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Strategy for Tackling Flood and Water Scarcity for Adequate Water Supply and Public Health in Nigeria

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ABSTRACT

Remedial and Management strategies of flood control include the construction of structures for irrigation and the use of excess run-off water for inter-basin transfer as an alternative to absorb excess water from the soil. Losses due to floods reduce the asset base of households, communities and societies through the destruction of standing crops, dwellings, infrastructure, machinery and buildings, in addition to tragic loss of life. The aim of this research is to obtain strategy for tackling flood and water security for adequate water supply and public health in Nigeria. The net benefits from flood plains was highlighted in order to reduce flood risks and minimize loss of human life due to flooding in a sustainable manner. Ground water flooding occurs as a result of water rising up from the underlying rocks or from water flowing from abnormal springs. This tends to occur after much longer period of sustained high rainfall. Recommendations given in this paper can serve as a strategy for tackling flood issues.

Key words: Management, Strategies, Flood, Run-off, Infrastructure

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1. INTRODUCTION

Flood is a large amount of water covering an area that is usually dry. It could be caused as a result of heavy rainfall or over flowing of a river. Flooding is a disaster and should be curbed to avoid being inimical to lives. Flood could cause so many negative things which among them are encroaching the area meant for farmlands. It could also cause erosion which may lead to earth-quake, inability to access good water, and sometimes it may affect land quality. Flooding is an unpleasant situation which has affected the lives of people and natural endowments. In some of our communities, flooding is one of the natural disasters we face as a challenge.

Floods of August 2002, caused casualties, made thousands of people homeless and caused a damage amounting to several thousand million Euro in many countries across Africa and Europe. Although floods are natural phenomena, human activities and human interventions into the processes of nature, such as alterations in the drainage patterns from urbanization, agricultural practices and deforestation, have considerably changed the situation in whole river basins. In the same time, exposition to risk and vulnerability in flood-prone area have been growing constantly. The earth is undeniably growing warmer again. Scientists reached agreement on this point at a conference in Shanghai in early 2001. The Intergovernmental Panel on Climate Change (IPCC) assumes that we will see an average of temperature rise in the 21st century (1.4 to 5.8 degrees Celsius). Based on this assumption, the sea is expected to rise (9 cm to 88 cm by the year 2100). The precipitation pattern will also change. Humid areas will generally be-come more humid, and arid areas more arid. The amount of precipitation will also fluctuate more sharply (Interred Rhine Meuse Activities best practices - IRMA -2003). In general, this means a greater probability of flooding and extremely low rivers during dry periods. The rising sea level will make it more difficult for the rivers in the delta to drain into the sea. The impact of flooding increases: the impact of floods in terms of human health and economic losses has risen, and the planning of protection against floods can no longer be limited to protecting some isolated as-sets from certain types of danger. Access to improved water has been considered as the most important condition for human sustainability, sustainable development as well as ecosystems maintenance. Water is a critical component of cultural, spiritual, economic and social well-being for any society hence, the need for portable water supply. This work examines the application of knowledge of fluid mechanics in strategic water management. Water pollutants such as refuse and sewage, oil spills agricultural and industrial waste were identified as causes of shortage improved water supply; sources of improved and unimproved water supply were also

identified. The knowledge of fluid mechanics were prescribed for water sustainability and in solving challenges relating to type of flow and the determination of parameters like pressure, speed, density, volume and other flow parameters that will ensure safe flow rate of water to prevent spills while ensuring even distribution of improved water.

2. LITERATURE

2.1. Flood

Natural disasters, such as the occurrence of floods and erosion, cause much misery, especially in developing countries where low-income earners undergo great stress. Flood events are a part of nature. They have existed and will continue to exist. As far as feasible, human interference into the processes of nature should be reversed, compensated and, in the future, prevented. Flood strategy should cover the entire river basin area and promote the coordinated development and management of actions regarding water, land and related resources. Considering the evolution and trends, the approach to natural hazards requires a change of paradigm. One must shift from defensive action against hazards to management of the risk and living with floods, bearing in mind that flood prevention should not be limited to flood events which occur often. It should also include rare events. Transnational efforts should be intensified to restore rivers' natural flood zones in order to reactivate the ability of natural wetlands and floodplains to retain water and alleviate flood impacts. Human uses of floodplains should be adapted to the existing hazards. Appropriate instruments and measures should be developed for all flooding related problems: flooding, rising groundwater tables, sewage network disruption, erosion, mass deposition, landslides, ice flows, pollution, etc.

