



“I heard a loud bang (Vroom)...”: Public Perception of Causes and Socio-Environmental Effects of Landslides in Northern Abidjan, Côte d’Ivoire

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Abstract

Landslides in Côte d’Ivoire, are becoming increasingly frequent and severe, causing significant environmental devastation and loss of life in Côte d’Ivoire particularly in Northern Abidjan region. Though Abidjan is often prone to coastal flooding, it is highly susceptible to landslides. This study therefore explored community perceptions of causes and effects of landslides, and the associated responses in the affected region. A mixed-methods approach, incorporating a survey of 384 households, field observations, transect walks, and key informant interviews of key environmental and public safety officials in Côte d’Ivoire, was employed. Heavy rainfall/ long duration (51%) and steep slopes (23%) were identified as the primary perceived causes of landslides. Qualitative data strongly confirmed these, highlighting heavy precipitation, poor soil structure and unregulated construction in high-risk zones as key contributors. Perceived socio-environmental impacts include building collapses (46%), fatalities (33%), injuries (15%), widespread property destruction, displacement, and disrupted children’s schooling, confirmed by field observations. Community narratives revealed inadequate early warning systems and predominantly reactive institutional responses, often limited to post-disaster assistance. Consequently, residents actively implement local adaptation strategies (e.g., sandbags, tyres) to severe slope erosion. This study offers crucial insights for disaster risk management, aiming to improve public awareness and strengthen institutional capacity to effectively understand and mitigate devastating landslide impacts through informed decision-making, including improved early warning systems, community awareness programs, and preventative land-use planning and policies.

Keywords

Landslides, Environmental hazard, Qualitative research, Public perceptions, Côte d’Ivoire

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1. Introduction

Landslides are among the world's most destructive natural hazards, causing widespread casualties, material losses, and long-term environmental degradation (Shrestha, 2019). Primarily driven by a complex mixture of geological, morphological, anthropogenic, climatological, and hydrological factors (Benineza et al., 2019; Claude et al., 2020), they are characterised by the downslope movement of debris, rocks, or soil (Shanmugam & Wang, 2015) and vary considerably in expression and impact from place to place. According to the World Health Organisation (2022), between 1998 and 2017, landslides claimed approximately 4.8 million victims worldwide, while more than 4,000 non-seismic events kill over 5,000 people annually (Desodt et al., 2017). In 2015 alone, landslides directly or indirectly affected 150,332 people globally, with over 4,300 deaths rising to 32,322 the following year (McAdoo et al., 2018). The economic

toll is equally severe, with the World Bank (2020) estimating annual landslide-related losses at approximately 20 billion US dollars.

The primary physical trigger of most landslides is excess soil water from heavy rainfall, which reduces soil cohesion and initiates slope movement (Portillo, 2023; Yadari & Idrissi, 2021). Steep gradients amplify this risk, and even moderate slopes become dangerous when the underlying material is unstable. Anthropogenic activities such as excavation, mining, unregulated construction, and deforestation further modify the landscape and heighten vulnerability (Portillo, 2023). Climate change, in addition, intensifies these physical factors through changing patterns of precipitation and runoff, while rapid population increase, poor land-use planning and inadequate building regulation in hazard-prone locations accelerate social exposure (Haque et al., 2019; Ajake et al., 2022).

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Despite significant scientific advancement and financial investment in landslide risk reduction, the socio-economic impacts of this natural hazard on local communities are enormous and still unresolved, particularly in rapidly urbanising regions of the Global South.

Africa has experienced a marked rise in landslide-related fatalities in recent decades (Asmare, 2022). Gerrard et al. (2021) estimate that 34% of the global mortality from landslides in their study period was from Africa. Urban expansion due to rural to urban migration, estimated by Hope (1998) to be 3% per year for sub-Saharan Africa, six times that of developed countries, has populations clustered on unstable slopes, increasing susceptibility (van Niekerk et al., 2020). Documented events across the continent illustrate this toll. In Rwanda, landslides between July 2016 and June 2018 killed 39 people and damaged over 1,362 buildings (Nema et al., 2023); in Sierra Leone, according to the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), the August 2022 flash floods and landslides in Freetown affected 122 households and killed at least six persons (OCHA, 2022); and in Mauritania, a single week of heavy rains in July 2022 killed approximately 14 people and affected over 29,000 others (OCHA, 2022).

Côte d'Ivoire, and Abidjan in particular, exemplifies the convergence of physical susceptibility and social exposure that makes urban landslide risk so acute in West Africa. The country has recorded a succession of deadly events over the past five decades: landslides in 1977 and 1988 on the Man-Biankouma axis, widespread flooding and landslides in 2009 that left 22 people dead and 121 students homeless (Hauhouot, 2008), and the designation of 2014 as the year of hydrometeorological hazards in Abidjan, when Yopougon, Attécoubé, Abobo and Adjamé were worst affected (OCHA, 2021). By 2020, at least 18 people were killed in Abidjan following torrential rains, including events in the Anyama community to the north of the city. In June 2023, five family members died when three shacks were destroyed in a landslide after heavy rains, mirroring a 2022 event that claimed six members of another family (OCHA, 2023). Data from the Military Fire Brigade Group (GSPM) revealed a six-fold increase in recorded landslide events — from 14 to 89 — between 2020 and 2023 alone, a trajectory that signals structural deterioration rather than isolated incidents. Northern

Abidjan's seven municipalities such as Abobo, Adjamé, Attécoubé, Anyama, Cocody, Plateau, and Yopougon are particularly exposed built on steep slopes underlain by water-saturated sandy-clay soils, and home to a population that nearly doubled from 2,128,261 in 1998 to 4,654,536 by 2021 (Institut National des Statistiques (INS) 2021). These densely populated informal areas face a compounding hazard that the government's predominantly reactive, post-disaster response has been unable to contain (Coulibaly et al., 2024; Marcel et al., 2021).

