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Recurrence of Natural Risks and Sustainable Development Perspectives on the North Western Margin of Yaoundé

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Abstract

Natural hazards abound on the seven hills that border the city of Yaoundé, especially on its north-western margin where uncontrolled occupation accentuates their occurrence. Thus, how can we understand the dynamics of land use that exposes people to risks and makes people vulnerable? The memory of past events, the reading of archival documents, field observations, satellite image processing and other information are deployed for this research. It is, therefore, important to study the impacts of risks in order to reduce their devastating effects, reconcile constraints of the physical environment and development constraints and improve the living conditions of the populations. The resources available to the majority of developers do not allow them to be absorbed. The characterization and risk assessment of the physical environment are lines of thought for this study. The study provides new elements necessary for the sustainable and harmonious development of risks in urban areas. It highlights important parameters for their monitoring and control. Basic constructions amplify them on the flood-prone lowlands and steep slopes. On the NW margin, floods and landslides are experienced continuously. Analyzes show that the physical environment combined with poorly organized human activities are the root causes of recurring risks in flood-prone lowlands and steep slopes.

Keywords: natural risks, urban environment, sustainable development, NW margin, Yaoundé

I- INTRODUCTION

Natural risks recorded in the world are likely to awaken the consciousness of populations and decision-makers on the realities related to environmental degradation and its harmful effects. According to the statement of Hyōgo (2005), natural disasters seriously undermine, within a short time frame, the results of development investments for many years. They thus remain a major obstacle to sustainable development and the eradication of poverty in the world. All human societies are exposed to it, but at varying degrees depending on whether they are in a context of development or poverty and the technical, material and financial resources used. These means make it possible to control and minimize the catastrophic effects of risks.

Long stuck in the plateau of the administrative center at an average altitude of 750m, the city of Yaoundé is experiencing strong demographic pressure with profound repercussions on the consumption of space and exposure to risks through uncontrolled developments. The NW margin is a vast plateau with an altitude of more than 1000m. In the past, it was a natural barrier meant only for rites and other ancestral practices, consisted of small villages, is nowadays the object of a intense human occupation which is mostly uncontrolled leading to the emergence of a number of environmental risks. Hence the choice of the study area which extends between 11° 24"and 11° 30" E longitudes and 3° 49" 55" and 3° 58" N latitudes (Figure 1).

Oroparc (figure 2), according to the Master Development Plan (SDAU, 1982) and the Urban Master Plan (UMP), (2004), the area represents an ecological reserve. It is a high and rugged plateau culminating at more than 1000 m. Its limit, with the downtown plateau is marked by an escarpment that runs through the southwest to northwest with an indentation at the level of the Mefou River which causes repeated flooding at the Nkolbisson crossroads.

