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FLOODING AND PHYSICAL PLANNING IN URBAN AREAS IN WEST AFRICA: SITUATIONAL ANALYSIS OF ACCRA, GHANA



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Abstract

The need to explore the causes of the increasing incidences of flooding in West Africa in recent years motivated the investigation carried out in this research. It is natural to want to attribute the situation to climate change and the increased occurrences of high intensity rainfall predicted as a consequence. However, flooding and the devastation caused by it are not just determined by rainfall and runoff; human influences which significantly modify the nature of the ground surface and its hydrological response to rainfall do also play a major role.

The research used Accra as a case study city and involved a visit to the city to interview local experts, officials of agencies responsible for flooding matters and physical planning. The visit also involved collection of data relevant to the problem and afforded the physical inspection of the infrastructural facilities in place for coping with the flooding problems. Analysis of the data revealed that for the city, there is no evidence that unusual rainfall has been occurring recently that could explain the increased occurrences of flooding being experienced. Rather, the cause of the problem is the lack of, drainage facilities to collect the storm water for safe disposal. These could in turn be attributed to the ineffective planning regulations which either ignore or even condone the illegal erection of buildings and other structures on floodplains, and the unhealthy habit of dumping refuse and other solid wastes in the usually open channel drainage systems.

It is recommended that in order to have a long-lasting solution to the flooding problems, the city and others in similar situation should embrace sustainable urban drainage systems.

Keywords: Flooding, planning, urban cities, waste dumping.

1. Introduction

Planning and infrastructure development in Ghana

The development of a well planned and, good quality, urban settlement requires adequate infrastructure provided. Access roads, drainage systems, water and sewerage connections are among the important infrastructure services which need to be provided. Other services, such as connections to electricity, gas networks, garbage collection and public transportation are also important components in a proper urban development. In most markets this type of infrastructure is usually either provided by local governments or utility companies. Development of access roads and other infrastructure by municipalities creates orderly development that conforms to planning regulations. This also creates incentives for commercial developers to invest in the municipalities. This is however not the case in

many developing countries such as Ghana in West Africa. The lack of adequate infrastructure limits free flow of water and causes severe environmental problems such as flooding. These in turn cause social and health hazards and the most affected people have often been the vulnerable poor (Akrasi, 2008).

The Ministry of Roads and Transport in Ghana is the governmental body in charge of road construction and development. Although it is the responsibility of the government to carry out roads and drainage system maintenance, this is usually not regularly undertaken and when it rains the inadequate drainage system is unable to cope with the massive soil erosion to the extent that the water drainage system (gutters) are choked up causing flooding. The lack of proper and adequate sanitary systems means that septic tanks spill over and subject vast areas to environmental pollution.

Some of the main sources of drinking water are also contaminated in view of the underdeveloped state of the Ghanaian water sector. It is estimated that only 13 percent of the population have direct water connection to their dwellings (Karley, 2009). In addition, the relatively small existing water distribution infrastructure is old and ineffective. Most of the facilities and pipelines were laid more than 50 years ago and so water leaking further leads to water contamination and health hazards.

Like the water sector, the sewerage sector is very underdeveloped. Only seven percent of the Ghanaian population has flush toilets (TASC, 2005). In the greater Accra region this ratio reaches 25 percent. The minority of the population which enjoys flush or improved pit latrines uses private underground tanks which are emptied by sewage tank-trucks upon request. These tank-truck companies are either owned by the municipalities or in some cases privately owned. The trucks dispose the sewage in disposal sites managed by the municipalities. There are instances when the lack of proper and adequate sanitary systems means that flooding results in the pollution of main sources of drinking water as many other people use open spaces as free range toilets (own observation).

2. Historical background to flooding in Accra

Flooding from rivers, estuaries and the sea pose a serious threat to millions of people around the world. In Ghana the common causes of flooding are intense rainfall run-off, dam-burst and tidal waves. With the exception of the latter which occurs along the coast, the rest are experienced all over the country. The prominent areas are: Accra floods along the Odaw River; Pra River and Ankobra River floods in the Western Region; White Volta Floods in the Northern region; Black Volta floods in the Upper West Region; and Afram Plain floods in the Eastern and Ashanti regions.

