Rapid Disaster Waste Management Assessment
26 October Flash Flooding,
Central Accra - Ghana

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Cover photo: Storm water channel connecting to Odaw river/channel, Anna Nordlander, MSB Sweden

PREFACE

This report contains the findings of a rapid disaster waste management assessment undertaken following the flooding of the Odaw River and Channel in central Accra, Ghana that occurred on the 26th of October 2011.

The report was written with cooperation from the UNDP Ghana office, the Accra Metropolitan Assembly (AMA) Waste Management Department, the National Disaster Management Organisation (NADMO) and the Ghanaian Environmental Protection Agency (EPA).

The assessment was undertaken by a waste management expert from the Swedish Civil Contingencies Agency (MSB) during 1-11 November 2011.

"Poor planning resulting from lack of coordination, illegal structures as well as undersized hydraulic structures, designing problems, rapid changes in land use patterns due to urbanization, development of settlements in water courses and flood plains were some other causes of floods." Mr Kofi Portuphy, National Co-ordinator, National Disaster Management Organisation

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EXECUTIVE SUMMARY

The Rapid Disaster Waste Management Assessment took place during 1-11 November 2011 following an official request by the Ghanaian authorities to the United Nations Resident Coordinator. Through its network of the Joint UNEP/OCHA Environment Unit mobilized a waste management expert from by MSB Sweden. The assessment followed the flash flooding of the 26th of October in 2011. The flooding was caused by excessive precipitation (100 mm) that fell over Accra region. Even though the rains and floods are perennial this heavy rain fell outside the normal rain season. Peak rainfall was recorded at night. Since the overall preparedness for a flood in late October was low, the effect of the flood was pertinent.

The damages in loss of life, loss of livelihood, loss of economic value have so far been summarized to about 43 000 people affected, about 17 000 people lost their homes, 14 people have been killed during the flooding or as an effect of the flooding.

During the time of assessment (1-11 November), the acute phase of the flooding was over and the Government of Ghana, Accra Municipal Assembly, the UN and NGO's started focusing on the aftermath of the flooding.

The flooding caused the affected communities to discharge massive amount of waste generated from the flooding during a short period of time. It also caused environmental stress such as bringing waste from river and channels to the Odaw Channel and into Korle Lagoon. The flooding also caused hygienic pollution from sewage polluted water within the inundated areas. An increase of cholera incidents has been reported one week after the flooding.

Disaster Risk Reduction (DRR) measures needs to be taken in order to reduce the flood risk and effects on waste management due to the flood risk. It is important, however, to consider the findings within the larger context of the environmental stress already in place, the lack of proper solid waste management and the lack of sewage treatment in Accra.

With the support of the UN system, the Government of Ghana has developed a five-year National Plan of Action on Disaster Risk Reduction. The plan deals with both natural and man made hazards.

Bearing the local situation in mind and considering the National Plan of Action, proposals are made supporting DRR on short term, intermediate term and long term. From these general DRR proposals, the decisions for actions that need to be taken with high priority have been identified. Some of the actions to be decided upon will have outcomes within a short term and some actions that need to be decided upon will have outcomes in a longer term. These actions are;

- Desilting of Odaw Channel and its tributaries,
- Establishing a early warning system for floods,
- Reducing the number of people at flood risk,
- Conducting a contingency plan for waste management,
- Deciding on a properly designed landfill for Greater Accra Metropolitan Area.

