Gaps and challenges of flood risk management in West African coastal cities

Ouikotan, R.B[a], van der Kwast, J.[a], Mynett, A[a] , Afouda, A[b]

[a] *UNESCO-IHE, Water Science and Engineering Department P.O.Box 3015, 2601 DA , Delft, The Netherlands*
[b] *University of Abomey-Calavi, Applied Hydrology Laboratory, 01BP452, Benin*

Abstract

West African coastal cities have been struck by repeated flooding leading to huge damage and loss of lives. This testifies that the measures are not efficient. This paper tries to point out the gaps and challenges for an adequate flood risk management (FRM). Four cities were selected as case studies. In general, adequate data and assessment tools do not exist due to lack of fund and skilled personnel. FRM projects are isolated and measures are not well maintained. FRM should be handled in a holistic manner taking into account all possible flood types and climate and demographic changes scenarios.

Keywords: flood risk management strategies, West African coastal cities, climate change, urban growth

1. Introduction

Flood in West Africa is a growing issue. According to the Centre for Research on the Epidemiology of Disasters, the number of disaster flood events has evolved during the past four decades from 4 to 19, 42 and 105. Accordingly, the number of fatalities also, evolved from 0 to 252, 586 and 1155 respectively. From 2010 to 2015, 57 disastrous flood events were already recorded with 1169 fatalities. The present trend of flood frequency and the huge magnitude of the damage induced testify that flood management measures implemented are not adequate and efficient.

At a global level, flood management has evolved from flood control approach to flood risk management. Formerly, dikes, embankments and rainwater drainage system were implemented in many countries especially in the developed ones. After some experiences of dike failures and flood events larger than designed ones, it was realised that absolute flood security cannot be achieved since land use and climate are keeping changing and sea level rising. Therefore, the European Community, in the late 1990s began to consider a different approach: flood risk management. Flood risk management is defined as all activities that aim at maintaining or improving the capability of a region to cope with floods (De Bruijn, 2005). Flood risk is measured by determining where is flooding most likely to occur, what sorts of impacts would it have, and how much damage could it cause.

Flood risk management can be roughly divided into two parts: flood risk assessment and risk reduction. Flood risk assessment aims at establishing where risk is unacceptably high, i.e. where reduction measures are necessary. The aim of flood risk reduction is to select and implement measures in order to alleviate the flood risk.

In the light of how flood risk is managed at a global level, this paper tries to point out the gaps and the challenges that need to be tackled for a proper flood risk management in West African coastal cities.

This paper is divided into three sections. The first section is devoted to the methodology. The second section describes the current flood management in West African coastal cities. The last section presents the challenges followed by the conclusion and recommendations.

2. Methodology

Four coastal cities are selected as case studies. The selected cities are Dakar in Senegal, Accra in Ghana, Cotonou in Benin and Lagos in Nigeria. Each selected city is the political or/and economic capital of its country. It is the most densely populated and concentrates most of the industrial and commercial companies as well as the remarkable heritage of historical monuments and museums. Flooding is a major concern in the city and represents the most serious natural hazard so that flood damages have a great impact on the economy of the country. As example, for the 2009 flood in Senegal, the cost of damage was estimated to be US$ 42.32 Mi for the whole country and US$ 35.43 Mi for Dakar (Faye, 2011). These cities have also almost the same geophysical (climate, hydrology, geology, topography etc.) features. They occupy a low-lying site with some parts below sea level; rivers flowing to the sea form swampy lagoons behind long coastal sand spits or sand bars.

The data used for the analysis is mainly a secondary data obtained from various sources including the internet, scientific publications, reports, newspaper publication, international data base etc. Data obtained include statistics on annual occurrence of floods, economic and social damage features, mitigation and adaptation strategies by the communities and also by the governments. Little primary data include interviews of some flood affected people in Cotonou city.