Mitigation and non-structural measures tend to be potentially more efficient and long term more sustainable solutions to water-related problems and should be enhanced, in particular to reduce the vulnerability of human beings and goods exposed to flood risk.

Structural measures (defense structures) will remain important elements and should primarily focus on the protection of human health and safety, and valuable goods and property. We will have to keep in mind that flood protection is never absolute, and may generate a false sense of security. The concept of residual risk, including potential failure or breach, should there-fore be taken into consideration.

Fig. 2.1 Urban Flooding in Yenagoa, Bayelsa State, Nigeria

Flood forecasting and warning is a prerequisite for successful mitigation of flood damage. Its effectiveness de-pends on the level of preparedness and correct response. Therefore the responsible authorities should provide timely and reliable flood warning, flood forecasting and information. A specific preparedness to alert, res-cue and safety measures should be planned and implemented at all levels, including the public, by maintaining regular basic information and continuous ongoing training actions. With appropriate and timely information, preparedness, everyone who may suffer from the consequences of flood events should be able to take -if possible- his/her own precautions and thus seriously limit flood damages. Solidarity is essential; one should not pass on water management problems in one region to another. The appropriate strategy consists of three steps: retaining, storing and draining (first make every effort to retain rainfall at the spot, store excess water locally, only then let the water be discharged to the water-course). Flood prevention has also to be based on the precautionary principle.

A compensation system should sup-port the victims of flood disasters to re-store their economic basis and their living conditions in due time. Insurance solutions at the private or public level or subsidence by state, which reinforce solidarity, should be furthered. In flood-prone areas, preventive measures should be taken to reduce possible adverse effects of floods on aquatic and terrestrial ecosystems, such as water and soil pollution. It is necessary to distinguish between different kinds of flooding and the environmental conditions that contribute to the problem. For instance, there are significant differences between on the one hand sudden flooding in upstream or headwater areas where mitigating risk involves a wide range of innovative small-scale solutions and on the other hand lowland flooding where warning periods and the duration of flood events are longer and large-scale measure have to be taken.

2.2. Water Scarcity

Water security has been defined as "the reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks".

"Sustainable development will not be achieved without a water secure world. A water secure world integrates a concern for the intrinsic value of water with a concern for its use for human survival and well-being. A water secure world harnesses water's productive power and minimizes its destructive force. Water security also means addressing environmental protection and the negative effects of poor management. It is also concerned with ending fragmented responsibility for water and integrating water resources management across all sectors—finance, planning, agriculture, energy, tourism, industry, education and health. A water secure world reduces poverty, advances education, and increases living standards. It is a world where there is an improved quality of life for all, especially for the most vulnerable usually women and children who benefit most from good water governance.

There have been increased concerns for water resource management as a result of Increasing water-related pressures from industrial development and trans-boundary influences, Climate change; and changing global economy. One of the most basic human needs and prerequisites for health and sustainability is access to safe drinking water [1]. World Health Organization (WHO) and United Nation's International Children Emergency Fund (UNICEF) [2], identified improved water sources as: household connection, public standpipe, bore hole, protected dug well, protected spring and rain water collection while unimproved sources are unprotected well, unprotected spring, river or pond, vendor-provided water, bottled water and tanker-truck water. According to United Nations [3], about 1.1 billion people representing 18% of the world's population lack access to safe drinking water. The consequence of the failure to provide safe water is that a large proportion of human beings have resorted to the use of potentially harmful sources of water. The implications of this collective failure are dimmed prospects for the billions of people locked in a cycle of poverty and disease [4]. Brown [5] opined that at any time, more than half of the hospital beds in the world are filled with people suffering from water-borne diseases. Dowdeswell [6] concludes that about 80% of all diseases and more than one third of all deaths in developing countries are caused by contaminated water. It has been confirmed that with adequate supplies of safe drinking water, the incidence of some illness and death could drop by as much as 75% (UN, 2002). WHO and UNICEF (2004), observed that the quantity of water and the proximity of the supply point to the home are more important than actual water quality in improving health since the quantity collected from such distant source is likely to be too small for effective hygiene. Studies indicate that clean water within a distance of not more than 1 km from the house tends to lead to improved health status, since people tend to use substantially more water for cleaning and washing [7-8]. WHO and UNICEF view improved water source as water available from a defined list of technologies, with access to at least 20 litres of water per person per day from source within 1 km of the user's dwelling. The purpose aim of this work is to identify the roles of fluid mechanics in enhancing strategic water management. An understanding of this will definitely enhance the formulation of policies aimed at ensuring the development of improved and sustainable water system in Nigeria.

