

# Factors behind the Upsurge in Flooding in Abobo (Abidjan-Côte d'Ivoire)

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**How to cite this paper:** Marcel, B. K. (2025). Factors behind the Upsurge in Flooding in Abobo (Abidjan-Côte d'Ivoire). *Journal of Geoscience and Environment Protection*, 13, 126-135. <https://doi.org/10.4236/gep.2025.132009>

**Received:** December 17, 2024

**Accepted:** February 16, 2025

**Published:** February 19, 2025

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## Abstract

For the past decade, the communes of Abidjan have been increasingly affected by natural hazards, causing considerable damage. One of the most dreaded of these is flooding, which haunts the population during the rainy seasons. The State of Côte d'Ivoire has shown its commitment to eradicating flooding by taking preventive measures (evacuation, cleaning out gutters, etc.) in the city, particularly in the areas most affected by the damage. Despite the efforts that have been made, the municipality of Abobo, which is located in a basin and on a steep slope with inadequate development, still suffers from flooding, with more than 15% of victims. The aim of this study is to elucidate the reasons that amplify this hazard. The study was made possible by field surveys involving observation and interviews, documentary research, and photographs taken using our GPS-enabled mobile phone based on a topographical map of the Abobo commune. In short, morpho-structural conditions and man-made factors, the consumption of space in all its forms by urbanisation, the fundamental role of rainfall and the occupation of pavements and drainage networks are the basic reasons for flooding in Abobo.

## Keywords

Natural Hazards, Flooding, Inadequate Development, Illegal Occupation, Abobo

## 1. Introduction

Current events show that a number of natural phenomena are occurring more and more around the world. These phenomena cause loss of human life and relatively significant material damage. One of the most devastating is flooding. This natural phenomenon affects both rural and urban areas (Alla, 2013; Marcel, 2015). In this regard, ANDE (2003) estimate that the vulnerability of urban populations to

natural disasters and risks is increasing considerably. As a result, urban risks such as flooding are linked both to an increase in the density of diversified land use and to the manifestation of all forms of exchange (<http://scholar.google.com>, Veyret, 2004; Adaye et al., 2022). Thus, risk is defined as the possibility of a destructive natural phenomenon affecting people and their property (Kouadio, 2001). Localities with heavy rainfall where urbanisation does not take place are potentially exposed to natural hazards, including flooding.

Located to the north of the city of Abidjan, and second only to Yopougon in size, Abobo occupies a plateau site dotted with basins that are difficult to build on when rainfall is high. With more or less sustained development, urbanisation sometimes exceeds the boundaries of the plateau, which is dotted with basins that are difficult to urbanise with heavy rainfall. With more or less sustained development, urbanisation has sometimes gone beyond the limits of buildable areas to include other non-constructible zones, as a result of population growth and failure to comply with town planning regulations, with spontaneous settlements springing up. In this environment, where rainfall is abundant—more than 1800 mm per year—and where topographical, human and technical conditions no longer keep pace with the pace and specifications of existing urbanisation (Marcel, 2008), flooding occurs on a recurring basis, causing considerable damage. This is the issue that this study will attempt to address. In other words, the aim of this study is to draw up an inventory of the various conditions under which flooding occurs in the municipality of Abobo. In short, the morpho-structural conditions and anthropogenic factors, the consumption of space in all its forms by urbanisation, the fundamental role of rainfall, and the occupation of pavements and drainage networks are the basic foundations for the occurrence of flooding in the aforementioned municipality. This work focuses on one point: a diagnostic analysis of flood risk factors in Abobo. The technique used to complete the work is as follows.

## 2. Method

### 2.1. Presentation of the Study Area

The commune of Abobo is located in the northern part of the city of Abidjan and occupies plateau and basin sites that are difficult to urbanise. It borders the communes of Cocody to the north-east, Attécoubé to the north-west and Adjamé towards the centre (Figure 1).