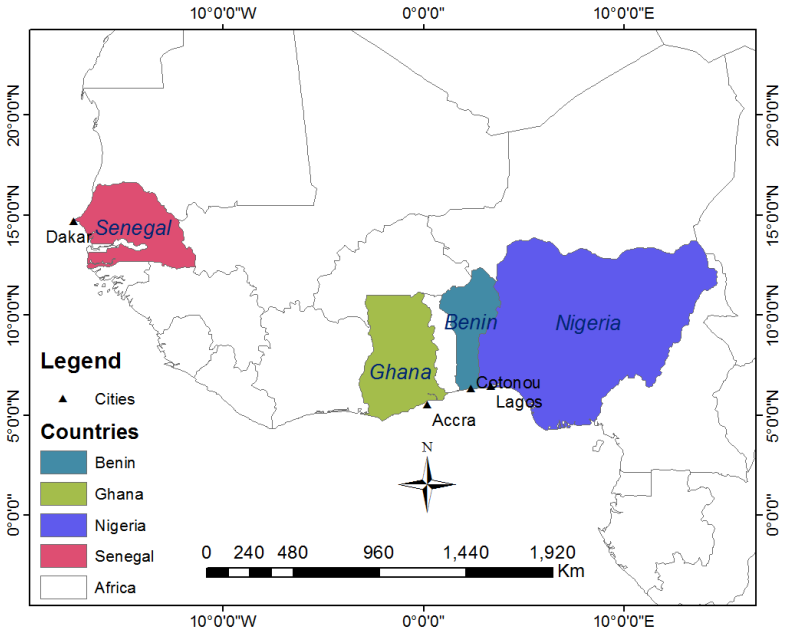

Figure 1: Location of the four cities in West Africa

3. Current flood risk management approaches in West African coastal cities

West African coastal cities are subjected mainly to riverine flooding since they are located in low-lying areas of lower reaches of rivers; coastal flooding due to storm surges and tidal effects at the estuarine reaches; pluvial flooding occurs mainly because of insufficiency of the drainage network capacity or due to lack of cleaning and maintenance of the existing drainage facilities. Flooding by seepage also occurs when the water level rises in the wetlands that surround the buildings, water table rises and infiltrates into houses especially where the level of the floor is not raised enough and/or the floor is not well tilled.

In general, in the four cities, the simple way of determining flood risk as at now is by flood prone areas mapping and this is done by observations and interviews, recordings, and mapping of flooded areas. This method is used by local authorities, particularly after flooding. Damage is estimated roughly after a flood event mainly to know the number of affected people and organise the relief services. It is only in Lagos, that sometimes some figures of damage cost are published by Lagos insurance companies in Nigeria.

A simple model is developed in Accra (Rain et al., 2011) and Cotonou (PUGEMU, 2014), using satellite data and GIS to understand which property is likely to be flooded given a certain return period of rainfall.

3.1 Structural measures

In West Africa, structural measures such as dams, dikes, coastal embankments and drainage network are insufficient and even the existing ones are not well maintained.

Structural measures consist mainly on rainwater drainage system. The first drainage master plans for the cities were drafted during 1960s. In Dakar, this master plans was not reviewed until 2013 in the case of Dakar (Diongue, 2014) due to a lack of political will; so all drainage works were designed without any scientific basis. In Accra, the master plan was reviewed in 1995 but most of the recommendations were not implemented due to lack of funding and some institutional capacity constraints (Abeka, 2014). In general, the drainage network is insufficient or not well maintained (African Development Bank Group, 2006), (Gnelé, 2010), Diop (2006).

In Lagos, structural measures are diverse and comprise storm water drainage channels, breakwater, dredging of rivers, channelization and revetment, were constructed to protect the city from storm surges and coastal flooding (Adelekan, 2015).