Flooding problems in Accra date back to the late 1930s when the city started to expand. The earthquake of 1939 necessitated the development of new housing to accommodate the affected people.

Although this was undertaken without any obstruction to water courses, there simply wasn't enough housing to meet demand. As a result additional housing began to illegally encroach upon land along water courses and dried valleys.

In 1942 there was an outbreak of influenza in Accra which was believed to be caused by the high population density. So the then British governors decided to open up the area by embarking upon major residential expansion. In addition, as the capital city of Ghana was moved from Cape Coast to Accra, it brought about trade increases, economic activities and caused further population expansion, which required residential developments. The Town and Country Planning Department (T&CPD) was therefore revitalised based on the British system and suburbs created with the basic drainage and other infrastructure prior to residential building. But certain areas were left out with no adequate drainage infrastructure because elders of clans owning land in those areas were against the idea of giving the land to the government led by the British governors.

After independence in 1957 the T&CPD inherited by the Kwame Nkrumah government also embarked upon further infrastructure development. But within these developments no adequate land was available for residential property development. At the same time the land tenure system was not well defined. With increasing migration to Accra from other parts of the country, the population growth did not match the dwellings and infrastructure developed. This resulted in illegal land encroachment and development of slums especially along water channels.

Another cause of flooding was the creation of an artificial lake along the Volta River. During the 1960s an artificial lake was created along the Volta River to develop the Akosombo Hydro Electricity Power station in Ghana. This changed the rainfall pattern affecting the area. Without the normal rains, agriculture activities ceased and unemployment rose and people moved to the Accra area to look for jobs. With rivers dried up, people needing land to build houses, either encroached or bought land along the dried river valleys from landowners (aware of the dangers of the land situation) who did not warn prospective buyers about the potential dangers of these areas. Thus, people built on potentially swampy areas below sea level where with normally high tides in the Gulf of Guinea, tidal and fluvial flooding was rife.

3. Incidents of severe flooding in Ghana

In 1999 rainfall induced storm caused coastal floods that resulted in many deaths across the coastal parts of Ghana, with Accra very much affected. In June 2001 torrential rain caused widespread flooding in Ghana and particularly Accra, leaving 11 people dead and over 100,000 without homes. Due to

heavy rains, most rivers in the city centre broke their banks and several roads were submerged or washed away completely. In 2005 Ghana was one of the worst hit of the countries in western Africa that experienced severe flooding. Reports (Daily Graphic, 2005) indicated that this flooding resulted in 20 people killed across the Upper East, Upper West and Northern regions of the country. The National Disaster Management Organisation (NADMO) estimates that about 350,000 people were severely affected during these flooding incidents and several hundred hectares of crops of farmland were completely washed away.

In more recent times (2007), many deaths have occurred across Ghana attributable to flash floods, in addition to those resulting from the more usual cause of river flooding. Over 25% of the population of Accra lives on fluvial flood plains or areas identified as being subject to the risk of fluvial flooding and about 50% of the population in the greater Accra region lives on the floodplain of the Densu and tributaries of other rivers showed on map 1 attached in Appendix 1. Also, across mountainous areas in Ghana, the population are at risk of flash floods, the most recent occurrence of this being Mallam near Accra in August 2008.



PLATE 1 : SUBMERGED FARMS IN NORTHERN GHANA, 2007

Whilst heavy rainfalls has been the main cause of recent flooding in Ghana, this has been aggravated by human activities including damming and opening of dam gates as well as dumping refuse in water causes. For instance, water from the Bagre dam in Burkina Faso allows people living nearby to irrigate their land during the dry season. It also replenishes levels of water in the Akosombo Dam in Ghana, which when dropped to below minimum levels cause power outages across the country. However, the

area is hit by floods when there is severe rainfall. In 2007, when the water from the dam reached very high levels the flood gate of the Bagre dam in the east of the country, was opened. This released water at a force of 900m³ per second into the White Volta River, which flows into Ghana and caused severe flooding. This affected the whole country and the northern regions in particular. The photographs Plates 1 and 2 show some of the affected areas with farms completely submerged.



PLATE 2: SUBMERGED FARMS IN NORTHERN GHANA, 2007 (SOURCE: PHOTOGRAPHS TAKEN BY RESEARCHER)

In 2008 it was estimated that the summer flooding in July and August caused more than US\$1 million worth of damage in the country. For Accra alone, the total value of assets at risk from flooding now exceeds US\$6 million (Vanguard Assurance Company, 2008).

