



(RESEARCH ARTICLE)



## Analyzing local flood risk management strategies in the municipality of grand-Popo

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### Abstract

Flooding is a major risk in the municipality of Grand-Popo, located in the delta of the Mono River. This study analyzes the local adaptation strategies developed by populations in response to this recurrent phenomenon. The data come from surveys of 374 households in seven districts. The results show that 48.6% of households experience floods each year, mainly between June and September. The causes mentioned are heavy rainfall, water releases from the Nangbéto dam, the configuration of the delta and the degradation of ecosystems. The impacts mainly concern agricultural losses, damage to infrastructure and disruption of fishing activities. Faced with these risks, populations adopt several adaptation strategies, but these remain insufficient, hence the need to strengthen environmental governance and risk reduction policies.

**Keywords:** Grand-Popo; Floods; Risk management; Adaptation strategies

### 1. Introduction

Floods are among the most frequent and destructive natural disasters in tropical regions, especially in coastal and delta areas where hydrological dynamics are strongly influenced by climate variability and interactions between river and marine systems. In recent decades, the intensification of climate change has contributed to increasing the frequency and intensity of extreme hydrometeorological events, exposing many populations to increasing risks of flooding [9].

In West Africa, the socio-ecological systems of riparian areas are particularly vulnerable to climate disruption. Flood events, combined with rainfall variability and changes in hydrological regimes, cause considerable damage to infrastructure, agricultural activities and the livelihoods of rural populations [5]. These phenomena are all the more worrying as local economies rely heavily on the direct exploitation of natural resources, particularly agriculture, fisheries and livestock.

In Benin, floods are one of the major climatic hazards affecting the national territory. According to the Ministry of Living Environment and Sustainable Development [7], several catastrophic events recorded in recent decades have led to considerable human and economic losses. The floods of 2010, for example, caused 46 deaths and economic losses estimated at more than 127 billion CFA francs, significantly affecting infrastructure, housing and agricultural production.

In this context, areas located in river basins and deltas appear to be particularly exposed to hydrological risks. The work of [4] and [1] notably showed that populations living near major rivers or in alluvial plains are confronted with

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recurrent floods related to rainfall variability, to the overflows of watercourses and the transformations of the hydrological functioning of watersheds.

The municipality of Grand-Popo, located in the delta of the Mono River in southwestern Benin, is a representative example of this environmental vulnerability. The geographical configuration of this territory, characterized by a low altitude, the presence of wetlands and the immediate proximity of the Atlantic Ocean, favors the stagnation of waters and accentuates the risks of flooding. In addition to these natural factors, there are hydrological changes related to the development of the Mono River, notably the commissioning of the Nangbéto dam in 1987. According to [2], this hydraulic infrastructure has profoundly modified the hydrological regime of the river downstream, leading to a recomposition of flow dynamics and a redistribution of flood exposure areas.

The impacts of these floods on local populations are multiple. They lead to the destruction of crops, the degradation of infrastructure and the disruption of fishing activities, thus compromising food security and the livelihoods of coastal communities. Similar observations have been reported in several municipalities of Benin, notably in Lokossa, where extreme weather events caused significant agricultural losses and a significant decrease in yields [3].

Faced with these environmental disturbances, populations gradually develop various adaptation strategies aimed at reducing their vulnerability. These strategies rely both on endogenous knowledge and on the adoption of new economic or environmental practices, such as crop diversification, fish farming, or ecological restoration initiatives [9]. However, the effectiveness of these mechanisms often remains limited in the face of the intensification of climatic hazards and the complexity of socio-ecological dynamics.

In this context, it appears essential to analyze local flood risk management strategies in order to better understand the adaptation mechanisms developed by communities and identify levers likely to strengthen their resilience in the face of changes environmental.

