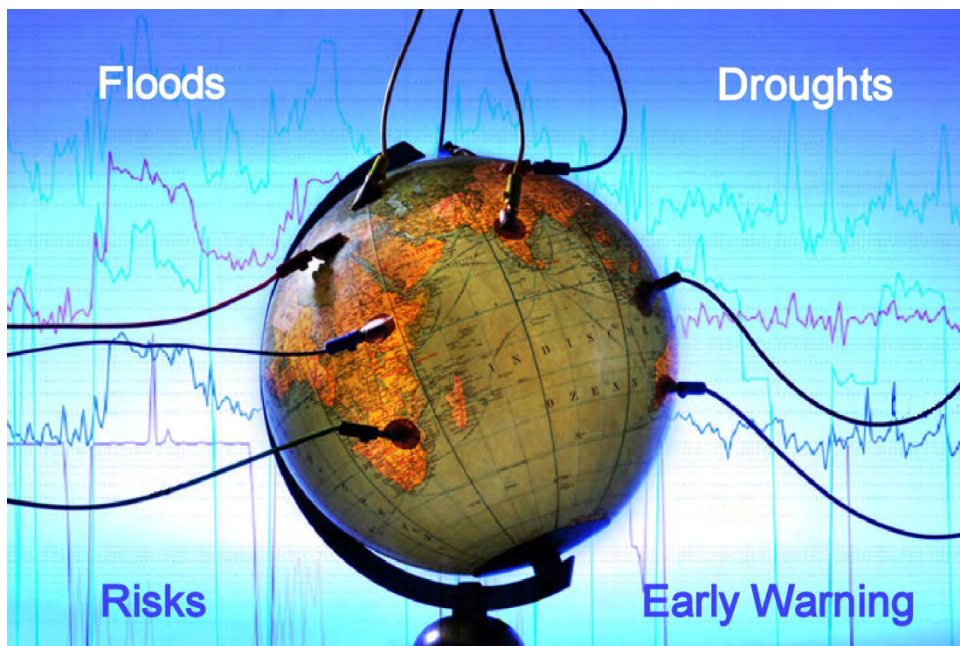




Consultancy Services for Development of Disaster Risk and
Early Warning Systems in Ghana

Risk Profiles of Hotspots in the Pilot Districts

Technical Report

UNDP Ghana

28 December 2014

Draft Report

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1 INTRODUCTION

The African Adaptation Programme (AAP) in 2012 commissioned a study on flood and drought risk mapping focusing on 5 pilot districts. The target of the study was community flood and drought disaster risk reduction (EPA, 2012). Its conclusion states: *Improving community capacity to prepare and respond to climate-induced phenomena through this risk mapping, will allow them to target the high-risk areas for risk mitigation. This flood and drought risk mapping also makes it possible for government and non-governmental organizations to identify the risk factors and allocate resources, build infrastructure, and ensure that early warning systems are put in place to guarantee community disaster resilience.*

The current CREW project is one of the efforts being deployed to follow up on the conclusions of the AAP study by extending the risk mapping to another 10 pilot districts, one in each of the 10 regions of Ghana. Within these pilot districts, hotspots (communities) were identified for more in depth risk profiling and definition of possible mitigation measures.

Risk mapping was done in the current project on the national level (Royal HaskoningDHV 2014a) as well as on pilot district level (Royal HaskoningDHV 2014b). During the field visits to the hotspot communities, the calculated flood and/or drought hazards were verified on site. During interviews with local (NADMO) officers, stakeholders and local people the causes, frequency and severity of the disasters were discussed. Besides an inventory of the risk profiles (this report), a mitigation measures assessment will be prepared for these hotspots, based on the information collected during the field trips together with other available background information (e.g. DEM data, modelling results). The proposed mitigating measures will be presented in a subsequent deliverable: Report 5.

The current report describes the risk profiles for the selected hotspot communities within each of the 10 pilot districts.

Chapter 2 presents the pilot districts, as well as the identified hotspots within the pilot districts. Chapters 3-12 describe the risk profiles of each pilot district separately.

2 PILOT DISTRICTS AND HOTSPOT COMMUNITIES

A total of 10 pilot districts were selected for the current project. In each of these pilot districts both risk mapping (hazard, vulnerability and risk) and development of an Early Warning System (EWS) take place. Figure 1 shows the location of the 10 selected pilot districts within Ghana.

Within each pilot district, 1, 2 or 3 hotspot communities were selected. Field visits were made to all these hotspot communities in order to make an assessment of their risk profile and to define proposed mitigation measures. These mitigation measures should reduce the mortality and economic losses as much as possible, and will be presented in Report 5.

Table 1. List of pilot districts and selected hotspots

Region	District	Community
Ashanti	Kumasi Metropolitan	Amakom Anwomeso Asnoyeboa
Brong Ahafo	Techiman Municipal	New Onyinase Ahenbronose Twimia Nkwanta
Central	Cape Coast Metropolitan	Kwaproh
Eastern	Fanteakwa	Begoro Bososo
Greater Accra	Accra Metropolitan	Alogboshie Avenor Odawna
Northern	Bunkpurugu-Yunyoo	Binde Najong no. 1 Najong no. 2
Upper East	Bawku-West	Galaka Kobori
Upper West	Lawra	Bagri Zongo Dikpe
Volta	Akatsi-North	Torve Wute
Western	Shama	Krobo Anlo Beach

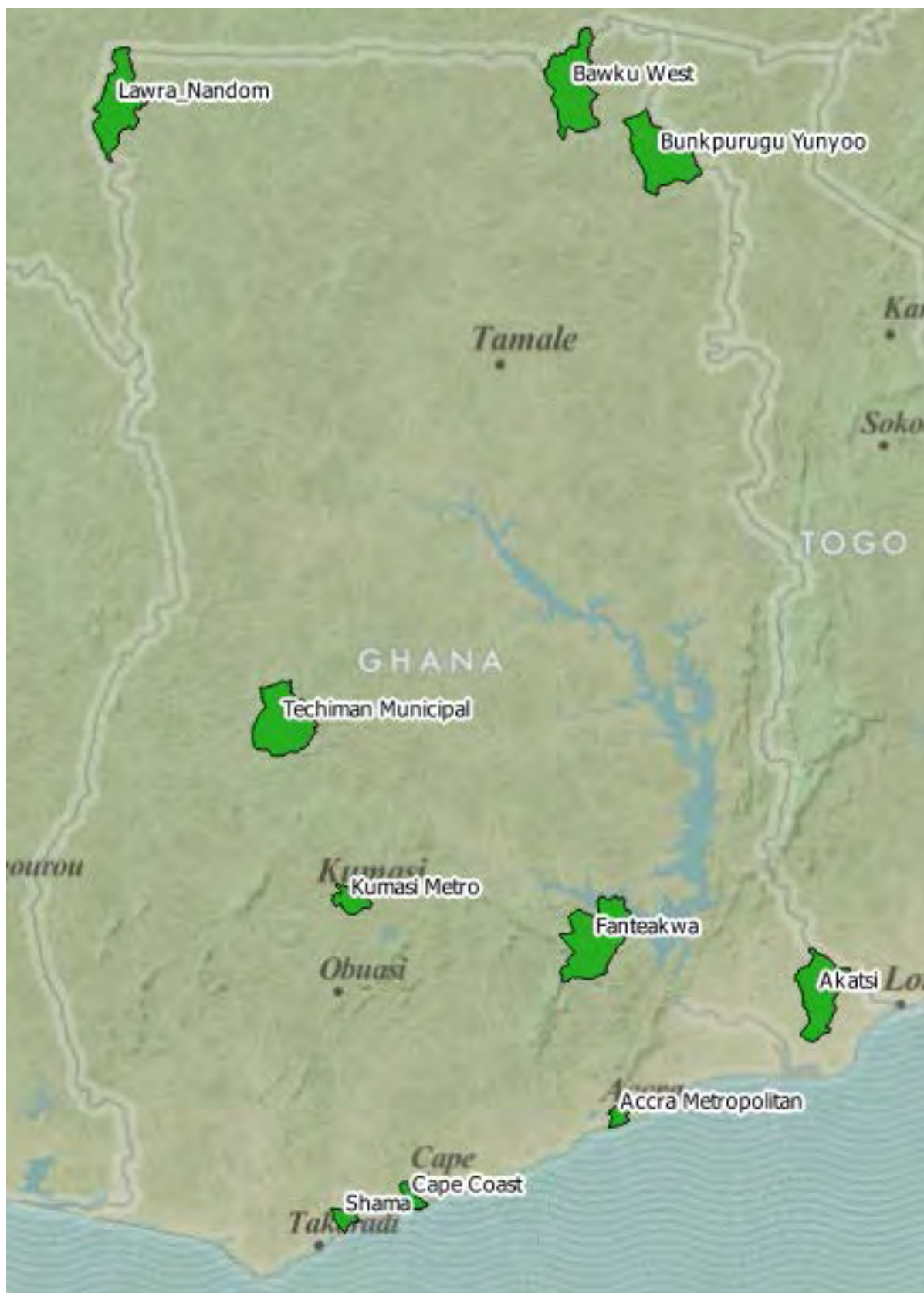


Figure 1. Overview of the location of the 10 selected pilot districts

3 PILOT DISTRICT KUMASI

3.1 Introduction of pilot district and hotspot communities

Kumasi is situated south of the centre of Ghana and is the second biggest city of the country. Kumasi is the capital of the Ashanti Region. The pilot district's official name is Kumasi Metropolitan District and its area covers the area governed by the Kumasi Metropolitan Assembly (KMA).

Kumasi Metropolitan District has an elaborate network of stream and rivers. There are four (4) main drainage basins in Kumasi: Subin basin, Aboabo basin, Sisan basin and Wiwi basin. The basins drain northern and central portions of the city. Kumasi has faced rapid infrastructural development but a major problem is the inadequacy of drainage facilities.

Subin River

The Subin rises out of a spring north of Kumasi and flows southwards through the commercial centre of the city in suburbs like Asafo, to the Kaase industrial area and joins the Daban stream at Sokoban. The Subin basin covers an area of about 230 km² and the river has a mean flow rate of 0.243 m³/s.

Aboabo River

The Aboabo River originates from Tafo-Pankrono at the northern part of Kumasi and flows southwards to the confluence with River Sisan at Asokwa. Its major tributaries are the Owusu Ansa and Dichemso streams. The length of the Aboabo River is 6.05 km. It is about 2.5 meters wide upstream and 30.5 meters wide downstream. The Aboabo River flows at an average speed of 0.87 m/s. The major settlements within the river basin are Pankrono, Moshie Zongo, Buokrom, New Tafo, Dichemso, Aboabo, Anloga, Amakom, Manhyia, Asokwa and Atonsu.

Sisan River

Sisan River takes its source from Kenyase in the Ejisu-Juaben district. It enters the city from Duase and Sepe Timpon and then takes a southward course through the industrial areas of Asokwa, Ahensan and Kaase.

Wiwi

The Wiwi River is located in the south eastern part of Kumasi. It flows in a south westerly direction through the Kwame Nkrumah University of Science and Technology (KNUST) campus and joins the Sisan at Ahensan.

The selected hotspots within Kumasi pilot district are:

- Amakom; the community is located in an area along the Sisan River (means back of the river);
- Anwomeso; the community is located in an area along the Subin River
- Asnoyeboa; the whole stretch of houses along the Abonsna River

All three hotspots are situated within Kumasi Metro and are densely built up areas. See Figure 2 for the location of the hotspot areas.



Figure 2: Kumasi Metro with the three hotspot areas.

3.2 History of disasters

Amakom

The community is located in an area along the Sisan Akyi River. The area suffers from regular flooding. The local people indicated that flooding occurs 3 to 4 times a year when the river breaks its banks and inundates the community. Apparently the river is blocked by debris and silt more downstream. The Sisan River drains into the Ofin River just south of the Eastern By-Pass. Currently the situation is worse than it was 20 years ago. When the floods happen the people are warned by community officers and advised to leave the houses as the flood waters can rise up to 1 meter above floor level.



Figure 3 Interview with local people along the Sisan River (left). Houses along Sisan River vulnerable to frequent flooding (right)

Anwomeso

The community is located in an area along the River Subin. The area suffers from regular flooding. A local man who lives along the river indicated that flooding occurs 3 to 4 times per year when the river breaks its banks and inundates the area up and downstream of the main road. The river is blocked by silt and vegetation.



Figure 4 . River Subin (left) and man indicating height of flooding at Anwomeso (right)

Asnoyeboa

The whole stretch of houses along the river Abonsna River is located in an area that is extremely wet with very high groundwater levels. The area suffers from regular flooding as it is situated in a low lying area. Retaining walls have been constructed to keep the water out of the houses. A local resident who lives in a block where two little boys were drowned due to flooding caused by a wall break last year indicated that too much water comes down to the place.



Figure 5. Asnoyeboa: abandoned school building (left) and ground water seeping through concrete court yard (right)

In the disaster database provided by the CREW team a number of events are recorded for the Kumasi Metropolitan district (Table 2). Several of these flood events have caused human casualties.

Table 2. Information within the disaster database related to Kumasi pilot district.

DATE	LOCATION/AFFECTED COMMUNITIES	TYPE OF DISASTER	DEAD	Remarks
January 2006	Bantama	Severe storm		Torrential rain with severe storm lasting 2 and half hours destroying property in Bantama – Kumasi.
January 2006	Fankyenebra	Severe storm		School buildings/homes Crumbles following heavy storm in Fankyenebra. Property damaged runs in several thousands of cedis.

January 2006	Santasi	Severe storm		L/A school building/homes Crumbles following heavy storm in Santasi, Fankyenebra. Property damaged runs in several thousands of cedis.
September 2007	Aboabo	Torrential Rain		Torrential rain flood Aboabo destroying properties in several thousands of cedis.
September 2007	Aboabo	Torrential Rain		Aboabu community flooded follwing torrential rains damaging property worth several thousands of cedis
September 2007	Ahinsan	Torrential Rain		Torrential rain flood Ahinsan destroying properties in several thousands of cedis.
September 2007	Ahinsan	Torrential Rain		Ahinsan community flooded follwing torrential rains damaging property worth several thousands of cedis
September 2007	Anloga	Torrential Rain		Torrential rain flood Anloga destroying properties in several thousands of cedis.
September 2007	Atonsu	Torrential Rain		Torrential rain flood Atonsu destroying properties in several thousands of cedis.
March 2008	Kumasi	Torrential Rain	3	3 people discovered dead and property worth millions of cedis destroyed after a severe rainstorm hit Kumasi.
April 2009	Ahinsan	Torrential Rain		Flood in Ahinsanwashaway properties in several thousands of cedis.
April 2009	Airport Roundabout	Torrential Rain		Flood in Airport Roundabout wash away properties in several thousands of cedis.
April 2009	Atonsu	Torrential Rain		Flood in Atonsu wash away properties in several thousands of cedis.
June 2009	Kyekyere	Torrential Rain	3	Homes submerged in flood leaving 3 dead in Kyekyere in Kumasi.
April 2009	North Patasi	Torrential Rain		Flood in North Patasi wash away properties in several thousands of cedis.
2-6-2011	MOSHIE ZONGO	FLOODING	-	Sewing machine, books, TV fridge, phones, furniture, clothes, DVD, fan
2-6-2011	MOSHIE ZONGO	FLOODING	-	machine, books, TV fridge, phones, furniture, clothes, DVD, fan
2-6-2011	MOSHIE ZONGO	FLOODING	-	Sewing machine, books, TV fridge, phones, furniture, clothes, DVD, fan, mattress
2-6-2011	MOSHIE ZONGO	FLOODING	-	machine, books, TV fridge, phones, furniture, clothes, DVD, fan
2-6-2011	MOSHIE ZONGO	FLOODING	-	machine, books, TV fridge, phones, furniture, clothes, DVD, fan
October 2011	Anloga Junction	Torrential Rain		Anloga Junction flooded after heavy rains with economic loss estimated in thousands of cedis.
October 2011	Kejetia	Torrential Rain	2	Kejetia flooded after heavy rains leaving 2 person dead and economic loss estimated in thousands of cedis.
October 2011	TUC	Torrential Rain		TUC flooded after heavy rains with economic loss estimated in thousands of cedis.
20-4-2012	AYIGYA ZONGO	FLOOD	-	2 TV, dvd, set of furniture, personal clothing.

