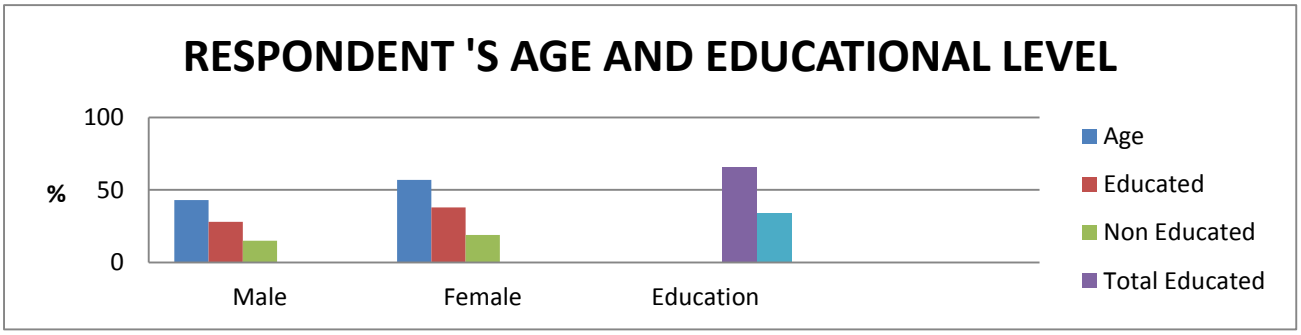
Academician in Universities

A few random people living and working in these urbanized cities

The questionnaire is formed by a true or false answer with some few bits which got a little briefing should in case the question needs more elaborate answer to settle confusion. The results of the survey were thorough quantitative analysis.

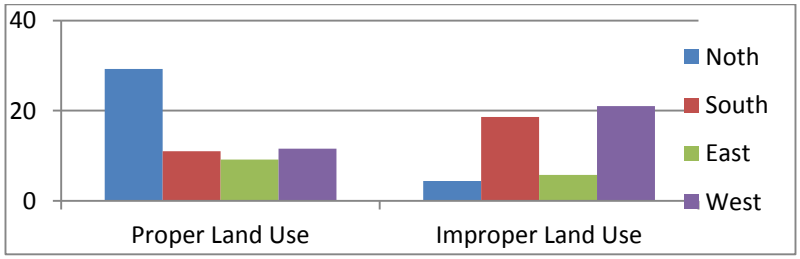
2.1 FINDINGS

FINDINGS REGARDING GENERAL INFORMATION OF RESPONDENTS:



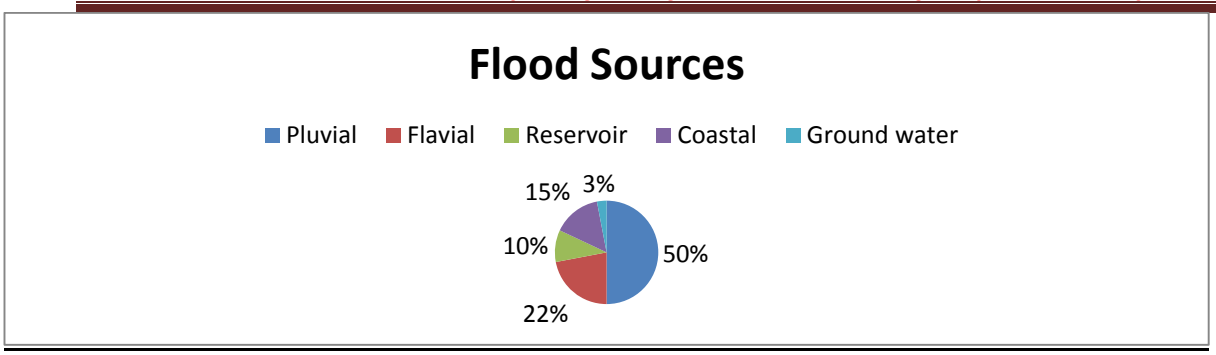
Age and educational level Distribution for Respondents

FINDINGS REGARDING GENERAL SITUATION IN THE NIGERIAN CITIES.