Seminar, conferences, discussions and workshops held globally aimed at determining the key elements for strategic water management and how related actions (keys to success) can be effectively implemented for water sustainability.

Table -2.1 Common Water Borne Illness

Disease and Transmission	**Sources of Agent in Water Supply**	**General Symptoms**
Anebiasis (hand to mouth)	Sewage, un treated water, flies in water supply	Abdominal discomfort, fatigue, weight loss, diarrhea, gas pains
Cholera (Oral fecal)	Untreated water, sewage, poor hygiene, crowded living condition with inadequate sewage facilities	Diarrhea, vomiting, occasional muscle cramps
Crytosporidiosis (Oral)	Collects on water filters and membrane that cannot be disinfected, animal manure, seasonal run off of water	Diarrhea, abdominal discomfort
Hepatitis (Oral fecal)	Raw sewage, untreated drinking water, poor hygiene, ingestion of shell fish from sewage flooded beds	Fever, chills abdominal discomfort and jaundice
Shingellosis (Oral fecal)	Sludge, untreated waste water, ground water contamination, poorly disinfected drinking water	Fever, diarrhea, bloody stools
Typhoid (Oral fecal)	Raw sewage, water supplies with surface water source	Fever, headache, constipation, appetite loss, diarrhea, vomiting, abdominal rash

Source: The Texas Department of Insurance, Division of Workers

Many industries empty their chemical waste directly into rivers and seas without converting them into harmless substances. These chemicals include: acids, alkalis, mercury compounds, organic compounds and detergents. Fertilizers and insecticides used in agriculture are washed by rain into soil and eventually reach the lakes, ponds and rivers. Many harmful chemical wastes like detergents and insecticides are non-biodegradable (they cannot be broken down into harmless compounds by living organisms). They remain in water and harm aquatic life. Mercury compounds tend to accumulate in the body of aquatic organisms like fish. This can lead to mercury poisoning when such fish is consumed. Also, several industries like oil refineries, steel mills, and breweries use water for cooling. Usually water from nearby

river or lake is pumped in and used for the cooling process. The resulting warm water is then emptied back into the river or lake. This causes an increase in temperature of the water, thereby resulting in death of aquatic life.

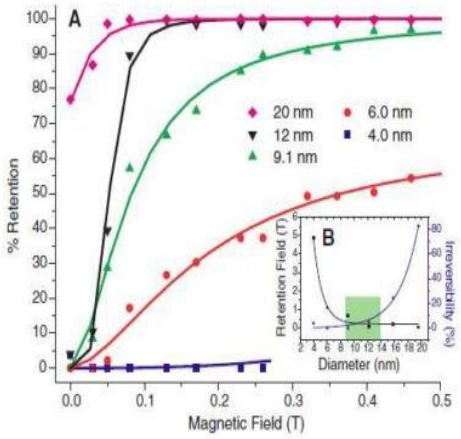

Fig. 2.2 Size Dependent Separation of Magnetite Particles following Flow through a Porous Column Exposed to a Magnetic Field

2.3. Erosion

Soil erosion is the process of weathering and transporting of solid, sediment, soil, rock and other particle in the natural environment [9]. It also occurs due to transport by wind, water or ice, by downslope creep of soil and other mineral under the force of growth. Egboka and Nwankor [10] in their hydrogelogical parameters as agent for gully-type erosion stated that most serious threat erosion however comes from storm water erosion on land surface and it occurs when heavy rain, falls on the land surface, sheet erosion appears as the rainfall, loosens and washes away soil particles down a slope surface to form rill erosion which eventually develops to gully-erosion. Podani [11] opined that erosion-induced soil degradation has been a vicious cycles that has devastated entire soil in the south-east and some part of south-south region, resulting in decline of crops productivity also caused intensification of agricultural activities, which increases the risk of erosion and its consequences. Nigeria Meteorological Agency [12] with evident of data advised the communities in the southeastern state especially Agulu-Nanka that flooding causing erosion has become now an annual occurring event, after heaving rain storm. This further worsened by the nature of topography and soil texture of the area which caused by poor/inadequate drainage net-work, leading to 53% evacuation of the people from their houses and farm lands to erosion as associated with loss of properties depending on the intensity of flood. Gully and soil erosion are very severe in this part of Nigeria because of high amount of rainfall in the region, unfavourable geology and rapid increase in construction of building and roads with poor or inadequate drainage system [13]. In 2012, the average annual rainfall in some south eastern state was 2025mm with prominent peak period in the late and early September-October. Under heavy rainfall, the area usually extensively recharged, resulting in significant reduction of average inter-granular friction and shear resistance, therefore causing the particles disaggregation rate of soil zone to increase in the sandy formation [14].