4. Areas affected by river flooding in Accra

Map in Appendix 1 shows the main rivers in the study area and the communities in Accra within the urban areas of Ga Metropolitan Area (GAMA) affected by the flooding. The major communities affected are named and described according to the rivers and/or water passage system covering the area. These are: Sowutoun, Lafa, Otorjor, Chemu, Mampong, Mateheko System, Kaneshi Odorkor Tunnel, Madina Mayehot, Achimota Community on Odaw River, Alajo, Nima system, Naaplajor, and the Sango System.

Among the rivers that bring water into Accra, the river Densu is the largest. The river is dammed upstream for potable drinking water as well as for agriculture purposes. However, with the damming of

the Densu River (Figure 2), it tends to cause flooding during heavy rainfall. When the spill ways are suddenly opened to prevent overflow of the dam, the runoff is often at very fast rate because of the large volume of water involved.

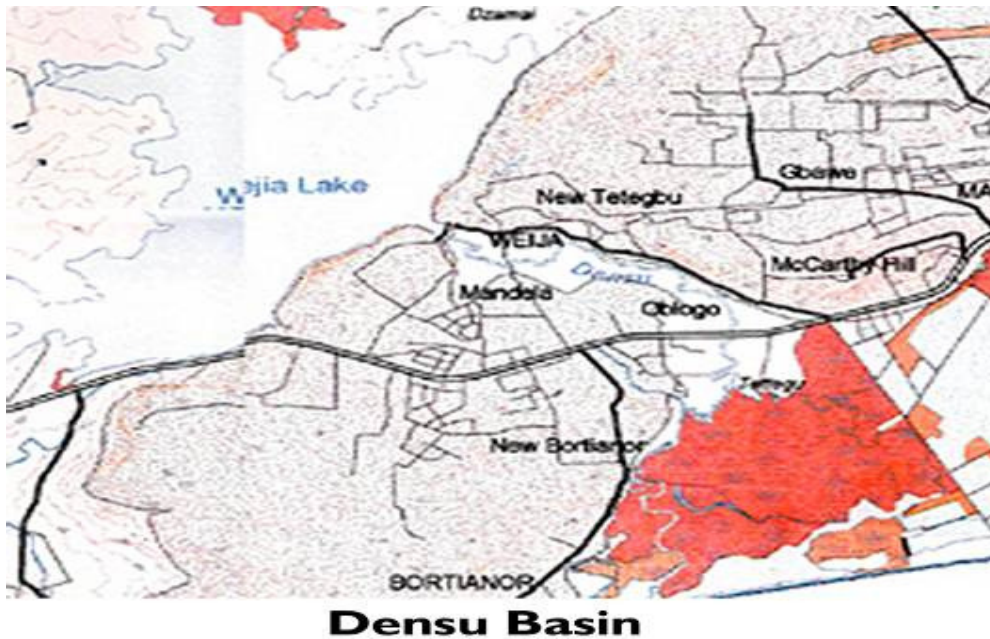


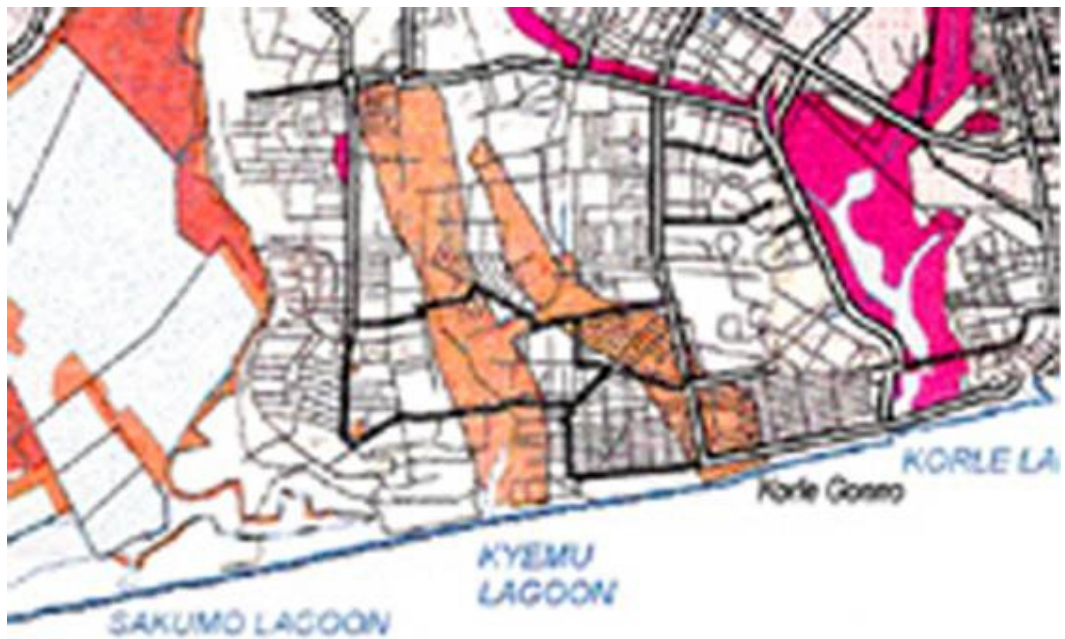
FIGURE 1 - MAP SHOWING THE DENSU BASIN

According to the experts from the T&CPD (2008) one of the main causes of recent flooding in communities (Figure 2) situated around the Lafa River is the construction of a secondary drain system. The system was designed to service a tertiary one that had no access into the primary drain, the Lafa stream. Thus, storm waters collected by the secondary drain are discharged into houses in the surrounding area. Also, it is observed that the community situated at the southern part of the area (called Dansoman SNNIT flats) was developed on the bed of the Lafa River. This makes it extremely difficult to construct any meaningful drainage system to serve houses within the community. Thus the initial drains constructed are always inundated when the storm waters from up stream are discharged into this vast plain. The topographical reading of the area indicates that it is only about one foot above sea level.



Sowutuom

FIGURE 2 - MAP SHOWING THE SOWUTUOM COMMUNITY AND LAFA RIVER



Kyemu

FIGURE 3 - MAP SHOWING THE KYEMU LAGOON AND THE MAMPONG AREA