20-4-2012	AYIGYA ZONGO	FLOOD	-	Laptop, desk top, set of furniture, fridge and 1 bed
20-4-2012	AYIGYA ZONGO	FLOOD	-	Personal belongings like TV set, set of furniture, personal clothing
29-5-2012	SAWABA ,ROYAL MAJEMAH, ALHAJI INUSAH	FLOOD	-	24 houses were flooded
1-6-2012	SEPE APRAPRAM	FLOOD	-	Wares and properties over 40000 were destroyed.]
19-6-2012	PLOT 12 BLOCK L OFORIKROM NEW SITE	FLOOD	-	5 beds, 5 mattresses, TV set, 3 computers, fridge, food items, educational materials etc.
2-3-2013	AKWATIA LINE	FLOOD	-	Set of furniture, electrical gadgets, clothes, other personal properties.
15-4-2013	KROFROM WEST NT 10 BLK 7	FLOOD	-	The roof of the whole building was ripped off
15-4-2013	TAFO NHYIAESO PLT 15 BLK D	FLOOD	-	The whole building got flooded destroying personal belongings
15-4-2013	SEPE BUOKROM	FLOOD	-	Four houses and its content were destroyed by the flood
15-4-2013	DOTE	FLOOD	-	Three houses were flooded destroying belongings worth thousands of cedis
15-4-2013	DICHEMSO D8	FLOOD	-	The whole building was flooded
17-4-2013	ASUOYEBOAH	FLOOD	2	Properties were destroyed and two children who were dragged away by the flood died. 2 girls died (Gloria Darko/ Priscilla Afful) as a result of the flood
25-4-2013	PANKRONO NEAR CENTRAL MOSQUE	FLOOD	-	A five bedroom house was completely flooded
May 2012	Moshie Zongo	Torrential Rain	2	Road washed away in flood at Moshie Zongo in Kumasi leaving 2 dead.
31-5-2013	DOMPOASE APRABO PLOT 18B. BLOCK D AND PLOT 1 BLOCK D.	FLOOD	-	The whole house and its content got flooded.
20-6-2013	GYINYASE NEAR PENTECOST JUNCTION		-	The whole house got flooded.
25-9-2013	PLOT 24 BLOCK G, ANWOMASO	FLOOD	-	17 rooms and the items destroyed include stationeries, computers, mattresses, monitor, and personal documents.
25-9-2013	HOUSE NO. 15 OFORIKROM NEW SITE	FLOOD	-	4 rooms rented premise, electrical appliances, sets of furniture, food items.
25-9-2013	ATONSU S LINE.	FLOOD	-	2 classrooms have completely broken down and 3 other classrooms in bad shape.
6-10-2013	Block KAMA 142, Anwomaso	flooding	-	Wall broken, back yard garden destroyed.
8-10-2013	Bomso, 36 plot C	Flood	-	
25-11-2013	Breman new york, Kwame anum street 17, Plot 41, plot 5	Rainstorm	-	The whole house got flooded including 4 cars. Mattresses, travelling bags, clothings, cash, documents, church instruments
25-11-	Breman new york	Flooding	-	2 houses, Cars, bags, mattresses, furniture,

2013				electrical appliances, documents,
25-11-2013	Atafoa tikese	flood	-	5 children were trapped in the building

3.3 Flood Hazard

The flood hazard level of the hotspots in Kumasi is very high due to several reasons. The major reasons for the flood hazard are:

- Urbanization of the catchment (less infiltration, more runoff)
- Blocking of the main channel by construction, garbage, silt and vegetation
- Settlements in low lying areas and very close to the rivers

Urbanization has been an important development in recent years. Development of large built up areas together with deforestation lead to a reduction of the storage capacity within the catchment so less infiltration of water can take place. The general effect of this on flood waves is a higher peak discharge and shorter lead times.

A second reason for the high flooding hazard level along the Sisan River and in Anwomeso is the discharge capacity of the river channel itself. Within the channel large volumes of waste are deposited, so that the discharge capacity of the river reduces. Also the maintenance of the rivers (dredging and removal of vegetation) is not always up to standards so that flood waves cannot pass easily and will cause backwater effects.

A third reason that was recognised during the field visits is the fact that the people are living very close to the rivers (at all hotspots) or in low laying areas (Asnoyeboa).

The flood hazard map for the whole district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

3.4 Drought Hazard

Drought hazard as defined for this project is not applicable in urban areas such as Kumasi.

3.5 Vulnerability

All hotspots are situated in densely urbanised areas. Therefore the catchment has a high vulnerability to flooding and no vulnerability to droughts.

In terms of flooding the vulnerability is mainly due to:

- Loss of economic goods, including housing.
- Loss of live, especially when flash flooding occurs (Asnoyeboa).

Within the vulnerability assessment it is not distinguished between residential areas and industrial areas as the information needed to make this distinction is not available. Residential and industrial areas are assumed to have the same vulnerability to flooding.

The flood vulnerability map for the whole district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

3.6 Risk

The flood risk assessment for the Kumasi district has shown that the houses located in low lying areas close to the rivers are at high risk. Higher laying areas are at medium or low risk.

There is no drought risk for the Kumasi district.

The flood risk map for the whole district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

4 PILOT DISTRICT TECHIMAN

4.1 Introduction of pilot district and hotspot communities

Techiman is the capital of Techiman Municipal district in the Brong Ahafo Region in central Ghana. Techiman is a leading market town. Techiman and Sunyani are the two main cities in Brong Ahafo region.

The land use within the district is mainly urban. The selected hotspots are (Figure 6):

- New Onyinase
- Ahenbronose
- Twimia Nkwanta

All three hotspots were visited during the field trip. The hotspots are located in urban areas where the flood hazard is caused by local runoff.

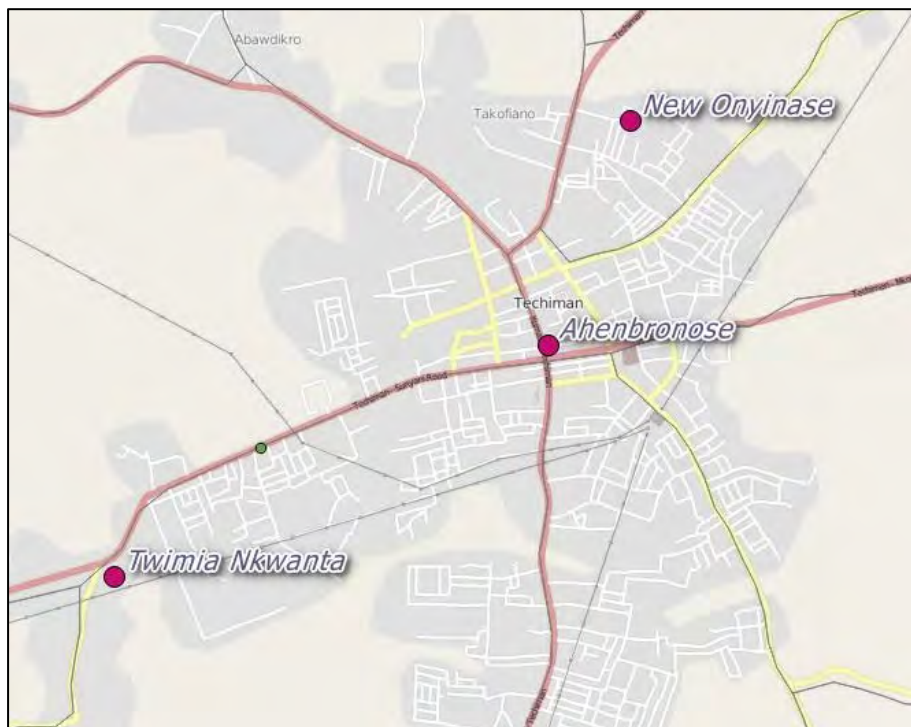


Figure 6. Locations of the Techiman hotspots

4.2 History of disasters

New Onyinase

The community is located in an area where a heavily eroded drainage channel flows from upstream to downstream. The area suffers from regular flooding. The drain seems not to have sufficient discharge capacity and erodes the area. Halfway down the slope, a house blocks the streamflow and a bypass is created by the owner. Some local people indicated that the flooding occurs 3 to 4 times per year when the drain inundates the community. There are some feasibility studies available at the Techiman Municipal Assembly (TMA) which might be useful.



Figure 7. New Onyinase: images of the drainage channel

Ahenbronose

In the middle of the town centre an area located behind Techiman-Nkonsia Road suffers from regular flooding. It is assumed that the water comes from the street but in fact the upstream area has no proper drainage system in place. The water flows freely downstream and eroded a gully to a depth of 0.8-1.0m before connecting to a lined channel (see picture below) downstream.



Figure 8. Ahenbronose: indication of flooding level (left) and lined outflow channel (right)

Twimia Nkwanta

This area suffers from regular flooding caused by the fact that it is a ponding area, all the water flows to this area. No drains are available and the houses get flooded

regularly. The area is wet and a little wooden bridge is constructed to connect the houses.



Figure 9. Twinia Nkwanta: images of the area

The only disaster found in the disaster database provided by the CREW team is the disaster in 2003 in Brong-Ahafo where torrential rain hit Tuobodom in the Techiman district rendering 1,000 people homeless.

4.3 Flood Hazard

The flood hazard of the hotspots in Kumasi is very high due to several reasons. The major reasons for the flood hazard are:

- Urbanization of the catchment
- Blocking of the main flow channel
- Settlement in low lying areas, flood plains

Urbanization has been an important development in recent years. Development of large built up areas together with deforestation lead to a reduction of the storage capacity within the catchment so less infiltration of water can take place. The general effect of this on flood waves is a higher peak discharge and shorter lead times.

A second reason of flooding is the lack of a proper drainage system (New Onyinase and Ahenbronose). Erosion based natural drains are insufficient to accommodate the flash floods from upstream areas.

A third reason which was recognised during the field visits is the fact that the people are living in low lying flood plains (New Onyinase and Twimia Nkwanta). In fact these areas are in high risk areas when it comes to flooding.

The flood hazard map for the whole district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

4.4 Drought Hazard

Drought hazard as defined for this project is not applicable in urban areas such as Techiman.

4.5 Vulnerability

All hotspots in this district are situated in densely urbanised areas. Therefore the area has a high vulnerability to flooding and no vulnerability to droughts.

In terms of flooding the vulnerability is mainly due to:

- Loss of economic goods, including housing.
- Loss of live, especially when flash flooding occurs.

Within the vulnerability assessment it is not distinguished between residential areas and industrial areas as the information needed to make this distinction is not available. Residential and industrial areas are assumed to have the same vulnerability to flooding.

The flood vulnerability map for the whole district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

4.6 Risk

The flood risk assessment for the Techiman district has shown that the houses located in low lying areas close to the rivers are at high risk. Higher laying areas are at medium or low risk.

There is no drought risk for the Kumasi district.

The flood risk map for the whole district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

5 PILOT DISTRICT CAPE COAST

5.1 Introduction of pilot district and hotspot communities

Cape Coast is the capital city of the Central District. The Central District covers an area of approximately 10,000 km². The Cape Coast pilot district has an area of approximately 100 km².

Within Cape Coast district the hotspot Kwaprow is selected (Figure 10). Kwaprow is a community that is located in an area that belongs to the Cape Coast University and that suffers from regular flooding from the Kakum River (Figure 11). The community is situated partly within the Cape Coast district and partly within the Komanda district.

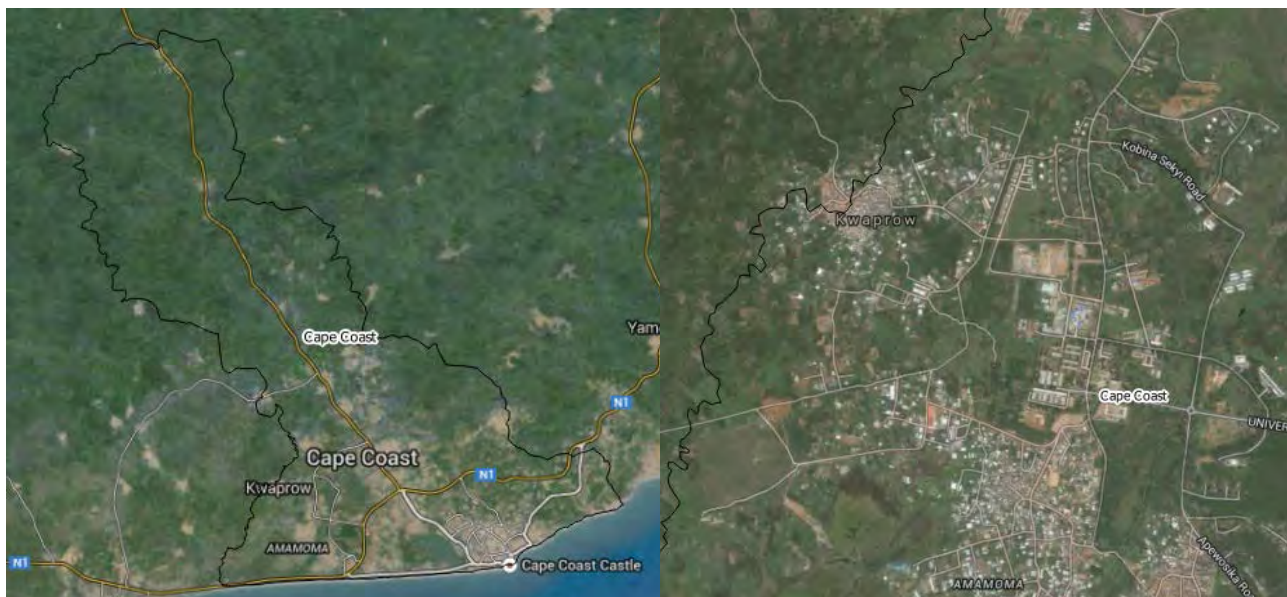


Figure 10. Pilot district Cape Coast indicating the location of hotspot Kwaprow (left) and the location of Kwaprow relative to the border of Cape Coast district (right).

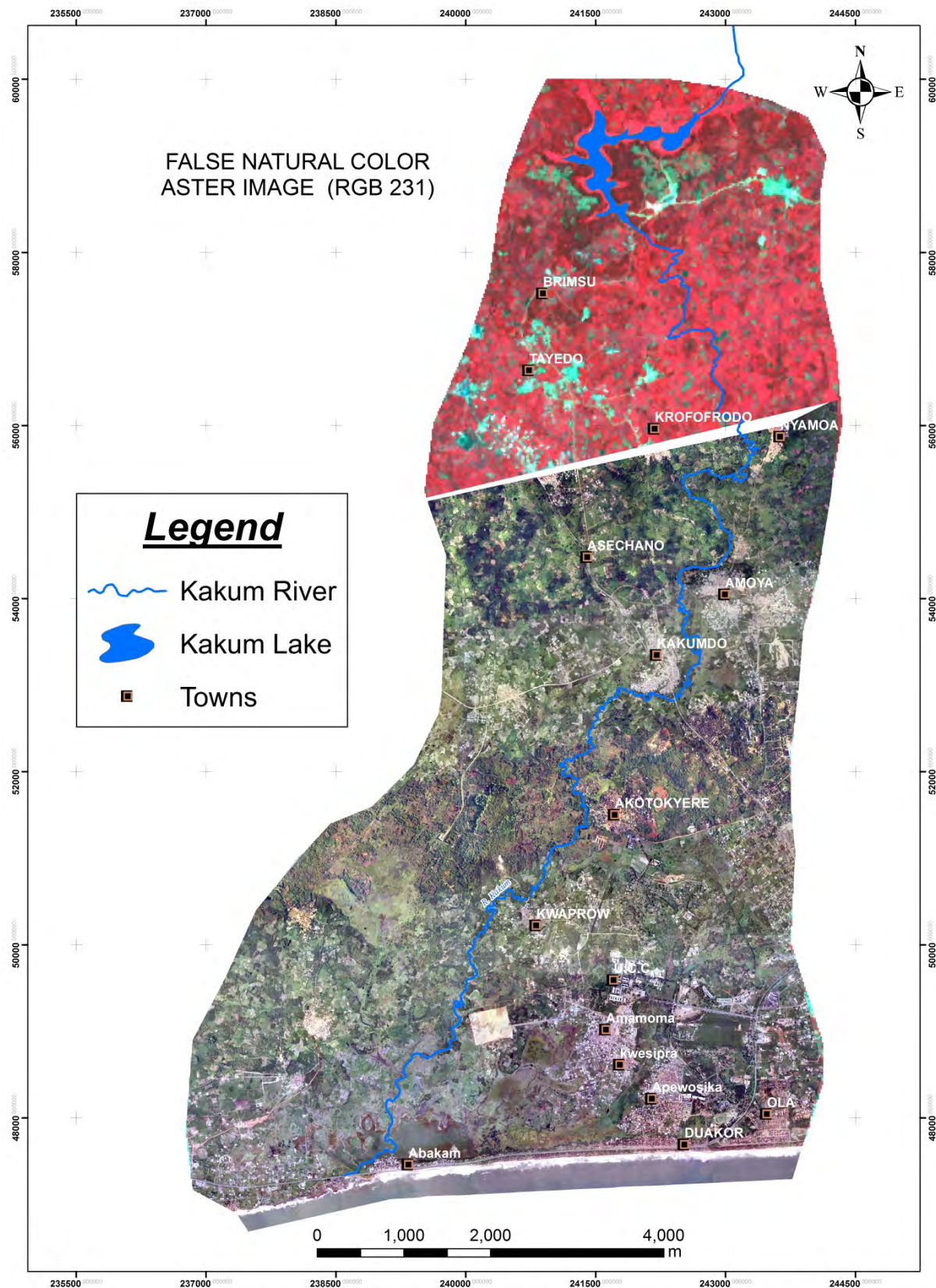


Figure 11. Location of Kakum River and Kakum Lake (source: University of Cape Coast)