3.2 Non-structural measures

3.2.1 Land-use control and catchment management

Most of the literature often pointed out the fact that in Sub Saharan Africa and especially in West Africa countries, laws and guidelines for land planning and management are diverse, uncoordinated with a lot of centres of decision making. (GFDRR, 2010). Urban planning policies until now were weak and were not capable of reducing settlements in low areas, flood plain and swampy areas and also to regulate the population movement towards the city; so that a lot of population are living in flood prone areas. According to Rain et al. (2011) 172,000 residents are estimated to be at risk in Accra of a 10-year flood and 33,000 residents are located in slums. The General census made by the Municipality of Cotonou showed that in 2010, 9% of the parcels were in flood prone areas. In Dakar, the irregular constructions cover more than 25% of the urbanized zones. In 2009, a pilot study financed by the Global Facility of Disaster Risk Reduction GFDRR found that up to 19% of Dakar urban centre and 40% of the new settlements in peri-urban areas face significant risk levels. Assets estimated economically up to 2 billion US dollars are located in highly flood prone areas (GFDRR, 2010). In 2006, a project for social housing construction was launched and one component was the Jaxaay Plan which objective was to build houses for floods victims (GFDRR, 2014). In 2010, this plan relocates 1800 households from flooded areas in state-subsidized housing to up 73 - 78%. This very high level of subsidy prevents the financial reproducibility of the plan (Diongue, 2014).

In Lagos, it is estimated that 70 per cent of the city's population lives in slums. Since 2011, Lagos state government has embarked on the demolition of buildings located on drainage paths (Adelekan, 2015).

3.2.2 Preparedness and planning disaster relief

For flood disaster relief, each of the countries has developed and implemented an emergency plan in case of disaster.

The National Disaster Management Organization (NADMO) was established by act 517 of 1996 to manage disasters and similar emergencies in Ghana. It is responsible for the preparedness against flooding, resources coordination of government institutions and non-governmental agencies, mobilization of affected communities and relocation of people with food provision in a post disaster scenario (NADMO, 2016).

According to Bhattacharya-Mis and Lamond (2011) the level of preparedness, recovery and response is very low and this increases the chances of further damage.

The Planning Department of Accra Metropolitan Assembly is engaged on flood prevention by public education through the use of radio and television announcements. It also desilts drains in floodable areas in the metropolis via some contractors (Attipoe, 2015)

The first emergency plan, the Civil Relief Organization Plan (plan ORSEC) of Benin was developed in 1989. It presents a rough hazard-based risk maps and the inventory of the personnel, equipment etc. With the magnitude and recurrence of floods in Cotonou, the municipal authorities have developed since 2003 a specific program called "Cotonou en Campagne Contre les Inondations (3CI)", Cotonou in Campaign against Flood.

The main objectives are to maintain the existing drainage system, to facilitate access of flooded people to safe places and have an as short as possible response time for interventions. Main activities are: construction and maintenance of tracks and paved roads before the rainy season; roads maintenance to improve traffic conditions; cleaning of gutters; digging/maintenance of trenches, pumping water from flooded health centres, schools and houses; drainage of flooded sites; assistance to flood victims.

In Senegal, the scheme to deal with major civil emergencies was adopted by Decree N°99-172 in 1999 in Senegal. The Government of Senegal has started the implementation of the Emergency plan in 2008. The emergency is declared by the Government, on the basis of information obtained on the recorded rainfall, the number of flooded houses and victims etc. The objective is to allow the State to bring a suitable response to floods in order to reduce significantly losses of human life, damage on properties and to limit the negative effects on the environment.

Activities to meet the objective are among others: collect the information on available different means and home sites; identify disaster areas; quantify the scale of the phenomenon, the damages and losses, define and estimate needs, organize the help, estimate the socioeconomic and environmental impact, update the mapping of the vulnerable zones, evacuate flooded population, and insure water supply, food, basic hygiene and sanitation.

The National Emergency Management Agency (Rafiee et al., 2009) was established in 1999 by Act. It coordinates disaster management activities at the national level and coordinates the necessary synergy amongst all emergency response agencies. It works closely with State Emergency Management Agency (SEMA) and Local Emergency

Management Committees (LEMC) to assess and monitor where necessary the distribution of relief materials to disaster survivors and displaced persons.