The Khemu stream stretches from the area called Russia through part of Sukura, New Mampobi, Old Dansoman and finally into the Khemu Lagoon (Figure 3) at Chorkor. Heavy siltation, coupled with an

estimated three quarters of the Lagoon basin encroached on by residential developments, blocks the main stream. Occasional bars at the estuary also compound the problem.

The Mampong River takes its source from Sukura and its environs and finally discharges its water into the Khemu West stream. There are undersized culverts on the Banana Inn-Mamprobi road as well as service lines running across the cross section of this culvert. Thus, storm waters transporting garbage blocks the undersized culverts thereby flooding all houses located upstream.

In another development, the Mateheko System can be located within the Mataheko community around the Faith Cathedral Church and Walako Hotel. The access way of waters in this residential area has been blocked by houses thereby diverting the course of the water unto the road. Thus, tertiary drains are submerged whenever it rains.

Whenever it rains heavily in Accra, the main tunnel that stretches from Odorkor and finally passes under the Obetsebi - Lamptey Circle unto the Korle Lagoon is heavily choked with garbage, mainly plastic waste. According to the AMA engineer spoken to (AMA, 2008), given the nature of the system's construction, it is practically impossible for the removal of this garbage to be done mechanically. Manual removal of waste is necessary particularly as until this is done stagnant water remains on the Kaneshie – Mallam road after each down pour causing slow traffic flow. Also towards the north eastern part of the city, it is observed that the drains of "Madina Maye Hot" like that of Haatso are all tributaries of the Odaw main drain. However, indiscriminate residential development in this particular community have created permanent feature of water stagnation. Not only secondary drains are choked with garbage but almost all the tertiary drains suffer the same fate. The problem of this area is thereby mainly human induced.