Despite the magnitude and frequency of this threat, a critical gap persists in scientific literature. Existing studies on landslide risk have mainly focused on physical mechanisms — rainfall thresholds, slope stability, soil composition — and on quantifying casualties and economic losses (Haque et al., 2019; Petrucci, 2022; Desodt et al., 2017). The local perceptions and life experiences associated with this risk remain largely unexamined in this context: how communities perceive the causes and effects of landslides and respond to the hazards in the absence of adequate institutional protection. Community-centered perception studies conducted in Indonesia, Rwanda, and parts of Latin America confirm that understanding these perspectives is essential for improving adaptation and disaster response (Setiawan et al., 2014; Nema et al., 2023; Slovic et al., 2024), and community involvement in local risk reduction plans builds community resilience and effective decision-making (Märgärint et al., 2021). To the best of our knowledge, very little is known about community perceptions of landslides in the affected areas of Côte d'Ivoire. Most of the literature on landslides in Abidjan consists of institutional bulletins and press reports that describe outcomes but not public understanding, local risk stories, or community-level coping behaviour (OCHA 2021, 2022, 2023; Centre Des Opérations d'Urgence de Santé Publique, 2019). This absence of tangible and socially grounded evidence constitutes the research problem this study addresses. Without understanding how affected communities perceive and respond to the landslide hazard, disaster risk reduction planning for Northern Abidjan lacks the foundation needed to move beyond reactive crisis management.

This study, therefore, aims to explore local communities' perceptions of landslides in Northern Abidjan, Côte d'Ivoire. Specifically, it seeks to identify the perceived causes and effects of landslides, the socio-environmental impacts on

affected households, how communities respond to these effects, and the relief initiatives taken by key organisations to support the population. While this study highlights the role of community preparedness in reducing the hazard's impact, the findings would constitute a significant contribution to local disaster risk management, especially landslide risk reduction in Northern Abidjan and elsewhere in Côte d'Ivoire.

2. Study Area

Côte d'Ivoire is a West African country located between latitudes 4° and 11° North and longitudes 2° and 9° West. It covers an area of 322,462 square kilometres and shares borders with Liberia and Guinea to the west, Mali and Burkina Faso to the north, and Ghana to the east. The country lies in a

transition zone between the humid equatorial and dry tropical climates and is divided into two main climatic zones: the southern and northern regions (Barima et al., 2020). The southern region has a humid equatorial climate, characterised by high rainfall, consistent humidity, and relatively stable temperatures between 24°C and 32°C. In contrast, the northern region experiences a tropical savannah climate, with a pronounced dry season and temperatures ranging from 20°C to 37°C. With seven administrative communes (Abobo, Adjamé, Attécoubé, Anyama, Cocody, Plateau, and Yopougon), Northern Abidjan is a forested region situated in the southern part of Côte d'Ivoire, between latitudes 5°10' and 6°00' North and longitudes 3°30' and 4°20' West (Fig. 1).