The law that established the Lagos State Emergency Management Agency (LASEMA) was signed in 2008. The aim of the Agency is to manage and mitigate emergency/disaster in the State. The Agency is responsible for the overall co-ordination of emergency management in Lagos State. The Lagos state flood preparedness plan was developed in 2003. It deals with flood prevention and mitigation, response and recovery, and it encompasses both short-term and long-term actions. The abatement unit is housed in the Lagos State Ministry of the Environment. The staff of this unit carries out pre-flood prevention activities. Other units get involved when a catastrophic flood occurs. Lagos state government constitutes an inter-ministerial policy and coordination committee composed of representatives from concerned agencies. This committee sets the general tone and direction for the plan but leaves the operational duties to the abatement unit and task forces.

3.2.3 Early warning systems

In West African coastal cities, early warning schemes have not yet worked properly as flood damage reduction measures. They are not yet implemented everywhere like in Cotonou and Dakar where they are on the way. In Accra and Lagos where they are implemented, they are not working properly as shown by the 200 losses of lives registered after the June 2015 flood in Accra (IFRC, 2015) and the 2012 flood in Lagos (IFRC, 2012). Early warning systems development in most of the countries has been implemented under projects funded mainly by bilateral agencies like UNDP, OMM etc. Unfortunately and in most cases, after the lifetime of projects, the system fails due to lack of maintenance.

3.2.4 Flood insurance

In general, in West Africa cities, insurance companies have not played an important role in flood risk management.

During the last widespread flooding event in Accra on 3 June 2015, the insurance industry of Ghana has given the assurance that all affected business of individuals who have insured their risks will be compensated adequately. But it is mainly business companies and rich people that are insured (Ablordeppey, 2015).

In Cotonou and Dakar, the insurance company does not take flood risk into account even when people apply for multi risk insurance package.

In Lagos, only multinational corporations and large manufacturing companies and some real estate property owners have benefit from insurance companies in managing flood risk. The country's insurance Act 2003, has made it mandatory for all public buildings to be insured against hazards, but the majority are not. In 2010, Lagos state took a further step of enacting a law on the insurance of public buildings against hazards but this has nevertheless not been enforced (Adelekan, 2015).

3.2.5 Adaptation capacities at individual, household and community level

In general, people always try to adapt to their environment. It is the case with West African coastal cities especially with the incapacity of the central government and the municipality to help properly the affected people. Due to the several damage and adverse effects of the recurrent flooding, communities tried to adapt themselves in order to improve their living conditions before, during and after the occurrence of flooding. The adaption strategies put in place by the communities are diverse and they are in general similar in the four coastal cities studied. They range from individual to community ones.

In Accra, ActionAid (2006) reported that children are taken to the rooftop to preserve them from flooding, canoes serve as mean of transport during flooding; blocks or sand bags are used to create pathways for pedestrians; valuables goods are displaced to higher places such as top of the wardrobes, cupboards, tables etc.

According to Abeka (2014), households in Accra fill and cement the compound of their houses; raise the building foundation and kiosk or they raise the door step, strengthen the doors, the windows and the roof or construct a retaining wall. In addition, they buy or hire motor pumps to pump out water; they dig some trenches to evacuate water from houses; they temporary relocate or seek shelter in high buildings.

In Cotonou, where water is permanent on the floor, people relocate themselves to a family member, friends or in the public places like health centres, schools or churches. Some people also definitively leave low land, flood prone area by selling their plots and buy another one in a safer place. Some people rebuild their houses at a very high level. Those who do not want to leave their houses because of thieves sleep on tables. Some people construct concrete or masonry barriers to prevent flood water entry at the doorsteps; they also raise the door sill level or construct barriers at the entrance of the doors. Sand bags are also used as water barriers.

In Dakar, people fill their yard with sands/solid waste or rubbles in order to increase its level. Those who can afford raise the house taking into account the past flood depth. During flooding, people evacuate floodwater with the means of buckets, basins or they dig some trenches or place some PVC pipes to drain water from the houses. Sometimes, old houses and latrines are rebuilt (Diongue, 2014).

According to Adelekan (2010), in Lagos, moveable property is relocated outside the flooded area, drains are constructed in front of houses, buildings are renovated, walls are built to prevent floodwater from entering houses, outlets are made at the backyard of houses to let floodwater flow from the houses. In shops that are still operating, goods are put on top of wooden platforms. Some people also choose not to cook food until the situation improves. Some people relocate to their relatives houses.

