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VULNERABILITY OF WOMEN TO HYDRO-CLIMATIC RISKS IN THE COMMUNE OF LOKOSSA, SOUTHWESTERN BENIN

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ABSTRACT

Climate change is one of the most pressing problems of our time. The vulnerability of women to climatic shocks varies with their degree of exposure and, above all, with their capacity to adapt, which depends on technical, technological, financial and sociocultural factors. This study aims to improve knowledge of the vulnerability of women in the Commune of Lokossa (southwestern Benin) to climatic constraints. Rainfall and temperature series for 1986 to 2020 were obtained from Météo-Bénin in Cotonou, and socio-anthropological data were collected from 162 respondents. A vulnerability matrix was used to characterize the level of vulnerability. The commune is subject to strong interannual rainfall variability punctuated by extremes. In the rainy season, women farmers face flooding, which also disrupts the activities of women traders. In the dry season, women have more difficulty obtaining water. Rising temperatures hinder their activities because they accentuate the drying up of watercourses and the drop of the water table. The major climatic constraints are flooding (score 4), drought (3) and heat (3). Elderly women (84%), widows (76%) and unmarried women (56%) are the most vulnerable. To cope, women have developed market gardening, joined savings groups, processed agricultural products and adopted adaptation strategies with the support of technical and financial partners.

Keywords: Lokossa Commune; Women's Vulnerability; Climatic Constraints; Hydro-Climatic Risks; Adaptation Strategies

1 INTRODUCTION

Sub-Saharan Africa is the region of the world where natural hazards are most recurrent, affecting nearly half of the total population. Since the 1980s, climate change has become one of the most serious threats facing the world. Natural and anthropogenic substances and processes that alter the energy balance of the Earth are among the factors that cause it [1]. Women are among the most vulnerable to climate change because of their limited adaptive capacity and their strong dependence on climate-sensitive resources such as water and agricultural production systems [2]. One of the major concerns of the international community today is the modification of the climate caused by the intensified greenhouse effect, itself due to the release of greenhouse gases, notably carbon dioxide, by some human activities. In recent decades disaster risks have increased, and the expected rise in extreme weather events will probably enlarge the scale and number of disasters [3].

Scientific research on the effects of hydrometeorological extremes on human activities and environmental quality has intensified over the last two decades [4]. It has drawn the attention of the academic community [5,6], as these extremes appear as more or less random anomalies and crises.

In Benin, in addition to the harmful effects of strong human pressure on natural ecosystems, hydro-climatic risks are among the main natural calamities linked to extreme climatic events [7,8]. They reduce food crop yields and cause food shortages [9]. The West African climate system, of which Benin is part, has undergone unprecedented disturbances for more than three decades. These appear as changes in the rainfall regime (late or early onset, a break in the middle of the season, early or late end), a decline in rainfall totals and rising temperatures [10,11]. In Lokossa, climate variability also affects local socio-economic development: roads are degraded and houses and infrastructure are undermined, with negative consequences for agricultural production. Climate change is thus a critical problem for the human development of the present generation [12].

This study aims to improve knowledge of the vulnerability of women in the Commune of Lokossa to hydro-climatic risks and of the strategies they use to cope with them.

2 MATERIALS AND METHODS

2.1 Study area

Lokossa lies in the northwest of the Mono department and is one of its six administrative subdivisions. It covers 260 km^2, that is 16% of the area of Mono (1,605 km^2) and 0.23% of the area of Benin (114,763 km^2). The commune is bounded to the north by Dogbo (Couffo), to the south by Athiémé and Houéyogbé, to the east by Bopa and to the west by Togo. It extends between 6°34′ and 6°46′ N and between 1°37′ and 1°55′ E. Its chief town is 106 km from Cotonou, the economic capital of Benin, and is also the capital of the Mono department. The commune has five arrondissements (Agamè, Houin, Koudo, Lokossa and Ouèdème-Adja), divided into 15 urban districts and 29 villages, that is 44 localities in all (Figure 1).