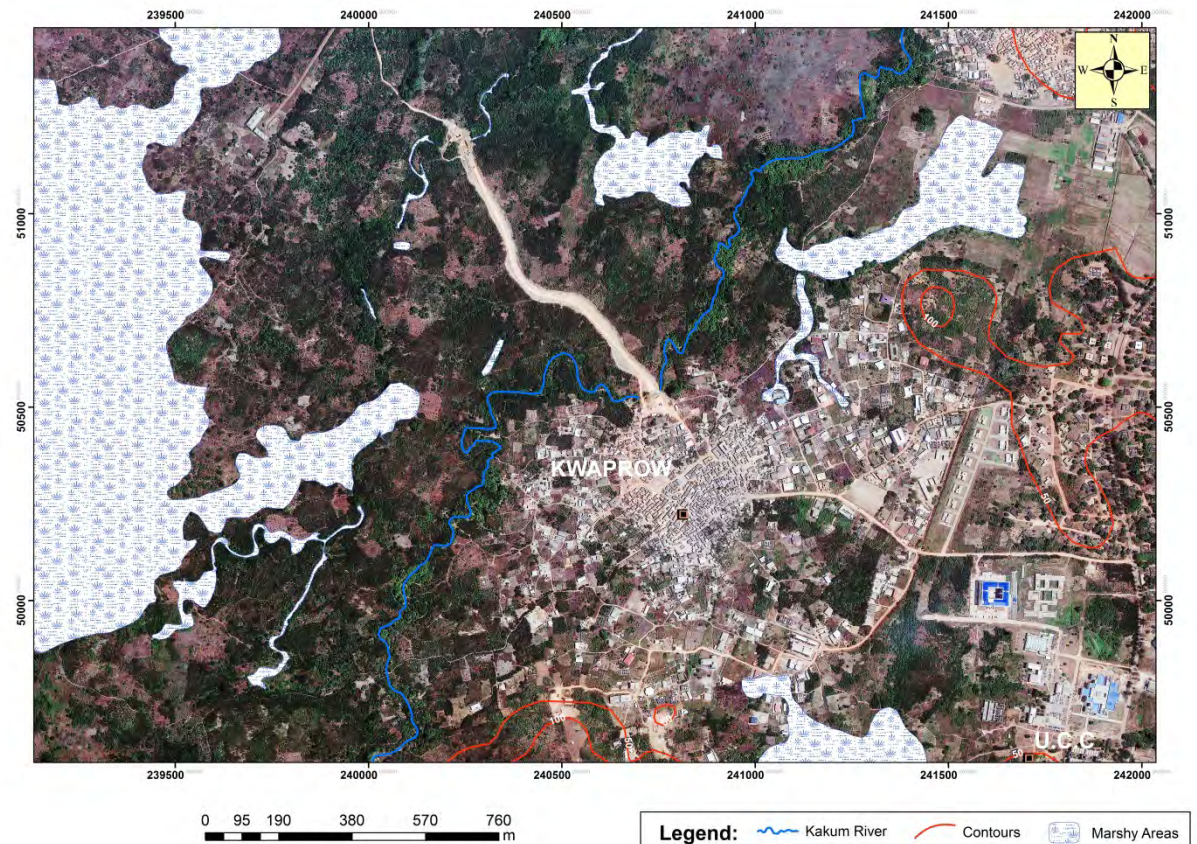


Figure 12. Satellite image of community Kwaprow, indicating the Kakum river and the location of urban settlement and marshy area (source: University of Cape Coast)

5.2 History of disasters

Flooding occurs every couple of years when the Kakum River breaks its banks and inundates the community. According to the community spokesperson, flood levels are significant: waist deep. Once the community is flooded the water stays there for a couple of days due to a lack of local drainage systems.

During the field trip, 4 locations were visited (Figure 13). In the following paragraph we will refer to these locations.



Figure 13. The visited locations within the hotspot Kwaprow.

5.3 Flood Hazard

The flood hazard within the Kwapro community is due to the following causes:

- High natural sedimentation.
- Man induced sedimentation due to illegal sand mining.
- Locally lowering of river bank.
- Lack of drainage systems within Kwapro community.

High natural sedimentation

The hydraulic gradient of the Kakum river in this part is low, the river is meandering strongly in this area. This means the sedimentation in the river is high, causing a reduction in the storage capacity of the river bed. In 2013 NADMO cut one river loop just upstream of a bridge (Figure 14) to alleviate the problems a bit. The river bed was dredged and the sediment of the river was used to raise the river bank. The newly formed river banks were planted. The roots of the plants hold the soil very well. The community would like to have more NADMO input to straighten the river's course further and to keep the river bed open. Straightening the river as suggested by the community's spokesperson would lower water levels upstream of the intervention while it could raise water levels downstream, where high tides pose a problem to evacuate the flood waters.



Figure 14. Upstream of bridge (stop 1) – the place where the river was dredged. Sediment was used to strengthen the river bank.



Figure 15. Downstream of bridge (stop 1) – on the left the river bank shows signs of erosion and sedimentation in the river bed. The houses build on the river bed are vulnerable to flooding.

Man induced sedimentation

The second and third spot visited showed clear evidence of sand mining in the river bed. This activity risks to change the river's course in some spots and poses a significant cave-in risk to the sand miners who often work under overlying topsoil layers. The sand mining does seem to have an effect on the river's course but the effect on the flooding seems to be doubtful. Increased sedimentation however can cause a reduction in discharge capacity.



Figure 16. Evidence of illegal sand mining at stops 2 and 3.

Locally lowering of river bank

Another problem that was identified in the field is the fact that local residents create paths through the river banks. These are weak spots where water flows from the river into the community (Figure 17).

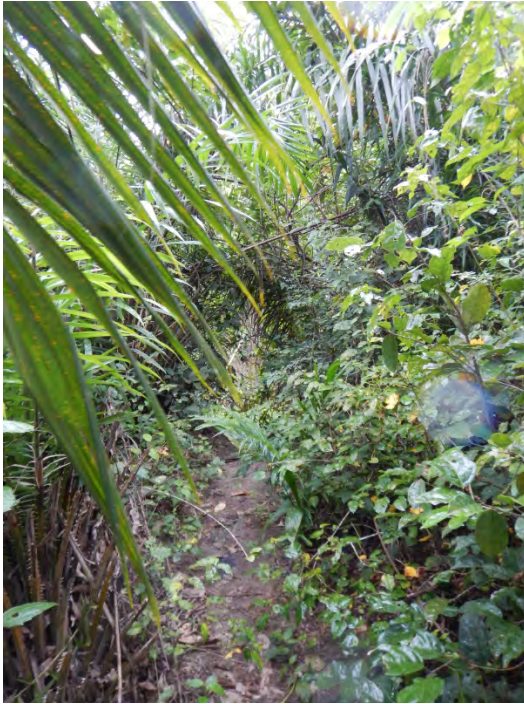


Figure 17. Local path from community to river bed, around stop 2 that leads to a local lowering of the river bank. From here the river water enters the community.

Lack of drainage systems

The fourth site we visited showed how the natural drainage system of this wetland was blocked by construction. Unsufficient drainage capacity leads to a prolonged presence of flood waters. This causes problems to the foundation of houses (Figure 18) but also poses a health risk (cholera, mosquitoes etc.) and according to our spokesman even crocodiles. A restoration of the local drainage capacity and construction of new drainage systems seems necessary to alleviate the problems in the area. Our local expert from the University of Cape Coast (Dr Nyarko) has already done some model studies to determine what type of new drainage system would be able to take on this task.



Figure 18. Houses within Kwapro community of which the foundation is affected by regular flooding.

5.4 Drought Hazard

Drought hazards are no issue in this hotspot. There are some local agricultural activities but there is no lack of water.

5.5 Vulnerability

Kwapro is an area with a significant amount of households. The whole area can therefore be indicated as highly vulnerable.

5.6 Risk

The flood hazard within the Kwapro community is medium to high. The overall vulnerability is high. Within the community there are people (like our spokesman) attached to the university that have a good knowledge about the working of the hydraulic system. This means that potentially the capacity can be increased to reduce the overall risk within the community.

6 PILOT DISTRICT FANTEAKWA

6.1 Introduction of pilot district and hotspot communities

The pilot district in the Eastern Region is Fanteakwa. Fanteakwa district is a mountainous area with peaks up to 750 m. The northern part is bordered by Lake Volta. The rivers in the northern part of the district flow towards Lake Volta. The rivers in the south are part of the Pra basin, which flows towards Cape Coast (Figure 61).

The following hotspots have been identified in Fanteakwa (Figure 19):

- Begoro - district capital
- Besoso

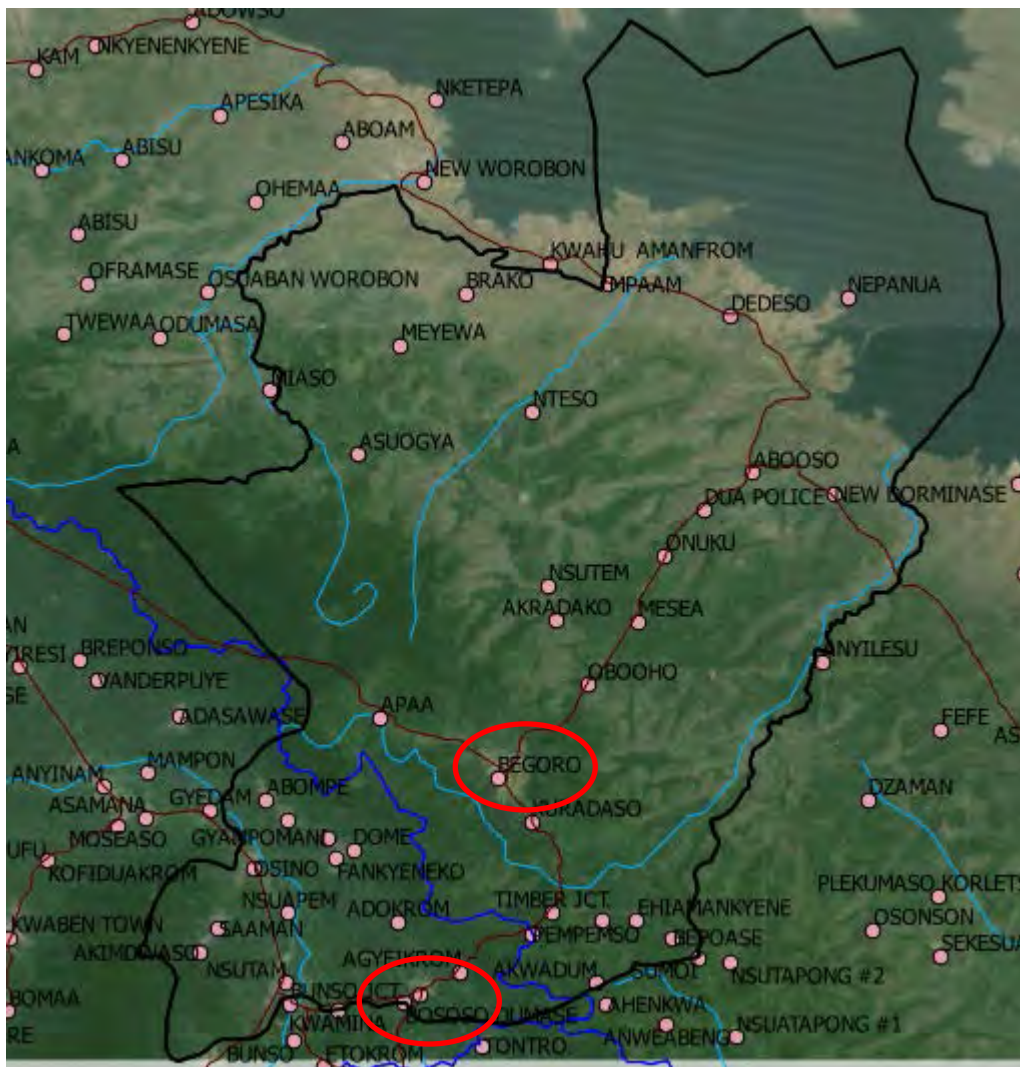


Figure 19: Overview of Fanteakwa district

6.2 History of disasters

The disaster database provided by the CREW team shows 3 recorded disasters in the area in 2002, 2010 and 2011. Very little additional information is provided. However field visit interviews indicated that more flood events have occurred.

Besoso

The town of Besoso is regularly flooded by a small stream that flows through the town. Figure 20 shows the stream on the left and the flood marks on the houses on the right. Flooding can occur all year round and is typically caused by several days of rain accumulating in the area. Once the upstream rural areas are saturated with water, the flood wave comes fast. Casualties have not been recorded, but a large part of the city is flooded with at least half a meter of water. Additionally the entrance road to the town, which is also the main road to the district capital, is often flooded as well. Figure 20 shows how close the normal water level is to the street level.



Figure 20: Besoso: stream (left) and flood marks (right)

Begoro

Begoro is the district capital. The hotspot area is located in the northern part of the town in the Dansor Begoro township. This area is flooded several times per year after consecutive days of rain. Figure 21 shows flood marks from a few days ago on the road and nearby buildings.



Figure 21: Begoro: flood marks

Drought is not a relevant disaster in this pilot district. This is acknowledged by annual precipitation graphs of the area, which shows hardly any period without regular rain (Figure 22).

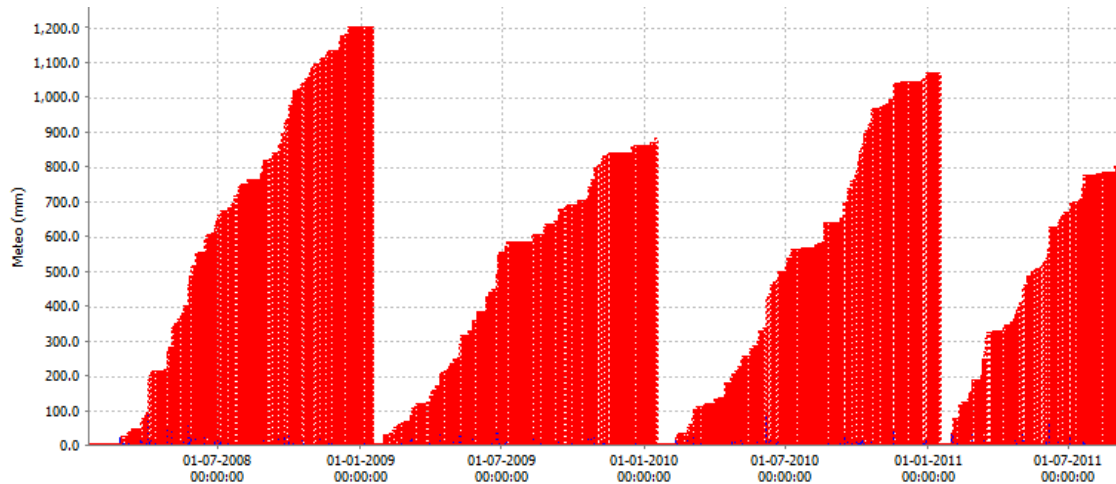


Figure 22: Annual cumulative precipitation at Begoro (source: TRMM database)

6.3 Flood Hazard

Figure 23 shows the flood hazard of Fanteakwa district. Especially the lower areas in the south, which are part of the Pra catchment, have a high flood hazard. This is also the area where Besoso is located.