At a community level, people are organized to fill up roads with sand in order to facilitate the passage of the local residents and the vehicles. They also construct wooden narrow bridges to allow the passage.

In Cotonou, richer people and/or companies living in the community associations who have their houses or office in the street pay for the cleaning of storm water drains and the fill the roads with sand and even sometimes for the construction of storm drains or some trenches to drain the storm water to another outlet. In Lagos, in a high-income residential

estate, people pay levy and purchase boulders to protect their houses from storm surges (Adelekan, 2015).

4. Gaps and challenges of flood risk management in West African coastal cities

4.1 Flood risk assessment

The flood risk management strategy for West Africa does not put emphasis on risk assessment but mainly on emergency management. Data acquisition is capital for flood risk assessment. Most important are data on climate, hydrology, hydraulic, land and soils. But in West African countries data collection is not prioritized.

Adequate tools like hydrological and hydraulic models and potential damage evaluation tools are needed for flood risk assessment and they cannot be applied mainly due to lack of data and lack of skilled personnel.

For hydrological and hydraulic models, accurate meteorological data, spatial and digitized data, upstream land-use data and scenarios of land and climate change within the cities and in the upstream catchment, urban growth predictions, river discharge data, soils data etc. are missing in the four coastal cities studied. At some meteorological stations data are still recording manually at a step of one day, this is less useful for operational models. It is only after severe floods of 2009, 2012 in Senegal and the 2010 event in Benin that accurate digitized spatial data for cities are being developed.

Detailed data on past flood damage or potential exposed items do not exist. Potential damage curves are needed but they do not exist for West African cities. To take into account the multi-dimensional aspect of the vulnerability, social, environmental and economic indicators are needed in order to evaluate in time and space the impact of the proposed flood reducing measures on the population and the ecosystems.

4.2 Flood risk reduction measures

Structural measures are quasi inexistent or insufficient and the existing ones are not well maintained.

There is usually no scientific baseline for the selection of flood risk reduction measures in West African cities. As for now, flood risk reduction projects are isolated, all covering a limited number of aspects related to flooding and separately do not address the complex flooding issues in a holistic manner.

West African coastal cities are at risk of being struck by at least four types of flooding (riverine, pluvial, coastal and groundwater) in a different proportion of each type. There is not much attention on coastal and groundwater flooding. Even though riverine and pluvial flooding are preponderant, it is much recommended to assess all possible causes of flood risk for long term planning.

4.3 The challenge of integrated flood risk management for coastal cities

Urban flood risk management especially in coastal cities is a complex and cross-cutting task that depends on urban planning and management, river basin management, infrastructure planning, coastal area management, wetlands management etc. So lack integration and also lack of regulations in one sector or the mismanagement of one will affect flood management. Most coastal cities are situated at the estuaries and downstream of main rivers, so riverine flooding in these cities depends on upstream catchment and/or river basin management. In flood propagation, the relationship between upstream and downstream river discharge is very important. Upstream flow depends on the river catchment land use and also on the rainfall pattern, so in long term planning, scenarios of land use and climate predictions are necessary in order to predict downstream river discharge which in turn will impact riverine flooding in the coastal city.

Coastal cities are often associated with wetlands which can buffer flood (pluvial flood, riverine flood and coastal flood). Integrate coastal, riverine, groundwater and pluvial flooding will shape better the benefits in swamps and marches restoration for example

Urban planning is very important for flood risk management. A good urban planning will not allow settlements in flood prone areas and will provide an efficient storm water drainage system. In the same way, a good transport infrastructure planning will help facilitating evacuation during flood events. On the contrary, a bad solid waste disposal will lead to block drainage network and increase the maintenance cost of canals and pipes.