Figure 1: The study area

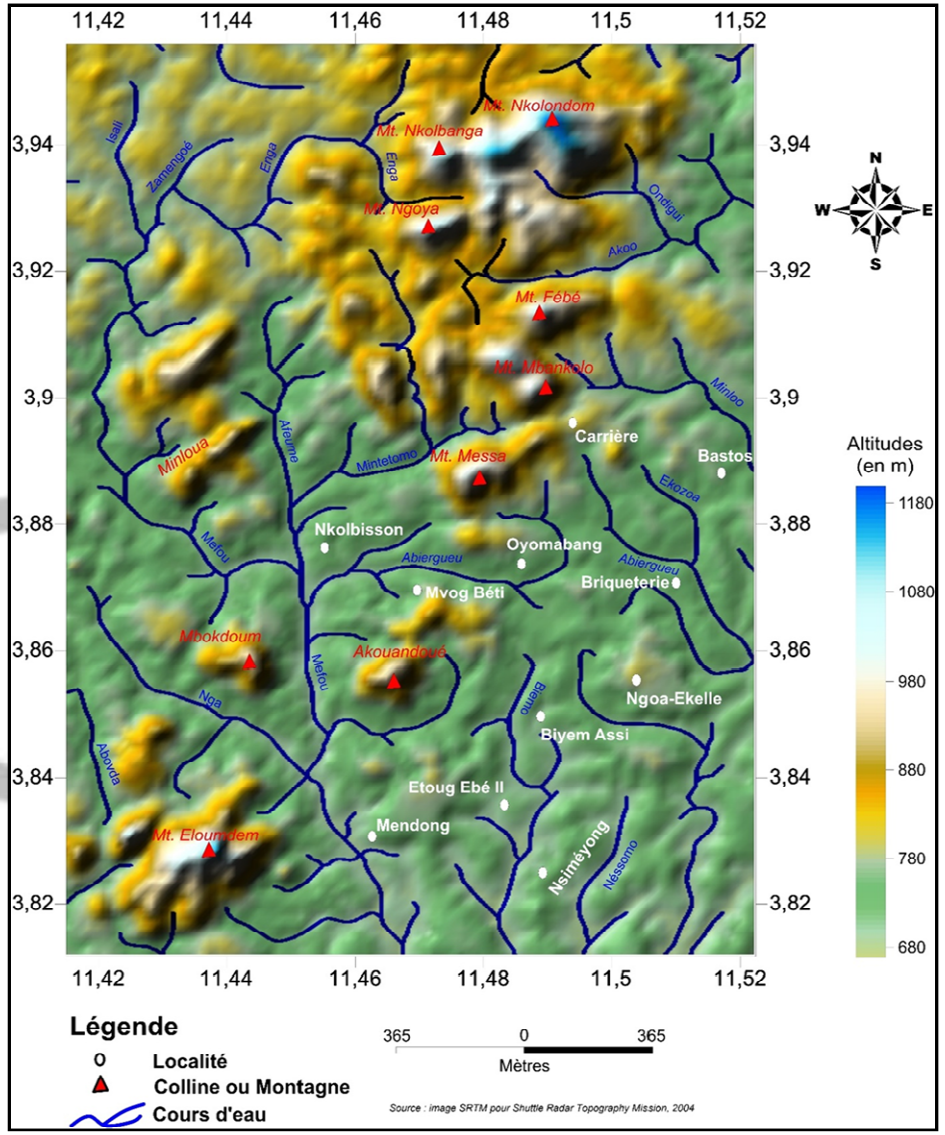


Figure 2: Digitalezed model of the NW margin of Yaoundé

II- METHODOLOGICAL APPROACH

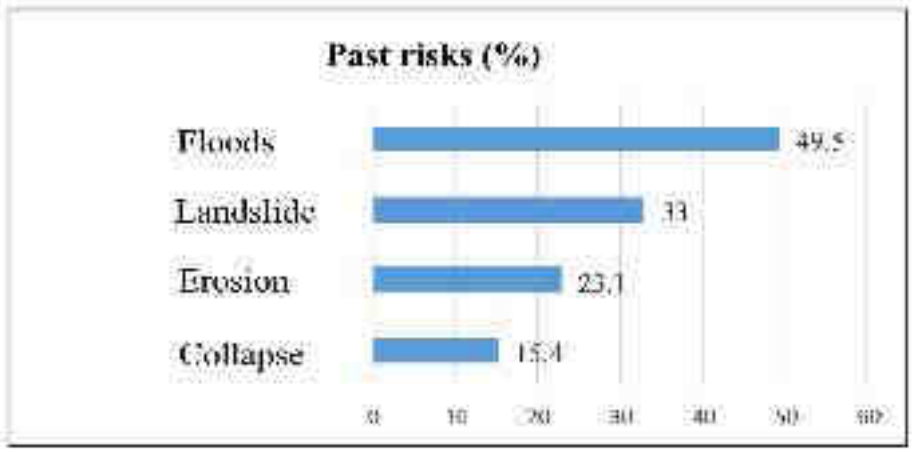
The hypothetico-deductive method used in this work relied on data collection from primary and secondary sources. A household survey was carried out using a questionnaire intended for heads of families who have lived at least 20 consecutive years in The North West Margin of Yaoundé. In absolute terms, 357 heads of households were surveyed. It made it possible to collect information on the identification, choice of site, knowledge and perception of the risks from respondents. Documentary research was carried out in the libraries of the department of Geography of the Faculty of Arts, Letters and Social Sciences of the university of Yaoundé I, in major research centers such as National Institute of Cartography (NIC), National Institute of Statistics and government ministries (Housing and Urban Development, Surveys State Property and Land Tenure Land and Higher Education...) councils, the archives of the Fire-fighters brigade and the Directorate of Civil Protection. This aided in the collection of data for possible identification facts and figures on risks of floods and mass movements that have occurred in the city of Yaoundé since 2004. Interviews were conducted with administrative and traditional authorities appraise their view points on risk factors. Landsat 8 image processing, obtained at the NIC and in specialized sites (Image taken by the Landsat Sensor, then processed by a ground station and then published online. Image downloaded from the earth explorer usgs site. gov, were made using Arc Gis, QGis, Envi and Erdas software to locate and appraise the evolution of risks.

