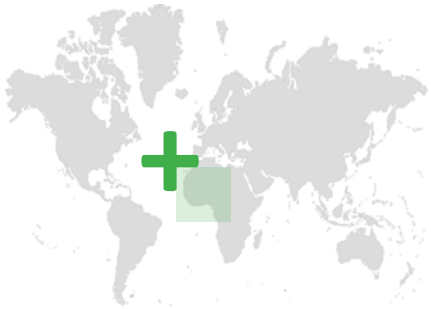
Developing Risk Profiles for Public Assets



INTRODUCTION

A risk profile of a public asset is an evaluation of the probability of the asset getting damaged depending on its exposure and vulnerability to a hazard. This determines potential risk reduction measures and the estimation of funds needed to protect the public asset, as a way of mitigating potential risks and threats. In addition, if there should be any residual risk after taking the necessary adaptation measures, these risks can then be transferred to third parties such as insurance companies.

It is in public authority's best interest to be proactive when it comes to risk profiling its public assets. When public assets, especially critical assets, are not protected, the extent of damage to the infrastructure as a result of a disaster could cause devastating economic impacts and disrupt the lives of people in a society.

In addition, political and administrative authorities of a city suffer a negative image since scarce resources that could have been used to advance development are diverted to repair and build back these damaged public assets.

Within the project Developing Risk Management Approaches for Climate Risks and on behalf of the German Federal Ministry for Economic Cooperation and Development, the Public-Private Partnership between the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and Allianz SE - Reinsurance developed risk profiles for public assets of some selected assemblies in the Greater Accra Metropolitan Area (GAMA), Ghana.

APPROACH

For determining risk profiles, several approaches could be adopted. The approach used in this project was:

- Establishing inundation maps or flood hazard profiles
- Developing vulnerability assessments using standardized exposure modelling
- Estimating the costs of potential green (e.g., growing grass) and grey (e.g., metal gratings) adaptation measures as well as their potential risk reduction effects

In establishing inundation maps, flood hazards are identified by revealing geographically dependent flooding patterns for rainfall events with different return periods.

To assess the risk of a municipal asset in flood zones, a vulnerability assessment is conducted. The vulnerability assessment is based on the flood hazard profile and vulnerability of the object itself. The vulnerability function describes how flood damage develops when objects are exposed to rising flood levels.

The total expected damage is subsequently calculated by multiplying the damage fraction (based on the inundation depth and the vulnerability function) with the maximum damage or building value. Object-based damage assessment is strongly dependent on local circumstances and actions by the asset owners.

It is important to note that the maximum damage to the building contents or inventory is approximated as a proportion of maximum damage. In addition, the indirect damage is approximated as a proportion of the direct damage. Thus, a risk profile combines the hazard profile with the vulnerability function.

Methods and techniques

The inundation maps/flood hazard profiles used for the risk profiling of the public assets were developed using the best available methods and techniques in flood risk management. This includes:

- The use of a Digital Terrain Model (DTM). The DTM is established based on satellite data with a resolution of 12 m (depending on the region) and an estimated vertical error of less than 0.6 m.
- The application of the official rainfall statistics in Greater Accra from Ghana Meteorological Agency (GMet).
- The inundation model and the inundation maps are validated by field observations, historical data, and the consultation of local experts.

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Generally, conducting risk profiles of assets is both a technical and expensive process. Hence, PPPs with insurance companies are recommended to help manage the cost and mechanical aspects of the process. This will ensure that the exposure and risk analysis is properly done as well as reflect realistic cost estimations that can adequately protect the asset in the event of a disaster. Essentially, knowing the risk profile of public assets contributes to their insurability and ultimate protection.

Adaptation measures

Risk profiles can be influenced by implementing adaptation measures or risk reduction measures. Factors influencing, for example, object-based flood damages are:

- Local or temporal flood protection and mitigation measures such as a floodwall or movement of equipment.
- The local construction and location of the inventory in the asset.
- Recent changes in elevation at or around the asset.