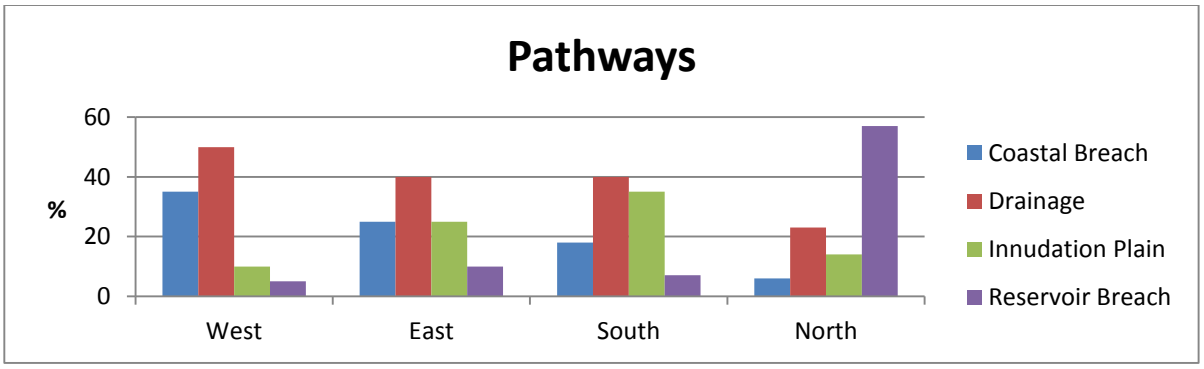
Proper and improper land use in the four geopolitical zones

FINDINGS REGARDING SOURCE OF FLOOD



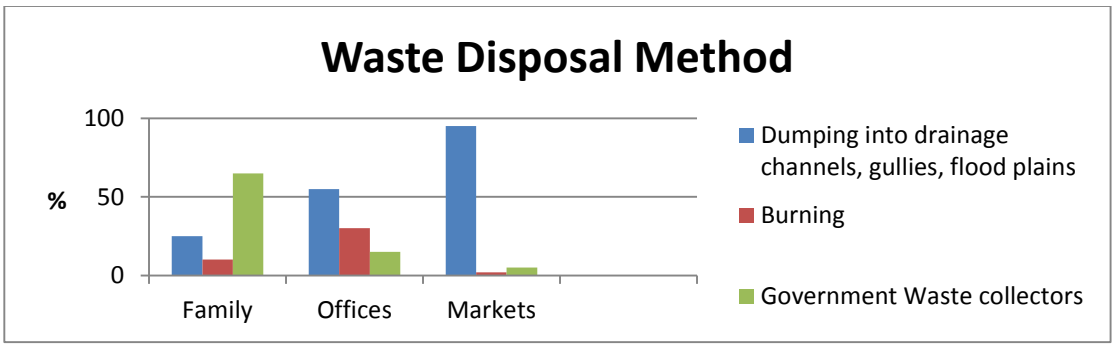
Percentage of flood sources in the country

REGARDING DETAILS ON PATHWAY SOURCE:



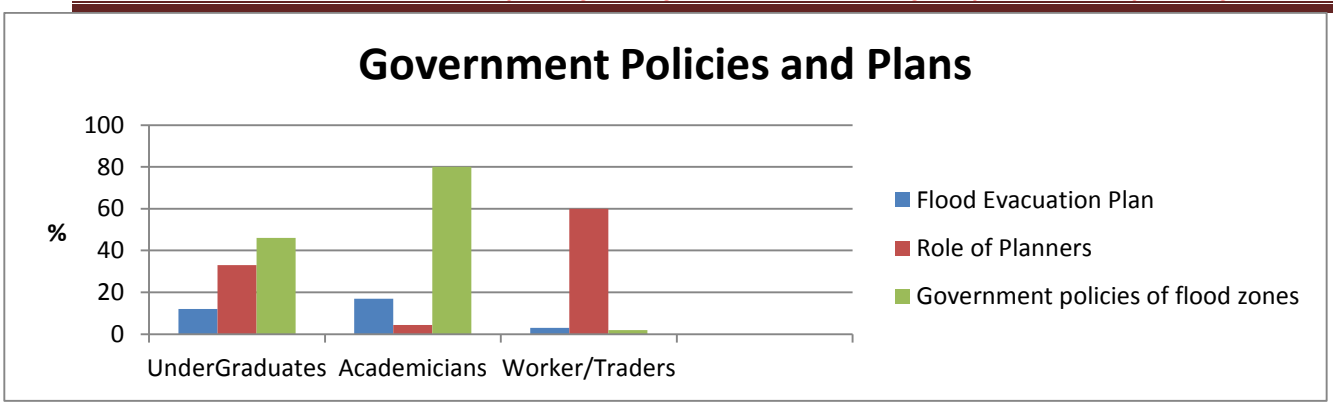
Pathways in each zone

FINDINGS REGARDING DETAILS ON DUMPING OF REFUSE:



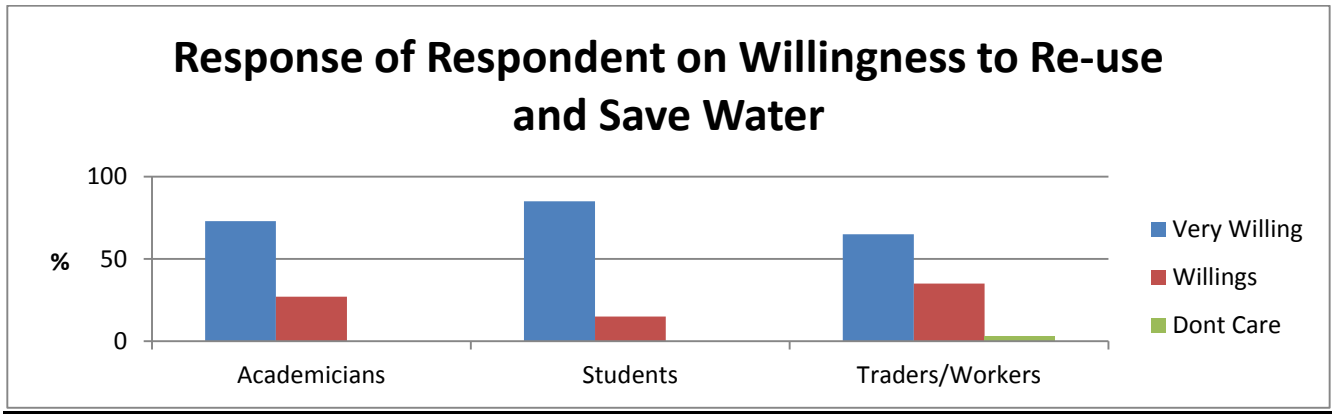
Waste disposal methods

FINDINGS REGARDING GOVERNMENTS APPROACH TO FLOODING:



Government policies and plans

FINDINGS REGARDING RECOMMENDATION OF WATER MANAGEMENT



Willingness to re-use and save water

RISK ASSESSMENT

Environmental Risk Management And Strategic Environmental Assessment (Sea)