III- RESULTS

1. North-western margin, a region geographically exposed to risks

Constraints of the physical environment can be defined as obstacles hindering development actions due to the nature of the relief (steep slopes and lowlands) liable to mass movements and flooding (Tchindjang**,** 1996). The area presents various obstacles:

Hypsometry shows that on nearly 1550ha of the site under study, more than 990ha is above 750m which is the average altitude of the downtown plateau giving an elevation percentage of more than 60% with a high proportion of steep slopes that exceed 20%. It constitutes more than 50% on the Mbankolo, Ngoya and Nkolondom sites.



Source: Field surveys,

Besides, the relief is very accidented and contrasted. Its morphology presents three levels of layering: from 650 to 800m, a plain or depression where all the rivers that drain the NW margin flow; from 800 to 1000 m, is the medium plateau; above 1000 m, is the high plateau made of rocky hills. The mountains (Eloumden, Mbankolo, Ngoya, Nkolbanaga and Nkolondom) are completely disconnected from the low plateau. The rugged terrain alternates with crescent and/or rounded summits of 900 and 1221 m separated by valleys. These peaks are more suitable for construction than steep slopes. U-shaped valleys are generally marshy and even liable to flooding. T V shaped

valleys located between two almost compressed mountains, drain the rivers that flow from the high plateaus. The contact between high and low relief is made from a sharp and sharp jump.

From field respondents, the main risks identified on the north-western margin of Yaoundé are floods and landslides (Figure 3) that occur during or after heavy rains. The factors of vulnerability are multiple and the number of people at risk is high because of their concentration per unit area in non-aedificandi areas is high.

Figure 3: Identification of natural risks on the NW margin of Yaoundé

Floods account for 49.5%, landslides 33%, landslides and collapses 15.4% and erosion 23.1%. In the plains and steep slopes, exposure to risks presents profound inequalities, depending on the site and the situation.

2. Typology of recurring risks on the NW margin of Yaoundé

According to the archives of risk officials in the Yaoundé 7 Council and surveys carried out in the field, many risks abound in the North West Margin of Yaoundé.

2.1. Flooding of lowlands in the NW margin of Yaoundé

Gleyse (2002) specified that flooding is the more or less rapid overflow of water out of the minor bed, following a significant, more or less rapid flood. The relief predisposes to these phenomena, the basic constructions grow rapidly. The risk (exposed populations and infrastructures) and its conditions (modification of the soil which favors runoff, create a new situation). The costs of the fittings are high. Human presence plays a dual role: it exposes people and goods to flooding and aggravates the hazard by changing the conditions of water flow.

2.1.1. Causes of flooding

According to Gleyse (2002), the causes of floods in the world are generally, the intensity and duration of precipitation, the size of the area and the slope of the watershed, the vegetation cover and the absorption capacity of the soil, poor maintenance of certain watercourses and certain hydraulic structures, obstacles to the circulation of water, deviations of the watercourse and the undersized drains.

The morphology of valleys on the NW margin is the aggravating factor (figure 4). Indeed, it alternates flared sectors and bottlenecks of 20 to 30m. In the event of heavy rain, water accumulates in the constricted upstream areas and quickly creates upwelling. In absolute terms, the flooding results from persistent rains that generate torrents, carry rubble and urban waste from areas of steep slopes to gentle slopes. Spontaneous constructions, anarchic developments and the extension of buildings and the low cost of land in non-aedificandi areas have equally aggravate floods in the North West Margin of Yaoundé.

They cover the low valleys between 700 and 710m altitude. Urbanization contributes to the creation of paved surfaces, concreting and waterproofing of large areas of the Mfoundi watershed, limiting infiltration and accelerating runoff. An investigation carried out in the archives of the National Fire Brigade made it possible to identify cases of drowning in the city of Yaoundé from 2004 to 2010. The shopping center is more affected with 7 or 8 deaths because of repeated flooding of the Mfoundi bed, buried in the city center. Nkolbisson, Mimboman, Nkomo and Nkolmesseng quarters recorded 4 to 6 deaths, Odza, Ahala and Ekounou3 of 4 deaths. Other municipalities are not spared.