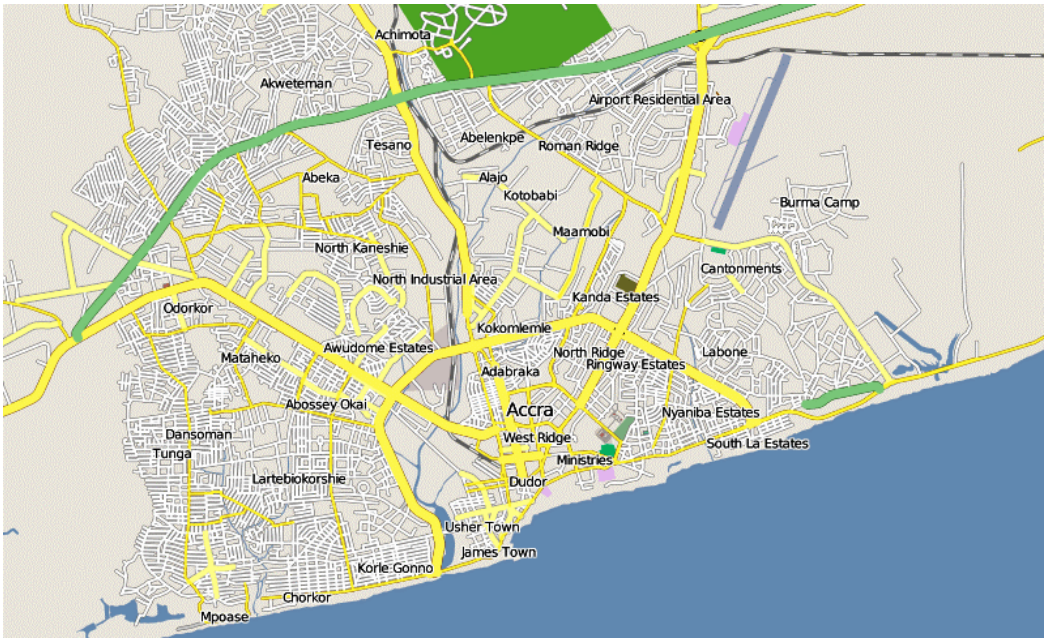
The **Joint UNEP/OCHA Environment Unit,** integrated into the Emergency Services Branch of the Office for the Coordination of Humanitarian Affairs**,** is the United Nations mechanism to mobilize and coordinate the international response to environmental emergencies.
The Joint Environment Unit works with affected countries to identify and mitigate acute negative impacts stemming from emergencies, providing independent, impartial advice and practical solutions. It also works with organizations dedicated to medium and long-term rehabilitation to ensure a seamless transition to the disaster recovery process.

1 INTRODUCTION

1.1 CONTEXT

The country of Ghana faces perennial rains, mainly in late spring/early summer. There is also a shorter period of perennial rains in the early fall. This year (2011) the rains were continues and thus, the water reservoirs are full and the ground to some extent saturated. This situation contributes to rapid surface runoff after heavy rains and flooding of watercourses.

The flooding of 26 of October in 2011 was due to heavy rainfall in the south east part of the country, the Accra region along to the Volta valley. Accra is situated on a plain facing the Gulf of Guinea. Even though the area has a low slope inclination it is divided in four main catchment areas, Korle-Odaw Catchment, Densu River Catchment, Kpeshie Catchment and Songo-Mokwe Catchment.



Map of central Accra. Odaw river runs along the railways down to what is called the Korle Gonno in the map.

In the city of Accra the rain had the greatest impact with flooding of Odaw River and tributaries within the catchment of the Korle-Odaw Catchment. The rain was estimated to be more than 100 mm. The peak of the flooding of Odaw River occurred during the early hours of 26th of October.

The Odaw River has been made a channel through the city. The last 3 kilometres from the passage under Nsawam road and downstream has been lined with concrete walls and in some areas a concrete bed. From Nsawam road and upstream the Odaw river flows naturally. The Odaw river/channel empties in the Korle Lagoon, a heavily polluted man made lagoon, which discharges excess water into the sea.

Within the city the tributaries, gutters and small channels connecting to Odaw channel have also to large extent a constructed waterway. The main streets are paved and most of the land in the catchment has been developed with hard surfaces such as rooftops and paved areas. Very small part of the catchment has capacity to retain water. This all contributes to a rapid surface runoff.

Flooding problems has been prevalent during the rainy season in Accra. The identified cause has been inadequate drainage channels and the flat nature of the terrain. The erosion causes silting of the cannels which reduces the capacity and contributes to clogging together with the waste dumped in the waterways.

Flooding in central Accra after the rain on October 26th, Photo: NADMO

Due to the heavy rain and the local rapid runoff the Odaw River rose above its riverbanks and flooded the nearby areas. Even though the rains and floods are perennial this heavy rain came in off season for flooding, at the end of October. Since the preparedness for a flood in late October was low, the effects of the flood were pertinent.

The flooding caused a lot of damage to houses and businesses along the river banks. The water level was reported to have risen more than 2 meters above the ground in some areas. There are no reports on the velocity of the flood, but a lot of damage and some of the victims were claimed by the velocity. Some of the deaths were also caused by electrocution, but most of them were caused by entrapment in the house due to the rapid onset.