Another issue is the link of flood disaster and outbreak of epidemics. As flood water spreads, it carries diseases. Proper solid and liquid waste disposal is not performed and flood waters mix with waste, carry and spread them and encroach with people. Also, affected people can be left for weeks or even months without clean water for drinking or hygiene. All these can lead to outbreaks of deadly diseases like typhoid, malaria, hepatitis A, and cholera (Abhas et al., 2012). This was the case in Dakar, from 2005 to 2006, Senegal was struck by cholera and one of the causes was the flooding in Dakar in August 2005, 25.5% of the population was affected with a lethality rate of 1.6% (Manga et al., 2008). This is also the case in Benin where more than 800 cases of cholera were recorded, mostly in Cotonou (UNCHA, 2010), with thousands cases of malaria and diarrheal diseases (CREDEL ONG, 2010) during the 2010 flood event.

4.4 Financing aspects

According to GFDRR (2010), disaster management structures in Sub-Saharan Africa do not have adequate financial support because disaster management does not get high priority in the national budget. In the national progress report on the implementation of Hyogo Framework for Action (2013-2015) of each of the four countries, it is clearly stated that the budgetary allocation for DRR is not enough (Agence Nationale de Protection Civile, 2014, Direction de la Protection Civile, 2015, National Emergency Management Agency, 2014, National Disaster Management Organization (NADMO), 2015). Also because of the complex and bureaucratic procedures, the contingency fund is not made available on time. Local authorities have a limited role in the financing of national disaster management institutions. According to Attipoe (2015), disaster education exercises and

desilting of storm water drains are not done regularly by Accra Metropolitan Assembly because of lack of funding.

Some countries like Nigeria have financed relief by themselves (GFDRR, 2010). For example, the Lagos State Government in Nigeria relocated about 681 people at the resettlement camp at Agbowa at the expense of the government providing them three square meals daily (Adelekan, 2010) but according to National Emergency Management Agency (2014), there are no regular budgets for DRR purpose even though local government carry out activities that are DRR in nature. Some countries like Benin finance relief from general sources such as donor funds (UNDP, CARITAS, Red Cross, etc.) and regular government budgets.

5 Conclusion and Recommendations

This paper tries to point out the challenges that West African coastal cities have to face for an efficient flood risk management. Adequate data are needed and should be collected. On the short term, governments should put emphasis on the:

- maintenance of the existing structural measures especially the roads and storm water drainage system
- partnership with universities so that researchers and administration people can cooperate for advanced research activities and for the training of the public and private personnel working in the sector , planning and funding of research project
- An integrated flood risk assessment should be done for different possible scenarios of climate change, urban growth and land-use change in the upstream catchment, etc. and for all possible types of flooding. This will help to avoid as many unforeseen consequences as possible and also to relate and link the potential impacts of mitigation/adaption measures.
- The criteria upon which the choice of both structural and non structural measures will be based should be clearly identified and accepted by all the stakeholders.

References

ABEKA, E. A. 2014. *Adaptation to Urban Floods Among the Poor in the Accra Metropolitan Area.* University of Ghana.

ABHAS, K. J., ROBIN, B. & JESSICA, L. 2012. *Cities and Flooding: A Guide to Integrated Urban Flood Risk Management for the 21st Century*, GFDRR, World Bank.

ABLORDEPPEY, S. D. 2015. Accra floods: Insurance companies confident of settling claims *Graphic Online*.

ACTIONAID 2006. Climate change, urban flooding and the rights of the urban poor in Africa- Key findings from six African cities. ActionAid International.

ADELEKAN, I. O. 2010. Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria. *Environment & Urbanization, International Institute for Environment and Development (IIED)* 22**,** 433–450.

ADELEKAN, I. O. 2015. Flood risk management in the coastal city of Lagos, Nigeria. *Journal of Flood Risk Management***,** n/a-n/a.

AFRICAN DEVELOPMENT BANK GROUP. 2006. *Ghana: Accra sewerage improvement project* [Online]. ADB. Available: http://www.afdb.org/en/news-and-events/article/ghana-accra-sewerage-improvement-project-3561/ [Accessed 11/10 2016].

AGENCE NATIONALE DE PROTECTION CIVILE 2014. Benin: National progress report on the implementation of the Hyogo Framework for Action (2013-2015) - Interim.