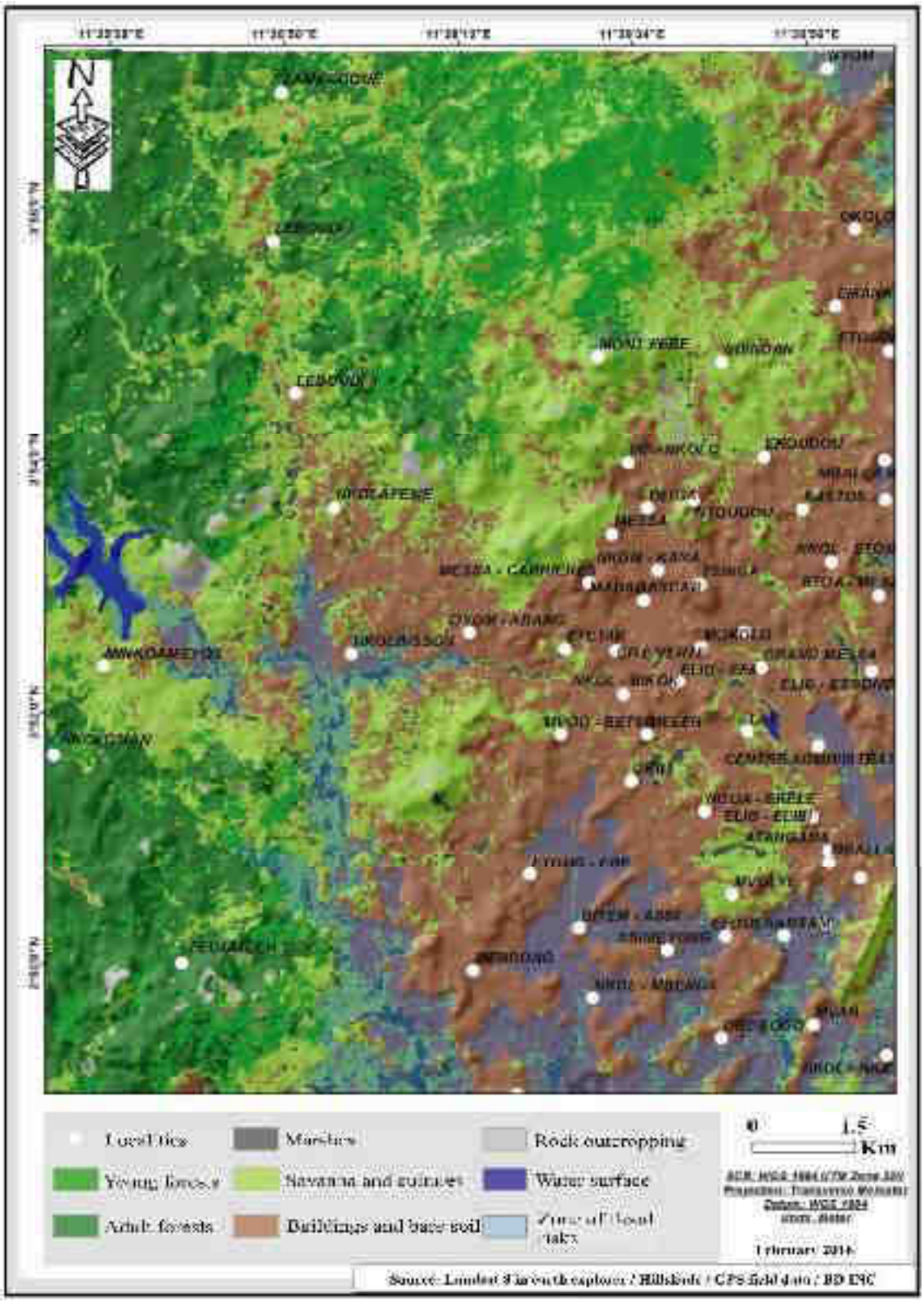


Figure 4: Spatial Distribution of flood prone areas on the NW margin of Yaoundé

2.1.2. Example of the Nkolbisson flood in 2008

On March 19, 2008 in Nkolbisson, the Méfou River accumulated water from its tributaries loaded with household waste from the surrounding neighbourhoods and blocked the drainage channels at the bridge resulting in flooding. This flood was catastrophic, though it occurred at the start of the short rainy season. Significant material damage and three deaths were recorded. That day, Yaoundé experienced heavy rain of about 60mm, in less than 24 hours, enough to trigger a flood. In August these are exceptional off-season rains in the short dry season.