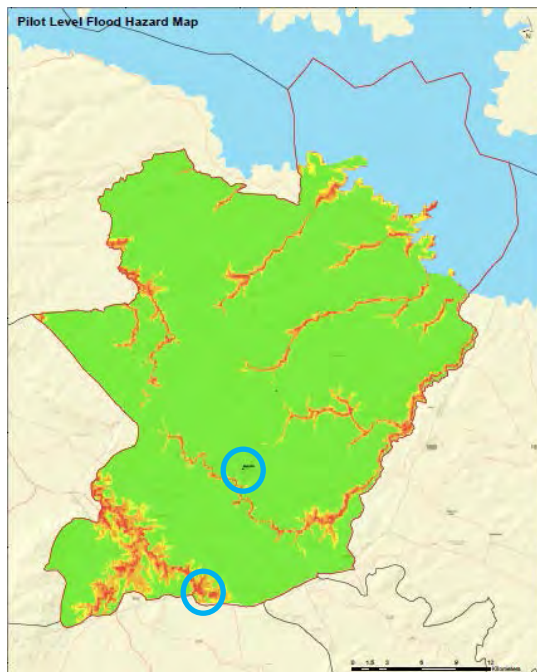


Figure 23: Flood hazard map of Fanteakwa metropolitan district and the two visited areas

Besoso

From interviews we concluded the area shown in Figure 24 has recently been flooded. The flood wave travels in a south-westerly direction. The town is built in a low lying area where several streams come together. Additionally, the right hand side of Figure 24 shows a dump site, that is blocking the river flow. The figure also shows the areas dense vegetation that blocks the drainage of the area.



Figure 24: historical inundated area and cause of the flood hazard in Besoso

Begoro

Dansur Begoro area does not show on the flood hazard map. This is because the floods in the hotspot area are mainly due to a local construction mistake: the low lying area collects a total of 9 streams and drains: three from the west and 6 from the east. The west drains are not connected properly and are blocked by the street. Culverts under the street are blocked and some planned where never constructed. On the east side 6 streams accumulate in a low lying area of which the downstream part is fully overgrown. The vegetation and debris functions as a weir which overtops once the area is full. Once full and saturated, every rain event immediately causes a flood from the east side.



Figure 25: Water accumulation east of the hotspot of Begoro

6.4 Drought Hazard

Drought is not a relevant hazard in this area.

6.5 Vulnerability

The built up areas of Besoso and Begoro have been identified as being vulnerable to floods (Figure 26). There is no real threat to agriculture from flooding according to the data we have.

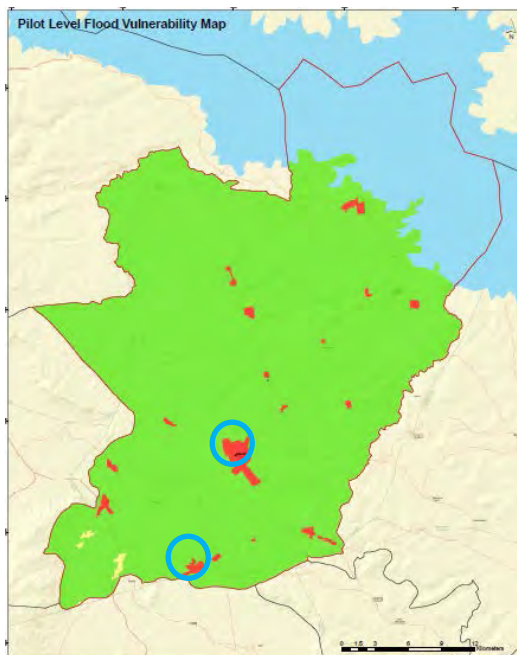


Figure 26: Flood vulnerability map of Fanteakwa district and its two hotspots

6.6 Risk

The district flood hazard, vulnerability and risk maps are shown from left to right in Figure 27. The flood risk is showing clearly at Besoso. During our fieldtrip we learnt that additional local risk is caused by flooding of the main road to the district capital Begoro. Also, the stream is flowing through a dump site, which can cause health issues when the dump is eroded by a flood wave.

The flood risk in Besoso does not show on the district map, as the problem is local and man-made. As stated man-made hazards are not captured by the flood hazard algorithm used for the preparation of the district level risk maps. The road that is prone to flooding in Begoro leads to the town's hospital. When this road is flooded the major part of the town does not have (fast) access to the hospital. This can be identified as an increased flood risk.

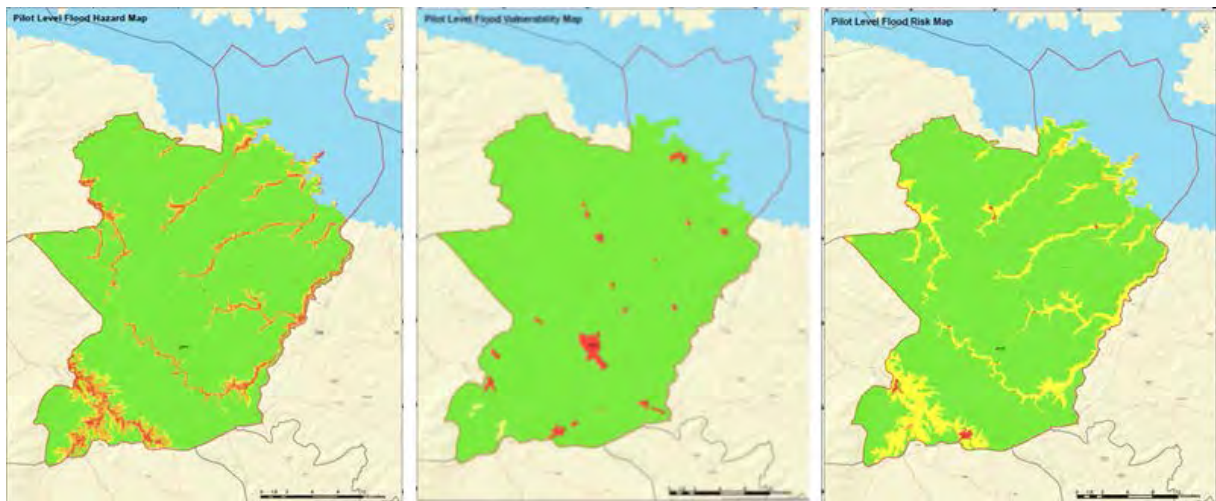


Figure 27. Flood hazard (left), flood vulnerability (middle) and flood risk (right) in the Fanteakwa district

7 PILOT DISTRICT ACCRA

7.1 Introduction of pilot district and hotspot communities

The pilot district in the Greater Accra Region is Accra Metropolitan District. Within this district several hotspots have been identified, all located in the catchment of or directly along the Odaw River. The Odaw River drains a catchment of about 300km² and runs from north of Accra towards the Gulf of Guinea. The larger part of the river is located within the urban area of Accra and acts as an urban drain, which is why the river is also called Odaw drain. The upstream part of the catchment is steeper and less urbanised compared to the downstream part. Peak flood discharges can easily reach 100 m³/s (2-year return period). The discharge of the 1/100 year return period is estimated at 275 m³/s (Ackom, 2009 and Nyarko, 2002). The Odaw drain flows into the sea near Jamestown, via the Korle Lagoon. Figure 28 presents the Odaw drain catchment outlined in blue.

The Accra Metropolitan District is indicated in orange in Figure 28. The hotspots that were visited within the district (shown on the same Figure) are:

- Alogboshie
- Avenor
- Odawna

Hotspot Alogboshie is given the highest priority. We note that Alogboshie is located just outside the pilot district. All three hotspots are situated along the Odaw drain and are densely built up areas.

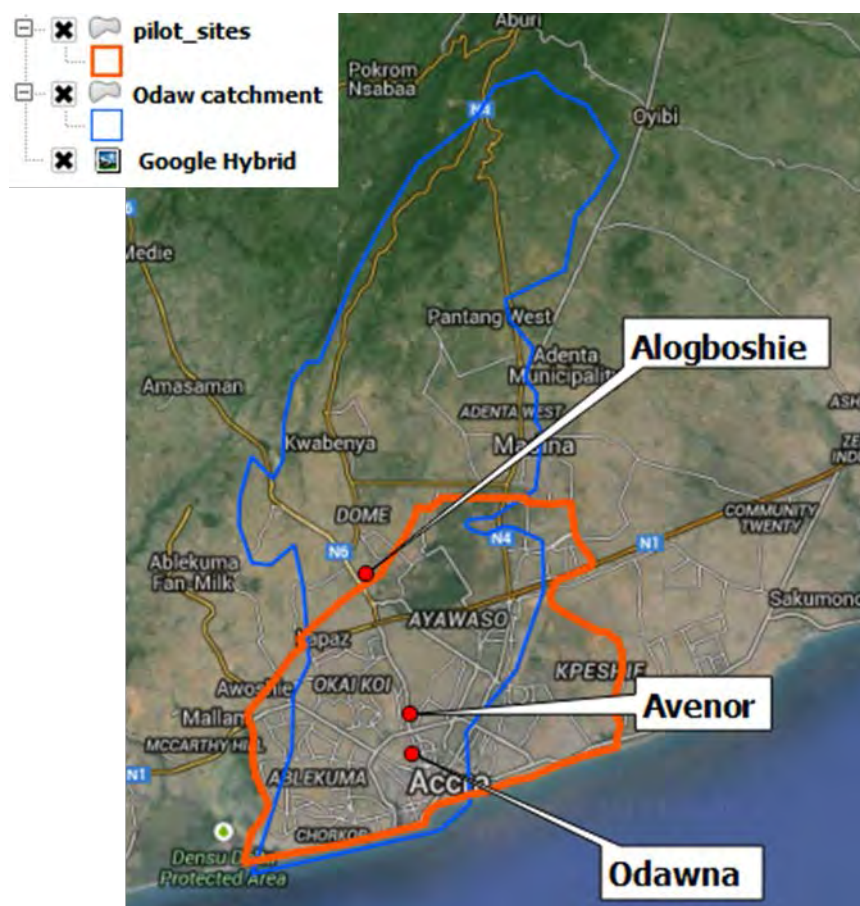


Figure 28: The Odaw catchment in Accra with the three hotspot areas.

7.2 History of disasters

The area around the Odaw drain has a long history of flood disasters. The disaster database provided by the CREW team contains records since 1987, and lists more than 106 flooding events in the Accra Metropolitan district. The largest registered disaster in the database was a flood due to torrential rainfall (258 mm) on 4 July 1995, leaving 145 people dead and causing millions worth of damage.

The frequency with which flash floods occur in Accra has increased in recent years. Currently flash floods are observed several times a year according to local sources interviewed during the field trip (5-10 times during the rainy season of 2014). In most cases the floods strike the Odaw riparian areas. According to the records, floods can occur almost all year round. Only during the month of January no floods were recorded.

A recent example is the flash flood that occurred during the night of 26 October 2011 killing about 10 people, who were surprised in their sleep. The flood also inundated areas around Kaneshi, Nkruma circle and nearby industrial areas. The total amount of rain was high, but not exceptional. This illustrates the high hazard and vulnerability levels of the area.

Alogboshie

Alogboshie was visited on 5 November 2014. During the field visit the photo shown in Figure 29 was taken. It shows a river crossing over the Odaw drain. The night before, a

small flash flood washed away the mobile bridge that normally connects this side of Alogboshie with the local school. The bridge is chained and can therefore be reinstalled easily. However, due to this flexible construction, it cannot always be used and as the picture shows, people are sometimes forced to walk through the river. The local assembly representative informed us that this causes fatalities each year. The right hand side photograph in Figure 29 shows the historical water level in the Alogboshie area during large floods.



Figure 29: Alogboshie : washed out bridge (left), historical water level (right).

Avenor

Figure 30 shows a picture of the Odaw drain in the Avenor area, where the right side is frequently flooded.



Figure 30: Odaw drain and local drain flowing into Odaw drain

Odawna



Figure 31: Odaw drain in Odawna area

7.3 Flood Hazard

Figure 32 shows the flood hazard map of Accra Metropolitan district. The Odaw drain is clearly visible as a high flood hazard. The hazardous area in the west is part of the Densu river and delta.

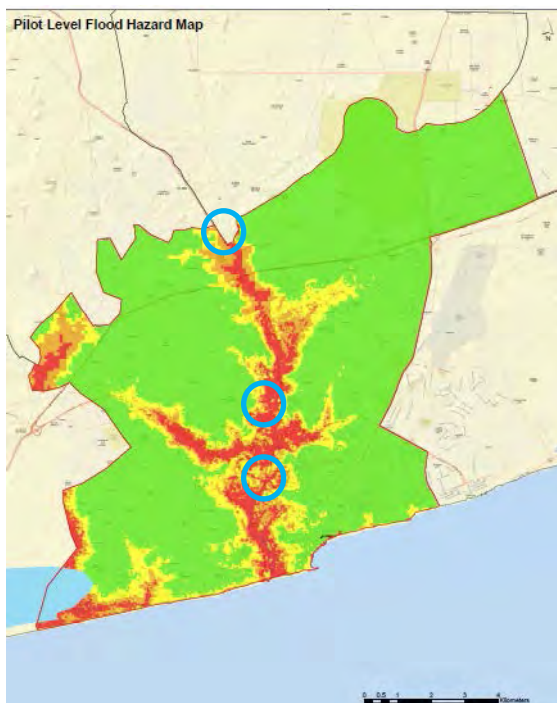


Figure 32: Flood hazard map of Accra Metropolitan district and the three hotspots

The high flood hazard level along the Odaw drain is caused by:

- Urbanization of the catchment causing very fast runoff.
- Urbanization of the old river bed and low lying flood plain areas, reducing the area available for river flow and storage.

- Limited discharge capacity of the Odaw drain and its tributaries.
- Backwater effects from solid waste and structures, like bridges and the Korle Lagoon interceptor weir.
- Possible interaction with high tide on the sea.

Urbanization of Accra in general and the areas around the Odaw drain specifically has increased strongly over the past decade. Figure 33 shows Google Earth based satellite images from the year 2000 and 2013 for the same location where the Odaw drains into the sea. The white line shows the channel in 2014. Over the past decade the Odaw has become more canalized: straighter and narrower. The floodplain areas have largely been deforested and developed. This results in fast runoff, limited water storage and less draining capacity.

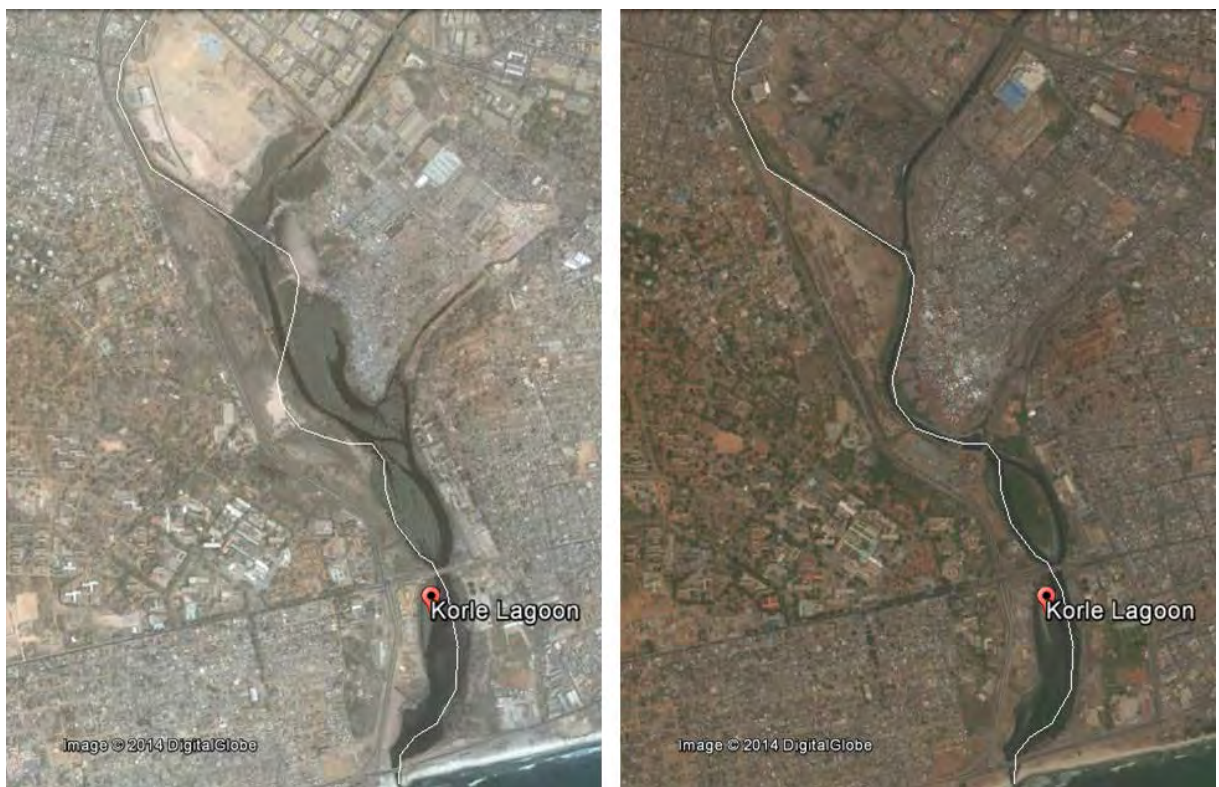


Figure 33: Effects of urbanisation along the Odaw drain, satellite imagery from 2000 (left) and 2010 (right). Source: Google Earth

The discharge capacity of the drain has decreased not only by narrowing the channel, but also by siltation and solid waste deposits and accumulation. The drains and streams connecting to the Odaw drain suffer from similar problems. Figure 34 shows an example of blocked local drains in the Odaw catchment due to waste deposits. The right hand side picture illustrates how Odaw drain is canalized and parts of the bank protection are washed away, causing flow blockage and trapping of additional debris. The picture also shows how fast the river reacts: The high flows captured in the picture are caused by a rainstorm that started an hour before.