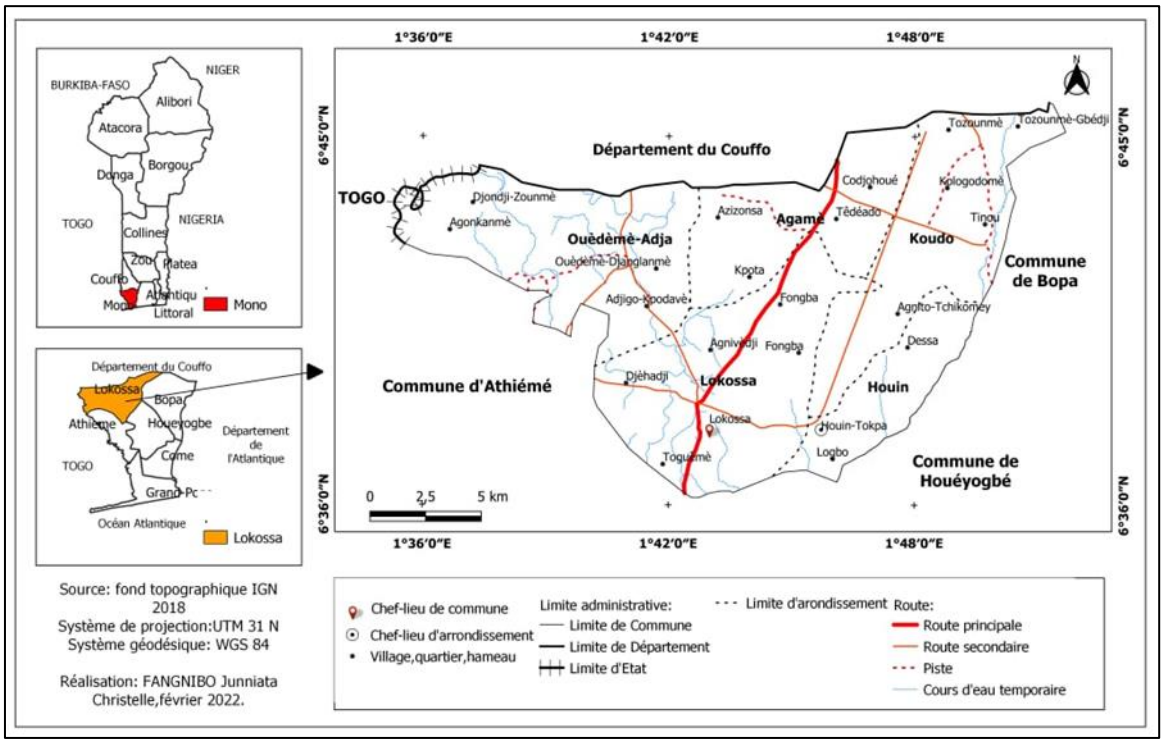


Figure 1: Geographical location of the Commune of Lokossa.

2.2 Data

Three types of data were used. Climatological data are the monthly and annual rainfall totals and the monthly and annual temperatures for 1986 to 2020, obtained from the National Meteorological Agency (Météo-Bénin). They were used to characterize the current state of the climate of Lokossa. Socio-anthropological data come from field surveys and cover women's perceptions of climatic events, the vulnerability of their livelihoods, and the adaptation strategies they use.

Demographic data come from the National Institute of Statistics and Demography (INStaD). All data were collected through documentary research, interviews and direct observation in the field.

2.3 Sampling

The sample size was determined with the formula of Schwartz [13], at a 95% confidence level and a margin of error of ±5%:

$$N = Z_{\alpha}^2 \cdot P \cdot Q / d^2 \qquad (1)$$

where N is the sample size, Z_{α} is the deviation of 1.96 corresponding to the 95% confidence level, P is the number of women engaged in a rural economic activity divided by the total number of women in the commune, Q = 1 − P, and d is the margin of error (5%). A sampling rate of 15% was applied in each selected arrondissement to obtain the exact number of women to be surveyed. In addition, questionnaires were administered to five arrondissement chiefs, and five resource persons in the study area were interviewed. In all, 162 people were surveyed.