The Achimota community lies on the main Odaw River. A railway line that stretches between Abofo and Achimota served as an embankment of the flood water collected from upstream of the river, that is, Haatso, Madina, Ashongman, Kwabenye and its environs. Overflow of this embankment is common during severe rainfall. In a similar situation, Alajo is a community situated between the two major rivers the Odaw and Onyasie Rivers that drain the central part of Accra. Although several tertiary drains have been constructed, the secondary drains which are supposed to serve as links between the tertiary and the primary ones are yet to be constructed. This has resulted in the discharge of waters from the tertiary drains into residential properties whenever it rains. In addition waters collected from the suburbs of Abelemkpe and Tesano also find their way into these residential homes thereby compounding the problem of these communities.

With respect to the Nima drainage system), commonly referred to as the Nima System, the AMA (2008) sources indicate that the flooding problem of the community emanate from poor engineering works at the entry point of the Nima System into the Faanofaa River. That, the right angle entry of the Nima System into the bigger water of the Faanofaa permanently slows down the Nima system thereby flooding all houses, roads and every available space of Asylum Down and the Kwame Nkrumah circle area, including the Pedestrian Shopping Mall. This feature is likely to persist until the engineering error is rectified.

The Naaplajor community is located at the northern part of Teshie but on a tributary of the Kpeshie stream (Figure 4). According to experts from the T&CPD (2008), the main flooding problem of this small community is inadequate bridge across the stream. Two lives were lost here in the past four years, through flooding. Also, the Sango System is another water course with three major portions of the basin requiring major attention. The problem of all communities affected by the system is that of the lack of larger access way of storm water. The worst affected of the three communities is Coco Beach which is at the extreme end of the stream. Recent dredging undertaken at this point of the stream seemed not enough to contain the storm waters.



Figure 4 - Map showing Naaplajor, Teshie communities and Kpeshie Lagoon

5. Planning issues

The discussion shows so far that the natural courses of rivers are often distorted by human activities. People deliberately build houses across river, courses, fill streams with rubbish, building material, human waste, plastics and food waste, etc. By dumping refuse into drainage/sewerage channels people conceive the idea that during rainfall the garbage will be carried away smoothly through gutters. But this causes flooding.

Poor physical planning causes flooding but where adequate drainage channels are constructed the problem of flooding reduces. Therefore, it is essential that the planning system be restructured to ensure proper monitoring and enforcement of regulations. The T&CPD is responsible for planning and controlling development of infrastructure and residential properties. T&CPD has the mandate to ensure that water courses are avoided in the development of properties. There is a master plan for infrastructure development in Accra but implementation is lacking creating bottlenecks. Thus, unless the master plan is completed there will always be such problems. As asserted by an observer, 'The problem is not *'not knowing'* but the lack of resources to implement the master plan'.

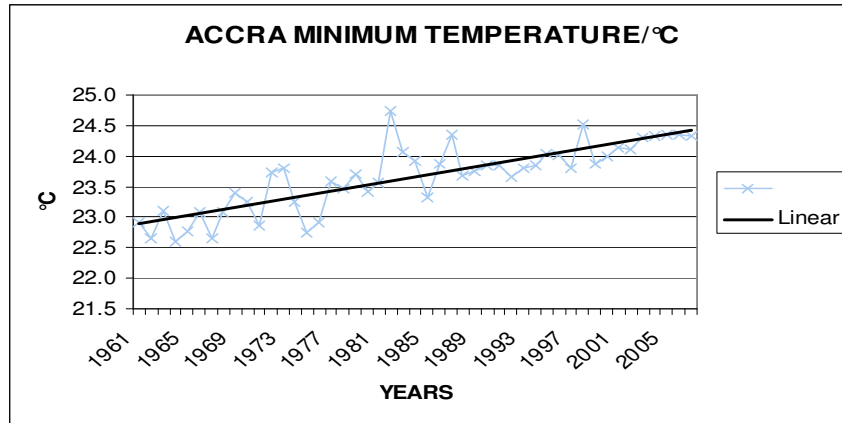
According to the T&CPD (2008) monitoring and enforcement has become very difficult. Ghana Legislation Instrument (LI) 30 stated that houses built must be at least 30 metres away from bank of rivers (Karley, 2008). Even with that the developer must carefully observe the area topography. Yet, people continue to ignore or violate laid down rules and regulations of the authorities.