Plate 1: Flood in Ebod-Méfou and built on the bed of Minlo'o at Mbankolo

Buildings in the floodplain obstruct the flow of water and increase the risk of flooding.

2.2. Mass movements

According to the Methodological Guide for the Preparation of PPRs (MATE et al, 1999; BRGM / RP, 2011), "land movements" are manifestations of gravitational displacements of land masses destabilized under the effect of natural stresses (heavy rainfall) earthquakes, etc. or anthropogenic (earthworks, vibration, etc.). The expression "land movements" on the NW margin includes several types of land instability phenomena, which vary depending on the mechanism involved. Thus, these are landslides, collapses and settlement.

2.2.1. Causes of mass movements

They depend on the nature and arrangement of the soil horizons. They occur when the weathering profile soaks up to saturation. Between the upper horizons and the crypto-decomposed rock, there is established a practically liquid level: the soap layer. At this level the movements take place according to a plane of detachment.

The importance of a land movement depends on several factors: the thickness of alterations, the nature of contact between the rock and alterites and its degree of slope, the amount of fallen rain. An earthquake, by shaking the earth's crust, can trigger mass movements. Human action is an aggravating factor, through the modification of the natural environment by deforestation, earthworks and mining etc. On the site, landslides mainly occur on steep slopes (figure 5) while subsidence is located in lowlands liable to flooding.

2.2.1. Landslides

That of Oyom-Abang, a former landfill colonized by settlement on a steeply sloping valley, is a memorable case that recorded deaths as five people were buried in the rubble. In the assessment of morphogenic risks, the slope factor remains predominant depending on the ground cover. The slope makes it possible to determine or appreciate and even quantify the degree of erodibility of an area. According to Assako (1995), the risk of land instability is inversely proportional to land cover. It is easy to translate land cover into the degree of risk of erosion and land movement. Erosion is more intense under buildings and on bare soils (plowed fields) on steep slopes.

2.2.2. Subsidence, collapses and settlements

Subsidence takes place in weakly consolidated and permanently humid lowlands. Uncontrolled constructions compact the soil and exert pressure resulting in settling and deformation of foundations, cracking of walls. Structures without foundations soak up water and the walls collapse over time.

The Elig-Essono, Etoudi and Mimboman districts are some of the places where the greatest number of collapses occurred in the city of Yaoundé. At Biyem-assi, anarchic constructions outside

MAETUR lots are not exempted; the number of victims is 4. At the Carrière, Ekounou and Kondengui quarters, there were 2 or 1 deaths, not to be neglected.