Figure 34: Examples of waste deposits in the Odaw catchment (left Avenor) and bad maintenance of the Odaw drain (right south Alogboshie)

Between 2004 and 2008 just upstream of Korle Lagoon a so-called interceptor weir was constructed, intended to intercept solid waste and wastewater before entering the Korle Lagoon (Figure 35). The weir should be opened during high flows from upstream, but solid waste is easily trapped behind the weir, blocking the flow to the sea. Additionally a flash flood can coincide with high sea water levels, as was the case during the flood of 26 October 2011.



Figure 35. Korle Lagoon – in 2008 just upstream of Korle Lagoon a so-called interceptor weir was constructed

The flood hazard in the hotspot areas are mainly caused by the above mentioned urbanisation, canalization, channel narrowing, siltation and solid waste disposal. The southern areas of Avenor and Odawna can also be affected by high sea levels and the interceptor weir blocking the Odaw drain outflow to the sea.

7.4 Drought Hazard

There is no drought hazard in the Accra Metropolitan district, because the area is completely urbanised.

7.5 Vulnerability

As the Accra Metropolitan district is almost completely urbanised, the flood vulnerability in the whole area is high. This is also the case for the Odaw drain area and the selected hotspots.

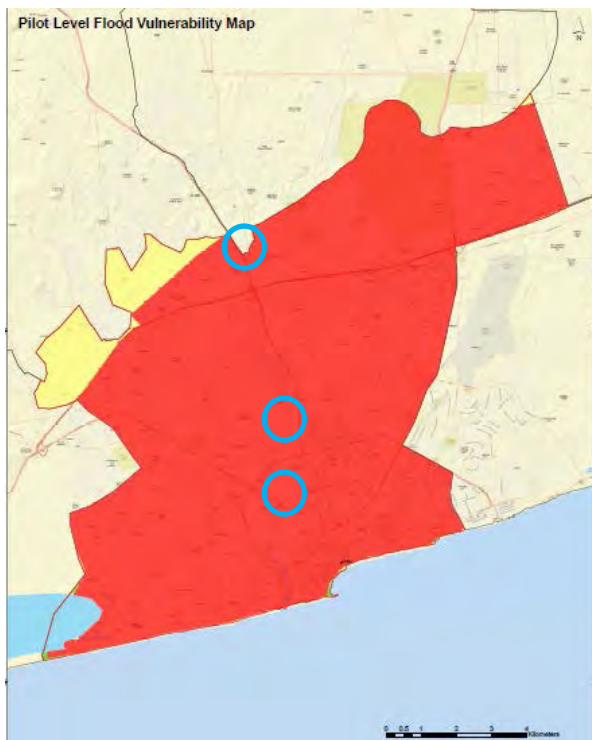


Figure 36: Flood vulnerability map of Accra Metropolitan district and hotspot areas

The urban areas are considered vulnerable because floods in the area might lead to:

- Loss of goods and stocks.
- Loss of livestock, such as chickens, goats and in some areas cows (also in the highly urbanised areas).
- Loss of human live, especially when flash flooding occurs during the night, but also when people try to cross the river when a bridge is out or order and the river flows are high, as mentioned in the Alogboshie area.

Within the vulnerability assessment no distinction is made between residential areas and industrial areas as the information needed to separate them is not available. Residential and industrial areas are assumed to have the same vulnerability to flooding, although it is recommended to differentiate them when the required data becomes available.

Figure 37 illustrates increased vulnerability in the Alogboshie area and Korle Lagoon; increase of urbanization is clearly visible.

There is no drought vulnerability for the Accra Metropolitan district.



Figure 37. Changes in urbanisation in Alogboshie area (above) and Korle Lagoon area (below).

7.6 Risk

As the whole catchment is urbanised, the risk zones are similar to the contours of the flood hazard. The flood risk assessment of the Accra Metropolitan district shows that the areas around the Odaw drain and its tributaries especially carry a high flood risk (Figure 38).

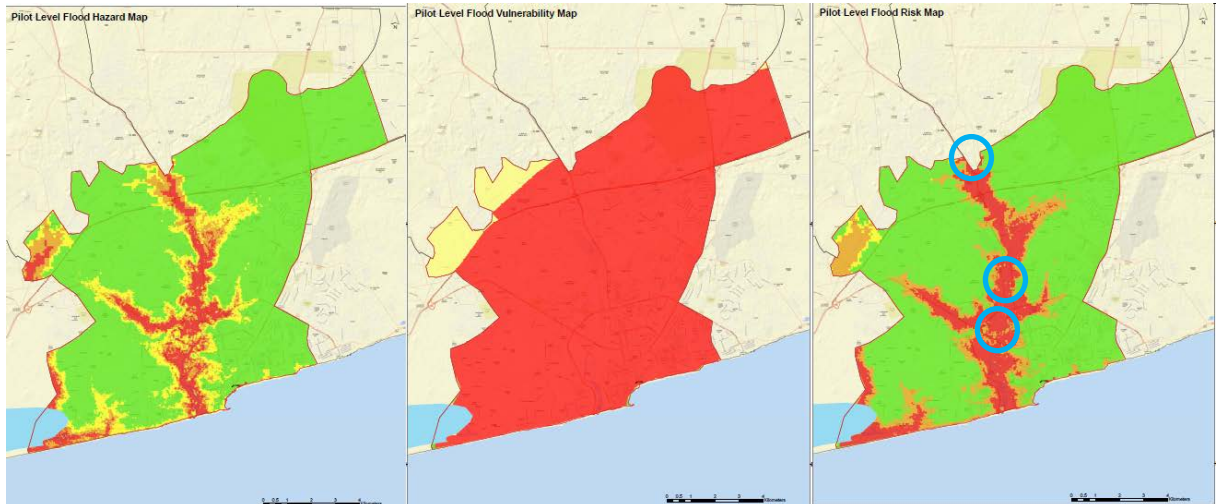


Figure 38: Flood hazard (left), flood vulnerability (middle) and flood risk (right) in the Accra Metropolitan district

The current project does not include environmental risks, although these could be quite important in some cases. When visiting the Accra hotspots, environmental risks are visible everywhere. During our visit to Alogboshie we came across a waste disposal location along the Odaw drain. When the Odaw is flooded, the waste is washed away as well. The southern part of the Odaw drain is even worse, and famous for its environmental disasters. Figure 39 shows the waste disposal in Alogboshie on the left. The right side picture shows a dark plume flowing into the sea and spreading along the coast.



Figure 39: Environmental risks in Accra

There is no drought risk for the Accra Metropolitan district.

8 PILOT DISTRICT BUNKPURUGU-YUNYOO

8.1 Introduction of pilot district and hotspot communities

The district of Bunkpurugu-Yunyoo is located in the Northern Region. The Gambaga Escarpment forms its northern border and the highest points in this pilot district reach a level of 400 m in the northern part of the district, from which the elevation declines southwards. The Oti River forms the eastern boarder of the district and partially acts as the Ghana-Togo international border. The rivers and streams run from north to south and all flow into a tributary of the Oti River. The land use within the district is mainly rural. The largest settlements are Nakpanduri, Yunyoo and Bunkpurugu (the district capital).

The selected hotspots that were visited are:

- Binde
- Najong no. 1
- Najong no. 2

The hotspots are all located along the Bunkpurugu to Nakpanduri road (Figure 40) and belong to the same river catchment.

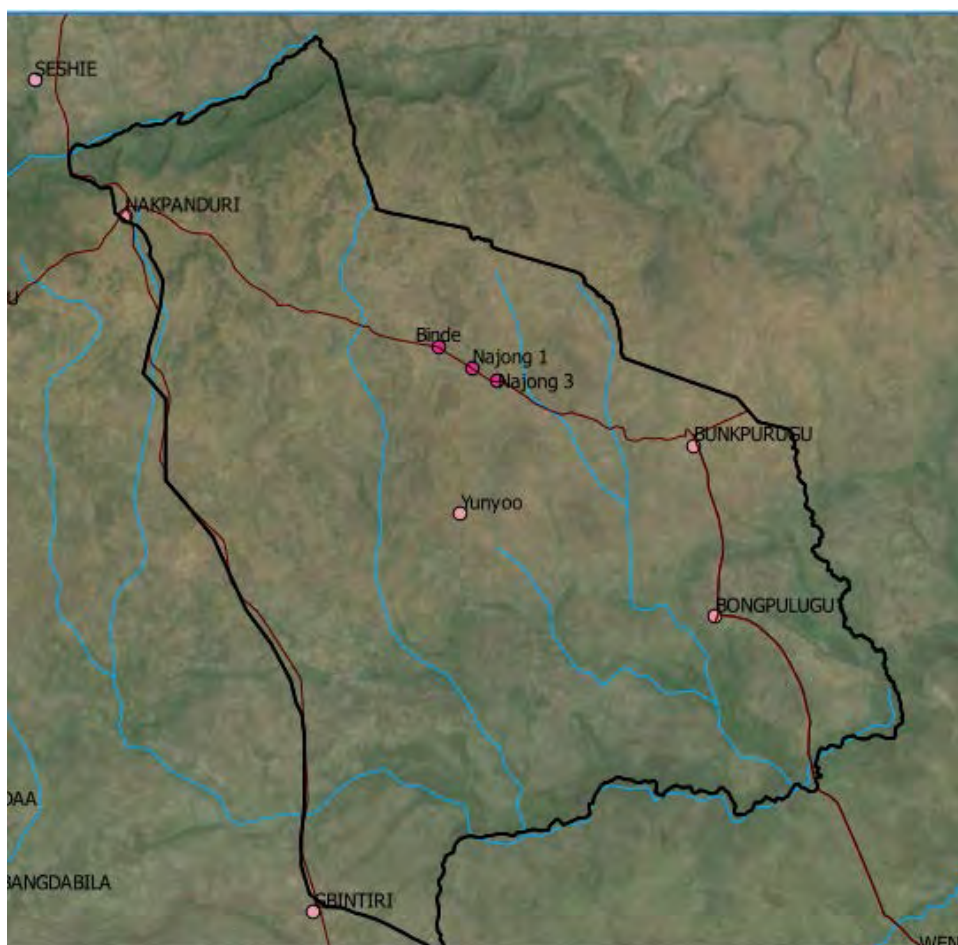


Figure 40: Bunkpurugu Yunyoo hotspots

8.2 History of disasters

Floods

The CREW disaster database has records of 20 flood events in the district, mostly from two floods during 2012 and one from 2010. Obviously more flood events occurred, as was mentioned by locals during the field trip interviews.

The communities of Binde, Najong 1 and Najong 2 are located along the road from Nakpanduri to Bungpurugu. Every year inundations occur in these communities, but in 2013 an extreme flood event struck the area. The flood of 2013 occurred after a 6-7 day period of rain. Flooding occurred from 29 August to 6 September. During this flood a number of houses were destroyed and crops were lost. Local inhabitants stated that the last flood of this extent took place in 1967. The local people said to be frightened that this year a similar situation as the September 2013 flood would occur. So far only little rain had fallen and they expect extreme events to come.

Droughts

In the interviews during the field visit and in the disaster database no clear records of drought disasters were found. However locals say that droughts occur regularly. The effect of these drought events was that the yield of the arable crops declined so that additional food needed to be bought by the locals.

8.3 Flood Hazard

The flood hazard in the district (Figure 41) is dominated by the river Pembi, at the southern border of Bungpurugu-Yunyoo and the tributaries that flow into it from the north. The larger part of the district consists of hills and valleys. The texture of the underground is a mixture of sand and stony soils. This would result in a fast reaction of the basin to rainfall.

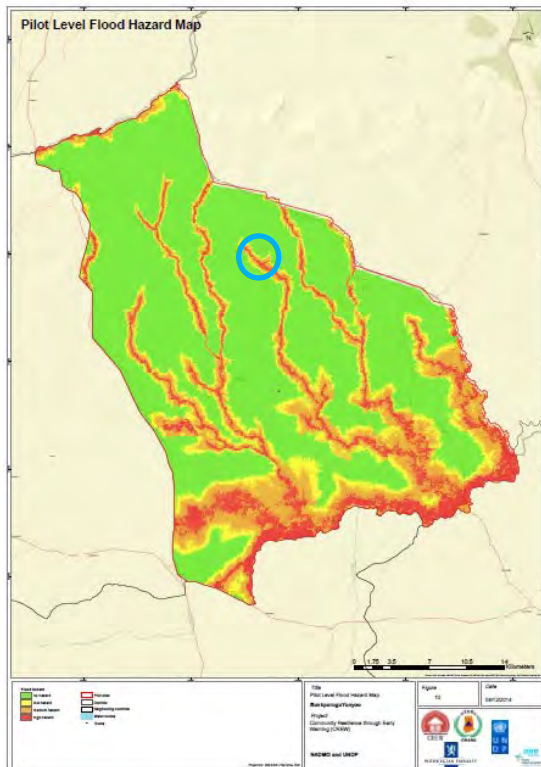


Figure 41: Bungpurugu-Yunyoo flood hazard map

Flooding in the catchment is caused by regional rainfall during the wet season. The wet season starts around July and lasts at least until September, although there is always a period with rainfall between 1 and 20 April. The first rain, preceding the start of the wet season, is usually recorded at the end of May or the beginning of June (Figure 42).

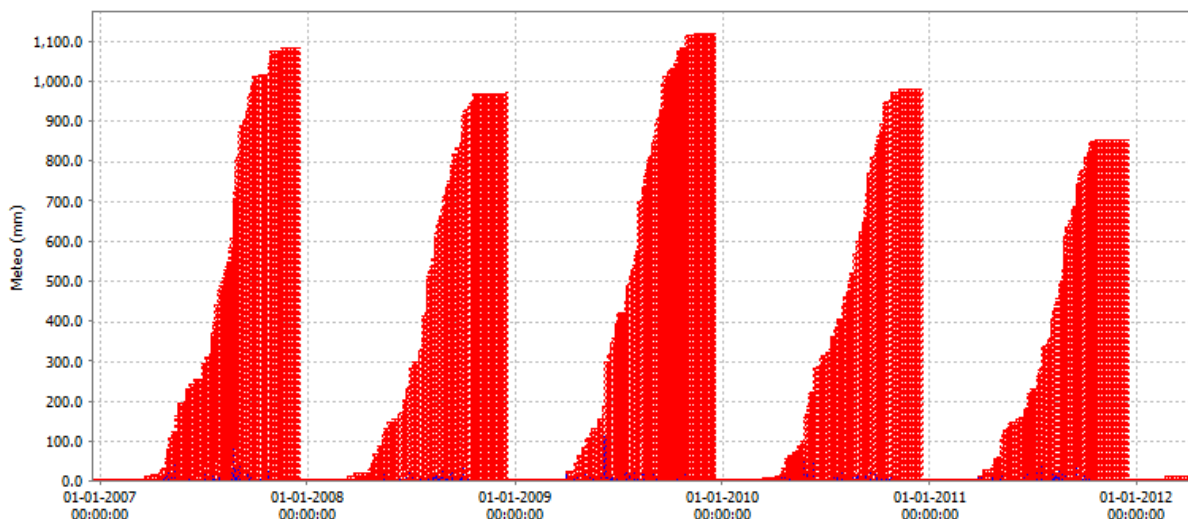
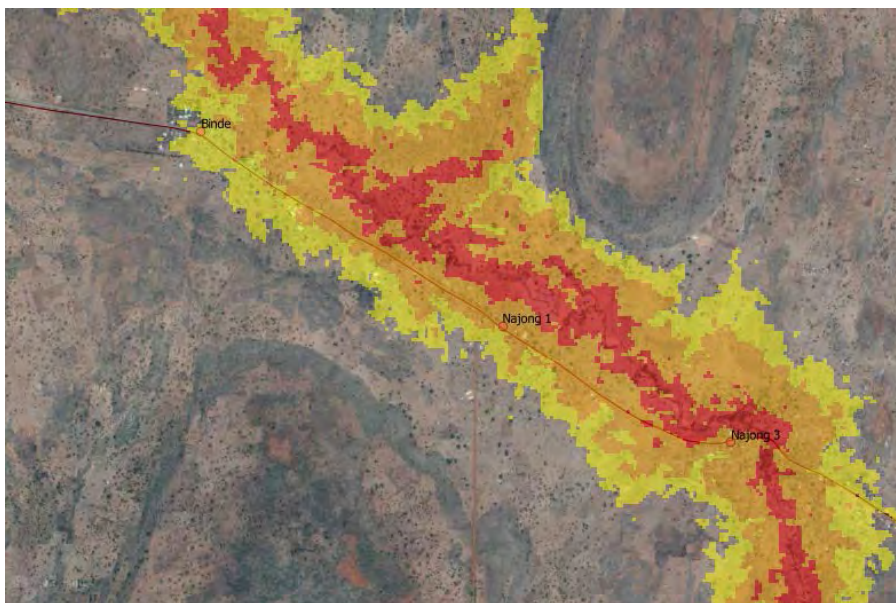


Figure 42: Cumulative annual rainfall in the hotspot area of Bungpurugu Yunyoo

The hotspots are located in the catchment of one of the north-south tributaries. The area of the hotspots has been marked with a circle on the flood hazard map (Figure 41). The cause of the recent floods in the hotspot area is a road that is constructed parallel to the stream. The road is constructed as a dam and has several gullies and culverts to drain

the adjoining area. However, the western side of the road has hardly any drains, and the ones that exist, are overgrown. Culverts do not exist. This means that all the water coming from the south-western side which normally drains to the stream on the north-eastern side is blocked by the road, causing the south-western side of the area to flood and creating an area where the water is stored. Once the water level rises above the level of the road, the road and the downstream areas are flooded as well. The locals say that the road was rehabilitated around 2012 after which the problems started. Also, the contractor that built the road extracted the soil needed for road construction from nearby lands, creating drains and low lying areas where water accumulates. The house of one of the local farmers was situated at the end of such a man-made drain. The house was washed away in the flood of 2013.