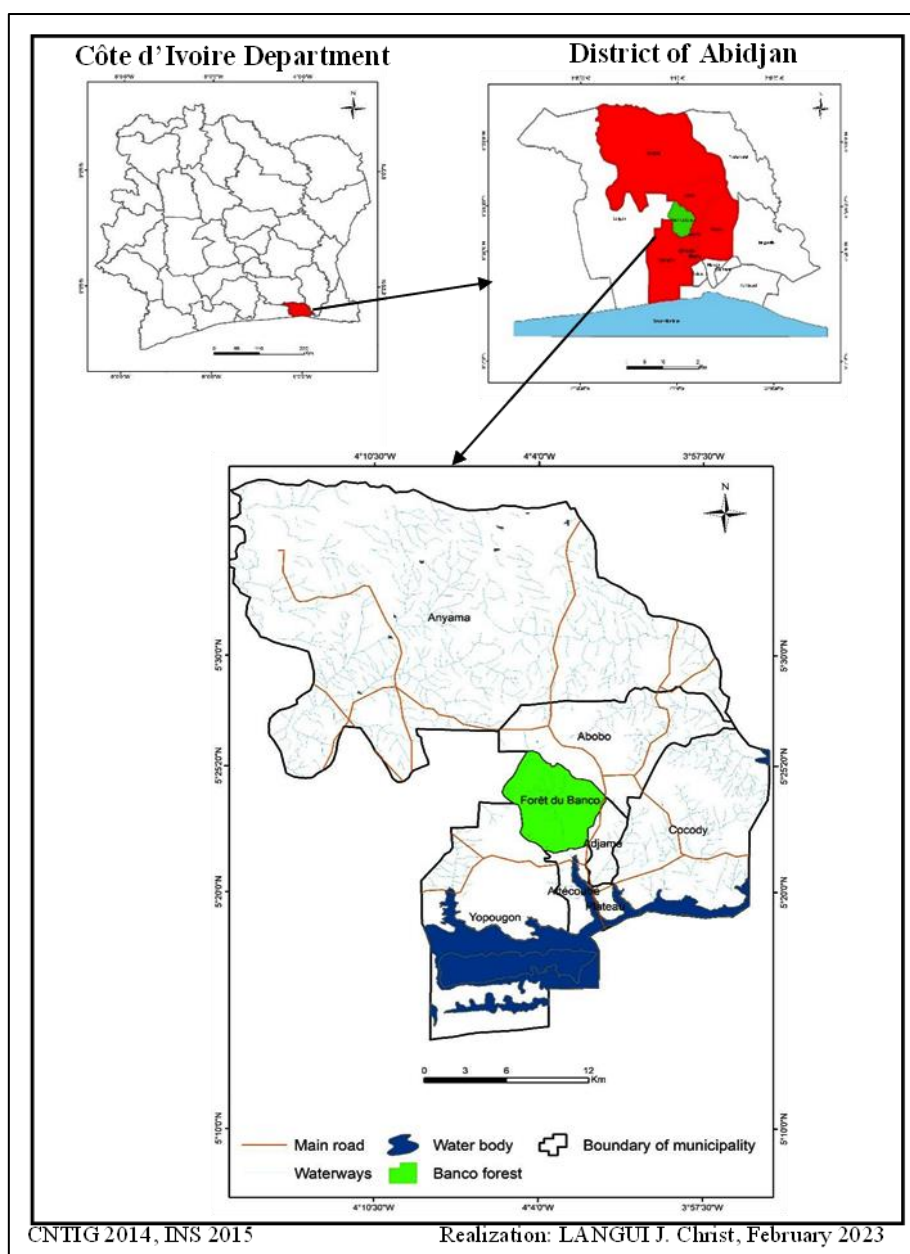


Figure 1: Northern Abidjan, Côte d'Ivoire

With an average annual rainfall of ~1,600 mm, the climate is characterised by four distinct seasons that vary in length (Dogoua et al., 2015). There are two rainy seasons: a long rainy season from May to July and a short rainy season from October to November. These are interspersed with two dry seasons: a short one from August to September and a long one from December to April. Overall, the study area is largely characterised by sandy-clay soil with ferruginous sandstone. Water-saturated sandy-clay soil is liable to slide down less-resistant slopes, often causing landslides. The total population in Northern Abidjan (2021) is 4,654,536, which is a tremendous increase from 2,128,261 in 1998 and 3,339,595 in 2014 (INS, 2021). This means that over 24 years, the total population in Northern Abidjan has grown remarkably, increasing the risks of landslides.

3. Methods

A mixed methods approach was adopted, combining household questionnaire survey, field observations, key informant interviews, and in-depth interviews to capture information on public perception, community experiences and institutional responses. Following Ryan (2013) sample size determination formula for large populations, a total of 384 households were surveyed (*Table 1*).

Table 1: Distribution of Households Surveyed

Municipalities surveyed	Number of households	Number of households surveyed
Abobo	280 206	114
Anyama	80,147	33
Attécoubé	67,683	27
Cocody	169,438	68
Yopougon	349 480	142
Total	946 954	384

Source: INS-RGPH (2021) and Field survey (2023)

Five communities within northern Abidjan, identified through municipal reports as being most affected by recent landslides, were purposive selected for the household survey. To complement the household survey, in-depth interviews were conducted with officers of key institutions involved in disaster risk reduction and environmental management – Bureau National d'Etudes Techniques et de Développement (BNETD), Office National de l'Assainissement et du Drainage (ONAD), Office National de la Protection Civile (ONPC), Agence Nationale de l'Environnement

(ANDE), and the Military Firefighters Group. The interviews focused on their institutional mandates, data on landslide occurrences, vulnerable social groups, emergency response mechanisms, at-risk populations residing in hazard-prone zones and practical actions needed to enhance landslide risk reduction efforts in northern Abidjan. Within each selected municipality, households were surveyed using a systematic random sampling technique. In each household, the household head was interviewed. In the absence of the household head, any adult with an age at least 18 years was approached.

Key informants were selected purposively, targeting local leaders and experts from the town halls of the surveyed communes who possess extensive knowledge and experience within their communes. The household survey was deployed using Kobocollect v2023.2.4.

The questionnaire was written in French, the language of the immediate environment. Responses were translated to English. Interviews were recorded in French, and notes were taken from field observations. Informed consent was obtained from all respondents before administering the survey and interviews, and they were assured that their privacy would be guaranteed and their responses would be kept confidential. Quantitative responses obtained were coded and analysed using IBM SPSS software version 20. Frequencies, percentages, and cross-tabulations were produced to summarise survey responses. Interviews transcripts were translated from French to English and transcribed. The textual data was later subject to content analysis so as to generate a number of themes on the lived experiences related to landslides.

4. Results

4.1 Sample Characteristics

Of the 384 respondents across Northern Abidjan, the majority were men (52.60%). About 45% of respondents were aged between 25 and 45, and almost 62% were married. The survey also showed that almost 46% of the population had a secondary education, 39% were traders and 43.23% earned between 20,000 and 50,000 CFA francs per month (*Table 2*).

4.2 Period of Occurrence

Based on periods of occurrence (*Fig. 2*), the majority of respondents (~76.6%) across all municipalities

believed that landslides occur mainly during the rainy season, with Yopougon (71.8%) and Abobo (81.6%) recording the highest proportions. 0.5% attributed landslides to occurring "at any time," while an even smaller percentage (0.3%) linked them to the "wrath of the gods." Notably, 22.7% of respondents indicated they had "no idea" about when landslides occur, with Cocody (39.7%) and Yopougon (28.2%) showing the highest levels of uncertainty.

4.3 Perceived Causes of Landslides in Northern Abidjan

Table 3 shows that abundant rainfall and long duration (50.52%) was the main perceived causes of landslides, followed by the presence of steep slopes (22.66%) and the nature of the soil (10.68%), while factors like absence of vegetation and population pressure were the least reported. Across the five municipalities, rainfall was the commonly perceived cause of landslides (50.52%).