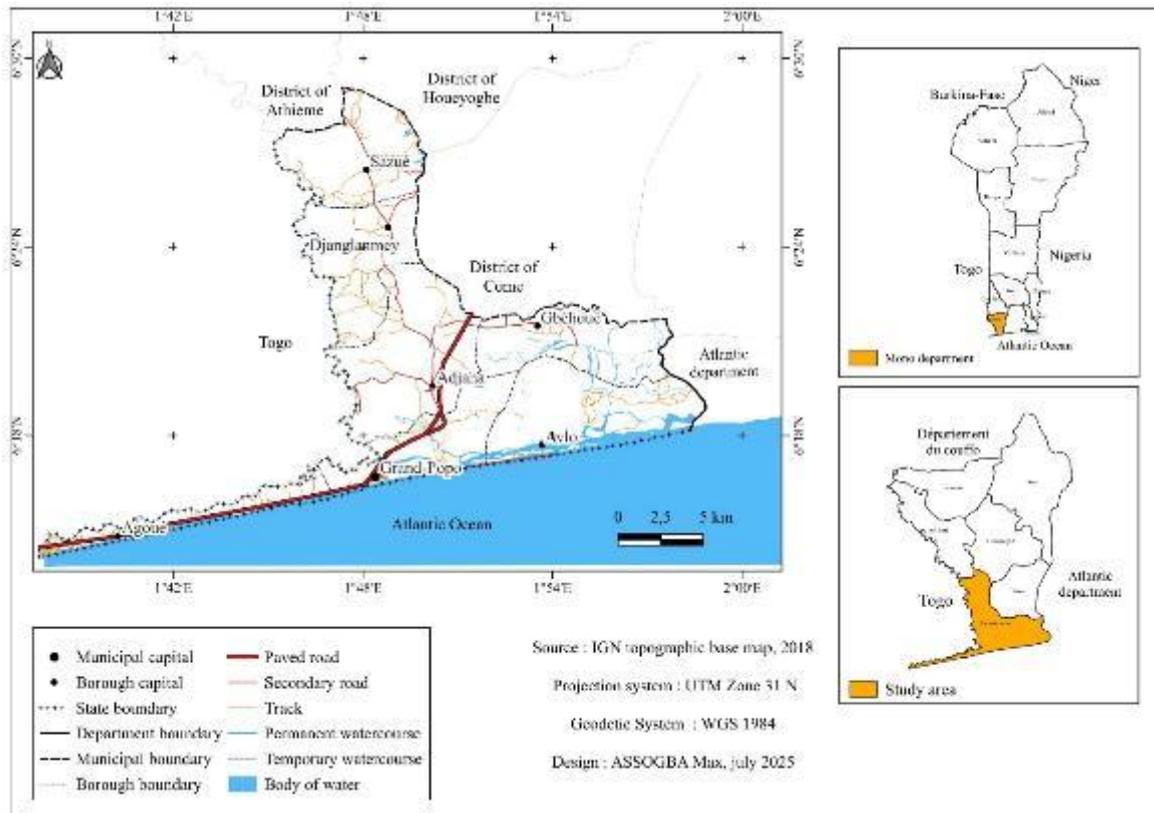
The present study thus aims to analyze local flood risk management strategies in the municipality of Grand-Popo, highlighting the perceptions of populations, the socio-economic impacts of floods and the adaptation mechanisms developed at the local level.

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## **2. Materials and methods**

### **2.1. Presentation of the study area**

This study was conducted in southwestern Benin, specifically in the municipality of Grand-Popo, located between 6°15' and 6°25' north latitude and 1°40' and 1°49' east longitude. It is a commune in the Mono Department bordered to the north by the communes of Athiémé, Comé, and Houéyogbé, to the south by the Atlantic Ocean, to the southwest by the communes of Ouidah and Kpomassè, and to the west by the Republic of Togo (Figure 1).



**Figure 1** Geographic location of the municipality of Grand-Popo

## 2.2. Material and methods

The data used in this study come from documentary sources and field surveys. The documentary data were collected in several documentation centers and specialized institutions.

