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SOCIAL DYNAMICS, VULNERABILITY AND COMMUNITY ADAPTATION TO CLIMATE RISKS IN DANGBO, BENIN

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ABSTRACT

The commune of Dangbo, located in the Ouémé Valley in southern Benin, is exposed to major climate risks: flooding, droughts and riverbank erosion weigh directly on agriculture and fishing, the pillars of local household economies. Beyond their physical dimension, these risks reveal social dynamics and unevenly distributed vulnerabilities, shaped by community organization, local knowledge and households' capacity for action. Drawing on the tools of development sociology, this article examines how these social dynamics structure exposure to climate risks and the community adaptation deployed by the populations of Dangbo.

The study combines an analysis of historical climate data, collected from the National Meteorological Agency of Benin over the period 1970-2023, with a socio-anthropological survey of 183 households and 38 key informants (village chiefs, community leaders), combining structured questionnaires and focus group discussions.

The results show that floods and droughts differentially affect agricultural production (maize, rice) and fishery resources, and are accompanied by progressive riverbank erosion that undermines agricultural landholdings. Faced with these hardships, communities are not mere victims: they mobilize a repertoire of responses rooted in local knowledge and proximity solidarities (resilient crop varieties, elevated housing, agroecological practices) that constitute a form of social capital in the service of collective resilience. The article argues for climate risk management that combines technical infrastructure with the strengthening of community organizational capacities and local governance.

Keywords: Social Vulnerability, Adaptation Strategies, Local Risk Governance, Climate Change, Dangbo (Benin).

1 INTRODUCTION

Far from being reducible to a set of physical phenomena, climate risks are today understood by the social sciences as the product of an interaction between natural hazards and socially constructed vulnerabilities. It is social relations, forms of community organization, and inequalities in access to resources that largely determine who bears the brunt of floods, droughts, or soil erosion, and who has the means to cope with them (Blaikie, Cannon, Davis & Wisner, 1994).

This perspective, now central to development sociology, calls for moving beyond the mere description of climate hazards to examine how rural societies socially construct their exposure and their capacity to respond.

The commune of Dangbo, located in the Ouémé Valley in southern Benin, offers a particularly suitable setting for this inquiry. This region, characterized by a subequatorial climate, is regularly exposed to extreme climatic phenomena such as floods, droughts, and heat waves. According to Doyen et al. (2017, p. 39), recurrent flooding in the region has a significant impact on agriculture and food security. Prolonged drought periods likewise affect agricultural yields, particularly for food crops such as maize and rice (Koffi & Oura, 2019, p. 45).

Climate projections for Benin point to a trend of rising temperatures and declining rainfall, with direct implications for food security and public health. Yabi and Afouda (2011, p. 30) report that declining rainfall, combined with rising temperatures, will reduce agricultural productivity and water resources, severely affecting rural communities. In Dangbo, these changes are manifested through recurrent flooding caused by rises in the Ouémé River, prolonged drought periods affecting food crops, and increased soil and riverbank erosion (Kodja, 2018, p. 47).

This body of work has made it possible to characterize in fine detail the climate hazards affecting Dangbo. The properly social dimension of vulnerability, however, that is, the way household organization, livelihood activities (farming, fishing), local knowledge, and community solidarities mediate exposure to risk and adaptive capacity, remains comparatively unexplored in its own right. It is this gap that the present article sets out to address, situating itself within the field of development sociology rather than within descriptive climatology alone.

The study thus aims to characterize the climate risks of the commune of Dangbo not as an end in itself, but as a lens onto the vulnerabilities and social resources of the communities that experience them. It analyzes the phenomena observed, their differentiated impacts on social groups and economic activities, and the responses populations bring to bear, so as to provide useful benchmarks for adaptation policies that are not confined to technical measures alone. Thiaw et al. (2017, p. 21) stress, in this regard, the importance of integrating local knowledge and community dynamics into the design of climate risk management strategies; it is this call that the present article takes seriously by placing social actors, rather than meteorological data alone, at the center of the analysis.

1.1 Social Vulnerability and Social Capital: A Development Sociology Framework

The notion of vulnerability constitutes the first pillar of this framework. Since the foundational work of Blaikie, Cannon, Davis and Wisner (1994), vulnerability to disasters has no longer been regarded as a mere consequence of exposure to a natural hazard, but as the product of “root causes” (power relations, unequal access to resources) and “dynamic pressures” that translate, at the local level, into “unsafe conditions” specific to certain social groups more than others. Adger (2006) extends this approach by defining vulnerability as a function combining exposure to a hazard, the sensitivity of the social and economic systems concerned, and their adaptive capacity, the latter never being uniformly distributed within a population.