Table 2: Sample Characteristics

Commune	Abobo	Anyama	Attécoubé	Cocody	Yopougon	Total	%
Sample	114	33	27	68	142	384	
Sex	Male	62	18	14	34	74	52.60
	Female	52	15	13	34	68	47.40
Age range	Below 25	22	9	2	8	11	13.54
	25-45	54	7	16	26	69	44.79
	45-65	30	11	9	30	42	31.77
Marital Status	Above 65	8	6	0	4	20	9.90
	Single	13	9	5	16	49	23.96
	Married	79	20	12	45	82	61.98
Occupation	Divorced/widowed	22	4	10	7	11	14.06
	No formal Education	11	1	3	2	10	7.03
Education Level	Primary	30	10	5	15	34	24.48
	Secondary	48	15	7	30	79	46.61
	University	25	7	12	21	19	21.88
Occupation	Farmer	24	6	5	11	28	19.27
	Trader	52	13	8	29	48	39.06
	Student	7	5	4	8	19	11.20
	Artisan	8	0	1	7	14	7.81
	Unemployed	19	9	2	10	24	16.67
	Other	4	0	7	3	9	5.99
Monthly income (CFA Franc)	Less than 20,000	38	10	8	15	33	27.08
	20,000 – 50,000	59	14	14	23	56	43.23
	50,000 – 90,000	10	6	5	20	42	21.61
	Above 90,000	7	3	0	10	11	8.07

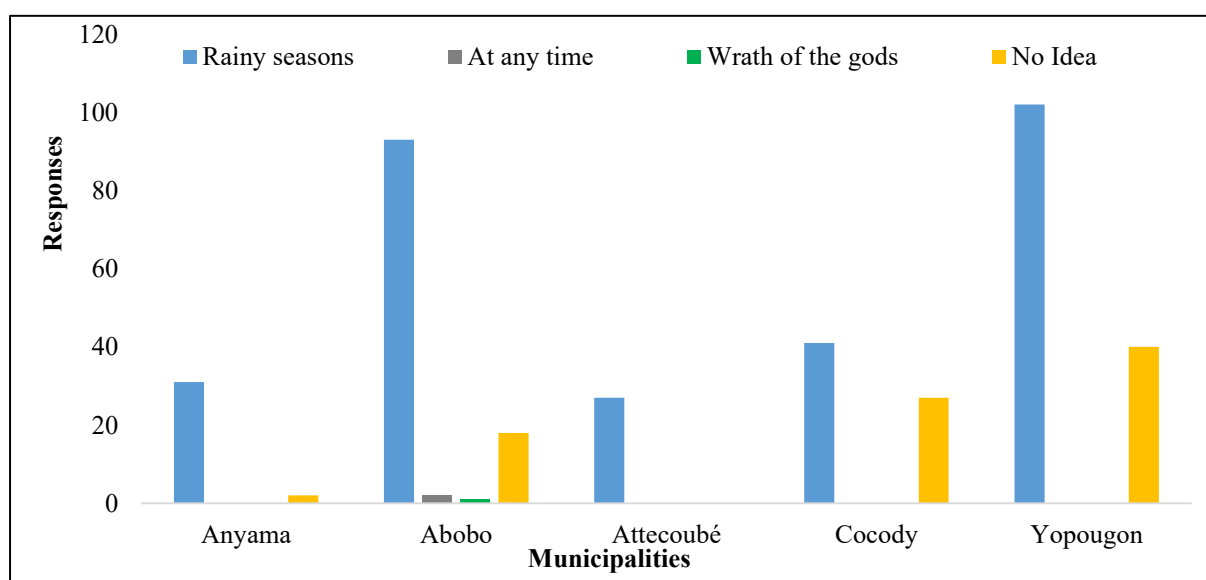


Figure 2: Period of Occurrence of Landslides in Northern Abidjan

Table 3: Perceived Causes of Landslides

Causes of Landslides	Municipalities						Total	%
	Anyama	Abobo	Attécoubé	Cocody	Yopougon			
Abundant Rainfall & Long Duration	17 (51.5%)	53 (46.5%)	11 (40.7%)	34 (50%)	79 (55.6%)	194	50.52	
Presence of Steep Slopes (PSS)	9 (27.3%)	21 (18.4%)	5 (18.5%)	17 (25%)	35 (24.6%)	87	22.66	
Nature of the Soil	2 (6.4%)	11 (9.6%)	1 (3.7%)	6 (8.8%)	21 (14.7%)	41	10.68	
Absence of Vegetation (AV)	4 (12.1%)	7 (6.1%)	1 (3.7%)	2 (2.9%)	2 (1.4%)	16	4.17	
Demographic Pressure (DP)	1 (3.0%)	3 (2.6%)	3 (11.1%)	2 (2.9%)	0 (0%)	9	2.34	
Unplanned Development (UD)	0 (0%)	10 (8.7%)	4 (14.8%)	5 (7.4%)	4 (2.8%)	23	5.99	
Lack of Sanitation Works (LSW)	0 (0%)	5 (4.4%)	2 (7.4%)	0 (0%)	1 (0.7%)	8	2.08	
None	0 (0%)	4 (3.5%)	0 (0%)	2 (2.9%)	0 (0%)	6	1.56	
Total responses	33	114	27	68	142	384	100.0	

Fieldwork, 2023

Responses from the interviews confirmed the earlier findings on the perceived causes of landslides:

“Rainfall is the main factor in triggering landslides, as it is very rare to observe this disaster outside the rainy seasons in the north of Abidjan. Over the last three years, in every rainy season, landslides have occurred in the north of Abidjan”. – (Male/Director of Operations Coordination, ONPC)

Another respondent corroborated that:

“The factors responsible for the landslides observed are: Rainfall, topography (sloping land is more susceptible to landslides) and soil type (in Abidjan, the soils are loose clay and sand and are subject to erosion when it rains). Rain is the most unpredictable factor in terms of its intensity and duration. – (Male/ Head of Technical Coordination, Sanitation and Drainage Department, BNEDD)

Another key informant also revealed that the uncontrolled urban development of high-risk sites (Plates 1 and 2) triggered landslides:

“The construction of infrastructure or buildings at the top (sic) of the slope increases the load on the slope and can cause a landslide. Also, buildings at the bottom of the slope can destabilise the foot of the slope (...) bare soil; housing estates built without a prior study (poor subdivision); buildings built without a geotechnical study; the sandy-clay composition of Abidjan's soils; and heavy rainfall are all factors that contribute to landslides”. (Male/Environmental and Social Impact Assessment Officer, ANDE)

Lastly, a key informant identified uncontrolled urban expansion as part of a complex web of causation of landslides:

“There are a number of factors that can explain the landslide phenomenon in at-risk areas, including the occupation of riverbeds, the uncontrolled occupation of non-constructible areas by local people, the effects of climate change, which means that we are increasingly seeing high rainfall intensities close together, etc.” – (Male/Head, Monitoring & Evaluation Department, ONAD)

With respect to the community leaders, in-depth interviews disclosed how landslides occurred, and the causes and impacts of gullies created many of which were visible during the transect walks (see Plates 3 and 4). They expressed the following about the gullies:

“It used to be a small hole where sand was used to build almost all the houses in the area. That's why the little hole has started to change shape, getting bigger every time it rains. So, the earth is no longer able to support itself, and the landslide phenomenon has increased, destroying all the buildings that were there” (Male/ 64 years old/Trader/Widowed/Anyama).

A female community leader attributed the gullies to the abandoned construction work in the neighbourhood:

“It's due to unfinished work by the Côte d'Ivoire water distribution company and another related structure (SODECI). They were building drainage gutters that were going to link our neighbourhood to another neighbourhood, but because they didn't finish the job, when it rains, it gets bigger and this causes the gully to widen, with the inevitable consequences in terms of loss of life. So today the big hole is there like that and it's a danger for us and our children” (Female/ 48 years old/ Married/Unemployed/ Yopougon).

4.4 Perceived Consequences of Landslides in Northern Abidjan

The results (Table 4) show that the most commonly reported consequence of landslides across the municipalities was the collapse of buildings (46%) followed by loss of life (33%), and injuries to people (15%). Deterioration of roads was least mentioned (5%), while a very small proportion (2%) indicated having no idea about the consequences. Across municipalities, Abobo recorded the highest percentage of building collapses (56%), while Yopougon reported the largest share of loss of life (42%).



Plates 1 and 2: Unplanned development in Abobo captured during the field observation in 2023



Plates 3 and 4: Pictures of gullies in the commune of Yopougon captured during the field observation in 2023

Table 4: Distribution of perceived consequences of Landslides

	Anyama	%	Abobo	%	Attécoubé	%	Cocody	%	Yopougon	%	Responses	%
Collapse Building (CB)	14	42%	64	56%	12	44%	33	49%	52	37%	175	46%
Loss of life (LOF)	11	33%	27	24%	10	37%	19	28%	59	42%	126	33%
People Injured (PI)	8	24%	19	17%	4	15%	9	13%	16	11%	56	15%
Deterioration of Roads (DOR)	0	0%	4	4%	0	0%	5	7%	11	8%	20	5%
No Idea	0	0%	0	0%	1	4%	2	3%	4	3%	7	2%
Total	33	100%	114	100%	27	100%	68	100%	142	100%	384	100%

Interviews with the key stakeholders further provided insights into the consequences of landslide events. The loss of human lives was a major effect of natural hazard. According to the Director of Technical Services at Anyama Town Hall:

“The landslide, which occurred on the evening of 18 June 2020 following an uninterrupted downpour, caused the deaths of seventeen men and women, including children (...) we arrived on the scene before the usual emergency services, and when we tried to help a young boy before help arrived, the child tragically died...”

It was further stressed by the following key informants:

“Landslides occur from the rainy season onwards, i.e. during the months of May-June-July each year. The social consequences are loss of life and material damage, and the environmental consequences are a deterioration in the population's living environment” – (Head of the Monitoring and Evaluation Department, ONAD).

“Last year, 177 people died in landslides. We recorded a total of 13 deaths, 151 victims who were brought to safety, 12 who were hospitalised and one victim who was buried in the rubble”. – Captain Bah Anicet (Director of Operations, GSPM).

“The landslides that have occurred this year have already resulted in the deaths of five people. I'm talking about a whole family consisting of a father, a mother, and their three children, and we're not even halfway through July yet” (Male/ 41 years old/ Married/ Artisan/ Attécoubé).

More specifically, in Yopougon, at the scene of the tragic June 11, 2023, landslide, the following accounts were recounted:

“There was heavy rain on the night of Saturday, 10 to Sunday, 11 June, which caused the death of an entire family here in Yopougon. At around 2 am, I

heard a loud bang (VROOMMM) that sounded like it was coming from a high-rise building that had crashed into the home of the deceased. As it was close to home, I woke up straight away and called my friends for help as soon as I saw the damage. We alerted the GSPM after noticing the presence of corpses in the area” - (Male/ 36 years old/ Single/ Farmer/ Yopougon).