The damage in loss of life, loss of livelihood, loss of economic value has so far been summarized to:

- About 43 000 people affected by the flooding,
- About 17 000 people lost their homes,
- 14 people have been killed during the flooding or as an effect of the flooding,
- Some infrastructural damage on roads, waterways and bridges have been reported,
- About 100 incidents of cholera have been identified during the last week after the flooding.

1.2 Rapid environmental assessment

The rapid environmental assessment of the waste management situation after the flooding in central Accra along Odaw River and channel has been made in three steps:

- Assessing the situation from the written information at hand, e.g. reports from the NADMO office and other information,
- Receiving information from the AMA Waste Management Department on the amount of waste generated from the flooding and meeting with NADMO and EPA, all non written information,
- Field visits along the Odaw channel, the Korle Lagoon and the dumpsites in western part of Accra, the Ablokume and Sarbah dumpsite.

The assessment has taken support from the following documents, the Disaster Waste Management Guidelines (UNEP/OCHA, 2011) and the FEAT, Flash Environmental Assessment Tool (UNEP/OCHA, 2009). .

2 BACKGROUND OF ENVIRONMENTAL STRESS IN ACCRA

2.1 FLOODING OF THE DENSU RIVER/WEIJA VALLEY

The Weija dam is situated in the west part of the Accra metropolitan area. The dam creates a reservoir in the Densu River. The purpose of the reservoir is to retain water for drinking purposes in the west part of Accra metropolitan area. The Densu River flows from Atewa range down to the Gulf of Guinea. Excess flow from the Weija reservoir discharges into the Densu River which creates a delta Lagoon by the Gulf. The lagoon and delta area constitutes one of Ghana's internationally recognised protected areas (Ramsar sites). The area has a rich bird- and wildlife.

The valley of the Densu River flooded due to opening of the spillway of Weija dam. Photo MSB

Due to the continuous rains during the rainy season the spillways of the Weija dam has been opened. The spillways have been open for some months, causing flooding in the Weija/Densu valley downstream.

The Densu River has flooded homes and businesses along the river banks. The flooding situation has not had a rapid onset such as the Odaw River which makes the situation less acute. The duration of the flood is ongoing and has not yet gone back to normal situation at the time of the mission.

The water in the Densu River is not as polluted as the Odaw River, this causes less environmental impact on the settlements from the water. But the ecologically sensitive area downstream the flooded area calls for caution and action. There is informal dumping of waste along the riverbed and that along with pollutants from settlements and businesses could cause severe damage to the protected area.

The flooding of the Densu River has caused the flooded households and businesses to discharge of a lot of waste. The waste is composed of destroyed food items from households and markets, destroyed electrical equipment and appliances from households and businesses, destroyed building material, furniture and clothing.

The ongoing flooding of the Densu River has stressed the waste management of the affected municipalities with larger amount of waste to be collected compared to normal situation. The waste generated is mixed and bulky. Most of the waste from the flooding has been taken to Sarbah dumpsite. This is the same dumpsite which received most of the waste from the flooding of Odaw River. This contributes to shortening of the lifespan of the dumpsite – which is now reaching its point of closure.

2.2 SOLID WASTE MANAGEMENT AND SANITATION SITUATION IN ACCRA

2.2.1 Solid waste management

AMA Waste Management Department has the responsibility for collecting and disposing of waste in the central metropolitan area of Accra where the Odaw river/channel is located. Three other municipalities are located within the Accra area.

The collection of solid waste is done by barrels and compactors, roll on containers, manual handling from piling at collection points or by request. Waste collection is a municipal responsibility which to a great extent is contracted to different private contractors. The financing situation of the solid waste management is poor, a lot is subsidized.

Some parts of the city have poor accessibility and there is a long walking distance for transporting the waste from the household or business to the collection point. The poor accessibility is mainly due to no roads, only walking paths, within the densely built areas. Some of these settlements are found along the Odaw channel and Korle Lagoon. In these areas some of the waste is transported to collection points with wheelbarrows but some waste is continuously left within the area. This causes piling of household and business waste. In some cases discharging is done by using the local storm water channels for dumping waste (cover photo). The storm water channels then transports the waste to Odaw channel.