Fig. 2.3 Farm Erosion in Anambra, South East, Nigeria

Okogbue and Ezechi [15] confirmed that erosion menace is viewed from two main perspective, firstly as a natural phenomenon which is a fundamental process for the formation and modification of land forms on earth surface according to their geotechnical characteristics of soils susceptible to severe gullying. The second perspective is the human

mismanagement of the entire biophysical environment and both are caused by inducement. Consequently, construction of groyne is viewed as a model for sustainable solution to erosion devastation in Nigeria. Groyne is a hydraulic structure designed for gully erosion which has been proved efficient in the control of erosion menace in the advanced countries. It serves to main channel for the purpose of flood control and protection [16]. The groyne placement model uses a set of mathematical equations of hydrodynamics which includes the sedimentation, momentum and continuity equations.

2.4. History of Flooding in Nigeria

Historically, flooding in Nigeria which dates back to the early 1950' are fluvial, coastal and pluvial in nature and have been a major cause of concern for rural areas and cities within the country. Fluvial and coastal flooding both of which affected mainly coastal environments were influenced by seasonal interruption of major rivers and water overtopping their natural and artificial defences and overflowing areas not typically submerged. Fluvial floods account for the majority of the flood threats experienced in locations along the plains adjoining major rivers in the country, including rivers Niger, Benue and Hadeja. The states in Nigeria mostly affected by such floods are Adamawa, Kano, Niger, Jigawa, Kaduna, Cross River and Kebbi. The worst fluvial flood in Nigeria was the Kaduna flood disaster of 2006 which affected hundreds of thousands of human lives with economic loss worth millions of US dollars. Coastal floods in Nigeria affect the low-lying areas in the southern part of the country (comprising for examples Lagos, Oyo, Ondo, Akwa-Ibom and Bayelsa states). The impacts of such floods have been severe due to the number of human populations exposed following the attractions of coastal areas for economic and social reasons. Nigeria is globally ranked with the top 20 countries whose present population and future scenarios in the 2070s (including climate change and socio-economic factors) are exposed to coastal flooding.

Pluvial floods usually occur annually during rainy seasons (between July and October) and affect mainly the urban areas in Nigeria. Such floods which are arguably unprecedented in recent times are caused by more frequent and severe rainfall which overwhelms the efficiency of drainage systems and soil infiltration capacity. The significance of urban areas in the economic and political development of Nigeria is generally acknowledged. However, urbanization is a critical anthropogenic influence on climate change and hydrological cycle in the country given that much impervious surfaces increase surface water runoffs and reduce soil infiltration capacity. Along with urbanization is the rapid population increase in many Nigerian cities which is also a global concern within the context of flooding in urban areas. It is estimated that more than half of the world's population has been residing in cities since the last 6 years and by 2030 the number of people living in urban areas (with urban areas of developing countries accounting for the most part) will grow to 5 billion. Regrettably, a major challenge with rapid population growth and urbanization in Nigeria which also seems to influence the risk of flooding in the country both presently and in the future (if not addressed) has been poor urban planning (in particular inadequate drainage system and the range of poorly serviced urban utilities).