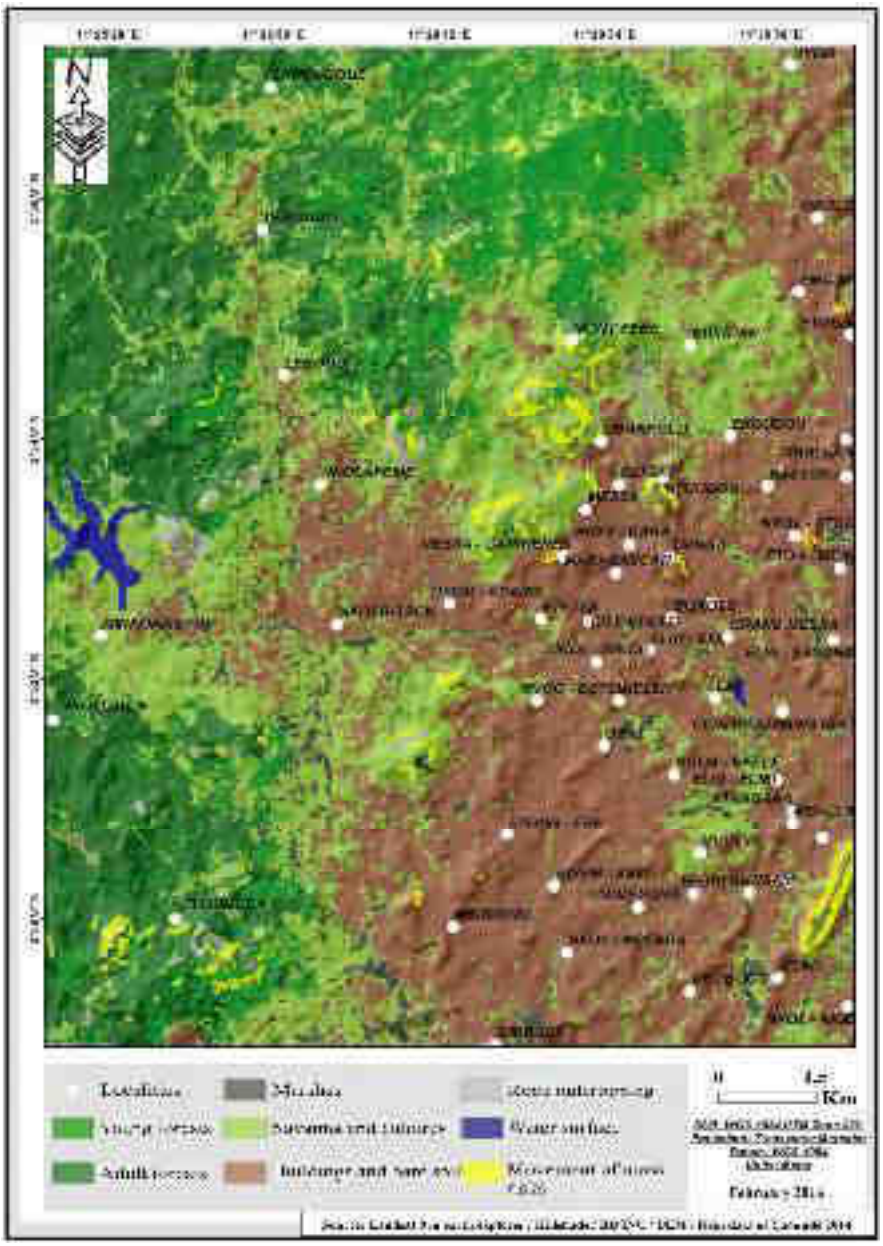


Figure 5: Land use and exposure to mass movements

3. Risk management strategies

3.1. Risk prevention measures

The first world conference on disaster reduction under the auspices of the United Nations took place in 1994 on the urgency and international nature of the phenomenon. The Hyōgo Declaration (2005-2015), insisted on the need to develop a culture of disaster prevention for all, to integrate risk into development planning and practice, to strengthen local and national capacities to face disasters. To limit the risks, several methods are deployed.

Securing access. On steep slopes, locals build stairs with old stuffed car tires. The use of reclaimed materials helps to stabilize the slope. Prevention by law: to avoid landslides or minimize these risks, deep digging at the bottom of the slope is prohibited. Prevention by wall building: Reinforced concrete barriers are built to ensure maximum security for vulnerable populations against blocks detachment. Prevention measures go through three general principles: adoption of preventive

measures and their implementation, monitoring, examination and review, raising awareness and training populations in a culture of risk.

3.2 Prospects and development strategies

Safety and protection measures must help to curb constraints: a protective barrier around high-risk areas, protective forests on steep slopes and sparse soils, anti-erosion installations in marshy basements and piedmonts, exceptionally, are measures to secure the environment. Appropriate equipment and adequate technical studies are necessary to protect populations from landslides. The NW can be the object of ecotourism or set up as ecological reserves.

For management in lowlands, the populations adapt by clearing passages of stagnant water, raising the foundations, protecting the banks with piles of tires, putting paving stones along tracks, bags filled with earth or old sheets to span the swamp and building concrete walls for the more affluent to limit floods.

To reduce floods, the Directorate of Civil Protection (DPC) organizes awareness and sanitation campaigns. The DPC develops strategies to inform populations about environmental risks and what to do. The Director of the DPC, Doctor NANA (of late memory) said: “Speaking of the floods, the populations cannot prevent the rain from falling, but they can at least discipline themselves, by throwing the garbage in garbage cans and not in watercourses and gutters”. It is necessary to initiate systemic evictions of the non-aedificandi zones, to free and clean the drains.