The risk management framework has many attributes that can be applied to improve the rigour of assessment in strategic environmental assessment (SEA), particularly the use of the source-pathway-receptor model and the consideration of probability and consequence. Risk assessment provides a valuable tool to inform decision-making about uncertain future outcomes. One of its strengths is that it can explicitly take account of uncertainties about future outcomes. In addition, the risk assessment process can be informed by dialogue with stakeholders, which can aid decision-making. Risk assessment can help SEA and sustainability appraisal by providing a framework to evaluate economic, social and physical outcomes (including impacts on human health and the environment) of proposed policies, plans and programmes. The probability of the occurrence of potentially damaging flood events is called flood hazard (cf.ITC 2004). Potentially damaging means that there are elements exposed to flood which could, but need not necessarily, be harmed (FLOOD site-consortium 2005). The flood hazard encompasses events with various features. Damages by flood hazards depend on the vulnerability of exposed elements. The term of vulnerability refers to inherent characteristics of these elements which determine their potential to be harmed (sarewitzet al.2003). It can be understood as a combination of susceptibility and societal value (FLOOD site-consortium 2005) and expressed by direct and indirect effects which are tangible or intangible (messner and meyer, this issue).Flood risk emerges from the convolution of flood hazard and flood vulnerability (WBGU 1999, 1SDR 2004). It can be defined as the probability of negative consequences due to floods and depends on the exposure of elements at risk to a flood hazard (cf.ibid). In terms of flood it is interpreted as harm to flood-prone elements with a specific vulnerability (elements at risk) due to probable flood events with their features.

Discussing the risk/hazard findings from the data collected,It was analyzed based on the probabilities, Driver and Pressure and the conceptual source-pathway- receptor-consequence-model (SPRC-Model).The drivers and pressure affect the risk in the future. The drivers are the forces that increase or mitigate pressures on the environment. Pressures are the stresses that an activity, situation or agent places on the environment (defra, 2011) whereas the SPRC Model shows a simple casual chain ranging from the metrological and hydrological events either in inland or at coasts (sources) through the discharge and inundation (pathways) and the physical impacts on elements at risk (receptor) to the assessment of effects (consequences).The chain links source, pathway and receptor refers to the physical process, whereas the assessment of the (negative) consequence is a matter of societal values. When dealing with river flooding which Nigeria experiences the most, the source of the risk is mainly heavy rainfall, river discharge, storm surge or whatever gives rise to the potential for flooding. A characteristic of flooding sources is that there is little or no ability to control the frequency of occurrence of the source. The pathway is the route which the flood source takes to the receptor. The pathway may include river channel, floodplain or embankments (drainage, tunnels) if submerged or breached. The receptor is the asset or person that can experience (usually undesirable) consequences from the flooding. The consequences are damages (whether capable of expression in monetary terms or not) and possible benefits from the flooding

The stages for environmental risk assessment:

- Hazard/Risk identification.
- Estimation of the Probability (P) of exposure to a hazard for current.
- Estimation of the magnitude of Consequences (C) should exposure for current.
- Determine the Source-Pathway-Receptor of the hazard.
- Drivers and Pressures of the hazard in the future.
- According to drivers and pressures, estimation of probability and consequence in the future.
- Risk Analysis for current and future. Risk= P × C
- To select the priority risks/hazard for option appraisal, base on the literature view, site visit and questionnaire survey. (Surendran, 2012)

Processes To Undergo In Environmental Risk Assessment and Management

Environmental risk management is a four-stage process. This is set out below with an indication of how it may be used in SEA. Risk management decision-making is an iterative process (as is SEA) so stages may need to be revisited as new information comes to light.

STAGE 1 (PROBLEM FORMULATION): The problem at hand should be clearly set out along with any constraints on the assessment and the final risk management decision and its implementation. Describing the problem in clear and unambiguous terms will assist in selecting the level, or type, of risk assessment required (e.g. qualitative / quantitative) and ensure that risk management decisions are as robust as possible.