This problem is most pertinent as an environmental problem along the north part of the Korle Lagoon. This part of the city has an extended informal business that uses electrical waste as a source of scrap metal and other recyclable materials. Household appliances (refrigerators, computers, radios etc.) are bought from dealers and what could be recycled from the appliances is sorted and sold. Sometimes the cables and other plastics are being burnt to reach and separate the copper or other metals. The residues, e.g. plastics, burnt waste, insulation and other materials are being dumped in the lagoon or in the vicinity. A lot of the waste ends up on the marsh areas. These areas are unsuitable for buildings due to the frequent flooding. The frequent flooding washes trough the waste and transport the heavily polluted leachate to the lagoon and further on into the sea. Some of the chemicals found in e-waste are Polyvinyl Chloride (PVC) plastics, polychlorinated biphenyls (PCBs), flame retardants such as Polybrominated Diphenyl ethers (PBDE). The informal business does not only imply pollution to air, water and soil. It is also has a great impact on human health, the exposure to toxic chemicals from the materials and the exposure to heavy toxic smoke. As a result, high blood levels of lead have been detected.

Dumping of electrical waste on the north shore of Korle Lagoon and burning of the waste in order to reach the metals. Photo MSB

Korle Lagoon is not only receiving heavily polluted leachate. It also receives a lot of the sewage water from Accra. The lagoon receives extremely high levels of Biological Oxygen Demand (BOD), suspended solids, coliform bacteriae and ammonia-nitrogen. The lagoon is so polluted with toxics and nutrients that there are no fish, the water is anoxic and the methane gas production is excessive. The lagoon only stores the pollution for a while and then it passes on directly into the sea.

The collected waste is transported by compactor trucks or lorries to the dumpsites. At present only two dumpsites serve the AMA area. These dumpsites are located outside of Accra Municipality and these are shared with the adjacent municipalities. The dumpsites, Ablokume and Sarbah dumpsite, are privately owned and run by contractors. The poor roads and the heavy traffic situation make it difficult to have an effective transport of waste to the dumpsite. Some contractors prefer to do the waste collection at night due to the heavy traffic. About 200 loads of waste reach these two dumpsites every day.

These two dumpsites, both Ablokume and Sarbah, are small and have quickly been filling up. The extra volumes from the flooding have shortened the time until closure of the landfills, especially for Sarbah landfill which has received materials both from the flooding of central Accra and the flooding of Densu River. The present estimation is that they will be full by January and need to be replaced with new dumpsites.

The dumpsites allow all waste that comes to the dumpsite to be put there also hazardous and toxic waste. About once a week the hospital waste is collected. The hospitals have incinerators and it is the residues along with general hospital waste that is collected. When this waste arrives a pit is dug in the waste and the infectious waste is buried under old waste.

There is no separate treatment of environmental hazardous waste since there is no separate collection system for this kind of waste. Some is dumped on the ground such as oils and if collected it is thrown with other materials on the dumpsite.

Recycling of material can be found as an informal business in Accra. Reusable materials such as building material, paper and wood are rarely found within the waste. It is sorted and recycled at its origin. Recycling of plastics and some metal is done both at collection points and at the dumpsites by the drivers, informal scrap dealers and scavengers.

2.2.2 Sanitation

The sanitation system in Accra is very poor. Some parts have a collection system for sewage but this is not covering the whole city. The sewage treatment plant is not working and is just discharging sewage. To a large extent the city is using the storm water channels for the grey water (from washing and showers) and sometimes also the black water (from toilets). Some parts of the city without sewage system have latrines that are de-sludged or dry toilets and thus only discharge the grey-water. Some areas have built the dry toilets directly on the Odaw river banks and sending the pollution with the water down towards Korle Lagoon and further on into the sea (picture below).

Those who do not have access to WC toilets or dry toilets also use plastic bags or other containers for defecation (i.e. flying toilets). These flying toilets could be found within the waste piles, on the ground or directly thrown in the channels.

Public showers, urinals and toilets directly discharging into Odaw channel. Photo MSB

3 ASSESSMENT FINDINGS AND OBSERVATIONS

During the time of assessment (1-10 November), the acute phase of the flooding was over and the Government of Ghana, the Municipal Assembly of Accra, the UN and NGO's are focusing on the aftermath of the flooding.

AMA Waste Management Department reported to have dealt with a lot of waste piling up along the streets after the flood. The waste was not only generated as an action of cleaning the streets. A lot of the waste from the households came after a while, after failing in trying to repair or clean materials and appliances. The waste was piled up on the streets causing several extra routes for contractors during many days to clean the areas affected. The total extra volumes have not been estimated.