Planning authority tends to be weak in circumstances where:

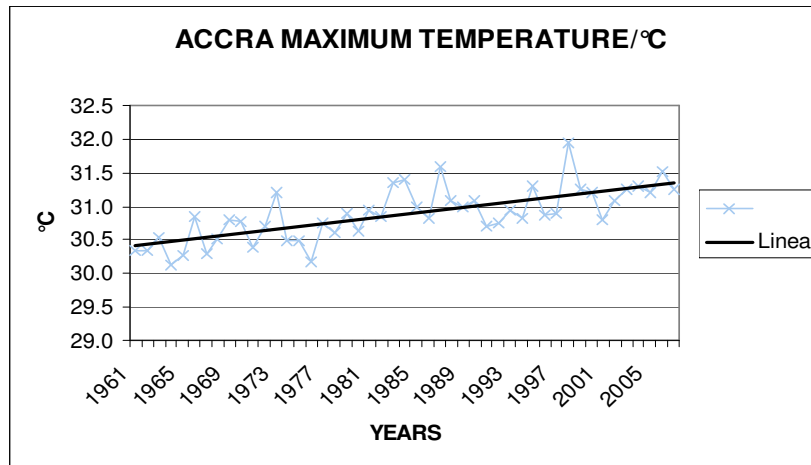
- Development control authorities in the locality and municipalities have no logistic support;
- Corruption occur due to poorly staff remuneration;
- Inefficiencies occur due to the lack of adequate equipment and capacity;
- It is morally difficult to demolish unauthorised properties.
- Enforcement of policy is marred by the fact that the legal system is overwhelmed with court cases.

Thus, it is common to see several areas in Accra that were previously not susceptible to flooding now being flooded after rainfalls because of illegal structures.

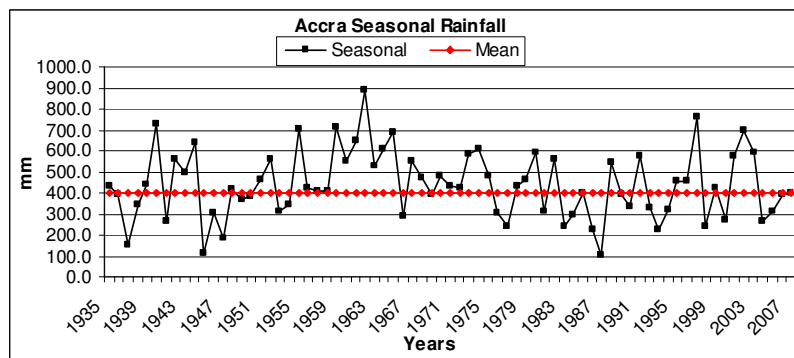
6. Climate change and flooding



(1)



(2)



(3)

FIGURE 5 - (1): ACCRA MINIMUM TEMPERATURE, 1961 TO 2005, (2): ACCRA MAXIMUM TEMPERATURE, 1961 TO 2005, (3): ACCRA SEASONAL RAINFALL 1935 TO 2007

Source: Data provided by Meteorological service department, Legon Accra station

Many parts of the world have experienced devastating flooding throughout the last few years, which have affected thousands of people and cost millions of dollars. The perception is that changing rainfall pattern is caused by climate change. This is probably not the case in the case of Accra, Ghana. For example, the average temperature data for Accra collected over 1961 to 2005 shows an increasing trend in the minimum and maximum temperatures over the period as shown in Figures 5.1 & 5.2 respectively. But, this is not the case for seasonal rainfall (measured - June, July and August) over the period between 1935 and 2007 as shown in Figure 5.3, which depicts a relatively flat mean trend over the period. However, unlike previous years, it is observed that in Accra the rains started early in April 2008 ahead of the usual June, July and August rain period.

Although it cannot be said clearly that climate change caused the recent heavy rainfalls, scientist predict we will see more heavy rainfall days in the future. It is also likely that major floods that have previously happened before, say 100 years on average, may now start to happen every 10 or 20 years. The flood season may become longer and there will be flooding in places where there has never been any before (The Environment Agency Sustainable Development Unit, 2001).