SOURCES	PATHWAYS	RECEPTORS
• Rainfall • Sea Level • Waves • River flows	• Overtopping and failure of flood defences • Breaching of coastal defences and beaches • Failure of defence components such as barriers and gates • Inundation of floodplains • Inadequate urban drainage	• People • Domestics and commercial property • Infrastructure • Ecosystems

Flood risk management examples of sources pathways and receptors

STAGE 2 (RISK ASSESSMENT): Risk assessments are undertaken to determine the significance (sometimes referred to as "acceptability") of the risk's and the need for management action to prevent or limit the risk. Assessments should start at a simple level and can become more sophisticated subject to the nature and complexity of the risks under assessment and the decision-making needs (in risk management this is known as 'a tiered approach'). Using a tiered approach should ensure that the complexity of risk assessment is proportionate to the risk. Risks assessment takes account of the probability of an event and the magnitude of the consequences of the event (see the figure below for a simple risk screening example)

STAGE 3 (SELECTION OF PREFERRED RISK MANAGEMENT TECHNIQUE): The next stage of the process considers the options available for managing the risk's, i.e. what measures are to be taken to prevent or control the identified risk's. It is likely that more than one possible risk management technique or action is available, including further refinement ofthe risk assessment, and Options Appraisal is used to provide a balanced assessment of each option so that the most appropriate option can be identified. The Options Appraisal process involves identifying the advantages and disadvantages of the risk management options (including, environmental, social, economic, and technological management considerations) and ranking them.

STAGE 4 (IMPLEMENTATION OF PREFERRED RISK MANAGEMENT TECHNIQUE): The preferred risk management options are implemented and monitored to ensure that they are effective in reducing risks to acceptable levels.

STAGE 5 (DEALING WITH UNCERTAINTY): Uncertainty can arise throughout any risk assessment and risk management process. Although uncertainty cannot be eliminated, it can sometimes be reduced by collecting more information. It is important to acknowledge all uncertainties including data gaps and assumptions. A simple sensitivity analysis can, for example, be undertaken to examine the behaviour of a model like the DPSOR framework (Surendran, 2008) by measuring the variation in outputs resulting from changes to its inputs.

DISCUSSION

We are to discuss the result below which is prioritised worst case scenarios following the format built using the framework above.

Scenarios	Risk analy-sis	Ranking
Risk 7	11HM	I
Risk 8	6H5ML	II
Risk 1	4H8M	II
Risk 16	4H7ML	II
Risk 10	4H6M2L	II
RISK 2	3H7M2L	III
RISK 4	2H8M2L	III
RISK 17	2H7M3L	III
RISK 14	2H6M4L	III
RISK 11	H9M2L	III
RISK 9	H8M3L	III
RISK 5	H8M3L	III
RISK 12	6M6L	III

The prioritised scenarios/risk

Since we have been able to analyse the risks involved and the worst case scenarios noted, the next thing to be considered would be option appraisal and the best risk management strategy to combat these flood scenarios. Appraisal is about gathering information and comparing options in a consistent way in order to support good decision-making; avoiding bad decisions; as well as maximising the likelihood that in time the chosen approach with hindsight turns out to have been the right choice (DEFRA 2009). Appraisal is necessary to justify Government investment in flood and coastal risk management. The appraisal process

in this work is one which would be approached in an open, constructive and creative fashion as an aid to problem solving and finding the right solution, rather than as a formality or a burden that is necessary to gain funding for an already established preferred option. The appraisal process for this work would point to how value for money can be maximised from any public investment or tax payer's fund. This is needed to help decision makers ensure that taxpayers' money is invested in those projects that will deliver the greatest benefits for society as a whole. For want of time, here is a guideline on how best to appraise each scenario and an option appraisal made on one of the scenarios.

Identifying the optimal risk management technique (defra, 2011)

Ref	Scenarios	Risk management strategies and options				
		Terminate	Mitigate	Transfer	Exploit	Accept
1	Pluvial flooding in populated environment (R_8).	Provision of a formidable SUD. Shunning builders and people building and living in highly rated flood plain zones. Using GIS mapping to produce flood hazard/risk maps.	Introduction of Downspouts Rain gardens Porous surfaces Earth shaping. Perform checks on drainage in sensitive areas. Monitoring the network during heavy rainfall to identify and clear blocked gullies.	Water recycling unit. Artificial lake (flood detention reservoir)	Used for watering our garden. Flushing of toilet. Irrigation.	If land is on a less vulnerable area.