The NW margin is a great reservoir of biodiversity, the home to various ecosystems, where plant and animal species live in close relationship. Depending on the degree of the slope, it deserves to be preserved with facilities that meet environmental standards: thus, from 0 to 2%, it is agricultural use with soil drainage; from 2 to 5%, practice of agriculture with minimal protective care; from 5 to 10%, the sensitive soil erosion and the protection measure is organic farming; from 10 to 30%, the land is conducive to gullying, thus necessary to practice tolerated sylvo-pastoral activities with the implementation of systemic anti-erosion measures; above 30%, the land is very conducive to accelerated erosion, all forestry and pastoral exploitation must be prohibited giving way to tourism. Moreover, with these measures, we can do ecotourism or simply set it up as an ecological reserve.

3.3. Resilience in the face of risks

In practice, the resilience of a system covers in fact four dimensions: technical, organizational, social and economic, in order to overcome the disturbance, recover the balance and integrate the changes. This resilience leads to the development of a systemic approach, more social than technical, to issues related to natural risks. Veyret et al. (2005) see a double capacity in the resilience of a system: going beyond the disturbance and recovering a dynamic equilibrium which characterizes the system before the occurrence of the disturbance, within the framework of a functioning "normal”, and integrating the changes following disturbances, without changing the qualitative constitution. The return to equilibrium is not necessarily the initial equilibrium.

It is difficult to speak of resilience on the site. Regardless of the action taken by the administrative authority, the victims always come back. The question of sustainability is at the center of the concerns of risk management and the development of urban ecosystems, in order to enable these territories to face threats and overcome affectations.

DISCUSSION

D’Ercole et al. (2005) technically explain the topoclimatic and orographic context which exerts a major role in the transformation of the threat into a chain of phenomena generating damage. D'Ercole (1994) advises that the savings made, by ignoring the hazards and letting the city expand tirelessly, are now derisory compared to much money necessary to repair the damage or limit the consequences of disasters. This analysis is consistent with the floods that regularly plague the northern part of Cameroon. On the NW margin, the most important thing is to find the necessary ways to draw on the results in order to adapt to the context of natural risks.

ECHOGEO (2011) shows that the increase in the impact of natural risks over the years remains because of the high density of occupation of fragile spaces. In general, in poor countries, human activities increase vulnerability. Yet all of these disasters, at varying degrees, are predictable. There is no such thing like zero risk, so prevention helps to limit the damage. To better understand the populations in a post-disaster situation, Gleyse (2002) presents the management methods and preventive measures to reduce or eradicate harmful effects.

The in-depth study of the dynamics of mountain areas made by Tchindjang (1996), in the western region of Cameroon, builds on the influence of phenomena in the physical environment in relation to the mountainous mass. It places specific emphasis on the details of the physical environment and the risks that arise from uncontrolled urbanization. The results encourage further research to help populations to better integrate space. Tchotsoua (1996) analyzes the risks associated with the accelerated erosion of the Yaoundé site, the characteristics of the topography and the human conditions that favor these risks. The analysis of topographic maps at 1: 50,000 was meticulous but the results would have been better with topographic maps at 1: 10,000. Assako (1995) developed hypotheses for erosion and flooding risks at the Yaoundé scale, based on satellite image processing. It shows that the flooding risks affect all the valleys as landslides and erosion increase on steep slopes. This work laid the foundations for a relevant analysis. However, these data cannot currently assess the almost permanent situation; they provide sustainable urban development solutions.

Conclusion

Natural risks that abound on the NW margin of Yaoundé are very difficult to apprehend and unforeseen effects often increase the dangers. This article focused on assessing risks of flooding and landslides on the northwestern margin of Yaoundé. It shows that the risk is real and even known by the inhabitants. However, for economic and land reasons, they do not avoid the area. It is more difficult, in a country where forecasting, protection and prevention are difficulty to take shape, to find solutions to risks. However, the actors must consult and communicate as much as possible, from the highest hierarchy of the state through committees and associations of residents in the neighborhoods for a great success of reconciliation of sustainable development and sensitivity of the site.

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