“On the evening of 15 to 16 June 2023, heavy rains caused landslides in the Dagouri area, killing one person, and in the number one industrial sector, killing seven. Not far away, the fence of a factory collapsed on the inhabitants who had built shelters at the foot of the embankment in sector number one. We recorded three deaths, including that of a mother and her two children in the petit Bouaké sector” - (Male/30 years old/Married/ University Professor/ Yopougon).

The most significant social consequence reported by households (Table 5) was the internal displacement of populations (59.64%), followed by the disruption of economic activities (31.77%). A very small proportion of participants (3.13%) reported no noticeable consequence, while 5.47% indicated no idea of the social impacts. Displacement was particularly pronounced in Abobo and Yopougon, with 72.8% and 53.5% respectively.

Table 5: Perceived Effects of Landslides in Northern Abidjan

	Anyama	Abobo	Attécoubé	Cocody	Yopougon	Total	%
Displacement of populations	22 (66.7%)	83 (72.8%)	12 (44.4%)	36 (52.9%)	76 (53.5%)	229	59.64%
Disruption of economic activities	11 (33.3%)	28 (24.6%)	14 (51.9%)	17 (25%)	52 (36.6%)	122	31.77%
None	0 (0%)	3 (2.6%)	0 (0%)	6 (8.8%)	3 (2.1%)	12	3.13%
No Idea	0 (0%)	0 (0%)	1 (3.7%)	9 (13.2%)	11 (7.7%)	21	5.47%
Responses	33	114	27	68	142	384	100.00%

Some household heads shared their experiences:

“Some people are leaving the area for good for fear of disaster, while we, who don't have much money, are staying close to the area. During this period, we are obliged to sleep in primary schools with our children until the storm passes and we can return to our homes.” (Female/ 52 years old/ Widowed / Trader/ Abobo).

“...After the tragedy, the mayor of the commune, accompanied by his delegation and the Minister of Hydraulics, Sanitation and Hygiene (Mr Bouaké Fofana), who were present at the scene, asked 18 households close to the scene of the tragedy to leave immediately.” (Male/ 36 years old/ Single/ Farmer/ Yopougon). – Mr. Douho Kohon Amédée (Neighbourhood Youth Organisation President)

“They are a source of family division, because when we find ourselves on the street, we are left to fend for ourselves. To make matters worse, it's

difficult for us to send our children to school, because in these areas where we have to live, we work to support ourselves and help our children go to school” (Male/ 68 years old/ Married / Retired/ Abobo).

4.5 Public knowledge on Landslides Occurrence

Table 6 shows that 37.50% of the households reported that landslides had previously occurred in their municipality, while 26.82% indicated that the 2023 landslide event was the first of its kind in their area. A significant proportion (35.68%) of respondents stated they had no idea whether landslides had happened before. The highest number of "No Idea" responses came from Yopougon and Cocody, suggesting a lack of awareness of previous landslide events.

Table 6: Public opinion on the occurrence of the 2023 landslides in Northern Abidjan

Question		Anyama	Abobo	Attecoubé	Cocody	Yopougon	Total	%
Is this the first time that landslides have occurred in your municipality?	Yes	6 (18.2%)	46 (40.4%)	2 (7.4%)	12 (17.6%)	37 (26.1%)	103	26.82
	No	21 (63.6%)	43 (37.7%)	25 (92.6%)	20 (29.4%)	35 (24.6%)	144	37.50
	No Idea	6 (18.2%)	25 (21.9%)	0 (0%)	36 (52.9%)	70 (49.3%)	137	35.68
	Total	33	114	27	68	142	384	100.00

4.6 Relief Initiatives

Field observations and stakeholder interviews revealed the state and non-state responses to landslide events in Northern Abidjan.

(a) Initiatives taken by local communities

Observations revealed that some residents have developed local solutions to reduce slope erosion, a known precursor to landslides. In communes such as Abobo and Yopougon, residents implemented basic stabilisation measures, including the use of sand-filled sacks and discarded tyres placed at the base of exposed slopes (*Plates 5 and 6*). Community members also often organise themselves into informal support networks during emergencies. In several cases, residents provide temporary shelter for displaced families in public primary schools or offered some form of assistance such as providing food, accommodation and financial support where possible in the immediate aftermath of landslides.

(b) Initiatives taken by the Town Halls of the Municipalities

Town halls across affected municipalities have taken active roles in landslide risk management, functioning as the State's primary local representatives. Key initiatives included seasonal awareness campaigns urging residents to evacuate risk-prone areas, as well as targeted demolition of informal housing constructed on unstable terrain. Visual evidence (*Plates 7 and 8*) shows a bulldozer deployed for structural demolition and public notices issued by the Ministry of Construction, Housing, and Urban Development, indicating zones marked for immediate evacuation or cessation of construction. Despite these interventions, many residents resisted relocation due to economic constraints, lack of alternative housing, and the absence of consistent compensation. Nevertheless, in collaboration with national authorities, some town halls facilitated financial assistance and temporary resettlement for displaced households.

In-depth interviews with officials from key institutions involved in disaster risk reduction and environmental management have revealed that they are also taking initiatives:

(c) Initiatives taken by ONAD

ONAD, under the Ministry of Water, Sanitation, and Hygiene, plays a significant role in infrastructural mitigation. Their interventions have been largely technical, focusing on the construction of primary and secondary rainwater drainage systems in vulnerable neighbourhoods. These structural measures were created to channel stormwater more effectively and reduce slope erosion during periods of heavy precipitation. Such infrastructural improvements contributed to the physical stability of affected areas and reduced the frequency of erosion-induced landslides in target zones.