The second pillar concerns livelihoods and social capital. The “sustainable rural livelihoods” framework proposed by Chambers and Conway (1992) calls for rural households’ strategies to be analyzed as the mobilization of a set of assets (material, human, social) to cope with shocks and stresses, rather than as a mere technical adjustment. From this perspective, solidarity networks, village mutual aid, and community institutions constitute a resource in their own right, one that Bourdieu (1980) conceptualized under the term social capital: the aggregate of actual or potential resources linked to possession of a durable network of relationships. In Dangbo, this social capital is visible in solidarity among households, in organization around village chiefs and community leaders, and in the transmission of practical knowledge for coping with hazards.

This framework, finally, is situated within the tradition of the socio-anthropology of development. For Olivier de Sardan (1995), understanding social change requires empirically capturing the actual logics of local actors, rather than presuming, as a matter of principle, their passivity as mere recipients of the policies or hazards that affect them. It is this methodological stance that justifies, in this study, the central place given to a participatory approach: gathering the voices of farmers, fishers, village chiefs, and community leaders is not a mere complement to the climate data, but the very condition for a sociological reading of risk.

It is in light of this threefold framework, socially differentiated vulnerability, livelihoods and social capital, and the agency of local actors, that the following pages analyze the climate risks of the commune of Dangbo, located in the Ouémé Department of the Republic of Benin, between 6°32' and 6°39' North latitude and between 2°28' and 2°34' East longitude.

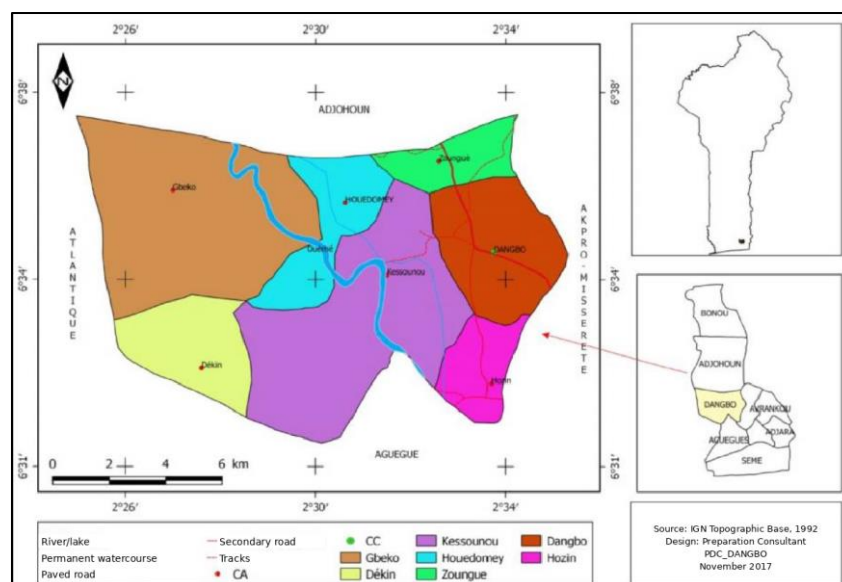


Figure 1: Map of Dangbo commune

The commune of Dangbo has a subequatorial climate. The rainy season extends from March to October, with rainfall concentrated between April and June: in April, mean monthly rainfall is approximately 132.2 mm over 7 days, that is, 23% of the days in the month. The dry season lasts from November to February; in January, the driest month, mean rainfall is 28 mm, with relative humidity below 60%.

Mean maximum temperatures range from 29°C in March to 25.3°C in August, with thermal amplitudes reaching up to 3.7°C. According to projections based on the RCP (Representative Concentration Pathways) scenarios, maximum temperatures could rise by 1.1°C to 1.8°C by 2100. This anticipated evolution in agriculture, water supply, and public health justifies the attention this article devotes to communities' social capacities for response rather than to climate trajectories alone.

2 MATERIAL AND METHODS

Consistent with the sociological framework adopted, the study combined two complementary but hierarchized approaches: an analysis of historical climate data, mobilized as the objectified context of the hazard, and a participatory socio-anthropological approach, placed at the core of the research design, to capture the perceptions, differentiated vulnerabilities, and adaptation strategies of Dangbo's populations. This methodological choice follows directly from the theoretical stance outlined above: understanding a climate risk requires, first and foremost, understanding the social actors who experience it and respond to it.