3 RESULTS AND DISCUSSION

3.1 Hydro-climatic risks to which women are exposed

3.1.1 Rainfall and temperature

Figure 2 shows the interannual variability of rainfall in the Commune of Lokossa from 1986 to 2020. The standardized precipitation anomaly reveals interannual variability in rainfall totals. The five-year moving average shows that this variability is made of alternating deficit and surplus years. About 40% of the years are dry (1986, 1992 to 2001 and 2015 to 2020) and 60% are wet (1987 to 1999 and 2007 to 2011). The linear trend line has a slight negative slope (a = −0.018), which indicates a downward trend.

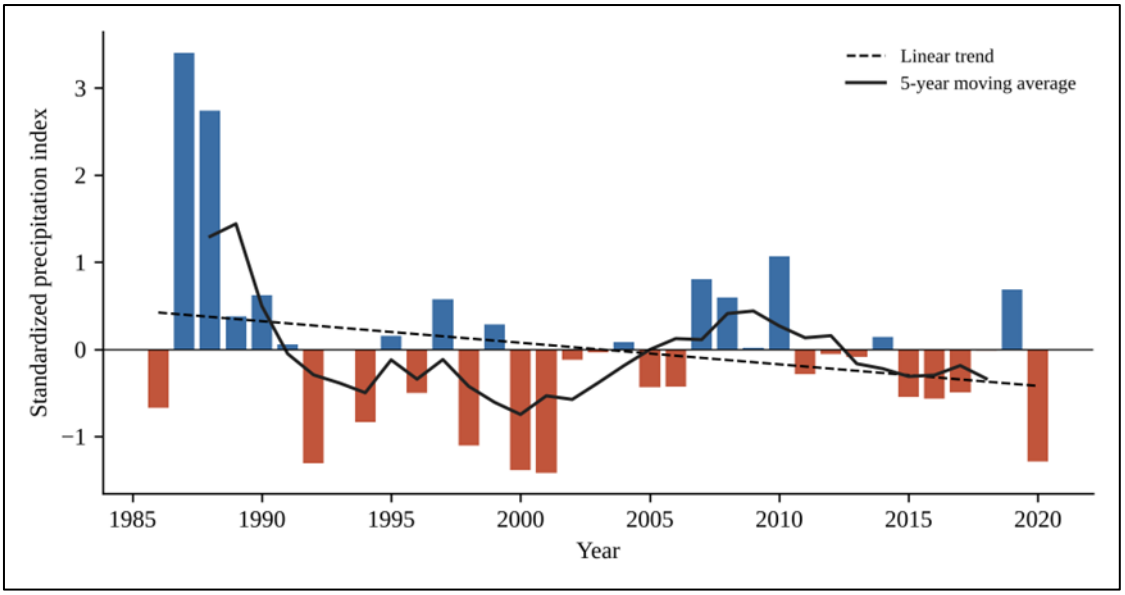


Figure 2: Interannual variability of rainfall in the Commune of Lokossa (1986–2020). Source: Météo-Bénin, 2022.

Figure 3 shows the annual rainfall totals. Between 1991 and 2001 the linear trend line lies below the mean annual rainfall (1,075.9 mm). It stabilizes between 2001 and 2010. During the last decade, the trend is above the mean, which marks a rather abrupt increase in rainfall over this period.