Field surveys were carried out among the populations affected by the floods as well as with stakeholders involved in risk management. The data collection was based on the Active Participatory Research Method (PRA), combining questionnaires, semi-structured interviews and direct observations.

A sample of 374 households was drawn from a random sampling based on the formula of Schwartz (1995), with a confidence level of 95% and a margin of error of 5%. The surveyed households were distributed in seven districts of the municipality.

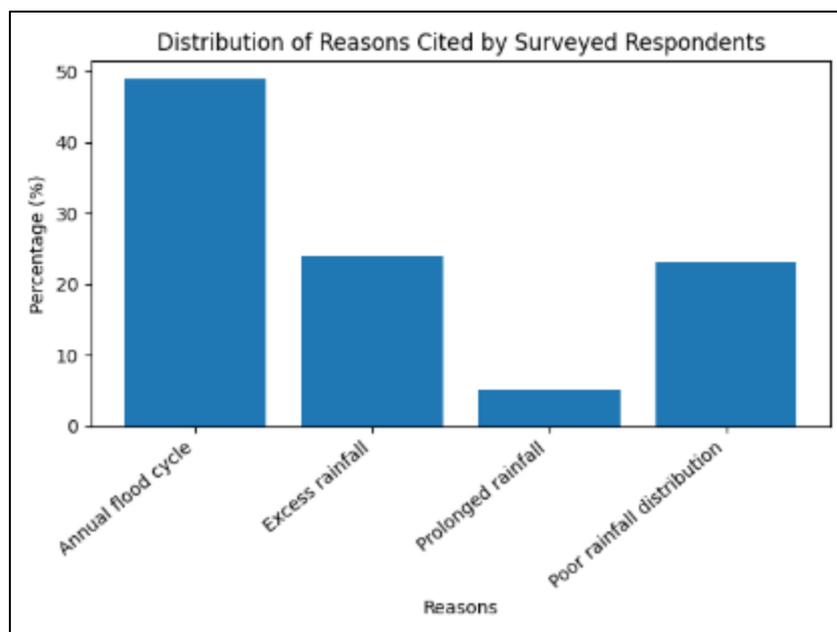
The data collected was processed using Excel and SPSS software (version 17.0). Statistical analyses are mainly based on descriptive statistics such as frequencies, means and comparison of observed values.

## 3. Results

### 3.1. Flood situation in the municipality of Grand-Popo

The inhabitants of Grand-Popo face serious dangers due to massive floods. What was once a five-year phenomenon even before the construction of the Nangbéto dam has now become an annual event.

During our exchanges on the ground, we collected many explanations given by the families to tell their experiences in the face of these floods in the commune of Grand-Popo. (Figure 2)



Sources : Fieldwork, July 2025

**Figure 2** Breakdown of the reasons mentioned by the respondents

In the municipality of Grand-Popo, nearly half of the households surveyed (or 48.6%) report experiencing flooding each year. These usually occur between June and September. About a quarter of the families surveyed (24.2%) attribute these annual floods to excessive rainfall. Only 4.8% of respondents believe that the floods are caused by the persistence of short-season rains, while 22.4% of households point to a poor distribution of showers.

Beyond these perceptions, it is important to know that multiple factors explain these floods. These include natural factors, such as the configuration of the land, especially the strong presence of marshy areas. Without forgetting the geographical position of the municipality, located at the mouth of the river Mono and the channel Aho. To this are added the significant floods, caused by the abundance of precipitation and the density of the hydrographic network. Other factors should also be mentioned, such as the proliferation of invasive aquatic plants (water lettuce, water hyacinth, water lily). Their growth reduces the normal flow of water, decreases its oxygenation and blocks light, thus creating oxygen-free conditions where only the most resistant species can survive. This lack of oxygen causes the massive death of aquatic species and, consequently, the siltation of streams and water bodies.