Example of waste and material for recycling piled up outside a house. Photo NADMO

At the time of this assessment the waste handling had to some extent gone back to normal volumes. There is still discharging of waste materials from the flooding, but not the same quantities as directly following the flood.

No reports of environmental accidents after the flooding have been found such as destroyed chemical containers or accidents on plants with environmental permits. The estimated largest environmental effect from the flooding is the flood water washing out a lot of polluted water from the Odaw River and Korle Lagoon into the sea. This heavily polluted water would have been discharged anyway, but not the same amount over a short period of time.

No shelters or camps for the homeless families have been established. The families loosing their homes have been integrated within the community.

No reports on flooding of hospitals or clinics generating infectious waste from the flood have been found.

Example of people moving their belongings into the street. Photo NADMO

The flooding naturally caused environmental stress such as washing waste from river and channels to the Odaw Channel and into Korle Lagoon. The flooding also caused hygienic pollution from sewage polluted water within the residents and surrounding areas. The polluted infectious water has affected areas with already poor hygiene standards. Some of these areas does not have access to tap water and have poor capacity to clean the polluted materials. An increase of cholera incidents has been noticed during the last week after the flooding.

According to NADMO flood hazard maps have been done for the city of Accra. But the report and maps are not easily accessible. To have such information and not make it available to the public is very insufficient. Information on flood risk, inundation maps and hazard maps should all be made public. This needs to be done in order to inform the public being at risk where they are at risk and where they are safe. In order to achieve actions, this is crucial for success. The memory is short and in some years this flooding will be forgotten and new settlers have moved into the flood prone areas. Continuous information and easily accessible information is very important.

Actions have already been taken in the direction of cleaning and desilting of the Odaw Channel. Some demolitions of buildings have been done in order to make space and access to the channel for machines and equipment. Preparation for desilting is at place. During the weekend of 12-13 November a desilting activity will take place as a community action in the smaller channels and tributaries to Odaw Channel.

4 POSSIBLE STRATEGIES FOR DRR

4.1 NATIONAL PLAN OF ACTION ON DRR

With the support of the UN system, the Government of Ghana developed a five-year National Plan of Action on Disaster Risk Reduction (DRR).

This plan is articulated according to the 5 pillars of the Hyogo Framework of Action. It represents a coordinated national framework which will guide the interventions of the Government of Ghana with the overall objective of making the country resilient to natural and man-made disasters. It entails policy change, advocacy and awareness creation, substantive investments in infrastructure and more in general the development and implementation of cross sectoral strategies to change systems and prevent disasters from happening (e.g. revision and enforcement of the Building Code, as well as the development and dissemination of building guides).

The Plan is a critical component of the current major shift of the national agenda from an emergency response approach to disaster prevention and risk reduction one.

4.2 DRR IN FLOOD PRONE AREAS OF ACCRA

Disaster risk reduction with focus on flooding in a waste management context could be done with several different strategies. Some of the main strategies are listed below with identified actions. Each action has an estimation of when the effect could be seen after a decision is made, in short term actions (within months), intermediate term actions (within 1-2 years) and long term actions (within 5-10 years)

Reducing the number exposed

- By reducing the number of people resident or working in flood prone areas. (Short and intermediate term action)
- By increasing the drainage capacity of the storm water system, i.e. maintaining installed capacity and by installing proper capacity where needed. (Short and intermediate term action)
- By reducing the runoff speed with greening the city, creating wetlands along the waterway, build retention basins upstream etc. (Long term action)
- By redesigning the storm water system, separating storm water and natural rivers and installing separate system for the sewage water. (Long term action)

Adaptation to the flood risk

- By implementing a early warning system along with public awareness and information campaigns to those living in flood prone areas (Short to intermediate term action)

- By reducing the amount of materials, buildings, storing or piling of waste along the drainage system and the channels in order to prevent clogging of the system. (Short and intermediate term action)

- By building flood proof new settlements in suitable areas, built to withstand high water table (Intermediate term action)

- By making sure no harmful substances could pollute the water during flooding, separating sewage water from storm water, cleaning the areas with e-waste. (Long term action)

Reducing the environmental impact

- By reducing the amount of waste (solid and liquid) disposed of in the channels that are washed out into the sea. (Intermediate term action)

- By reducing the amount of waste and hazardous materials located on the shores and flood prone areas that could be washed into the water in a flood situation. (Intermediate term action)

- By cleaning the shores and water area of Korle Lagoon to reduce the runoff of toxic and polluted water during a flooding. (Intermediate and long term action)

All these strategies could be further developed into upstream and downstream actions. Some of them could be further developed and divided into specified actions for each part of the city.