These various options been considered will have to face the risk management strategy, which is the final step for the risk management framework. Inorder to do this, the options from the appraisal were re-examined by risk management strategy through policy, Process, operation and science. By so doing, a much more sus-

tainable and reliable option is obtained which serves over a long period time for these scenarios. Figure below gives us the final review of the risk management strategy for the worst flood scenario.

REF.	HAZARD	MANAGEMENT OPTION	RESPONSES			
			POLICY	**PROCESS**	**OPERATION**	**SCIENCE**
1	Pluvial flooding in populated environment(R_7)	Introduction of flood hazard/risk map using GIS. SUDS Effective reduction and reuse of runoff and rain water. Transferring to recycling unit or artificial lake during peak periods. Used for domestic, industrial purposes	Encourage proper dumping of refuse. Encourage people on wise water consumption and saving. Government policies on land use	Giving incentives to developers who wish to develop on less vulnerable flood risk plains such as low mortgage and reduced tax. Increase water prices to inculcate cautious use of water and also give out subsidy on water saving device. Giving technical and financial support on setting up some of the mitigation operations set aside to reduce runoff.	Awareness and sensitization programmes sent across to school and the public via TV, radio and post. Proper maintenance of drainage channels and steady checks on it to see if it's blocked. Giving flood warning and evacuation of people in times when things get out of hand.	To promote the use of GIS to produce flood risk maps. Invent lower cost of suds. Use of more effective facilities to save urban lives from been flooded.

CONCLUSION & RECOMMENDATION

Haven seen the gradual development of Nigeria and its urbanization and population growth, it is clear that there is need for more research to be made on sustaining this nation's wealth and lives on a day to day bases. The 2012 flood disaster that did cut across 23 states of the nation would ever be the worst flooding disaster the Nigerian government has ever seen. The sad experience in this whole issue comes from the ill management and non-strategic planning for flood situations in the country and its states. The framework achieved in this work is meant to meticulously arrest most of the flooding problems in these states if judiciously followed by the government starting from the federal government to the state government down to the ministry of environment of the state to the urban and regional planners who the onus of this whole work lies on to make sure the developers stick to the rules attached to the area they are developing.

According to research, there are little environmental policies in Nigeria. The policies partially cover the aspect of environmental protection, and have very little effect. It is important to hold public hearing which would set up more effective policies. Based on the questionnaire results, most of the urban dwellers challenged the government on poor public enlightenment on the risk of flooding and ill information of planners to developers on land use. Most of them are of the opinion that the high flood risk zones should be mapped out and shown on a billboard and to developers as well to help in sensitizing the public most especially those living there to know the risk they are facing. This in an adverse effect means that there should be more scientific means to monitor the ecosystem. There should be large improvement of the GIS system in the country. Furthermore, it's expected that the government should be paying special attention on the type of structures to be built in such areas and shun the development of residential buildings in such area However, solutions to these flooding problems could be decentralised to the private companies by seeking help from them either by funding or building recycling units which will be taxed at a small rate. This will help the federal government to stretch its hand to other perilous factors which need to be tackled.PRINCE2 and MSP project management strategies should also be adopted in order to sort more of these environmental problems.