(d) Initiatives taken by ONPC

ONPC is a military-based institution under the Ministry of the Interior and Security that responds to landslides through a combination of emergency and preventative actions. Immediately following incidents, ONPC establishes safety perimeters, conducts search and rescue operations, and facilitates emergency medical care. As part of its preventative mission, the ONPC has also engaged in public education campaigns, field assessments, and zoning enforcement. It has contributed to identifying and demarcating high-risk areas where construction should be prohibited and has worked with local authorities to plan resettlement strategies and discourage reoccupation of evacuated zones.

(e) Initiatives taken by BNETD

The National Bureau of Technical Development Studies (BNETD) contributes through technical planning and landscape rehabilitation. One of its key interventions was the development of the "Coulée Verte" project in Banco, Yopougon. This initiative integrated slope stabilisation with ecological restoration by planting vetiver grass on exposed slopes and reinforcing drainage channels with gabions. The efforts of BNETD illustrate the value of combining civil engineering with nature-based solutions. These improvements not only reduced landslide risk but also supported the re-establishment of plant cover, contributing to longer-term ecosystem resilience in vulnerable areas



Plates 5 and 6: Initiatives taken by locals in Abobo and Attecoube captured during field observation (2023)



Plates 7 and 8: Initiatives taken by Town Halls in Abobo and Yapougon Municipalities captured during field observation (2023)

5. Discussion

The paper examined the community perception of causes, effects and the mitigation associated to be a widespread natural hazard in Northern Abidjan. The combination of heavy and incessant rainfall and steep slopes were considered to be the main causes of landslides in the area. This is because the sandy-clay soils with ferruginous sandstones, which characterise the study area (Chafai et al., 2022), are eroded when heavy rain penetrates the soil and the surface below. The high rainfall in the study area can be explained by the fact that the climate is transitional equatorial and characterised by abundant rainfall, with an average of 1,600 mm of rain per year (Dogoua et al., 2015; Konate et al., 2023).

Moreover, the district of Abidjan is also the wettest area in Côte d'Ivoire during each rainy

season, due to its proximity to the Atlantic Ocean. High amounts and long duration of rainfall can cause landslides, and the results of Liu et al. (2021) indicate that for a landslide to occur, the intensity of the rainfall must be greater than 40 mm/hr, whereas in Abidjan, the intensity remains moderate to heavy and could reach 115 mm/hr in within 15 minutes (Dogoua et al., 2015; Yao et al., 2024). Our results are similar to previous research on landslides in Malaysia and Shaanxi province of China, where rainfall was found to be the primary cause of landslides (Rosly et al., 2022; Zhang et al. 2019). In other words, landslides are primarily caused by precipitation of certain attributes such as unusually high quantity, intensity and long duration.

Even though heavy rainfall has proven to be the main cause of landslides in Northern Abidjan, the limited recognition of human-induced contributors

like the absence of vegetation, unplanned development, and lack of sanitation infrastructure indicates a gap in public understanding of how land use and infrastructure deficits exacerbate landslide risks. For instance, the north of Abidjan is rapidly becoming more urbanised, leading to the destruction of vegetation cover over the years. Apart from the Banco Forest Reserve, which is the only significant expanse of green space, vegetation cover is virtually absent across the study area. Kouadio (2021) explained that the main causes of the deforestation vegetation loss in the city of Abidjan are due to rapid urbanisation. Moreover, arable land along the slopes is facing increasing demographic pressure. As urban areas become more populated, environmental hazards are becoming more pronounced (Mukherjee et al., 2025). Hence, natural hazards are occurring more frequently as a result of uncontrolled land use and conversion. The lack of compliance to building codes, and the filling in of watercourses for these projects, which unfortunately decreases the capacity for water drainage (Barajas et al. 2018; Kaiser & Akter, 2025). These factors, often overlooked by the public, play a significant role, in the occurrence of landslides and damages within the study area.

Like previous research (Kazmi et al., 2017; Bizimana, 2015; Maki Mateso et al., 2023), our findings show that triggers of landslide occurrence generally depend on the physical properties of the environment and the predominant human activities. These include, vegetation, soil type and relief, length and inclination of slopes, the nature of the geological structure, and the amount of rainfall, as well as demographic pressure and unplanned settlement (Bachange & Deuboue, 2019; Mathlouthi, 2011; Gnagne et al., 2025; Matougui et al., 2025). Moreover, the enormous built-up area at the foots of the hills modify the relief and make the slopes less stable especially at the bottom (Zhu et al., 2024). Uncontrolled urban development on or near vulnerable slopes emerged as a recurring theme in the qualitative accounts of our study respondents, as experts pointed to construction practices such as building without prior geotechnical studies or site planning as key contributors to slope destabilisation, especially when such developments increase pressure at the top or foot of the slope. This way, significant mobility of materials is facilitated by erosion, which considerably modifies the geometric properties of the soil and increases the instability of slopes.

Landslides have a much higher incidence of annual fatalities than some studies have indicated in the past, so much that their impacts are often

detrimental to people's lives, health, and property (Pollock & Wartman, 2020). Our study reveals that the immediate consequences of the landslides in the region were the collapse of buildings, injuries, and loss of life, highlighting the direct threats to safety and shelter. These findings are consistent with previous research on landslides, for instance, in Colombia, where people died and went missing, and hundreds of homes were devastated (Garcia-Delgado et al., 2022). Community narratives provide examples of the localised devastation caused by these events, recounting, for example, the death of an entire family in Attécoubé, illustrating how rapidly these disasters can escalate. Similarly, in Yopougon, residents described hearing a thunderous crash at night, followed by the discovery of fatalities amid collapsed structures. Stakeholders repeatedly identified the months of May to July as the critical landslide season, with the immediate outcomes including fatalities and infrastructural damage, and longer-term environmental degradation that diminishes the habitability of affected areas.