4.3 DRR IN WITHIN WASTE MANAGEMENT CONTEXT

Flooding such as the one that occurred on October 26th had a major influence on the amount of waste generated. The flooding stressed the already poor functioning waste collection system and the already overloaded dumpsites.

Since the road capacity, accessibility, and general capacity of the waste collection system is poor one of the critical issues in Accra is to reduce the amount of waste produced from a future flood. The general priority must be to reduce the total amount of waste produced before and after a flood. General solid waste management strategies need to be applied:

- Reduce the amount of waste produced,

- Recycle and reuse materials and products,
- Regenerate into new materials or use other properties of the waste such as the energy or use as fodder.

This could then also be broken down in short term actions (within months), intermediate term actions (within 1-2 years) and long term actions (within 5-10 years)

Actions to reduce the amount of waste produced

- Banning of plastic bags and other soft plastics, the soft plastics is not recycled and ends up mixed in the silt of the channels and to some extent clogs waterways. A lot of this plastic is also washed out into the sea. (Short and intermediate term action)
- Better enforcement of building regulations along the shores to reduce risk for damaged houses which produces wastes and also reducing the risk for poorly built houses to be washed away and clogging watercourses. (Intermediate term action)
- Waste attracts waste. Keep the streets, gutters and channels clean. This discourages from dumping waste. This calls for heavy cleaning actions, better enforcement and public information. (Intermediate term action)

Actions taken to improve reuse of packaging

- Encourage larger scale of recycling of bottles, cans and other recyclable materials. Implement a system for refunding. (Intermediate term actions)

Actions to regenerate material/recycling

- Better enforcement on the illegal dumping and disposing of waste within the channels. (Intermediate term action)
- Stop the importation of electric goods that are being dumped along Korle Lagoon. (Intermediate term action)
- Introduce better recycling procedures for materials, for example introducing a deposit value on bottles and cans. (Intermediate term action)

The residual waste and materials that still need to be put on landfills should be collected and brought to proper landfills. Collection capacity should be sufficient for the amount of waste produced. Collection should serve the whole city, in order to give opportunity to dispose of waste in proper manner.

Actions to improve collection and final disposal

- New proper landfills need to be established, with correct technical design; proper accessibility and suitable volume. (Long term action)

- Establishing access for collection vehicles to serve all settlements, businesses and households with collection points. When desilting the channels, some houses need to be demolished along the riverbanks of the Odaw Channel. To easily access the channel for the next desilting situation and to establish collection points along the river/channel roads are suggested to be built on each side of the channel along with new collection points. (Intermediate term action)

All these actions need to have legal enforcement and institutional support. This means legal enforcement on the building codes, the building permits, the environmental permits and certificates by the AMA and by EPA. This also calls for actions for the legal enforcements on the buildings and activities without permits, by the police.

The recycling should work on business level and should not need to be enforced since it is a money generating business. But proper and effective law enforcement is crucial for success also in the case of recycling.

In order to achieve success the actions also calls for sensitising of the public to the effects of the risk exposure they are facing in a flood prone area.

There is also need for public information and education on the environmental effects of their actions, to reduce the amount of waste disposed of in Korle Lagoon.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 ENVIRONMENTAL EMERGENCIES

The Rapid Environmental Assessment has focused on the disaster waste management situation and environmental problems caused by the heavy rain during the early morning of October 26th 2011. It is important, however, to consider the findings within the larger context of the environmental stress already in place.

- The ongoing pollution of the Odaw River and Korle Lagoon,
- The insufficient waste management in Accra,
- The mixture of sanitary waste in the solid waste and the discharge of sanitary waste in the Odaw River.

The Rapid Environmental Assessment has shown that the Municipality of Accra together with NADMO has coped with the early recovery phase after the emergency concerning solid waste. A lot of the waste due to the flooding has been collected and the situation is not acute. There is no need for recommendations focusing on the waste management as a part of early recovery phase.

However, five actions have been identified that need to be addressed urgently. To a large extent these actions find support in the National Plan for Action on DRR. Some of the actions are not explicitly discussed in the National Plan for Action on DRR, for these actions the suggestion is to complement the national plan.