REFERENCE

- Abam, T.S.K., 2006. Development Policy Framework for Erosion and Flood Control in Nigeria. *EARTHWATCH - Magazine for Environment and Development Experts in Nigeria*, 5(1), 25-32.
- Abhas,K. J.,Robin, B.and Jessica,L.,2012. Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century. Washington DC: The World Bank
- Barker, D. (1948) *Harvest Home: the official story of the great floods of 1947 and their sequel*. HMSO, London.
- Brown, M.E. and Funk, C.C. (2008) Food security under climate change. *Science*,319, 580–581.
- Chiadikobi, K., C., Omoboriowo, A., O., Chiaghanam, O., I., Opatola, A.,O. and Oyebanji, O., 2011. Flood Risk Assessment of Port Harcourt, Rivers State, Nigeria, Advances in Applied Science Research, [online] Available at :http://www.pelagiaresearchlibrary.com [Accessed 22 May 2013].
- Cotton. A, (1986), Rainwater for Drinking in Sri Lanka', Aqua, 2, 72-76.
- DEFRA (Department for Environment, Food and Rural Affairs),2011. Guidelines for Environmental Risk Assessment and Management: Green Leaves III [online] London: Department for Environment, Food and Rural Affairs. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69450/pb13670-green-leaves-iii-1111071.pdf [Accessed 17 March 2013]
- Davin, J, Hann, C, Lester, J.,2011 Cambridge and Milton Surface Water Management Plan—Detailed Assessment and Options Appraisal Report, Cambridgeshire: Cambridgeshire city council
- Environment Agency (2009), Investing for the future, Flood and coastal risk management in England: A long-term investment strategy
- Environment Agency (2009), MDSF2 Detail System Design Report, SC050051/SR3
- Fewkes, A, (1996). Field-testing of a rainwater collection and reuse system. Proceedings of water recycling: Technical and social implications, IChemE, conference, 26, March, 1996, London , UK
- Folorunsho, R. and Awosika, L.F., 2001. *Flood Mitigation in Lagos, Nigeria through Wise Management of Solid Waste: a case of Ikoyi and Victoria Islands; Nigerian*, Paper presented at the UNESCO-CSI workshop, Maputo 19-23 November 2001
- Gray. N. G, (1989), Biology of wastewater treatment, Oxford University Press.

- Godwin O., A., Peter, A., O., Odjugo and Alex, E., U., 2011. Changing rainfall and anthropogenic-induced flooding: Impacts and adaptation strategies in Benin City, Nigeria,[Pdf] Available at<http://www.academicjournals.org/JGRP> [Accessed 17 April 2013].
- Hawkes,p., Surendran,s. and 0. Richardson,.O., 2003. Use of ukcip02 climate-change Scenarios in flood and coastal defence.london , 31st January 2003.london : *CIWEM*
- Haigh. I., Nicholls, R. and Wells, N. (2008)Extreme sea levels in the English Channel:preliminary observations (Abstract).International Conference on CoastalEngineering, Hamburg, September 2008
- *INERIS, 2008.* Assessing the Vulnerability of Local Communities to Disasters: An Interactive Guide and Methodology. Milan: UNEP
- IPCC, (2007): Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland
- Jim, W., H., Edward, P., Evan, Edmund, C., Penning-Rowsell, Paul, B., Sayers,Colin, R., Thorne, Adrian, J. and Saul, 2003. Quantified scenarios analysis of drivers and impacts of changing flood risk in England and Wales: 2030–2100, Environmental Hazards 5, [online] Available at: http://www.elsevier.com/locate/hazards.com [Accessed 12 May 2009].
- Jenkins, G. J., Murphy, J. M., Sexton, D. S., Lowe, J. A., Jones, P. and Kilsby, C. G. (2009). UK Climate Projections: Briefing report. Met Office Hadley Centre, Exeter, UK.
- Kofo A., A., 2012. Global warming and challenges of floods in Lagos metropolis, Nigeria [Pdf] available at:<http://www.savap.org.pk/journals/arint./Vol.2(1)/2012(2.1-46).pdf> [Accessed 20 April 2013]
- *Kofo, A., Martins, O., Shade, O. And Toun, A.,2012.* Challenges of Poor Drainage Systems and Floods in Lagos Metropolis, Nigeria, Advances in Applied Science Research, [online]Available at: http://www.ijsse.com/sites/default/files/issues/2012/Volume%202%20Issue%203,%202012/Paper-39/Paper-39.pdf [Accessed 15 May 2013].
- National Population Commission Nigeria and ICF Macro, 2009. Nigeria Demographic and Health Survey 2008. Abuja: NPC and ICF.
- Nwafor, J.C., 2006. *Environmental Impact Assessment for Sustainable Development: The Nigerian perspective.* Enugu: EL 'DEMAK pubs, pp. 359-394.
- Office of the public work Dublin, 2009. The Planning System and Flood Risk Management: Guide-lines for Planning Authorities, Dublin: stationery office
- Ogah, A.,T., Abiola, K.,A., Magaji, J., I., Ijeogu, E.,O. and Opaluwa, O., D.,2013. Flood risk as-sessment of river Mada: A case study of Akwanga local government area of Nasarawa state, Nige-ria,Advances in Applied Science Research, [online] Available at :http://www.pelagiaresearchlibrary.com [Accessed 22 May 2013].
- Planning Policy Wales, 2004, Technical Advice Note 15: Development and Flood Risk, Cardiff bay: PPW.
- Pratt. C. J, (1999) Use of permeable, reservoir pavement constructions for storm water treatment and storage for re-use. Wat. Sci& Tech, Vol 39 (5), 145-151.
- Rahmstorf, S., Cazenave, A., Church,J.A., Hansen, J.E., Keeling, R.F., Parker,D.E. and Somerville, R.C.J. (2007) Recent climate observations compared to projections. *Science*, 316, 709.