### 2.2. Information Gathering and Processing

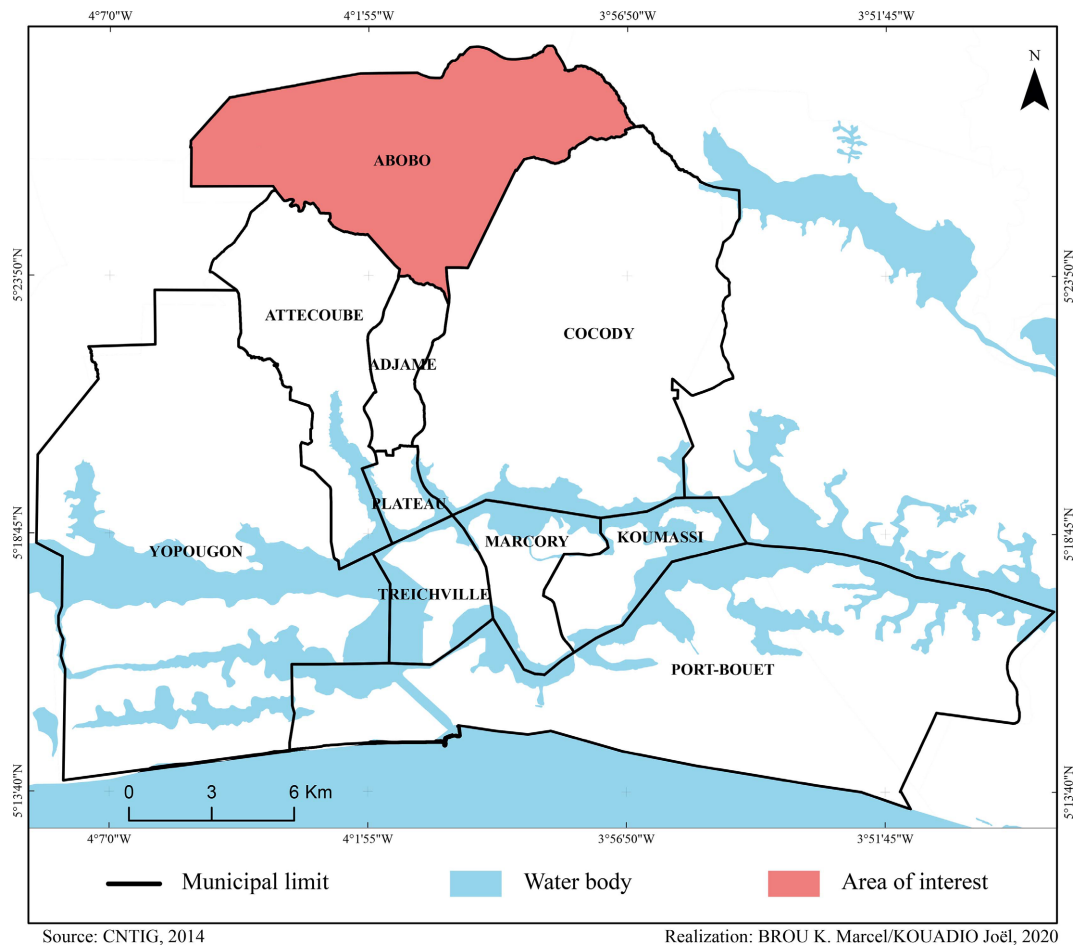
#### 2.2.1. Gathering Information

Techniques were used in this phase to obtain succinct information about the events. This involved interviews with local people and authorities, as well as documentary research. This work was carried out using geographical aids that enabled us to find our way around the most affected areas of the commune.

##### 1) Documentary research

The information gathered for this study came from documentation centres such as the library of the IGT (Institut de Géographie Tropicale) and our various

documents on natural phenomena already acquired. The technical and environmental departments of town halls were also consulted.