Beyond natural causes, certain human activities also contribute to the worsening of floods in the municipality of Grand-Popo. We are thinking in particular of the construction of dwellings in low-lying areas and the release of water from the Nangbéto dam. These releases cause the overflow of the Mono river and flood a large part of the territory of Grand-Popo. For the inhabitants living along the Mono river, these water releases are the main cause of annual floods. The populations also estimate that, since the construction of the Nangbéto dam, water submerges 56% of the villages in the commune of Grand-Popo every year. These floods severely destabilize local economies, which are already very fragile.

### 3.2. Socio-economic consequences of the floods in the municipality of Grand-Popo

In low-lying areas, where water tends to stagnate, farmers report that in 2024 they lost most of what they had grown. The floods mainly impacted the agricultural season.

To really understand the scale of the disaster, we surveyed corn and vegetable farmers. Their testimonies are striking: almost 85% of them reported having lost between 40% and 85% of their maize harvest.

That is why, faced with this situation, some farmers are now trying to plant different kinds of crops on the same plot. The idea is not to focus on a single activity.



Shooting : ASSOGBA, July 2025

**Figure 3** Presentation of a variability of market crops

Apart from agricultural activities, it should be noted that part of the population engages in fishing production activities, while exploiting the rivers kplabè and Gbagan taking into account the Aho channel.



Shooting: ASSOGBA, 2025

**Figure 4** View showing a citizen engaged in fishing activity in Avlo



Shooting: ASSOGBA, 2025

**Figure 5** View showing the degradation of infrastructure in Hounsoukouè

As soon as the showers are particularly intense, rivers and lakes overflow their banks and water submerges the surrounding land. It is often the agricultural world that suffers the most because entire harvests are devastated, hundreds of animals drown, not to mention the fish that disappear en masse due to damage suffered by farms and fishing infrastructures. The destructive waves also do not spare the buildings, tracks and production equipment of

workshops, workplaces, machines that are damaged, sometimes to the point of being unusable, as well as the reserves of goods.

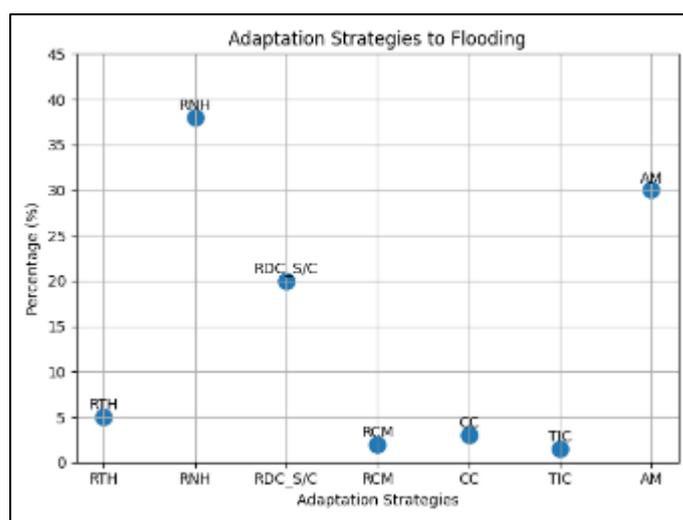
Faced with this recurring reality in the municipality of Grand-Popo, local populations are gradually putting in place various adaptation strategies to limit losses and preserve their livelihoods.

### 3.3. Flood risk management strategies in the municipality of Grand-Popo

#### 3.3.1. Adaptation and mitigation strategies

Faced with the constant concern of floods, which can be very destructive, and the many problems they cause for the economy, the interactions between environmental dynamics and the livelihoods of communities, the inhabitants of this region have found different ways to adapt. These solutions, created from their own local experiences and observation of how water behaves, aim to make homes safer and limit material damage.

The main actions they have implemented are grouped and shown in figure 6. This illustration highlights the diversity of adjustment strategies that communities living near water have adopted to face the difficulties imposed by floods.