8.4 Drought Hazard

The local people that were interviewed indicated that the area suffers from drought as well. They defined drought as: "21 days without rain during the sowing/growing season." The impact of drought depends on the stage of the crop growth it coincides with: drought damages crops more in the beginning of the growing season because young crops are not strong enough yet to withstand a prolonged period without rain.

This year (2014) the drought was becoming a serious problem because the rainy season has not started yet at the time of the field visit (end of July). Only a few rain showers had been observed so far. Because local farmers had already planted their crops with the first rains, the crops had not been developing well in the absence of sufficient water.

Despite the drought problems, local people state that flooding is a more serious problem than drought.

8.5 Vulnerability

The district of Bunkpurugu-Yunyoo is sparsely populated. Throughout the district there are small settlements. The main source of income for the people is subsistence farming.

No reservoirs exist in the area of the hotspots to improve the water availability during the dry season. The only source of water is the stream in the valley. Therefore there are no opportunities to reduce the vulnerability of the agriculture to droughts.

The vulnerability of the hotspot areas in Bunkpurugu-Yunyoo district is mainly due to:

- Loss of crops (droughts and floods)
- Loss of (food) stocks (floods)
- Loss of houses (floods)

Figure 43 shows the vulnerability of the district to floods and the location of the hotspots.

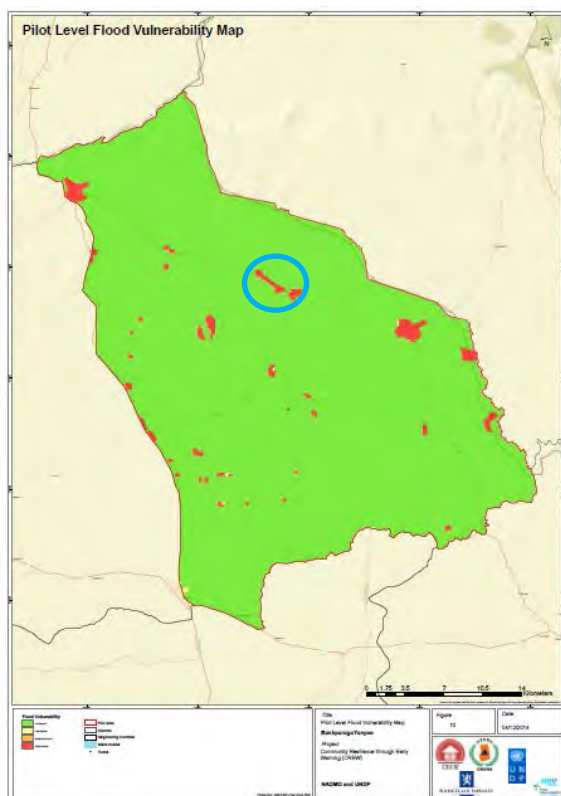


Figure 43: Bungpurugu-Yunyoo flood vulnerability map and hotspots

8.6 Risk

The flood hazard, vulnerability and flood risk maps are presented in Figure 44. The hotspot areas are most at risk within the district.

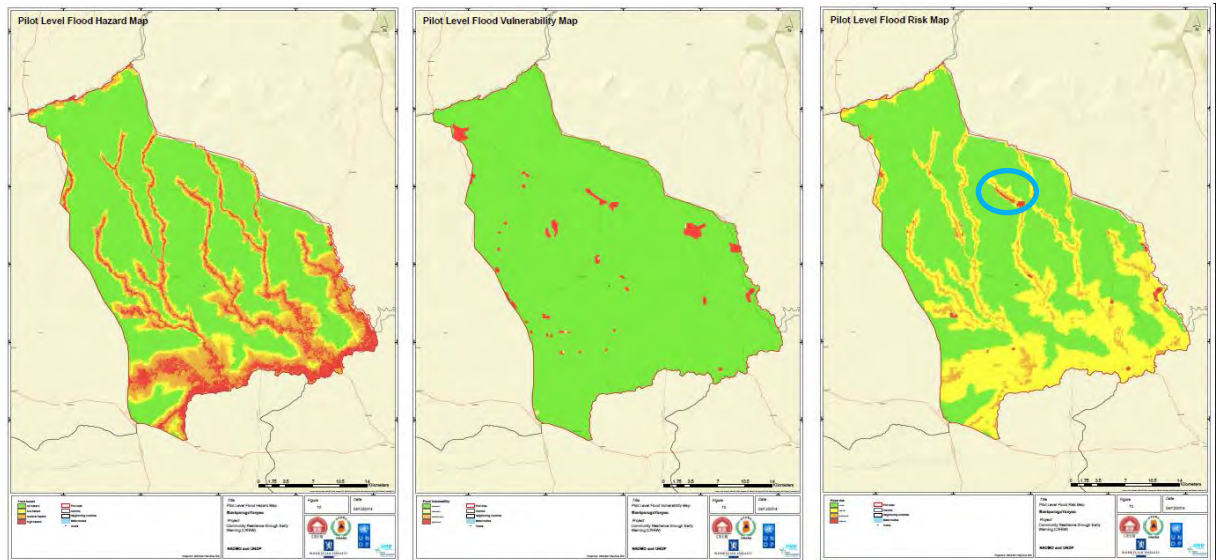


Figure 44: From flood hazard (left), flood vulnerability (middle) and flood risk (right) in the Bungpurugu-Yunyoo district

9 PILOT DISTRICT BAWKU-WEST

9.1 Introduction of pilot district and hotspot communities

The district of Bawku West is bordered by the Red Volta in the west, Burkina Faso in the north and the White Volta in the east and south.

The following hotspots were selected (Figure 45):

- Galaka village, located in the north of Bawku West, near the White Volta at the confluence between the White Volta and the Nouhao Rivers.
- Kobori village, located just south of the bridge over the White Volta in the direction of the city of Bawku.

Bawku-West is a rural district with several larger towns like Zebilla, the capital and Kokole. The White Volta River enters Ghana at the northern border of Bawku West and is an important source of prosperity for the local people: the floodplains are fertile and used for farming and the river also provides fish. The White Volta is relatively wide and not very steep when it enters Bawku-West district, more downstream where it reaches the Gambaga scarp, the river becomes steeper. Peak discharges of almost 1,500 m³/s have been recorded, for example in 2012. The Red Volta has a relatively steep river bed and reacts fast on rain events. Although flood peaks are much smaller on the Red Volta, they can still reach up to 425 m³/s.

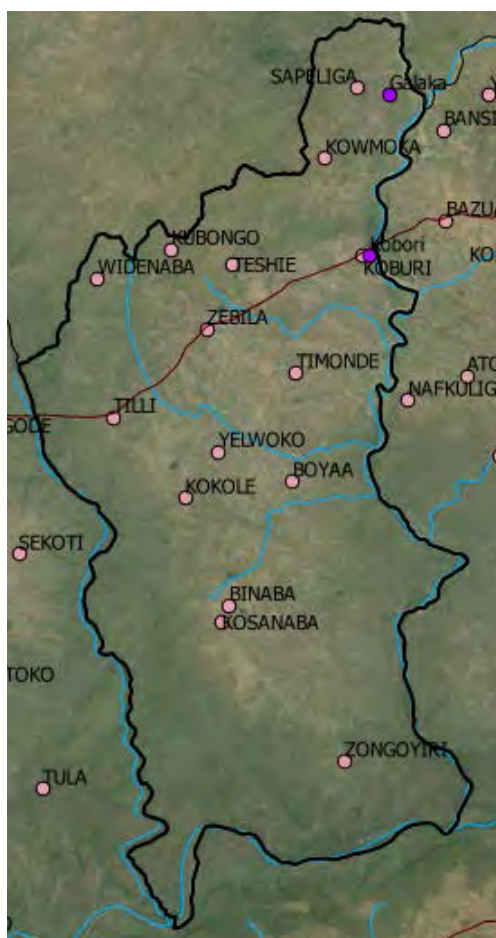


Figure 45: Bawku West towns and hotspots (purple)

9.2 History of disasters

The CREW disaster database holds records of 28 flood events in this district. Mostly from September 2012 when the Bagre dam on the White Volta in Burkina Fasso spilled causing record breaking water levels in the upper parts of the White Volta. Two other flood events (in 2012 and 2010) were recorded as well. Obviously more flood events occurred, as was mentioned during the field trip interviews. Most of the floods that occur along the upper parts of the White Volta are caused by Bagre dam spilling. One of the flash floods recorded in the CREW disaster database was not known to the local NADMO staff.

The visited communities of Galaka and Kobori both suffer from White Volta flooding caused by spilling of the Bagre dam. As mentioned before, the 2012 flood was one of the most destructive, destroying crops and livestock around Galaka and flooding parts of Kobori. The automatic water level gauge on the White Volta at Kobori that was a critical component of the flood early warning system for the White Volta was washed away in this flood.

Droughts were not recorded for this district in the CREW disaster database but during the interviews local people clearly stated that drought is a serious problem in both Galaga and Kobori. Especially Kobori seemed to suffer from drought. During our field visit the drought impact was visible: crops bearing little fruits and cracked soils.

From interviews we learnt that in the recent past drought events occurred in 2012, 2013 and 2014. The year 2013 was better than 2012, but 2014 is the worst one. In 2012 the drought started in July. There was no rain in the July for 4 weeks. In 2013 there was a drought between July and August: there was no rain for 6 weeks. In 2014, this year, the rains were also very late. There had only been very little rain on three occasions (twice in June and once in July) while May was completely dry.

Note: The night after the field visit (end of July) a big rainstorm hit the area.

9.3 Flood Hazard

The flood hazard level in Galaka and Kobori is caused by the White Volta River. The White Volta water levels rise during the wet season and inundate the riverbanks and part of the flood plains. When Bagre Dam in Burkina Faso starts spilling, the flood extent can become very large.

The people of the Galaka area mentioned that rainfall can cause inundations of the lower lying areas as well. However these were not mentioned as disastrous events. However, some Internet research turned up an item, stating that in April 2014 twenty households in the Bawku West district were destroyed by heavy rainfalls. The article also mentioned the Galaka community (<http://news.peacefonline.com/pages/social/201404/196915.php>). The timing of this rain event is not normal, because April is still in the dry season. Most of the rain falls in July-September as presented in Figure 46.

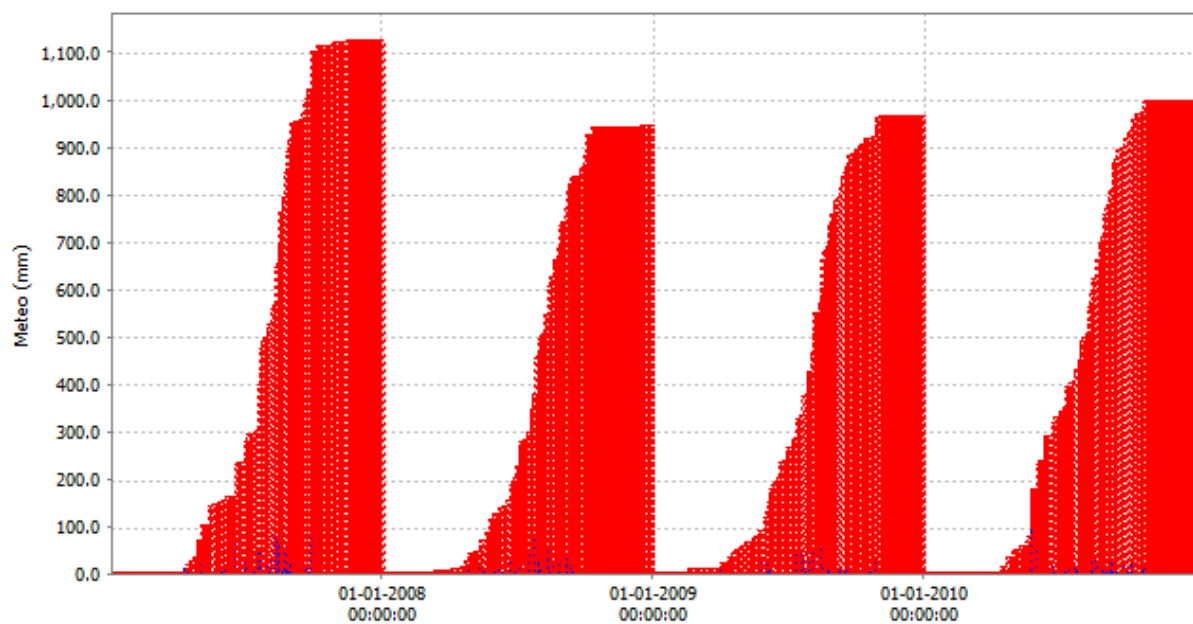


Figure 46: Cumulative annual rainfall in the hotspot area of Bawku West

The district flood hazard map is presented in Figure 47.

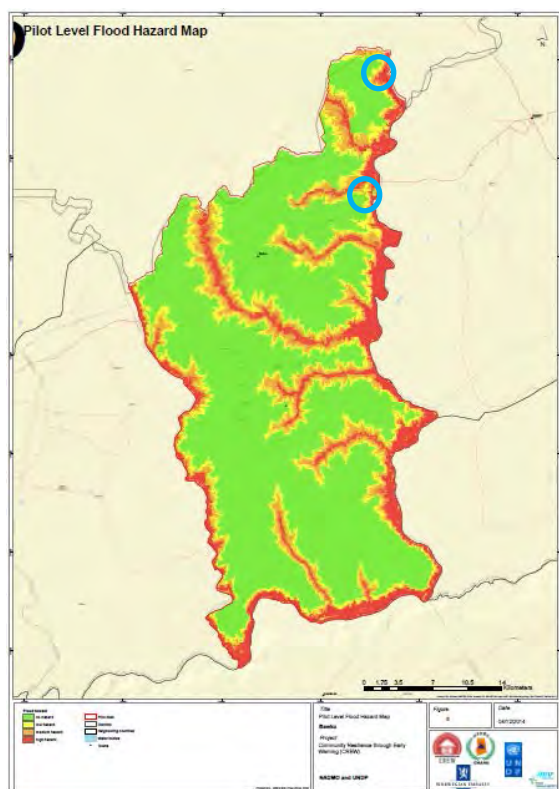


Figure 47: Flood hazard map in Bawku West with hotspot locations

9.4 Drought Hazard

The local people that were interviewed indicated that the area suffers from drought as well as from floods. Similar to Bungpurugu Yunyoo they describe drought as a period of about 3 weeks without rain during the growing season. The impact of the drought depends on the stage of the crop growth: drought damages crops more in the beginning of the growing season, because young crops are not strong enough yet to withstand a prolonged period without rain. As in Bungpurugu Yunyoo drought seems to become a serious problem in this year (2014).