**Figure 1.** Location of Abobo commune.

## 2) Population surveys

This work combines qualitative and quantitative approaches. These include surveys carried out in the field in 2014 and 2022 in order to gather brief information. In fact, these various surveys consisted in objectively introducing us to all the neighbourhoods of the aforementioned commune, in order to identify the most vulnerable areas and those most exposed to natural hazards. Secondly, to identify the factors behind the recurrence of flooding, despite the efforts made every year to prevent it. This is a qualified exhaustive survey because most of the areas affected were visited in order to make the work more credible.

## 3) Interviewing local authorities

The first people to be indexed after the occurrence of a natural phenomenon are the local authorities. In order to obtain more information, we questioned the various agents of the town hall, i.e., those in the technical, environment and population departments. These questions concerned the site on which people are building, the types of pipes, and the various developments.

### 2.2.2. Information Processing

Most of the information obtained came from the Abobo town hall. It consists of documents that state when the phenomenon occurred. We also read from the authors. The information was also presented in Word and on maps. Adobe Illustrator and Arcgis software were used. Example of the above maps.

## 3. Analysis of Results

As mentioned above, this work can be summed up in one point: a diagnostic analysis of the factors behind the resurgence of flooding in the commune of Abobo. There are several reasons why flooding occurs in Abobo.

### 3.1. Urban Growth Regardless of Site Conditions

As the population grows, so does the demand for land to live on. The standard of living becomes an imminent factor. As a result, non-oedificandi sites are being snapped up for construction.

The population of this commune is growing rapidly. In 1955, the urban population was estimated at 30,000; in 1975, the resident population rose to 141,000, more than five (5) times in 20 years; in 1988, the population quadrupled to 401,211 in 13 years; in 10 years, the population almost doubled to 638,237 in 1998. In 2011, the population rose to 938,424, with an annual growth rate of 2.69%. This trend does not stop; in the 2014 Recensement Général de la Population et de l'Habitat, the population rose to 1,030,658. At this stage, the details are well established. Nationals and non-nationals have been identified on the basis of status. In terms of Ivorians, we count 439,337 men and 436,319 women, with a total population of 875,656. Within this total, the under-18s (–18 s) account for 374,102 inhabitants compared with 501,554 inhabitants for the over-18s (18+s). Non-nationals in 2014 (non-Ivorians) were as follows: men 83,655 and women 71,347 with a total of 155,002 inhabitants.

In 2021, more than 300 inhabitants will be added. Our population will therefore rise to 13,483, with 680,422 men and 6,566,061 women. The number of households will rise to 280,206. INS-RGPH (1955, 1975, 1988, 1998, 2011, 2014 and 2021) adapted Porna (2021).

However, this population will occupy an area that is more or less suitable for urbanisation, as it is affected by closed depressions that expose it to flooding every year in the warmer seasons. On the margins of the interfluvium, there are natural obstacles.

To the east, the relief is highly rugged and dissected by a dense network of ravines. These are the tracks left by the streams, tributaries of the Djibi. The difference in level of these ravines is pronounced, ranging from 40 to 60 metres. To the north, the head of the Djibi valley forms a forty-metre deep cut, blocking any harmonious urban development towards Anyama; to the west, the ravines are deeply incised (40 to 50 metres deep), forcing the extension of the Sagbé (Derrière-rails) district to take a jagged course; to the south of Abobo-té, Abobo-baoulé,

Djorogobité 1 and 2 and the town of Abobo, a series of ravines with varying degrees of gradient constrain urban development to the south and south-east. They separate Abobo from the urban areas of Adjamé North and Deux-Plateaux (Alla, 2013) (Figure 2).