7. Costs associated with flooding

Human and physical costs

Although the death tolls that have been reported during recent floods in Ghana are often low for an international disaster, the affected areas are very poor, and a disaster of this scale has a high human cost over the long run in disease and starvation. Usually after flooding there are additional concerns about a possible outbreak of waterborne diseases. The health problems triggered by floods are numerous. For example evidence from the severe floods that led to the displacement of as many as 290,000 people in the north of the country in 1999 indicate that floods are primary vectors for waterborne diseases outbreak. In such situations, there is often very strong risk of communicable disease breaking out. Following the 2005, 2007 and 2008 flooding in Ghana, cases of diarrhoea, dysentery and cholera were reported in the affected regions. This is compounded by the fact that open wells are often contaminated, causing gastric problems, and increasing cases of cholera and watery diarrhoea. In addition, the influx of black flies after flooding has occurred causes river blindness (EPC 2008).

Flooding often damages public infrastructure such as bridges, roads, schools and water supply systems. Furthermore, flooding results in the loss of crops, farms and livestock. Also common is the collapse of dwellings especially in rural areas where dwellings are built of mud and often, lack proper

foundations. As water rises up from the soaked ground, the bricks are weakened, causing the walls to collapse. It was estimated that most hard-hit areas of the 2007 flooding provide 45% of the country's domestic food supply, meaning that there is both an immediate and long-term crisis. When the harvest season is over and people run out of food because crops have been destroyed, a new vulnerability is created by the lack of access to food.

Economic and emotional costs

Whenever it rains heavily in Accra, economic activities come to a standstill. Government businesses and private trading activities are halted as roads are rendered impassable in most cases. Whole communication systems e.g. telecommunication are submerged in waters, and factories shutdown for flooding to go down.

There are huge financial costs associated with flooding. The annual flood damage is expected to increase from US\$2 million to US\$4 million over the next few years (NADMO, 2008). According to estimates from Vanguard Assurance (2008) company payout for household flooding and storm damage last year alone amounted to US\$0.2 million. The 2007 summer floods in Accra alone caused an estimated US\$0.5 million of clean up costs (NADMO, 2008). In 2008 many flood victims faced yet more problems, with some insurance policies encumbered by large excesses, some now exceeding US\$2,000, whilst others have been denied insurance all together. However, it is not just the cost of flood that causes devastation and disruption. Nearly two years after the summer 2007 flooding, several hundred people are still homeless – many living in cramped conditions with very limited space (NADMO 2008).

8. National and international responses to flooding

In view of the magnitude of recent floods, the government of Ghana declared a state of emergency in the inundated regions. Inter ministerial disaster relief committee and district task forces teams were formed to oversee activities including distribution of relief items in affected areas. Regional authorities launched appeals to the central government and humanitarian organisations for assistance. Relief items such as food, blankets, emergency lights and clothing are often distributed by the regional National Disaster Management Organisation (NADMO).

Responses from international organisations such as the United Nations Disaster Assessment and Coordination (UNDAC) team along with the Red Cross include deployment of support to the emergency operations in the affected areas. For example, after the 2007 flooding in Accra, the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) Regional Office for West Africa fielded a

team to support humanitarian coordination activities including the formulation of relevant resource mobilisation framework and tools (OCHA, 2007). Red Cross volunteers and staff were also mobilised in affected areas to help provide first aid, evacuating people to high ground, and assisting in salvaging whatever belongings they can. They also distribute relief items, and provide chlorine tabs and other forms of rendering safe drinking water to people.

In view of the dramatic impact of widespread flooding across the country, flood risk management is needed by national and international organisations. Thus, it is essential to highlight the issues associated with flooding, along with practical guidance on how to obtain detailed flood risk assessment information to allow people to make sufficient preparations to minimise damage and inconveniences. Whilst findings of assessments of flooding will help to determine the gaps in the response that need to be addressed to ensure that people are well catered for after flooding have occurred, it is imperative that causes and preventive mechanisms are identified.

9. Evidence of action taken toward flooding

Field observation shows that the government is currently constructing wider concrete drainage systems in the city of Accra. Yet, rivers continue to overflow their banks. One expert respondent asserted that this is primarily due to design problems— including inaccurate prediction of the amount of rain and the lack of better estimate of water passing.

Also, as mentioned above human problems including abuse of water channels, rubbish and sand filling up the drainage system overflow the banks. The government agencies and the metropolitan authorities have embarked upon campaign to educate the masses on the dangers of flooding and the best way to disposing wastes and garbage. Plate 3 shows an educational campaign on bill boards about waste disposing and dangers posed by indiscriminate waste and garbage disposal.