In determining the impact of a specific adaptation measure, a cost-benefit analysis (CBA) or Economics for Climate Adaptation approach can help to compare the cost of a measure with the reduction of future expected damages that the measure is expected to lead to (=benefit). A CBA generates a factor that can be readily interpreted to make decisions as to whether to implement the measure or not. For example, a CBA factor of 1.5 means that an investment of GHC 1 into the measure is translated to a benefit of GHC 1.5. Therefore, all measures with a CBA factor of greater than one are economically wise to be implemented.

It must be pointed out here that green measures (i.e. waste collection and recycling, desilting, water harvesting, and reuse, etc), flood zoning, and education have been marked by literature as non – regret measures. This means that they have proven over time to have high CBA factors and are therefore placed on the upper quartile of the analysis scale.

EXEMPLARY RISK PROFILES OF ASSETS IN CITIES OF GHANA

Within the above-mentioned project, several risk profiles for public assets in GAMA were developed. Therefore, the remainder of this flyer gives an overview of the flood hazard profiles, vulnerability assessments, risk profiles, and suggested risk reduction measures of some selected public assets that could also be of interest in other contexts. These selected assets are market centers, fountains, and educational facilities.

Market Center

The project surveyed the Abokobi market in Ga East Municipality within the Greater Accra Region. According to information received from city authorities, this public asset has a history of being flooded as drains are not directly located at the market. The Abokobi market has one shed with three bays, which has a total of 72 stalls.

The hazard profile with the probability (x-axis) of Abokobi market experiencing a particular inundation depth (y-axis) is shown in figure 1. For instance, an inundation depth of 0.33 m occurs in the "current" situation about once every 10 years. The hazard profiles are established up to a probability of occurrence of once per 100 years.

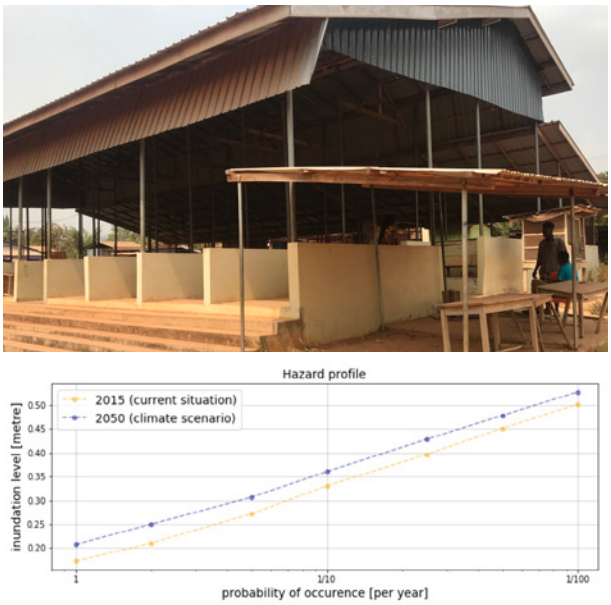

Figure 1: Hazard profile (occurrence of inundation depths) at Abokobi market

The vulnerability function of the market depends on the type of building and its purpose, hence for the Abokobi market, the building category is *Market and Shop*. Details on the approach are described in the main report of the exposure modelling for municipal-owned objects in Accra [HKV, 2019].

The maximum damage can be approximated as follows:

- The value of the premises of the Abokobi market is GHC 105,000.00. This is only the direct cost of damage and is estimated based on averaging the available data per category.
- For bungalow type of buildings, the maximal contents/ inventory damage is estimated at 105,000*100%.
- The indirect damage is approximated as a proportion of the direct damage. For the *Market and Shop* category, the maximal indirect damage is estimated at 9.1%.

Figure 2 and Figure 3 describe the risk profile in terms of the damage fraction for the premises and the inventory.