5.2 CONCLUSIONS ON DRR - REDUCING FLOODRISK FROM ODAW CHANNEL

The following recommendations are of priority from the listed actions in previous chapter. These are actions that need urgent decisions, some with short term results and some with long term results.

5.2.1 Desilting of the Odaw Channel

Expected outcome: Short term

Urgency level: High

Responsible for the action: AMA

Desilting of the Odaw channel and its tributaries increases the runoff capacity in the system. In previous years, desilting was done on regular basis due to the erosion upstream that brings silt and waste downstream the channels.

The desilting is done to reduce the risk for poor capacity in the system. It also reduces the risk for clogging when the waste is removed. The flood risk is thus reduced.

The desilting activity needs to coincide with public awareness campaigns on reducing the amount of waste disposed of in the channels. Otherwise the discharging will continue.

Desilting does not have a long term effect. New silt material is continuously being transported to the channel from erosion upstream. To uphold the effect, this activity it needs to be continuously redone. In order to facilitate these actions in a better way, roads are suggested to be built along the Channel.

The activity needs to be combined with better waste collection system. The routes need to be disseminated into the densely built areas with new access roads in order to establish new collection points. This needs to be done so collection can support the awareness campaigns. These new routes could be done along the roads suggested above.

Estimated environmental impact of the action

The impact is given the colour green, yellow or red according to the estimated impacts. Green is assumed to be a positive impact, yellow means caution is needed during implementation and red means that negative impacts could be expected.

When reducing the risk of flooding the action also reduces the risk for damage and economic distress to homes and businesses with polluted water, the action also reduces the health risk and exposure to polluted sewage water. The action reduces the risk of washing more pollution in to the channels.	
The desilting of Odaw channel and the tributaries is estimated to produce 20-30 thousand cubic metres of silt mixed with waste. This material needs to be brought to landfills due to the pollution content of waste and the hygienic risk from the sewage pollution. The landfills at hand to receive this amount are all situated on slopes. The silt need to be dewatered and distributed on the landfills with low slope inclination to reduce the risk of erosion and transportation of the silty material down the slopes.	

The desilting is done to improve the discharge capacity in the channel. This means that the velocity of water could be increased by this action in case of a flood. Caution must be taken if this could contribute to damages and an increased risk.	
The desilting improves the discharge capacity. The water in case of a flood will have greater velocity and wash more of the pollutions from Korle Lagoon into the sea.	

5.2.2 Early warning system for floods

Expected outcome: Short to medium term

Urgency level: High

Responsible for the action: NADMO and Accra Metropolitan Assembly

Establishing an early warning system is very crucial in order to cope with unexpected, off season rains, such as the one occurring on the 26th of October.

Risk mapping/hazard mapping has been done. This information needs to be disseminated to the public through various actions. Where the flood prone areas and the safe areas are should be general knowledge among the exposed population. Public awareness campaigns for those living and working in flood prone areas should be conducted. Activities should include information of where to get the information, how to act after a warning message and where the closest safe areas are in case of flooding.

There is no early warning system that focuses on actions in place at the moment. The warning system at hand is a general weather forecast that predicts flooding, this information is given to the public by radio and TV-stations.

This activity is supported in the Ghana Plan of Action for DRR and Climate Change Adaptation 2011-2015.

Estimated environmental impact of the action

Establishing and early warning system is not predicted to have extensive positive or negative environmental impacts by itself it mainly serves to save human life. This activity should take into account the ways of communicating to the public. In flood prone areas there might be non Ghana language speaking persons, disabled and people that for other reasons do not understand or have the ability to react in expected way to the information.

5.2.3 Reducing number of people at flood risk

Expected outcome: Short to medium term

Urgency level: High

Responsible for the action: AMA

By reducing the number of residents and businesses in flood prone areas, the loss of life, livelihoods and economic impacts could be reduced. This action also reduces the risk of the water washing materials from the activities on the activities into the channels.

This activity gives access to the channels for the desilting activity that needs access to the riverbanks for machines and equipment. This activity should be implemented with the construction of roads along the riverbanks. The roads give opportunity to continue the desilting activity since this is a short term action and need to be repeated on regular basis. The roads also give AMA opportunity to collect waste along the riverbanks, new collection points can be established and the discharging of waste in the rivers would decrease.

The reduction of residents in flood prone areas does not only mean that the houses should be demolished. This could also be done by raising the ground, i.e. making the ground surface higher. The activity could also mean that other activities such as improving the drainage system reduces the probability of flooding to such extent that some areas might no longer be considered flood prone.