Source: Statistical treatment of fieldwork, September 2025

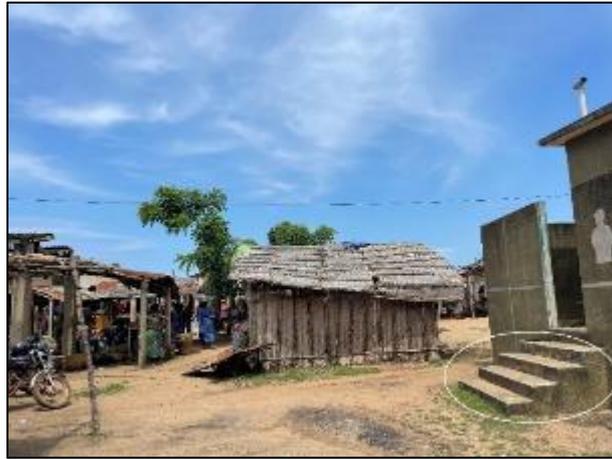
Legends: RTH: Strengthen the Roof of the Dwelling; RDC\_S/C: Backfill from the storefront or from the Court; RNH: Raise the Level of Housing; RCM: Rebuild other Rooms or another house; CC: Build the Fence; TIC: Waterproofing Works (Cement) of the Court; AM: No Measure.

**Figure 6** Flood risk adaptation measures

It is very often found that, to cope with floods, the most common gesture among residents is to raise the foundations of their house. Around 38% of respondents regularly adopt this trick. Their goal is to prevent water from seeping in and thus better protect the occupants and their precious goods.

For nearly 20% of the families we surveyed, backfilling the space in front of their door is a major concern. Other strategies to counter floods are also used by some households. For example, we think of the consolidation of roofs (4.5%), the addition of new rooms or even the construction of another house (1.90%), the consolidation of a medium-sized fence for dwellings that do not have one (2.60%), or to arrangements to make the yard water-resistant (1.50%).

Nearly 31% of the people surveyed do not take any specific measures to limit the damage when the water rises. Beyond these usual gestures, other reflexes are adopted without fail as soon as the rainy season approaches.



Shooting: ASSOGBA, September 2025

**Figure 7** View showing the enhancement of a habitat

One can observe through this photo that the level of the dwelling has been raised. This strategy essentially aims to raise the immediate surroundings of houses in order to curb water intrusion and reduce the exposure of people as well as material goods.

### 3.3.2. Flood risk prevention strategies

By repeatedly suffering financial losses, seeing their living environment deteriorate and the well-being of their families gradually decrease, the inhabitants of Grand-Popo, those who live in areas regularly affected by floods, have gradually found different ways to protect themselves. These steps show a real willingness not to be surprised and to limit the damage, relying on everything they have learned from previous floods.

The main prevention actions implemented by these riparian communities are summarized in Figure 8, which highlights the richness of local solutions found to address this environmental fragility that lasts.



Shooting: ASSOGBA, September 2025

**Figure 8** An alert information panel

Figure 8 present a local system to anticipate floods. It is an alert sign, installed near the river, which serves both to educate people and to give them clear instructions. It aims to understand the different alert levels related to rising waters and the pipes to be maintained according to the urgency of the situation.

The principle of this system is a vertical color code (green, yellow, orange, red), painted on a large plate clearly visible from afar. Each color has its meaning: it indicates a precise degree of alert and the state of progress of the phenomenon. Green is when everything is going well, it stipulates a slight attention. If it is yellow, this explains that the water begins to rise gradually, so one must be vigilant and prepare. The orange is a more serious alert: we must stop dangerous activities and everyone must mobilize to help each other. And the red one, there, is the absolute urgency: it is necessary to act quickly, such as evacuating the premises, calling for help, and putting one's belongings in shelter.

This tool therefore helps to anticipate and make communities stronger in the face of hazards.