- Rohling, E.J., Grant, K., Hemleben, C.,Siddall, M., Hoogakker, B.A.A., Bolshaw,M. and Kucera, M. (2007) High rates of sea-level rise during the last interglacial period. *Nature Geoscience* (advance online publication). Available at: www.nature.com/naturegeoscience
- Surendran S, Evans S, Benn J, Heron E, Jackson V, Marks K (2009), Modelling and Risk Theme Review, Vision and Work Plan, Update summary (Sept 2005 - Mar 2009)
- Surendran, S., Linford, T., Evans, E., Mcgahey, C., Sayers, P., Wicks, J., (2008), System Based Risk Modelling and Decision Support for the UK's Catchment, Coastal And Estuary Flood Management Planning, 42nd Environment Agency / Defra FCRM Conference, Manchester University, 1st – 3rd July 2008.
- Townend, I. and Burgess, K. (2004)Methodology for Assessing the Impact of Climate Change Upon CoastalDefence Structures. In: *Proceedings of 29th International Conference on Coastal Engineering*, ASCE, New York,pp.3953–3966.
- Udale-Clarke,H.,2006. Flood Risk Assessment Guidance for New Development Phase 2: Framework and Guidance for Assessing and Managing Flood Risk for New Development – An Overview.[Pdf] London: Defra - Flood Management. Available at <http://southplanning.wiltshire.gov.uk/public-planning-application-documents/00524500/00524187_Applicants_Supporting_Statement.pdf> [Accessed 19 April 2013]
- UKCIP (2007) Updates to regional net sea level change estimates for Great Britain. UK Climate Impacts Programme. Available at:www.ukcip.org.uk. [Accessed 22 May 2013].
- WASA Group (1998) Changing waves and storms in the northeast Atlantic. *Bulletin of the American Meteorological Society*, 79,741–760.
- Webster, M., Forest, C., Reilly, J., Babiker,M., Kicklighter, D., Mayer, M., Prinn, R.,Sarofim, M., Sokolov, A., Stone, P. And Wang, C. (2003) Uncertainty Analysis of Climate Change and Policy Response.*Climatic Change*, 61(3), 295–320.
- Zhang, K.Q., Douglas, B.C. and Leatherman, S.P. (2000) Twentieth-century storm activity along the US east coast.*Journal of Climate*, 13, 1748–1761.