This activity is supported in the Ghana Plan of Action for DRR and Climate Change Adaptation 2011-2015.

Estimated environmental impact of the action

If the number of residents and businesses in flood prone areas could be reduced, this also gives opportunity to build access roads along the riverbanks. This will give AMA access to these densely built areas and possibility for establishing new collection points. Constructing roads along the riverbanks has a positive environmental impact since the collection of waste, and especially the e-waste could be improved. It also reduces the number of people at risk.	
The reduction of activities, dwellings and businesses along the Odaw channel and Korle Lagoon needs to take in mind the affected population. This activity needs to take into account the gender perspective and the children's perspective. This activity should not only be supported with new homes and livelihood possibilities, social aspects need to be considered. The activity needs to be done in close cooperation with the community.	
This activity generates a lot of waste that needs to be taken care of. Most of the building material could be reused and recycled. Hazardous material should be treated properly.	

5.3 CONCLUSIONS ON WASTE MANAGEMENT IN A DRR CONTEXT

5.3.1 Waste Management Contingency Plan

Expected outcome: Short to intermediate term

Urgency level: High

Responsible for the action: AMA

The contingency planning for the city of Accra should include contingency planning for the Waste Management Department. In case of flooding it is not only the production of debris and excess waste that causes problem and stress to the waste management system. It also causes a problem by disrupting the waste management system that normally stores, collects, and disposes of solid waste.

Disruption could be made for example of the accessibility to collection points, on collection routes etc. A contingency plan should focus on making the collection system resilient in order to facilitate collection of the regular waste in a hazard situation. A contingency plan should also focus on making the collection of disaster waste in effective manner, by having order of decision ready at hand and having calling lists established to contactors etc.

This activity is supported in the Ghana Plan of Action for DRR and Climate Change Adaptation 2011-2015.

Estimated environmental impact of the action

A contingency plan for the AMA Waste Management Department has a positive effect on environment. With a contingency plan the disaster waste is collected more efficiently and the ordinary waste is collected at regular schedule. This reduces problems with waste piling for long time, this reduces attraction of pests and reduces nuisance from the waste. An effective cleaning and collection of waste has a positive effect of the recovery phase after a hazard.	

5.3.2 Improving the landfill capacity

Expected outcome: Intermediate to long term action

Urgency level: High

Responsible for the action: Ministry of Local Government and The Metropolitan Assemblies of Greater Accra

Preparedness for large volumes of waste generated after a hazard needs to be considered before the hazard. The waste management situation at hand in Accra gives very little room for any extra volumes of waste generated by a disaster, the collection capacity is overloaded and the volume for emergency and disaster waste at the dumpsites is very small. Cleaning of the Odaw Channel and the shores of Korle Lagoon, i.e. increased collection of the e-waste, also calls for proper landfills.

Establishing a correctly designed landfill with proper logistics and layout is essential for the future. This activity is called for not only as a DRR action, it is also necessary for the long term solid waste management system of Accra.

Plans have been taken in order to do this action, but a new landfill has not been established. This action has a high urgency level and prompt action needs to be taken in order to have proper landfills to dispose of all the solid waste, including the toxic and hazardous wastes collected. Even if decisions are made today, the landownership process, the permit process and construction phase are long.

Estimated environmental impact of the action

New properly established landfills has an positive environmental impact, both on leachate treatment, risk for exposure to hazardous materials and it could also establish better facilities for recycling of materials.	
A location of a landfill on virgin land always have environmental impacts, an EIA needs to be undertaken to confirm that measures can be taken in order to reduce environmental impacts to an acceptable level.	
A properly located and designed landfill could mean that existing dwellings and businesses needs to be demolished in order to find a properly located area with enough land. The location must be considered with the local context of Accra, due to the traffic situation the distance should not bee too far in order to have effective use of the collection vehicles.	
Old dumpsites need to be properly covered and maintained. A long time after the closure there are still environmental implications to consider. Former dumpsites need proper coverage, leachate treatment and possible fencing of the area to prevent people from using the areas for different purposes.	

List of abbreviations

AMA	Accra Metropolitan Assembly
EPA	Environmental Protection Agency, Government of Ghana
DRR	Disaster Risk Reduction
DWM	Disaster Waste Management
HFA	Hyogo Framework for Action
NADMO	National Disaster Management Organisation, Government of Ghana

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