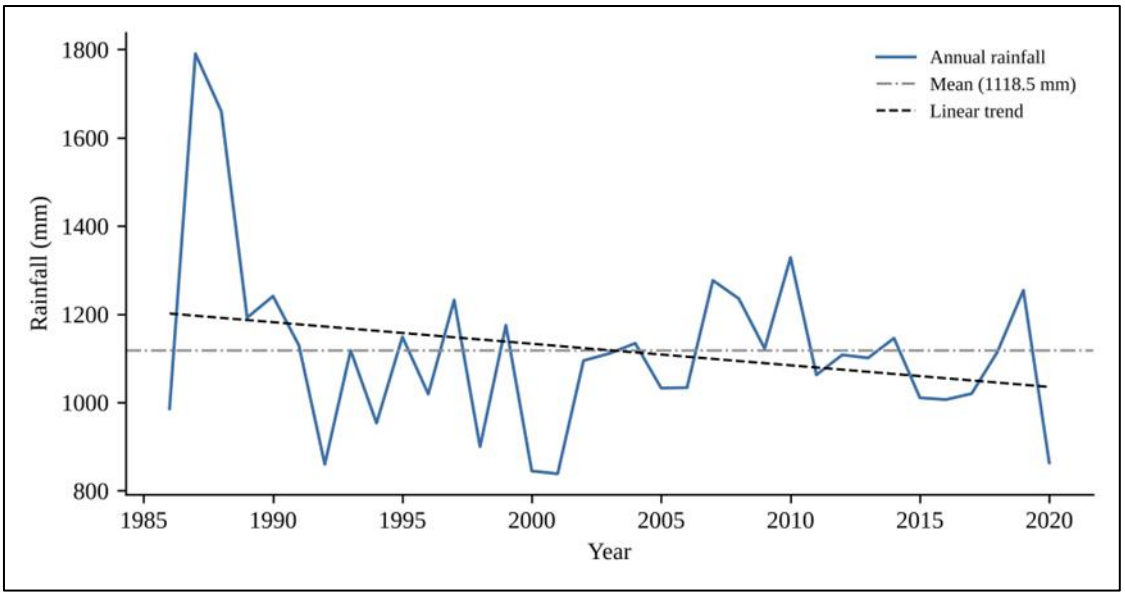


Figure 3: Annual rainfall in the Commune of Lokossa (1986–2020). Source: Météo-Bénin, 2022.

The ombrothermic diagram (Figure 4) shows that Lokossa has a bimodal rainfall regime. The first peak occurs in May, with a mean of 184.2 mm, and the second in September, with a mean of 136.9 mm. The long rainy season runs from May to July and the short rainy season from September to October. Mean temperature varies between 25.3 and 29.2 °C over 1989–2018, which accounts for the intense heat of recent years and amplifies evaporation and evapotranspiration. March and April are the hottest months, August and September the least hot.