The local inhabitants state that flooding is a more serious problem than drought, although a young man interviewed in Koberi considered drought to be worse.

9.5 Vulnerability

Along the White and Red Volta there are small settlements. The larger villages in the district are located in the higher areas of the district along the Bolgatanga - Bawku road. In the district some teak production was seen. Subsistence farming is the most common land use. The vulnerability of the two hotspots of Bawku West district is mainly due to:

- Loss of crops (droughts and floods)
- Losses of livestock (floods)
- Loss of houses (flooding)

The inhabitants say that their houses are not affected by the White Volta floods as these are situated on higher ground. However, as the news item (link provided above) says torrential rainfalls have destroyed houses in the area.

From the Koberi visit the following was noted: all farmers in the community and all crops are affected by drought. The drought causes hunger and means less water for the animals that sometimes die. The animals cannot get into the river because of the steep river banks. Also, the children have to go to school and cannot get water from the river.

In order to adapt to droughts some farmers grow drought resistant crops, such as millet and sorghum. Rice is grown in depressions along the river banks where water remains available longer in the dry season. People tend to migrate to other less drought prone areas, or sell their belongings to compensate for bad harvests.

A few years ago an NGO constructed a pumped irrigation system, but after a year they left, leaving the pump behind but without the motor. Local people are not able to re-launch the system. Why the initiative stopped is unknown.

9.6 Risk

The flood hazard, vulnerability and risk are presented in Figure 48. The hotspot areas are located in the high risk zones in the district.

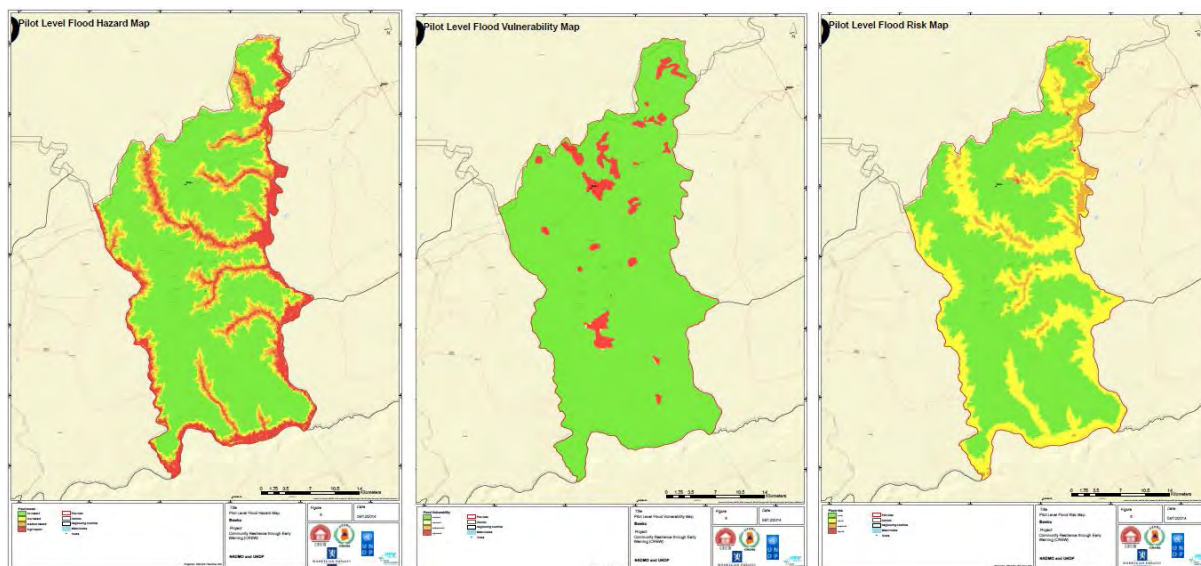


Figure 48: Flood hazard (left), flood vulnerability (middle) and flood risk (right) in the Bawku-West district

The district drought risk maps still need to be revised and are therefore not presented in this report.

Capacity

The people in the two hotspot communities explained that they receive a warning before the Bagre Dam starts spilling. The local people receive this warning 1 to 7 days before the highest water levels are expected. Zonal coordinators from NADMO are normally sent from the district office in Zebilla issue flood warnings to the local people. Ghanaian and Burkinabé authorities have agreed that Bagre dam operators should provide a two-week notice before they start spilling. From the moment the spilling starts, it takes a while before the flood peak reaches its maximum in Bawku-West or even before the floodplains are inundated. Normally the local people should start harvesting when the flood warning is received; however, if they would get a more accurate and timely warning, they could decide to harvest a little later stage to get a better yield from their crops.

Figure 49 illustrates that the spilling of Bagre in 2012 started at 24th of August, with its peak 14 days later. The figure also shows that the White Volta in Bawku-West reacts very fast on the Bagre spills. It takes about 12 hours for the waters to reach Bawku-West.

Reservoirs are present in the district and near to the hotspot communities. However, they are mainly natural and normally dry up during the dry season. When these reservoirs are managed better and their water would be made more easy accessible this might decrease the drought vulnerability.

More education and accessibility to drought resistant crops will also decrease the vulnerability.

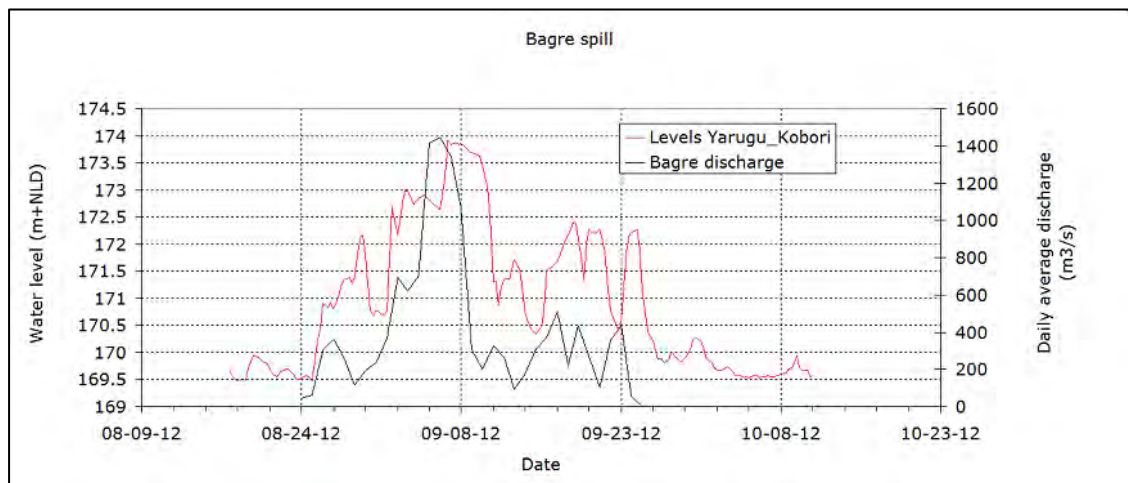


Figure 49. Spilling of Bagre in 2012

10 PILOT DISTRICT LAWRA

10.1 Introduction of pilot district and hotspot communities

The Lawra District is one of nine (9) districts in the Upper West Region of northern Ghana. Its capital is Lawra. The district of Lawra is situated between the Black Volta on the west, Burkina Faso to the north and Jirapa/Lambussie district to the east.

In the district two hotspot communities were visited (Figure 50):

- Bagri Zongo
- Dikpe

The Lawra district is a rural district with mainly small settlements. The most striking flood hazard for this district is caused by the Black Volta. When it has rained in Burkina Faso, large inundations along the riverbanks occur. The river regularly floods a zone with an average width of 500 m on each side.

According to the disaster database provided by the CREW team also some disasters caused by flash flooding have been recorded in the district.

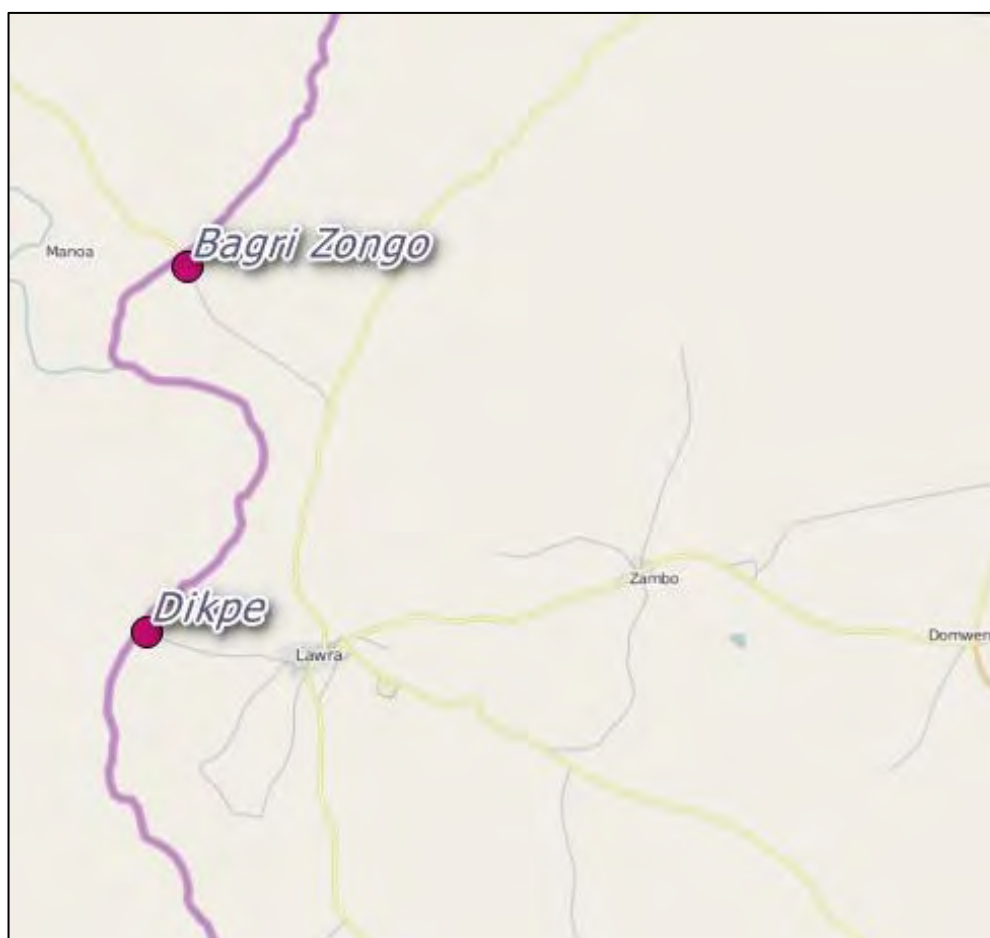


Figure 50. Hotspots within Lawra pilot district

Bagri Zongo

This community along the Black Volta is located in an area which suffers from regular flooding from the river. The water level in the river can rise several meters and floods the areas on either side to a total width of up to 1 km during the months August-October. The flood waters reach the community's settlement, where some 60 houses are flooded regularly. Sometimes houses collapse. The community will not move away from their location as they want to protect their fishing rights. The people accept the risk that their houses get flooded.

Another problem is caused by the people crossing the river in small boats to cross from Ghana to Burkina Faso and back. Almost every year people drown while crossing the river during high flows.



Figure 51: Bagri Zongo, along the Black Volta River (left) and fishing community (right)



Figure 52. Overview of hotspot Bagri Zongo

Dikpe

The fertile farmland along the Black Volta River suffers from regular flooding. The water level in the river can rise several meters and floods the adjacent lands depositing nutrient-rich silt and creating fertile topsoil that is valuable to the region's farmers.

In the Dikpe hotspot community only farmland is threatened by the floods. The houses are located on higher grounds.

An abandoned river gauging station was found on the Black Volta River in this area (see Figure 53).



Figure 53. Dikpe: Abandoned gauging station Black Volta (left), Overview (right)

10.2 History of disasters

Floods

In the storm of January 2013 a boat capsized when crossing the Black Volta from Zambo (Ghana) to Zambo (Burkina Faso). Six people were on board, one died.

Droughts

In the interviews during the field visit and in the disaster database no exact dates of drought disasters were found. However locals say that droughts occur regularly. This causes the yield of the arable crop to decline so that additional food needs to be bought by the locals.

10.3 Flood Hazard

The flood hazard of the two zones is mainly caused by the Black Volta. The Black Volta rises yearly and inundates the banks of the river. Although the Black Volta is a major river, its water level can rise very quickly in response to upstream rainfall.

10.4 Drought Hazard

The inhabitants of the two zones report that there is a drought hazard. The pilot drought hazard map shows the whole district to have a high drought hazard level.

10.5 Vulnerability

Along the Black Volta mainly small settlements exist. The larger villages in the district are located in the higher areas of the district along the river. Farming is the dominant land use in the district.

The vulnerability of the two hotspot communities in Lawra district is caused by:

- Loss of crops (droughts and floods)
- Losses of human lives (river crossings)
- Loss of houses (flooding)

The inhabitants in Bagri Zongo indicated that their houses were situated at the extremities of the flood zone and therefore sometimes affected by the Black Volta floods.

10.6 Risk

The flood vulnerability map for Lawra district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

The CREW team stated that an on-time warning of flooding would be good for the farmers in order to anticipate on the flooding. A longer lead time would allow the farmers to harvest their crops just in time.

11 PILOT DISTRICT AKATSI

11.1 Introduction of pilot district and hotspot communities

The district of Akatsi is located in the Volta Region. The western border of the district is the Tordzi River, draining towards the Keta Lagoon in the south. The Tordzi provides the main drainage of this area, and also defines the potential hazard

The land use within the district is mainly forest, shrubs and agriculture. The largest settlement is Akatsi (the district capital). The selected hotspots are (Figure 54):

- Wute
- Torve

The hotspots are all located in the Tordzi river valley.



Figure 54: Akatsi hotspots

11.2 History of disasters

In the CREW disaster database only one event (December 2010) is recorded for this district. The precise location of this event is unclear.

Torze

Torve is located along a branch of the Tordzi River. The 'official' naming of this river stretch did not become during the visit. Although Akatsi is a relatively dry district, the

village of Torze is often flooded, with levels up to 1 meter. A recent flood also destroyed some property. The village looks deprived. Flooding is caused by blocked water ways. The river is hardly visible as it is completely overgrown with trees and shrubs. However, in order to make a good assessment of possible measures, the whole river stretch from the bifurcation to the Tordzi confluence should be considered.



Figure 55: Resident indicates flood level (left), visible damage in the village due to flooding (right)

Wute

The village of Wute is located close to the road from Ho to Akatsi. Flooding occurs from the Tordzi River. The village was recently flooded according to the residents. However, the frequency of flooding seems low. Water overflows the river banks occasionally, but rarely (every 10 - 20 years) reaches the village. Hardly any houses are located between the river banks and the village, only some agricultural lands. A shed recently got flooded and has been rebuilt.



Figure 56: Gauge recorder at the Tordzi river (left), path to the river near Wute (right)

11.3 Flood Hazard

The flood hazard in the region is caused mainly by the Tordzi River, see Figure 57. Within Akatsi district, the Tordzi River bifurcates and merges again, as this is already the delta stretch of the river. For example, the water causing the recurrent problems at Torve is a bifurcation that flows back into the main Tordzi River further downstream.

Floods in the catchment are caused by regional rainfall during the rainy season. The most recent floods were caused by rains in the northern part of the Tordzi catchment in both Ghana and Togo.

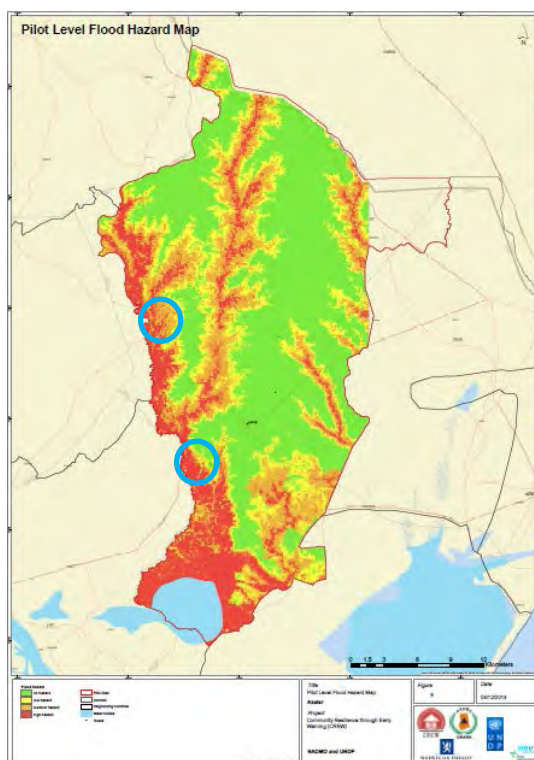


Figure 57: Flood hazard map Akatsi district (north and south)

11.4 Drought Hazard

The inhabitants of the two zones did not report drought hazard. However, according to the maps, the hazard is categorised as having a medium drought hazard level. The local inhabitants state that flooding is a more serious problem than drought. As the local people live very near to the river, drought might be less of a problem at the hotspot sites.