There is no doubt that economic growth and urbanisation trends have increased the demand for infrastructure in the last few years and the problem that settlements like Accra face include the lack of maintenance that causes serious environmental and health problems. However, action has been undertaken recently to improve the performance in the provision of infrastructure with a massive investment aimed to upgrade the system such as wider roads and water drainage systems as well as water sector infrastructure upgrades. Thus the government has recently received a US\$103 millions loan from the World Bank to rehabilitate old pipelines throughout the country.



PLATE 3 : GARBAGE DISPOSAL EDUCATIONAL CAMPAIGN IN ACCRA, 2008 (SOURCE: PHOTOGRAPHY TAKEN BY RESEARCHER)

10. The way forward and suggestions

Whilst climate change and increased intensity of rainfall may be blamed for the recent rampant flooding, the fundamental problem is that water courses are being blocked as a result of human activities such as building houses on river beds and across water courses, the lack of adequate and the right drainage infrastructure and the siltation of limited drainage systems. Although it is essential to have a holistic approach to resolving the flooding problems in Ghana, several approaches are necessary to mitigate the perennial flooding problems given the particular problem of various communities highlighted earlier.

The population of Accra is currently about 4 million and with high population density, sanitation becomes a problem especially during flooding. But no specific plan to arrest the problem, except the proposal to relocated the capital of Ghana elsewhere to relieve population pressures on the city. This could be enhanced with improvement of the railway systems to help transportation so that people will be willing to live elsewhere and travel to Accra for their business activities to ease concentrating in the city. The river channels could also be opened up and used as means of transportation. Action is also needed to tackle problems of unauthorised structures.

Problems associated with flooding of individual communities along rivers and systems in Accra described earlier must be approached given individual community needs. For example, it would be a worthwhile investment for an avenue to be created possibly with an excavator in the Lafa River, for the storm waters to enter the main Lafa River. This temporary measure may ease the problem in this community. With respect to communities around the Otorjor River, it is recommended that residents of

this community be made to vacate the place till the rains are over in order to forestall possible loss of life during the peak period.

Although the Khemu stream itself has been widened and deepened, the main basin into which the stream discharges its waters has been taken over by residential developers, thereby reducing the volume of water that the lagoon should naturally hold before discharging it into the sea. It is therefore recommended that residential buildings sited within the Khemu lagoon be demolished and finally the lagoon dredged. Service lines like water pipes of four inches diameter and that of Telecom as well as Electricity Company of Ghana all run horizontal to the culvert that serve as bridge on the Banana Inn - Dansoman Exhibition road at a point called "Osofo Dadzie", these service lines need to be relocated.

The channel upstream of the Mampong River needs to be widened and deepened in order to contain the storm water. The service lines in front of the undersized culverts at Abolo Junction will need to be relocated and the undersize culvert changed. With respect to the Mateheko system an access way should be created for waters in this neighborhood to run into the main drain that cross the Eduardo Mudlana road into Abossey Okai and finally into the Korle Lagoon. The Kaneshi Odorkor Tunnel requires immediate removal of the rubbish accumulating there to forestall possible loss of life and property. For the Achimota community, it is recommended that the lower stream be widened and deepened in order to forestall the usual backlash, since it is posing a greater danger to passengers who patronize the Achimota taxi rank. For the Alajo community, in order to forestall future catastrophe it is suggested that temporary constructions through the creation of access way for these waters into the primary drains i.e. Odaw and Onyasia be made pending receipt of funds for actual concrete works.

Finally it is observed that the benefit of the correction of the engineering error around the Nima System far outweighs the costs involved through disruptions of business during heavy down pour with its attendant inaccessibility of the Kwame Nkrumah circle by motorist and pedestrians and also possible destruction of the road network leading to huge economic losses.

11. Conclusions

Whilst heavy rainfalls and increased intensity of rainfall may result in flooding, the fundamental problem is that water courses are being blocked as a result of human activities such as building houses on river beds and across water courses, the lack of adequate and the right drainage infrastructure and the siltation of limited drainage systems. Thus, it is essential to have a holistic approach towards resolving the flooding problem and at the same time devising approaches necessary to mitigate the specific problems of affected communities.

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