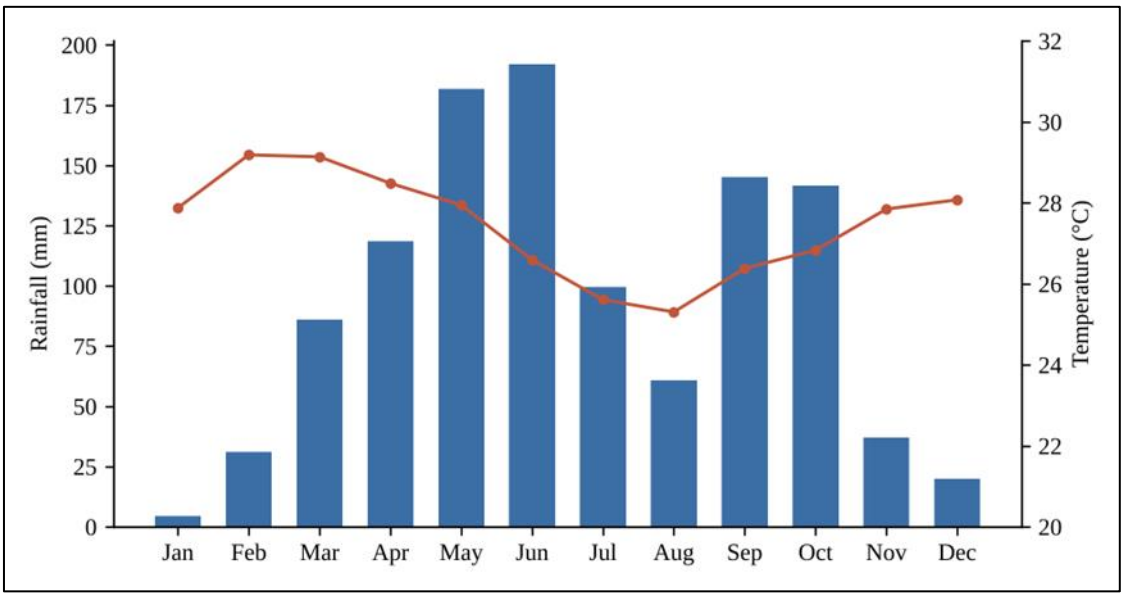


Figure 4: Ombrothermic diagram of the Commune of Lokossa. Source: Météo-Bénin, 2022.

3.1.2 Identification and manifestation of hydro-climatic risks

According to studies carried out in Benin, particularly under the National Adaptation Programme of Action (NAPA-Benin) [14], the main extreme hydrometeorological phenomena are floods, droughts, late and violent rainfall, and excessive heat. In the Commune of Lokossa, the main hydro-climatic risks identified are flooding, violent wind, heat, rainfall erosion and drought. Figure 5 shows a flooded house and road at Atikpéta in the rainy season. Flooding is responsible for diseases such as malaria and diarrhoea, and impassable roads prevent women from leaving home for their daily occupations.



Figure 5: Flooding at Atikpéta (a, b). Photo credit: Fangnibo J., May 2022.

3.2 Women's activities most dependent on climate

The female activities most dependent on climate in Lokossa include gravel quarrying, the cultivation of *crincrin* (*Corchorus olitorius*) and maize, food processing and the marketing of agricultural products.

3.2.1 Food processing

Women in Lokossa process palm nuts into red palm oil and cassava into flour (*gari*). Figure 6a shows a woman processing palm nuts into red palm oil in the open sun at Atikpéta, and Figure 6b shows a cassava processing workshop at Koudo. The women at work wear very light clothing because of the intense heat.



Figure 6: Food processing: palm oil at Atikpéta (a) and *gari* at Koudo (b). Photo credit: Fangnibo J., February 2022.

3.2.2 Agricultural production

Women also grow crops such as *crincrin*. Figure 7 shows a group of women in a *crincrin* and maize field in the dry season. The field lies in a flood-prone area.



Figure 7: Cultivation of *crincrin* and maize at Ouèdèmè. Photo credit: Fangnibo J., February 2022.

3.2.3 Marketing of agricultural products

Women are often exposed to the sun while trading. Figure 8 shows women in the Nesto Dalmeda central market of Lokossa. Many women of Lokossa trade in agricultural products such as fresh tomato and pepper, and in processed products such as red palm oil, cassava flour and maize. Of the women surveyed at selling places, 59% report that poor sales and illness are the main difficulties they face.



Figure 8: Women traders in the sun in the Nesto Dalmeda central market, Lokossa (a, b). Photo credit: Fangnibo J., February 2022.

3.3 Impact of hydro-climatic risks

3.4 Degree of impact

Table 1 gives the sensitivity matrix used to assess the impact of hydro-climatic risks in the Commune of Lokossa. Degrees of impact are the mean of the scores assigned to each exposure unit, and the intensity classes (strong, medium, weak) follow the impact scale.

Table 1: Degree of impact of hydro-climatic risks on exposure units (score).

Exposure unit	Flooding	Water erosion	Drought	Heat	Violent wind
Agricultural production	5	2	5	3	3
Marketing of fishery products	4	1	4	1	4
Infrastructure and housing	5	3	4	3	3
Livestock	3	2	1	2	1
Trade	5	4	3	4	3
Women's health	5	3	5	5	3
Total score	4	2	3	3	2
Impact index	Fairly strong	Fairly weak	Medium	Medium	Fairly weak

Source: field survey, January 2022.

Figure 9 shows the vulnerability of women according to their social status. The exposure index of every category of women exceeds 50%, with the exception of married women and girls. Elderly women, widows and unmarried women are the most vulnerable, with exposure indices of 84%, 76% and 56%, against 52% for female heads of household and 48% for married women. Women are therefore not sheltered from the harmful effects of climatic constraints in the Commune of Lokossa.