2.5. Water Security in Nigeria

Despite Nigeria's apparent potential water abundance, Nigerians are in short supply, which is more glaring in many states. According to United Nation System in Nigeria (2001), only 54.1% of the total population of Nigerians has access to safe drinking water, 71% urban area in 1999, compared to 48% for rural areas. Moreover between 1995 and 1999 access to water decreases in urban areas but increased by 9% in the rural areas within the same period. UNS analysis on housing and facilities condition nationally in 1994/1995 only 24.2% of the households had access to pipe borne water, 9.6% to borehole water, 27.3% to well water and 38.9% to stream/pond (UNS in Nigeria 2001). Water supply in our communities is facing serious challenges. Inadequate expansions of water supply infrastructure are stressing the population of most communities below satisfactory level. The result over the years since independence is that many water supply schemes have been and are still being commissioned to satisfy political promises and aspirations without resources management viewpoint. Traditional methods of exploiting water in Niger State consist of direct collection of rain water in containers and extraction from springs, stream, ponds and hand-dug wells. Water shortages are rampant during the dry season when most of these sources dry up. Apart from the unreliability of water supply, there is the problem of pollution and contamination by household and human waste. The water may be contaminated at source or during storage. These make water-borne diseases rampant in many communities. In many communities, the water authorities are finding it increasingly difficult to meet the water demands of the people. Gigantic and earth dams are built on rivers like Niger, Kaduna, and former on rivers Gurara, Etswan, Chanchaga, Gbako and many others in order to ensure adequate supply of water for both domestic and irrigation.

3. METHODOLOGY

3.1. Integrated Flood Management (IFM)

Integrated Flood Management is a process of promoting an integrated rather than fragmented approach to flood management. It integrates land and water resources development in a river basin, within the context of Integrated Water Resources Management and aims at maximizing the net benefits from the use of floodplains and minimizing loss of life from flooding. Globally, both land – particularly arable land – and water resources are scarce. Most productive arable land is located on floodplains. When implementing policies to maximize the efficient use of the resources of the river basin as a whole, efforts should be made to maintain or augment the productivity of floodplains. On the other hand,

economic losses and the loss of human life due to flooding cannot be ignored. Treating floods as problems in isolation almost necessarily results in a piecemeal, localized approach. Integrated Flood Management calls for a paradigm shift from the traditional fragmented approach of flood management. Integrated Flood Management recognizes the river basin as a dynamic system in which there are many interactions and flux between land and water bodies. In IFM, the starting point is a vision of what the river basin should be. Incorporating a sustainable livelihood perspective means looking for ways of working towards identifying opportunities to enhance the performance of the system as a whole. The flows of water, sediment and pollutants from the upper catchments of the river into the coastal zone (ridge to reef) – often taken to extend dozens of kilometres inland and to cover much of the river basin –can have significant consequences. As estuaries embrace both the river basin and the coastal zone, it is important to integrate coastal zone management into IFM. Figure 3.1 depicts an IFM model. It has to be recognized that the objective in IFM is not only to reduce the losses from floods but also to maximize the efficient use of floodplains with the awareness of flood risk – particularly where land resources are limited. That is, while reducing loss of life should remain the top priority, the objective of flood loss reduction should be secondary to the overall goal of optimum use of floodplains. In turn, increases in flood losses can be consistent with an increase in the efficient use of floodplains in particular and the river basin in general.

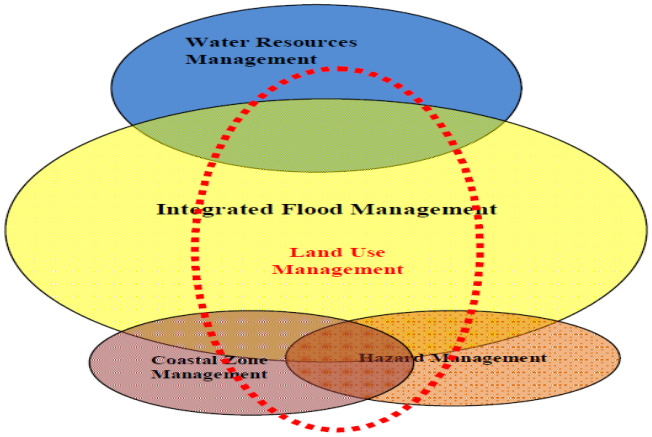

Fig. 3.1 Integrated Model for Flood Management

Table -3.1 Flood Prevention Strategies

Strategy	Options
Reducing Flooding	Dams, levees and flood embankments. High flow diversions. Catchment and managements.
Reducing Susceptibility to Damage	Floodplain regulation Development and redevelopment policies. Design and location of facilities Flood proofing Flood forecasting and warning
Mitigating the Impacts of Flood	Information and education Disaster preparedness Post-flood recovery Flood Insurance
Preserving the Natural Resources of Flood Plains	Floodplain zoning and regulation