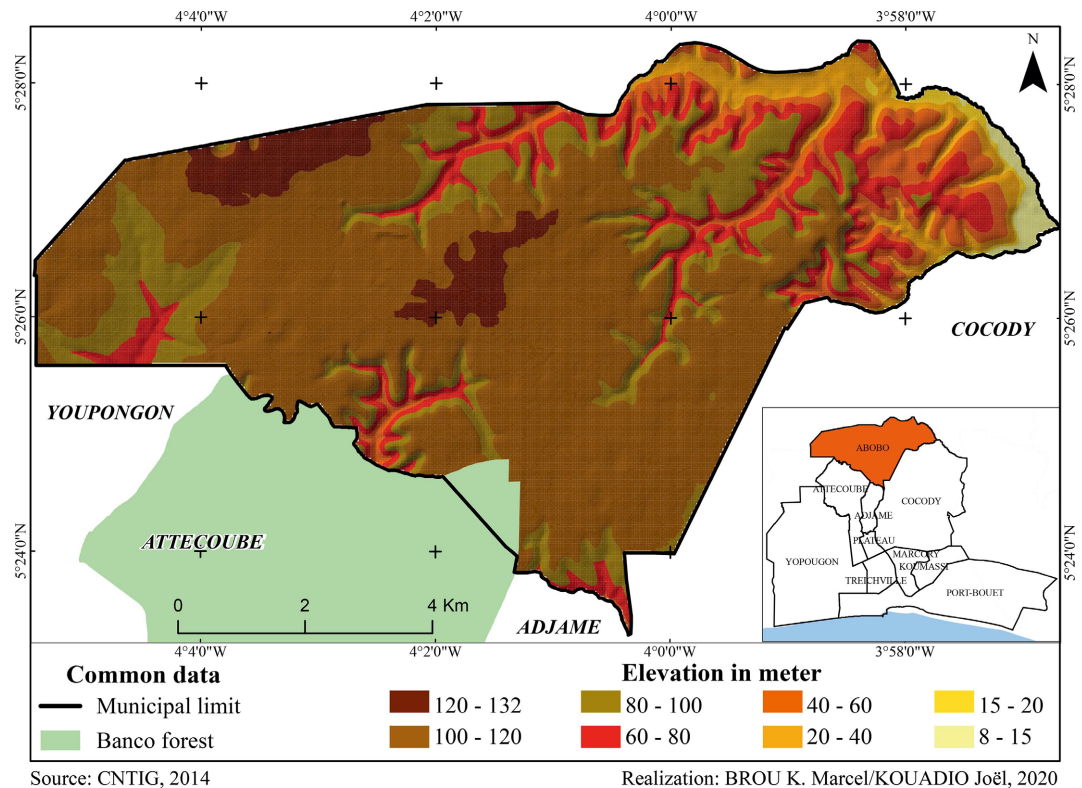


Figure 2. The topography of Abobo.

However, these reliefs are different because of the degree to which they have been dissected. It is a plateau broken up on the sides by hollows known as natural depressions.

These are areas where rainwater collects naturally, making them difficult to build on. There are around thirty of them in the current urban area.

These depressions vary in size from 100 to 125 metres and are no more than five (5) metres deep. Abobo has eighteen (18) storm water basins and ten (10) ravines. Among these storm water basins, there are eight (08) critical basins likely to cause enormous damage. These include the Houphouët-Boigny, Agnissankoi, Plaque rouge, Lac aux caïmans, Pays-Bas, Glacier, Monastère and Bougounisso stormwater basins, all of which expose the population of Abobo to flooding. Understanding the causes is a matter of understanding everything that has been said. Example of a flooded site in the monastery district (Figure 3).

In addition, this urban growth, which takes no account of site conditions, shows how often unsuitable or even flood-prone areas are taken over by the population. The surface area of the commune was 290.6 hectares in 1971 at the start of its urbanisation, then 1101.7 hectares in 1979, 1929.3 hectares in 1989, 3948.2

hectares in 2007, then 7800 hectares in 2011 to reach 9000 hectares in 2021 (Alla, 2013 addition and adapted to Brou in 2023).



**Figure 3.** A flooded neighbourhood. Houses built in non-oedificandi extension zones flooded by rainwater. Shooting: N’Goran, 2019 adapted Brou 2022.