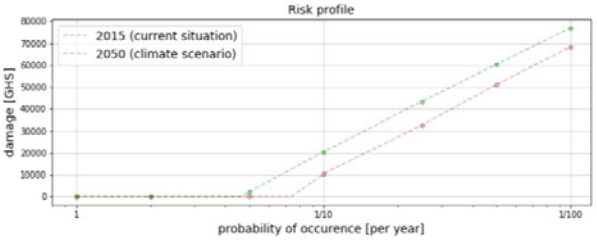

Figure 2: Risk profile of the premises in terms of the direct damage

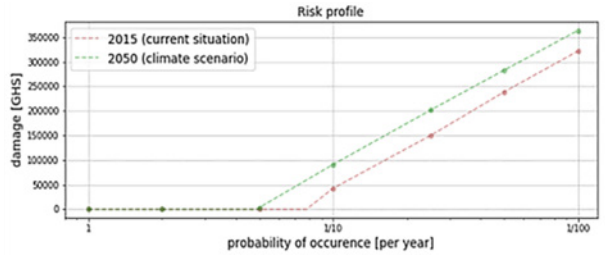

Figure 3: Risk profile of the inventory in terms of the damage

The below-proposed risk reduction measures can be implemented at the market center to reduce the impact of a flood:

- Introducing roof gutters and collect water into open drains on both sides of the shed
- Desilting all drains once a month
- Completing the partially constructed trapezoidal drain to join the drain at the other side of the market area (about 450 m long); and
- Setting up space shop containers along the trapezoidal drain to ease the flow of runoff water from uphill the market.

These measures are estimated to cost GHC 380,410.00 and will reduce the risk by 42 percent with a cost-benefit analysis factor of 0.025.[1]

Fountain

Moreover, the Kwame Nkrumah Dubai Fountain was surveyed, which is located in the Accra Metropolitan Assembly (AMA) within the Greater Accra Region. According to the information provided by officials of AMA, this object has been flooded in the past. The asset is located right opposite the emergency services areas at the Kwame Nkrumah Interchange. The asset provides electricity, water, and other services to the emergency area. It shares a compound with a building that houses the managers of the fountain.

The flood hazard profile of the Kwame Nkrumah Dubai Fountain is presented in Figure 4. For example, an inundation depth of 0.77 m occurs in the "current" situation about once every 10 years. The hazard profile is established up to a probability of occurrence of once per 100 years. The water level with a probability of occurrence of once every 100 years is 1.6967 m.

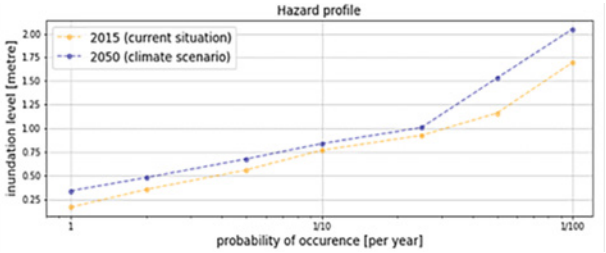

Figure 4: Hazard Profile at Kwame Nkrumah Dubai Fountain

The expected changes in rainfall for 2050 range from a decrease of 20% to an increase of 30% (based on CMIP5 climate simulations and regional downscaling). The applied increase of 10% in Figure 4 is therefore just an example of the potential effects of climate change in 2050.

For the vulnerability function of Kwame Nkrumah Dubai Fountain, the building category is *Government Admin* block [HKV, 2019].

The maximum damage can be approximated as follows:

- The value of the premises of Kwame Nkrumah Dubai Fountain is GHC 323,000.00 and is estimated based on averaging the available data per category.
- For bungalow type of buildings, the maximal contents damage is estimated at 323,000*100%.
- For a *Government Administration* block, the maximal indirect damage is estimated at 9.1%. The indirect damage is an average which is derived from literature. Details and literature can be found in HKV (2018).

Figure 5 and Figure 6 describe the risk profile in terms of the damage fraction for the premises and inventory, respectively.

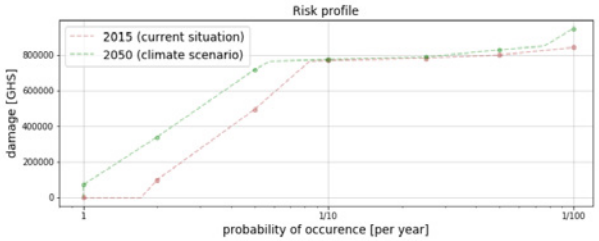

Figure 5: Risk profile of the premises in terms of the damage

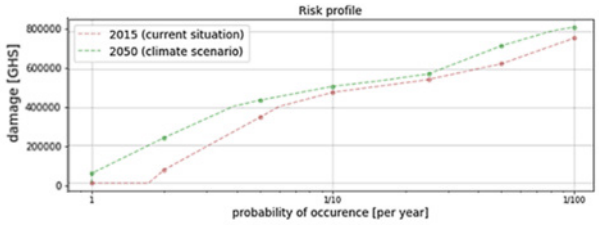

Figure 6: Risk profile of the inventory in terms of the damage

The proposed risk reduction measures include:

- Changing some of the concrete slabs covering the drains around the fountain to metal gratings to give better access of rainfall-runoff water into the drain.
- Cleaning service chambers regularly and cover with concrete slab.