3.2. Strategic Management of Water Resources

3.2.1. Safe Water Treatment Process and Distribution

Pipe borne water is prepared in a water treatment plant. This water is usually germ- free but it contains mineral solutes like sodium chloride. Water from rainfall, river or lakes is stored in reservoirs. This water is purified by various methods which include: coagulation, sedimentation, filtration and disinfection. The water purified is then distributed to towns and cities via underground pipes for domestic and industrial uses. The knowledge of fluid mechanics helps to fix type of flow and the determination of parameters like pressure, speed, density, volume and other flow parameters that will ensure safe flow rate of water to prevent spills while ensuring even distribution of improved water.

The treatment of water to make it fit for use can be done in the following ways: First, the untreated water is passed through large settling tanks where chemicals like potash alum $(KAlS0_4)_2$, or sodium aluminate (III), $(NaAlO_2)$, are added

to cause coagulation or flocculation. The impurities clump together to form big particles of dirt or flocs which settle down rapidly. Next, the water is passed through a filter bed to remove other impurities like fine particles of dirt. The water is then treated with chemicals like chlorine to kill germs. Other chemical such as iodine and fluorine may be added in the right amount as food supplements to prevent goiter and tooth decay respectively. Finally treated water is now germ free and can be stored and distributed for use.

Other ways of enhancing Improved Water Supply are:

3.2.2. Safe Refuse and Sewage Disposal

Refuse should be burnt in an incinerator with in-built devices to prevent air pollution. Sewages should be processed, treated and converted to useful fertilizers in sewage plants

3.2.3. Prevention of Crude Oil Spills

Through the knowledge of fluid mechanics, storage vessels, oil pipes are designed with satisfactory rigidity and strength to prevent oil spill

3.2.4. Control of Water Pollution by Companies and Individuals

Strict laws must be passed to control water pollution by individual and companies.

3.3 Remedial and Management Strategies of Flood Control

Flood menaces in Nigeria have been on the increase in recent times. Proactive and preventive options involving structural and non-structural measures need to be adopted and implemented at curbing the menace of floods. The structural measures such as check dams, levees, flood walls and adequate drainage systems will help control periodic inundation in the areas that are liable to flooding in the following ways:

a. The construction of structures for irrigation and the use of excess run-off water for inter-basin transfer as an alternative to absorb excess water from the Cameroons.
b. Levees and flood walls confines flow within predetermined channels
c. Adequate drainage systems will reduce peak flow stages of flood and divert excessive flow.
d. In communities where the rate of flow of storm water is high, embankments should be constructed to breakdown storm water so as not to result into floods. These embankments could be permanent or temporary, such as sandbags placed when a flood is imminent.

However, the adoption of structural measures alone could lead to sub-optimal development of the flood plain and may even invite greater loses when storms occur which exceed the design limits of the structures, as the collapse of the Bagauda dam in Kano clearly showed.

Moreover, structural measures are expensive; hence there is also need to regulate floodplain development with the adoption of non-structural measures.

Consequently, the following non-structural measures could be adopted to curb the menace of flood in Nigeria.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

Flood events in recent years resulting in life losses, huge damages, demand urgent reaction. The emergency is also stressed by the fact that we face the threat of climate change. Success can only be reached if an interdisciplinary approach is adopted.

This research gives measures and best practices to prevent, protect and mitigate the adverse impact of erosion and flood events as well as water scarcity on human health and safety, on valuable goods and property, and on the aquatic and terrestrial environment.

Floodplain management is seen to be the best approach. In finding solution to flooding using this approach, the first step is to construct a flood-frequency curve based on historical records and an examination of vegetation to determine how often on average a flood of a certain size occurs in a particular area. Although this approach does not tell exactly when floods will occur, but it gives an insight of how often they might occur based on past history.

Heavy precipitation cannot be managed neither can extreme floods. The message of the latest flood events is the following: "We have to learn to live with those events".

We have to do everything to avoid anthropogenic augmentation of floods, to behave in a manner to mitigate potential risks for people and valuable goods. We have to make people aware of potential and actual risks in order to induce their precautionary actions. Further-more, fight against flood damages can have positive effects in different other policy fields like nature conservation for instance.