In addition to these immediate consequences, the displacement of people is another major concern held by households. This is also justified in a previous study on erosion by gullyng and landslides in south-eastern Nigeria. Egboka et al. (2019) note that, besides damage to infrastructure and transportation, displacement occasionally pushes people to become refugees within their nation. These sentiments were echoed by a sociologist at BNETD, who observed that beyond loss of life and property, landslides result in involuntary displacement, economic disruption, and interruptions in children's education. Household interviews further revealed the deep social and emotional toll experienced by vulnerable residents, with accounts of displacement-induced family fragmentation. This includes how the inability to afford relocation forces economically disadvantaged families to seek temporary shelter in primary schools during heavy rains, and how landslide-related displacement not only separates families but also impairs their ability to provide consistent schooling for their children. They go even further, citing a lack of financial resources to buy decent housing. This highlights socioeconomic challenges that increase the vulnerability of disadvantaged groups and the poor population (Idukunda et al., 2025). As a result, they are unable to afford to rent good houses and must remain in these dangerous, high-risk places, where landslides are a constant threat during the rainy season. More so, human, animal, and plant life, as well as

agricultural land, are lost as a result of landslides (Mebirouk et al., 2023).

Like in many cases of landslides and disaster management (Ajake et al. 2022; Alam 2020), responses in Northern Abidjan have involved local communities, municipal authorities, and national agencies. Observed community-based efforts such as using sand-filled sacks and tyres to stabilise slopes and mitigate erosion reflect an encouraging level of local agency. These grassroots responses reveal the urgency with which communities seek to protect their lives and property (Claude et al., 2020). Town halls issue demolition notices, evacuate residents from high-risk zones, and conduct awareness campaigns despite facing resistance from some inhabitants due to socioeconomic constraints. Through more structural interventions, national institutions such as ONAD, ONPC, and BNETD have complemented these efforts by constructing drainage infrastructure, enforcing safety perimeters during emergencies, land-use planning, and technical slope stabilisation projects. Notably, the implementation of erosion control measures like gabions and vetiver revegetation as part of urban development initiatives demonstrates a forward-looking approach to risk reduction by BNETD. These interventions illustrate the growing recognition of the threats and impacts of landslides, requiring coordinated and sustained efforts across governance scales (van Niekerk et al., 2020).

Despite these efforts, we found that many people still live in areas at high risk of landslides, as the majority of households have experienced several events. Hence, every rainy season, they must deal

with the damage resulting from disaster. This highlights the urgent need for integrated and inclusive risk reduction strategies that address both the environmental and socio-economic vulnerabilities of at-risk populations to ensure long-term resilience and safety for communities in landslide-prone areas.

6. Conclusion

The study investigated the causes and socio-environmental repercussions of the frequent landslides in northern Abidjan, Côte d'Ivoire. The combination of abundant rainfall and long duration is the main factor triggering landslides in the region. Other contributing factors include steep slopes, the sandy-clay nature of the soil, poor or absent drainage systems, and unplanned settlements by residents. Landslides occur annually during the rainy season, leading to building collapses, displacement, deaths, and injuries. Faced with this constant risk, residents mobilise and adopt local strategies such as using sandbags and tyres to prevent soil erosion on slopes. Key institutions involved in disaster risk reduction and environmental management such as ONAD, ONPC, BNETD, and the town halls of each commune, implement large-scale actions to assist and relieve the population. Nevertheless, landslides persist within the region. This study therefore provides insights to inform disaster risk reduction and management in northern Abidjan and other regions of Côte d'Ivoire. To this end, we recommend effective early warning systems, community awareness programs, and policies to prevent human settlements in at-risk areas.

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Ethics declaration

Before conducting this research, a request for authorisation was submitted to the National Agency for the Environment and Sustainable Development of Côte d'Ivoire. Informed consent was also obtained from all individual participants before the study was conducted.

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Appendix 1: Survey questions used to capture people's perceptions

Survey Question	Survey Response	Options	Coding
Have you noticed or observed landslides in your municipality?	a	Yes	2
	b	No	1
In your opinion, what are the causes of landslides in your municipality?	a	Rainfall Abundance and Duration (RAD)	8
	b	Presence of Steep Slopes (PSS)	7
	c	Nature of the Soil (NS)	6
	d	Absence of Vegetation (AV)	5
	e	Demographic Pressure (DP)	4
	f	Unplanned Installation (UI)	3
	g	Lack of Sanitation	2
How do landslides affect your municipality?	a	Collapse Building (CB)	5
	b	Loss of life (LOF)	4
	c	People Injured (PI)	3
	d	Deterioration of Roads (DOR)	2
	e	No idea	1
When do you think landslides occur?	a	Rainy season	4
	b	A tout moment	3
	c	Wrath of the gods	2
Is this the first time that landslides have occurred in your municipality?	a	Yes	2
	b	No	1
How do landslides affect your living environment?	a	Population displacement	3
	b	Inability to carry on an activity	2
	c	None	1
Do you think you are vulnerable to landslides in your municipality?	a	Yes	2
	b	No	1
What are you doing to reduce the impact of landslides in your community?		Open question	