The cast metal gratings are estimated to cost GHC 300,000.00 and will reduce the flood risk by about 5 percent with a cost-benefit analysis factor of 1.34.

Eductional Facility

The Islamic Basic Primary was surveyed at Ga West Municipality in the Greater Accra Region. According to information provided by the Ga West Municipal assembly representatives, the object has been flooded in the past. The school has five main buildings on the compound. Out of the five buildings, three are completed and two are uncompleted. The other structure on the compound of the school is a toilet facility.

1 Green measures e.g.: desilting gutters and grey measures e.g.: widening drains were included in the CBA

The probability of Islamic Basic Primary school flooding is presented in Figure 7. For the Islamic Basic Primary school location, an inundation depth of more than 0.3 m is not expected.

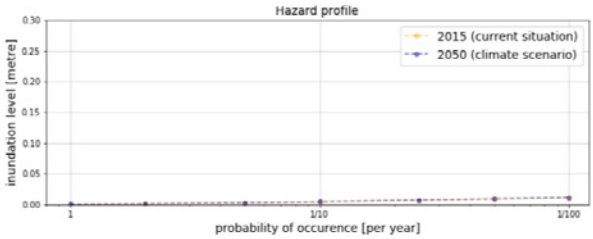

Figure 7: Hazard Profile (Occurrence of Inundation Depths) at Islamic Basic Primary

The hazard profile in figure 7 for 2050 is based on a 10% increase of rainfall in 2050. The flood hazard profile in figure 10 shows that the inundation depth with a probability of occurrence of 1/100 per year is less than 30 cm. The object is therefore classified as outside the flood zone and no significant damages are expected. If such an object does flood anyway, the impact is typically constricted to the cleaning of buildings.

Nevertheless, some risk reduction measures could be implemented, these include:

- Redesigning the school compound to slope towards the drains to allow rainfall runoff to flow toward the drain.
- Creating outlets in the fencing of the school to ease the exit of stormwater from the school compound into the drains. The mesh will help filter sand and any other solid material from the rainfall-runoff.
- Harvesting rainwater to reduce the volume of rainwater trapped in the compound and provide portable water to the school.
- Desilting drains and educating the community about the impacts of disposing degradable and non-degradable materials into the drains.
- Planting grass and shrubs to aid in percolating the rainfall-runoff water into the ground as well as the drains.

The adaptation measure for the Islamic Primary School is estimated to cost GHC 132,682.00 and will reduce the flood risk by about 45% percent with a cost-benefit analysis factor of 0.056.

Glossary of the Technical Terms

Digital Terrain Model (DTM). A topographic model of the bare Earth that can be manipulated by computer programs.[2]

References

Ingenieur Bureau Consult (2020). Cost-Benefit Analysis for Eco-friendly Adaption Measures. Allianz/Gesellschaft für Internationale Zusammenarbeit

HKV (2019). Exposure Modelling Accra. Allianz/Gesellschaft für Internationale Zusammenarbeit. PR3892.10.

2 Please see EEA glossary.

Activity name

Developing Risk Profiles for Public Assets

Focus area

Greater Accra Metropolitan Area (GAMA), Ghana

Local partners

Administration of GA East, GA West and AMA
GMet—The Ghana Meteorological Agency

Target group

Public assets under the control of assemblies in GAMA

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This activity was part of the project...

Developing Risk Management Approaches for Climate and Health Risks

Project duration

01.01.2018 – 30.09.2021

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Photo 3: © Ga West Municipality

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For more information please refer to the factsheet "Developing Disaster Risk Management Approaches for Climate Risks in Ghana".

Disclaimer

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