It is necessary and urgent to implement experiences of the European countries presented in this document. For trans-boundary river basins, actions on international level have to be developed.

For each river basin, a flood management plan should be developed. In setting up such a plan, consideration should be given to the aspect of solidarity within the river basin that is to prevent as much as practicable the passing on of problems in one geographical area into another one.

The plan should be based on an integrated approach covering all relevant aspects of water management, physical planning, land use, agriculture, transport and urban development, nature conservation, at all levels (national, regional and

local). In the development of a flood management plan, decision makers at all levels (local, regional, national and international) as well as stakeholders and civil society should be involved.
Where applicable, the best practices described in this document should be taken into ac-count, in particular on:

i. Integrated river basin approach
ii. Public awareness, public participation and insurance
iii. Research, education and exchange of knowledge
iv. Retention of water and non-structural measures
v. Land use, zoning and risk assessment
vi. Structural measures and their impact
vii. Flood emergency
viii. Prevention of pollution

Access to improved sources of domestic water supply is largely influenced by the main source of domestic water. Inadequate water supply points and fluctuating release of water to populace by Water Corporation is manifested in overcrowding around public standing pipes. Other determinants of access to improved water include: distance from improved source to house, average time spent to fetch from main source, average number of trips per person per day due to main source, adequacy of supply from main source and quantity of water used per person per day. Efforts should therefore be made to bring piped water close to the homes.

4.2. Recommendations

- All appropriate action should be taken to create legal, administrative and economic frameworks that are stable and enabling and within which the public, private and voluntary sectors can each make their contribution to flood prevention, dam safety and the reduction of adverse impacts of dangerous flood events on human health and safety and valuable goods and property, and on the aquatic and terrestrial environment.
- Priority should be given to integrated water management measures for the whole catchment area rather than to the management of floods as such.
- The impact of all major human activities concerning flood prevention and protection in the catchment area on society as a whole should be properly considered. All major undertakings with the potential of adversely affecting human health or significantly affecting water quality or quantity, biological communities, landscape, climatic factors, architectural and archaeological heritage, or the relationship between them should be subject to Environmental Impact Assessment (EIA) and – if suitable e.g. because of the size or impact of the building activity authorization procedures. EIA should also be applied on an international scale, in particular with regard to activities with a potential trans-boundary effect on health and aquatic ecosystems.
- Physical planning as well as urban and rural development and construction should take into account the requirements of flood prevention and reduction, including the provision of retention areas. The real development is to be surveyed by monitoring of urban settlement in areas that may seriously be affected by floods.
- The National Inland Waterways Authority (NIWA) of Nigeria should urgently take steps to desilt waterways and tributaries which are sited and taken over by shrubs to allow for channels and easy flow of water to curb the ravaging flood in the coastal communities.
- In setting up these frameworks local problems, needs and knowledge, and local decision-making mechanisms should be duly taken into consideration.
- An information policy that covers risk communication and facilitates public participation in decision-making should be developed.
- It is rational to consider the construction of more dams as a viable option and if cost will be prohibitive, it is suggested that the capacity of existing dams be upgraded
- The conventional centralized water supply and distribution systems can no longer be effective in rapidly growing cities hence, water supply and distribution should be decentralized in towns and cities.
- To ensure strategic management and availability of water supply, it is urgent for Water Corporation to expand piped water network close to homes, hence they must ensure ceaseless flow of water from pipes, regular maintenance of the system and quick response to leakages.
- Drainage systems should be regularly inspected and monitored to take note of any failure with a view of effecting repairs. Also sedimentation and littering of the drainage systems should be guided against while vegetation like trees whose rooting system tends to or are likely to distort, break or undermine the drainage system should be removed.
- The immediate downstream culverts which helps to ensure effective runoff discharge and hence effective self-cleaning of the drainage systems should be desilted and properly aligned.
- Collaborations between local communities, NGOs, voluntary groups, local and international donor organizations towards managing floods should be established.
- Within the realm of professional practice (good land use planning and management) professionals should undergo training and re-training programmes in related fields (human capacity development) and uphold the ethics of their profession, particularly avoiding corrupt planning practices that can jeopardize lives and properties of the people.

- Dangerous political interventions in land use planning and management should grossly be avoided in order to protect the occurrence of avoidable flood menace and blaming of innocent professionals.

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