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#### 4. Discussion

The results obtained highlight the high vulnerability of the municipality of Grand-Popo to flood risks, resulting from a complex interaction between natural factors, hydrological dynamics and anthropogenic pressures. The high frequency of floods reported by the populations, of which nearly half of the households surveyed report experiencing this phenomenon each year, confirms the trend observed in several delta areas of West Africa where the hydro-variability climate increases the exposure of riparian territories to hydrometeorological hazards [8]. In the municipality of Grand-Popo, floods are mainly associated with the flooding of the Mono river, the abundance of rainfall and the geomorphological configuration of the territory. Located in a deltaic environment characterized by a low altitude and a high density of wetlands, the commune presents natural conditions favorable to stagnation and accumulation of water. Similar observations have been reported in other river settings in West Africa, where low topography and proximity to rivers are major factors of vulnerability to flooding [1]. Beyond these natural factors, anthropogenic transformations of the hydrological system also contribute to modifying flood dynamics. The commissioning of the Nangbéto dam on the Mono River in 1987 has profoundly transformed the hydro-sedimentary regime of the watershed. According to the work of [2], artificial flow regulation has led to a modification of natural flood and recession cycles, with significant consequences for downstream areas. In this context, the release of water from the dam is an aggravating factor for flooding in the municipality of Grand-Popo, particularly when these operations coincide with episodes of heavy rainfall. The observed socio-economic impacts confirm the extent of the disturbances caused by these hydrological events. Agricultural losses reported by producers, sometimes reaching more than half of the harvests, illustrate the sensitivity of local farming systems to climatic and hydrological fluctuations. Comparable results were observed in the municipality of Lokossa, where [3] showed that extreme climatic events regularly cause flooding of agricultural plots and a significant decrease in yields. Similarly, [4] points out that rainfall variability and seasonal floods are key factors in the degradation of agricultural production in several regions of Benin.

Faced with these environmental constraints, local populations are gradually developing adaptation strategies aimed at limiting losses and strengthening their resilience. The results of the study show that some strategies rely on structural adaptations, such as raising housing or backfilling yards, which reduce direct exposure to floods. These practices testify to the capacity of local communities to mobilize their empirical knowledge to cope with environmental hazards. At the same time, adaptation strategies also include a diversification of economic activities, notably through the development of market gardening, livestock and fish farming. These initiatives aim to reduce the exclusive dependence on rain-fed agriculture and secure household livelihoods. Similar dynamics have been observed in several rural regions of West Africa, where diversification of activities is a key mechanism for adapting to climate change [9].

In this context, the sustainable management of flood risks in the municipality of Grand-Popo requires an integrated approach taking into account both environmental, economic and social dimensions. Mangrove restoration and sustainable management of wetlands appear in particular as important levers to strengthen the ecological resilience of the territory. Indeed, these ecosystems play an essential role in the stabilization of banks, hydrological regulation and protection of coastal areas against floods. Furthermore, improving hydrological governance is a central issue. Better coordination in the management of the Nangbéto dam, combined with warning and territorial planning mechanisms, could contribute to reducing the population's exposure to floods. Similarly, the integration of local knowledge into risk management policies appears to be essential for enhancing the effectiveness of adaptation strategies. Thus, the combination between endogenous knowledge of communities, institutional interventions and sustainable land management policies is an essential condition to improve the resilience of populations facing flood risks in the commune of Grand-Popo.

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#### 5. Conclusion

The analysis of local flood risk management strategies in the municipality of Grand-Popo highlights a high vulnerability of populations facing hydrological and climatic dynamics. Floods result from a combination of natural and anthropogenic factors, including rainfall variability, the geographical configuration of the Mono delta, ecosystem degradation and water releases from the Nangbéto dam.

The socio-economic impacts are particularly marked in the agricultural and fisheries sectors, leading to production losses, a degradation of infrastructure and a weakening of livelihoods.

Faced with these constraints, populations develop various adaptation strategies based on local knowledge and the diversification of economic activities. However, these initiatives remain limited in the face of intensifying climate hazards.

Sustainable management of flood risks in the municipality of Grand-Popo therefore requires the strengthening of prevention policies, the integration of local knowledge into spatial planning strategies and the promotion of economic activities compatible with ecosystem preservation.

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### **Compliance with ethical standards**

#### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

#### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study

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