### 3.2. An Insignificant Drainage Network

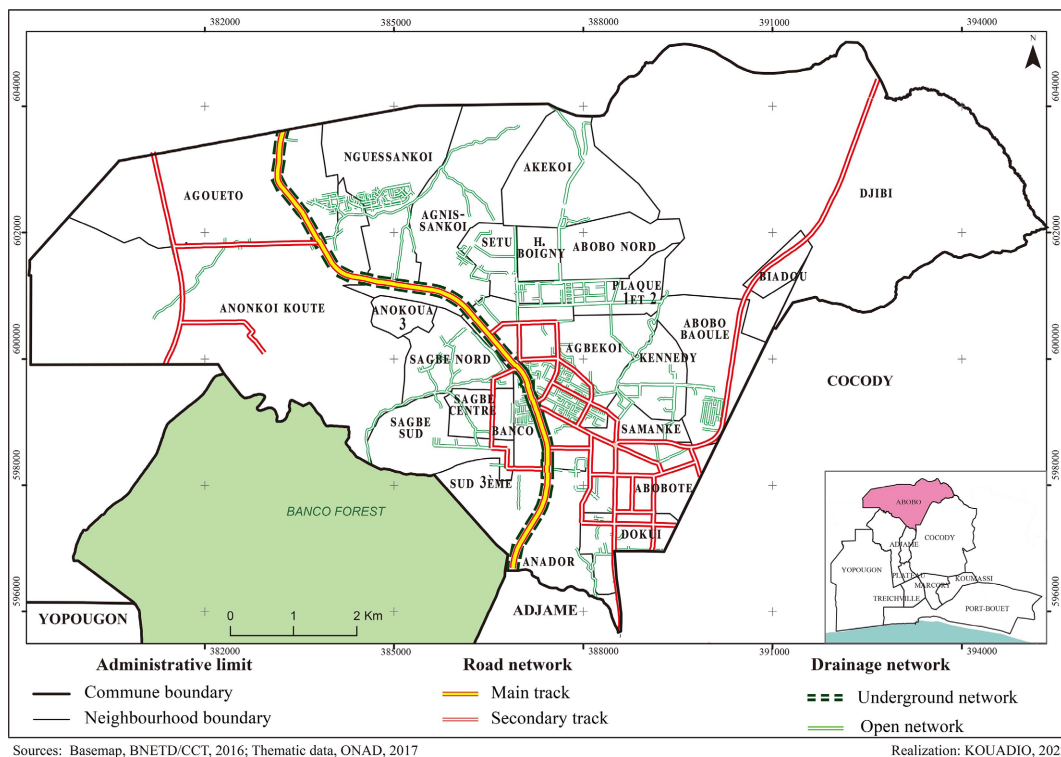
A city’s development is based on its infrastructure, particularly land and surface infrastructure. This includes development. The key element in this dynamic is the drainage system, also known as the road network.

The diagram below shows the road network in the commune of Abobo as a whole in the city of Abidjan in 2009 (Table 1).

**Table 1.** Breakdown of the Abidjan drainage network by commune. **Source:** SODECI/DT computerised mapping service, 2009; taken from these Alla, 2013.

Communes	Rainwater network (m)				Unitary Network (m)	Linear total (m)	
	Gutter	Circular duct	Grand Canal	Other	Circular duct	In absolute value	En %
Abobo	23,679	43,440	0	12,301	840	80,260	6,70
Adjamé	49,070	35,761	0	1028	24,702	110,570	9,20
Attécoubé	8595	14,063	929	866	1674	26,127	2,20
Cocody	85,773	170,468	0	23,580	15,867	295,688	24,60
Koumassi	36,437	10,502	0	9600	0	56,539	4,70
Marcory	31,792	41,587	1400	24,103	6269	105,151	8,70
Plateau	19,651	19,021	0	1374	30,161	70,207	5,80
Port-Bouët	30,084	6718	0	4044	0	40,846	3,40
Treichville	21,112	40,459	0	4068	71,922	137,561	11,40
Yopougon	111,621	144,600	4623	18,715	560	280,119	23,30
<b>Total Abidjan</b>	<b>417,823</b>	<b>526.619</b>	<b>6952</b>	<b>99,679</b>	<b>151,995</b>	<b>1,203,068</b>	<b>100</b>