ATTIPOE, S. K. 2015. *An assessment of flood mitigation measures in Accra, Ghana.* PhD, KNUST, Ghana.

BHATTACHARYA-MIS, N. & LAMOND, J. 2011. A review of the flood risk situation in African growing economies.

CREDEL ONG 2010. Changements climatiques et inondations dans le grand Cotonou : situations de base et analyse prospective. Projet de Protection de la Communauté Urbaine du Grand Cotonou face aux Changements Climatiques (PCUG3C), Rapport final.

DE BRUIJN, K. M. 2005. *Resilience and flood risk management: a systems approach applied to lowland rivers.* PhD Thesis, TU Delft.

DIONGUE, M. 2014. Périphérie urbaine et risques d'inondation à Dakar (Sénégal) : le cas de Yeumbeul Nord. *eso, travaux & documents,* n° 37.

DIOP, I. 2006. *Contribution à l'amélioration du réseau d'assainissement pluvial de Dakar: Cas de l'ensablement.* Diplome d'Ingénieur de Conception Université Cheikh Anta Diop de Dakar.

DIRECTION DE LA PROTECTION CIVILE 2015. Rapport national de suivi sur la mise en œuvre du Cadre d'action de Hyogo (2013-2015) - Interim. Ministère de l'Intérieur, Senegal.

FAYE, M. M. 2011. Cadre de gestion environnementale et sociale du PROGEP: Rapport final Agence de Développement Municipal (ADM).

GFDRR 2010. Report on the status of Disaster Risk Reduction in Sub-Saharan Africa. The World Bank, Washington, USA.

GFDRR 2014. Sénégal: Inondations urbaines Le Relèvement et la Reconstruction à partier de 2009.

GNELÉ, J. 2010. *Dynamiques de planification urbaine et perspectives de développement durable à Cotonou (République du Bénin).* Thèse de doctorat, FLASHUAC, Bénin, 339p.

IFRC. 2012. *Emergency appeal operation Nigeria: Floods* [Online]. http://reliefweb.int/report/nigeria/nigeria-floods-emergency-appeal-n%C2%B0-mdrng014-operation-update-n%C2%B01: Reliefweb. [Accessed 11/10 2016].

IFRC. 2015. *Emergency Plan of Action (EPoA) Ghana: Floods* [Online]. http://reliefweb.int/sites/reliefweb.int/files/resources/MDRGH011.pdf: ReliefWeb. [Accessed 11/10 2016].

MANGA, N. M., NDOUR , C. T., DIOP, S. A., DIA, N. M., KA-SALL, R., DIOP, B. M., SOW, A. I. & SOW, P. S. 2008. Le choléra au Sénégal de 2004 à 2006: les enseignements d'épidémies successives. *Médecine Tropicale,* 68**,** 589-592.

NADMO. 2016. *National Disaster Management Organisation Background* [Online]. http://www.nadmo.gov.gh/index.php/features/background: NADMO. [Accessed 11/10 2016].

NATIONAL DISASTER MANAGEMENT ORGANIZATION (NADMO) 2015. National progress report on the implementation of the Hyogo Framework for Action (2013-2015) - Interim. Government of Ghana.

NATIONAL EMERGENCY MANAGEMENT AGENCY 2014. National progress report on the implementation of the Hyogo Framework for Action (2013-2015) - Interim. Nigeria: National Emergency Management Agency.

PUGEMU 2014. Actualisation du Plan Directeur d'Assainissement Pluvial de Cotonou. Cotonou: AGETUR Bénin.

RAFIEE, R., MAHINY, A. S., KHORASANI, N., DARVISHSEFAT, A. A. & DANEKAR, A. 2009. Simulating urban growth in Mashad City, Iran through the SLEUTH model (UGM). *Cities,* 26**,** 19-26.
RAIN, D., ENGSTROM, R., LUDLOW, C. & ANTOS, S. 2011. Accra Ghana: A City Vulnerable to Flooding and Drought-Induced Migration

Case study prepared for Cities and Climate Change: Global Report on Human Settlements 2011.