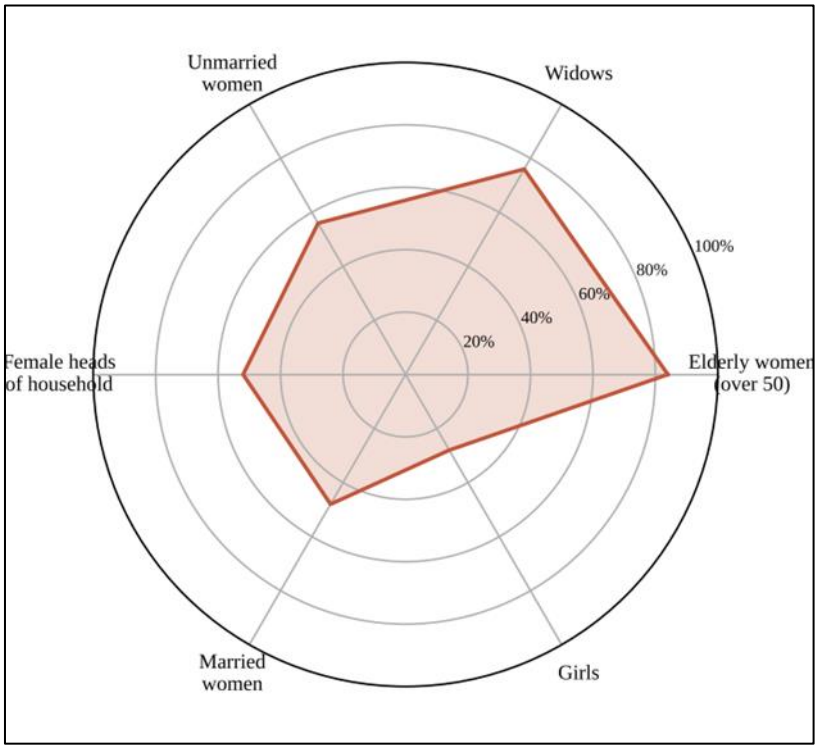


Figure 9: Vulnerability of women by social status in the Commune of Lokossa. Source: field survey.

4 DISCUSSION

For a few decades, hydro-climatic variability in West Africa has appeared as extreme climatic events such as insufficient and poorly distributed rainfall. These extremes have become more frequent since the end of the 1960s [15,16] and have led to hydro-climatic risks, chiefly drought and flooding. Hydrological risks are therefore a major concern for land planning and management. In humid tropical areas they are linked to very intense rainfall, sometimes of long duration. The resulting environmental disasters include landslides, floods and erosion, which have very serious consequences for socio-economic activities and for the women concerned [17].

These results agree with those of Amoussou [18] on the Mono-Ahémé-Couffo watershed for 1961–2000. According to that work, rainfall is not the only parameter explaining the hydrological functioning of the basin: the geological

substratum and surface conditions also play a part. These hydro-climatic phenomena make the women of the locality more vulnerable.

Strategies are developed by women and by the authorities at various levels to reduce these risks, but they must be combined with the maintenance and development of Ouèdème-Adja and Koudo and with dredging of the Mono River, in order to reduce the harmful impacts of hydro-climatic risks effectively.

5 CONCLUSION

This study improved knowledge of hydro-climatic risks and of the vulnerability of women in the Commune of Lokossa. Observations and field investigations also made it possible to assess how these risks manifest themselves and to measure their impacts. The data show that the commune is exposed to several major risks, chiefly flooding and drought. These cause considerable socio-economic losses and increase the vulnerability of women. The sectors most vulnerable to these risks are women's health and agricultural activities.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The author declares that there is no conflict of interest regarding the publication of this paper.

Statement of informed consent

Participation in the survey was voluntary. All respondents were informed of the purpose of the study and provided their informed consent before participating in the interviews. Confidentiality was maintained, and responses were anonymised to protect participants' identities. No formal ethical approval was obtained for this study.

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