Looking at the table, we can see why flooding occurs in Abobo. The municipality has only 6.70% of the water drainage network. This is still very low for an area with closed depressions, where urban growth is in full swing, and where rainfall is high, at around 2200 mm/year, as a result of the occupation of peripheral areas and even non-oedificandi extensions for housing. In fact, as *Alla (2013)* explains, the rainwater drainage network is limited to areas where the public authorities have intervened in the development of urban space (SETU, SOGEPHIA and 111 ha). The figure below gives a good idea of the situation (**Figure 4**).



**Figure 4.** Drainage network in the municipality of Abobo.

### 3.3. Tight, Unmaintained Networks

One aspect of sustainable stormwater management is the construction of gutters and culverts. After the rains, work is constantly being carried out to alleviate flooding problems, but it does not respond effectively to people’s aspirations. In areas where improvement work has been carried out, faults are immediately apparent. The sizing of gutters is a major problem in development projects. Everywhere, the narrowness of the drainage systems leads to overflowing in all directions during rainfall. The permanent silting up of culverts is a major problem in the day-to-day management of road networks. In addition to the constant silting up of the water, it should also be noted that the drains are used as dumping grounds for local people, who make no effort to dispose of their rubbish in the bins, despite the rubbish banks located in each neighbourhood sector. Cleaning is almost non-existent. All this clogs up the gutters and, in the rainy season, causes

them to overflow. These photos illustrate the situation.

#### 4. Discussion

La manifestation voire la survenue des inondations dans la commune d'Abobo résulte de plusieurs facteurs. La croissance démographique, l'occupation des espaces non oedificandi pour construction dans les zones d'extension, le niveau insignifiant de l'aménagement, la nature de l'assiette spatiale en sont autant de raisons (Marcel, 2008, 2015; Alla, 2013).

As a result, urban risks such as flooding are linked both to an increase in the density of diversified land use and to the manifestation of all forms of exchange. Indeed, the exponential urban growth over the last thirty (30) to fifty (50) years and the exposure of the site to threatening phenomena are reflected by physical and technical factors that accentuate the damaging capacity of geophysical and hydrometeorological phenomena (Géocarrefour, 2000; Alonso et al., 2020). In particular, all the contributions denounce the intervention of physical factors for which man is directly responsible (Cissé, 2020). Indeed, urban growth is accompanied not only by an alteration in the traditional town-country relationship, but also by a host of urban dysfunctions as a result of the proliferation of informal settlements. The way in which land is occupied by a highly assertive demography is both the source of the harmful effects induced in the cities of developing countries (DCs) and the consequence of land policies (Thouret, 1994; Marcel et al., 2024; Marcel et al., 2021). It should also be noted that site conditions have a direct influence on spatial growth and urban densification, as well as maintaining permanent natural risks such as flooding (Assako, 1996). According to Thouret (1995), population growth in developing countries is so exponential that urbanisation can no longer satisfy the population's need for urban land. N'Guettia (2020), in the same vein, describes the Third World city as a juxtaposition of official housing estates and private initiatives that do not comply with the legal provisions on urban planning. The production of serviced plots of land is low, and there is no wastewater or rainwater drainage network. This leads to frequent and alarming flooding during the rainy season. All these approaches confirm those mentioned in the course of our work.

#### 5. Conclusion

Over the years, Abobo, a town increasingly sought after by the population, has been the scene of flooding. The physical context of the site (topography with closed natural depressions and large, dissected plateaux), the settlement of populations on all parts of the relief, the narrow, unmaintained gutters and the heavy rainfall are the main factors. So, in this environment where urbanisation is insignificant with a restrictive site, where the population is constantly increasing, if the authorities are not careful, in the long term we will be faced with a dramatic situation.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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