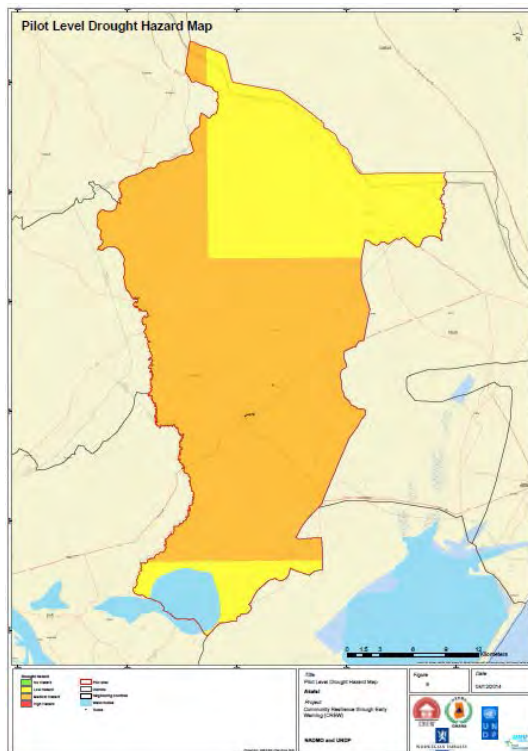


Figure 58: Drought hazard map Akatsi district (north and south)

11.5 Vulnerability

The vulnerability for both floods and droughts is at some locations at medium level, but overall categorised as low. The main reason for this classification is that agricultural activity is limited according to our land use map and the population density is relatively low. One of the problems in Torve was that during a flood, inhabitants were not able to reach their land and other villages at the other side of the stream. This resulted in indirect losses.

The vulnerability of the two hotspot areas is mainly due to:

- Loss of crops (droughts and floods)
- Loss of stocks (floods)
- Loss of houses (floods)
- Indirect loss as some areas cannot be reached

11.6 Risk

Figure 59 presents the flood hazard, vulnerability and risk for the district. Especially the town of Torve is indicated as having a high flood risk. This was confirmed by the field visit.

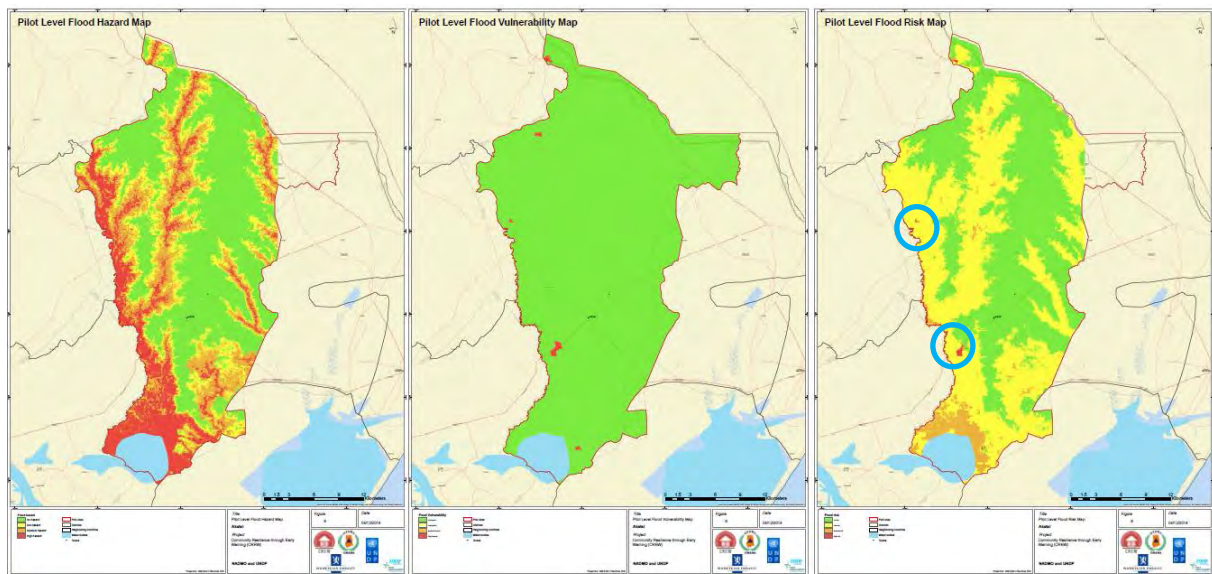


Figure 59: Flood hazard (left), flood vulnerability (middle) and flood risk (right) in the Akatsi district

12 PILOT DISTRICT SHAMA

12.1 Introduction of pilot district and hotspot communities

The Shama district covers an area of about 174 km² and is part of the Western Region that measures almost 24,000 km². The land use in Shama district is predominantly rural (Figure 60 and Table 3). There are however also some medium to large urban areas. Among these Inchaban, Aboadze and Shama are the largest. Developments in land use tend to move towards a reduction in agricultural land use and an increase in built up areas.

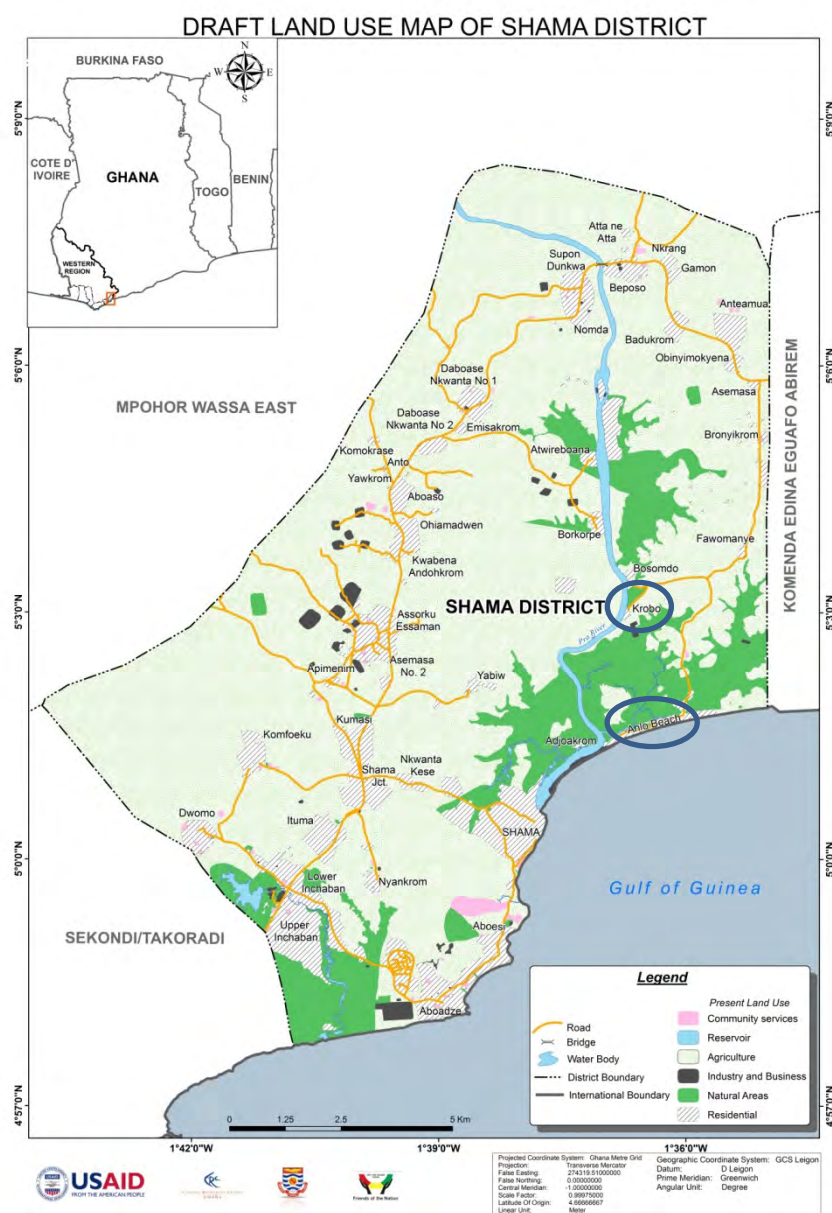


Figure 60. Land use map of Shama district indicating the location of the hotspots Krobo and Anlo Beach along the Pra River (source: Dei et al., 2011).

Table 3. Land use types within Shama District (Dei et al, 2011).

Land use type	Area in km ²		Area in percentages	
	Existing	Preferred	Existing	Preferred
Agriculture	130.1	84.9	74.6%	48.7%
Community service	1.0	11.5	0.6%	6.6%
Industries and businesses**	1.9	19.6	1.1%	11.2%
Residential	17.1	38.9	9.8%	22.3%
Natural Areas	24.1	19.4	13.8%	11.1%
Reservoir	0.3	0.3	0.2%	0.2%
Total	174.5	174.5	100.0%	100.0%

The following 2 hotspot communities along the Pra River were selected in the Shama pilot district (Figure 60):

- Krobo
- Anlo Beach



Figure 61. Pra river and major tributaries (source: Wikipedia).

12.2 History of disasters

Krobo

Krobo is a small village (~70 people) on the banks of the Pra River that suffers from flooding. Figure 61 shows 2 pictures taken during the field visit. Two community members were available to provide information. One was a member of the village elders and the second was a resident. According to these sources, the flooding occurs on average once every 5 years and it occurs when the river discharge is very high due to heavy rainfall upstream. Figure 62 shows the height of the water level during the most recent flooding.

According to one of the spokespersons, the river water becomes very salty when flooding is imminent. The river mouth is some 6 kilometres downstream and it seems strange that salinity would increase with high river discharges. Possible the high discharge leads to a mixing of the saline intrusion that is normally located at the bottom of the river bed.

Maximum flood levels in the village were quite substantial, at around 1 meter above the floor level of the houses. The community is located between the river and a wetland that is connected to the river by means of a culvert. Therefore the flood waters come from both sides. In response to the flood, the families move in with relatives living in the area on higher ground. The community sees resettlement as the only viable solution to their problem.



Figure 62. Interview at Krobo besides the Pra river (left), households within Krobo (right).



Figure 63. Flood level indication – recent flood level was at the height of the writing ‘Happy’

Anlo Beach

The second hotspot in the Shama district is Anlo Beach, located on the narrow strip of land between the Pra river and the sea. This is the most prominent beach in the Shama District. It is more than 170m wide in its mid-section tapering longitudinally eastwards but curving at the Pra estuary. By the nature of its form, its formation may have originated offshore and gradually moved onshore blocking the former estuary of the Pra and pushing it westwards. It is evident that the Pra provided an enormous amount of sediment to the longshore drift in its formation. The meeting of the muddy waters of the Pra and the long-shore drift of beach material provided the materials that built the bar that the village is built on.

We spoke with a delegation of the village elders who explained that flooding happens on average once every three years. This is up from the earlier frequency. Flooding is announced by the fact that the flow in the (tidal) river only moves downstream. Flooding is always from the river and enters the village from the north. The lower ground, closer to the river is flooded up to a water depth of approximately 60 cm. Another major threat to the community is posed by coastal erosion of the bar the village is built on. This has ‘eaten up’ half the village already. Faced with the combined threats, the community has decided that resettlement is their only realistic option. An area to the east of the village that is on higher ground is targeted for resettlement.

The University of Cape Coast has done modelling studies of the Pra river. However detailed modelling was not done for Anlo Beach due to the complexity of the landscape and lack of data. To get a clear picture on the extent of flooding, the MICRODEM software was used as a simulation tool. This was to verify areas along the coast that will be inundated in case of sea level rise due to the effect of wind and tides.

Results from the MICRODEM simulation indicate that a in the sea level of up to one meter will have little effect on the coastal area. However, if the sea level rises above one meter, marginal part of the area will be inundated. From field observations, Anlo Beach and its environs get flooded due to a combination of tidal level, high discharge of the Pra River and the low lying nature of the topography. Anlo Beach floods when high discharges from the Pra River are not able to flow into the sea freely due to high tides. In periods of high river discharge and high tidal level the reduction in flow velocity generates a back water effect leading to the spread of water on the either side of the Pra River. From the observations and the simulation results, areas such as Krobo and Anlo Beach that are below the high water mark will be flooded.

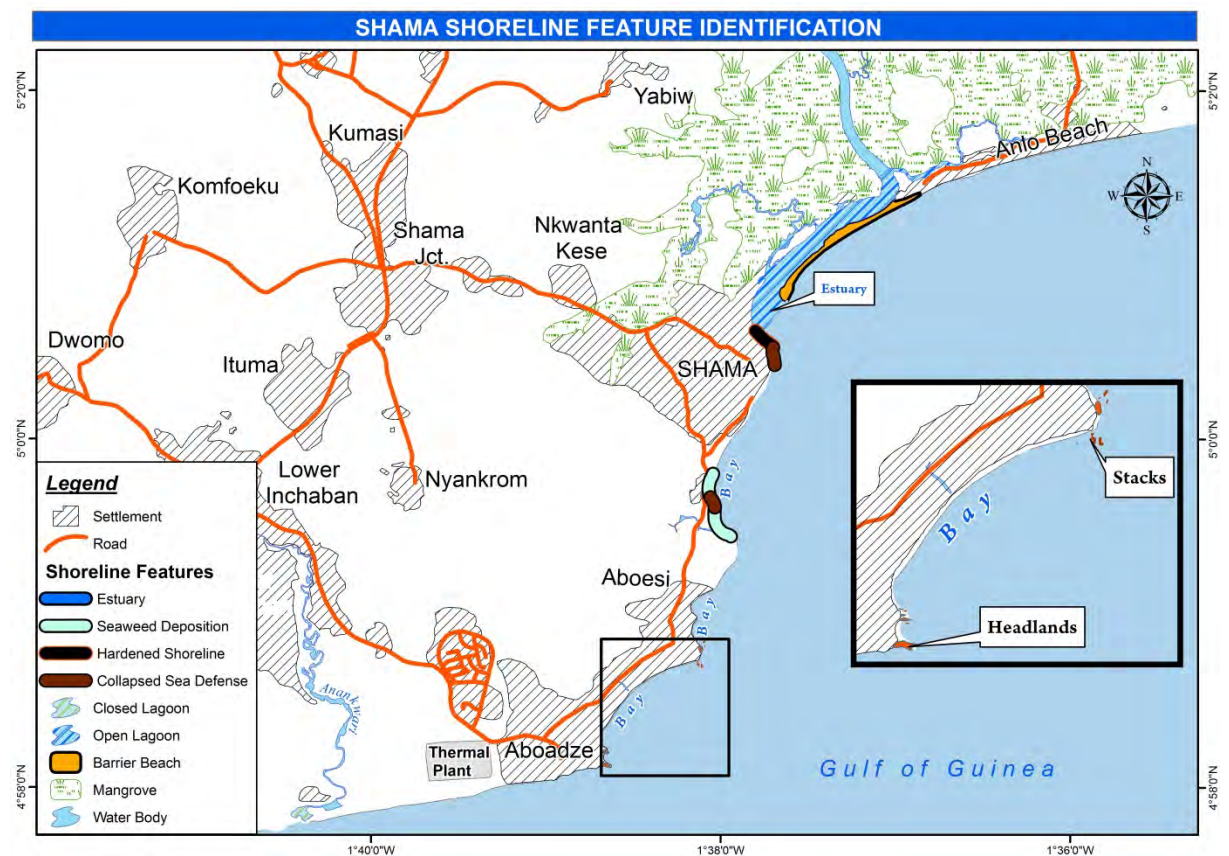


Figure 64. Shama shoreline with location of Anglo Beach hotspot (source: University of Cape Coast)

12.3 Flood Hazard

The flood hazard map for Shama district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

12.4 Drought Hazard

Drought is not an issue in this area.

12.5 Vulnerability

The flood vulnerability map for Shama district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

12.6 Risk

The flood risk map for Shama district has been presented in a previous deliverable (Royal HaskoningDHV 2014b).

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