2.1 Collection of Climate Data: The Context of the Hazard

Historical climate data were collected and analyzed to identify trends and variability in rainfall and temperature in the commune of Dangbo over the period 1970-2023. These data come from the archives of Benin's National Meteorological Agency (ANM), which provides detailed information on monthly rainfall and maximum and minimum temperatures. This analysis made it possible to identify trends in rainfall and temperature regimes and to assess the interannual variability of climatic conditions, particularly drought and flood periods. Reports from earlier projects on climate risk in the region were also consulted to complement these data and to analyze extreme events such as flooding of the Ouémé River and heat waves. In this study, however, these climate data serve only as a contextual framework: they situate the hazard but are not, on their own, sufficient to account for vulnerability, which is a social construction.

2.2 Participatory Socio-Anthropological Approach

This approach constitutes the core of the survey design. It aimed to gather, not mere anecdotes, but sociological data in their own right on perceptions of climate risk, on vulnerabilities differentiated according to respondents' social and economic position, and on the adaptation strategies actually mobilized by local communities, particularly farmers and fishers, the commune's principal economic actors.

Surveys were conducted with 183 households and 38 key informants (village chiefs, community leaders, etc.), selected to represent the diversity of social positions vis-à-vis risk, in order to gather information on perceptions of climate

change, observed impacts on local economic activities, and the adaptation strategies implemented. Two instruments were used.

Structured questionnaires were administered to farmers and fishers to gather information on their perceptions of climate change and their experience of its impacts: declining agricultural yields (maize, rice, cassava, etc.), diminishing fishery resources (reduced fish stocks, altered reproductive cycles), and the increased frequency of extreme climatic events such as floods and droughts.

Focus group discussions were then organized with the main community actors (village chiefs, association leaders, etc.) to gather qualitative testimony on the effects of climate change, local perceptions of these phenomena, and the adaptation strategies put in place by communities. These discussions highlighted the challenges faced by residents as well as the local solutions envisaged to strengthen resilience, that is, in the terms of the framework adopted, the concrete forms taken in Dangbo by the mobilization of social capital and local knowledge in the face of risk.

This participatory approach thus made it possible to cross-reference the objectified data drawn from climate archives with the socially situated perceptions of local populations, offering a comprehensive view of the impacts of climate change in Dangbo and of the region's specific adaptation measures.

2.3 Future Climate Projections

Future climate projections for the commune of Dangbo were drawn from the reports of the Intergovernmental Panel on Climate Change (IPCC), which provide global climate change scenarios based on simulation models. These scenarios make it possible to estimate future variations in temperature and rainfall regimes in the region, and are used here as a risk horizon rather than as an object of analysis in their own right.

These projections are based on the RCP scenarios, which model different levels of greenhouse gas concentration depending on whether mitigation action is undertaken. Both the RCP 4.5 (moderate) and RCP 8.5 (high-emission) scenarios indicate increases in maximum temperatures in the region, as well as a decrease in rainfall and a shift in its seasonal distribution. These projections shed light on long-term challenges for water resource management, agriculture, and public health, challenges that, in our view, call for technical responses as much as for strengthened social and organizational capacities within communities.

3 RESULTS

The results are presented in two stages: first, the climate trends observed in Dangbo over the period 1970-2023, which constitute the framework of the hazard; and second, their sociological reading, namely differentiated vulnerability, impacts on livelihoods, and community perceptions, which constitutes this study's own contribution.

3.1 Climate Trends Observed in Dangbo

3.1.1 Trend in Annual Rainfall

Figure 2 presents the trend in annual rainfall in the commune of Dangbo over the period 1970-2023 and offers an overview of climatic variation over time. The interannual variability of rainfall reflects the irregularity of climatic regimes and the difficulty of anticipating agricultural seasons, which renders communities particularly vulnerable to hazards.

Periods of heavy rainfall, notably in June and September, often coincide with rises in the Ouémé River, increasing flood risk in the commune's low-lying areas. Conversely, prolonged dry spells, particularly in January and February, exacerbate difficulties in water supply and crop management, reducing yields and the availability of resources for local populations.

This observation is decisive for the sociological reading that follows: it is not climatic variability alone that produces vulnerability, but the way it collides with livelihood systems, farming and fishing, and with social positions that are themselves unequally equipped to cope with it.

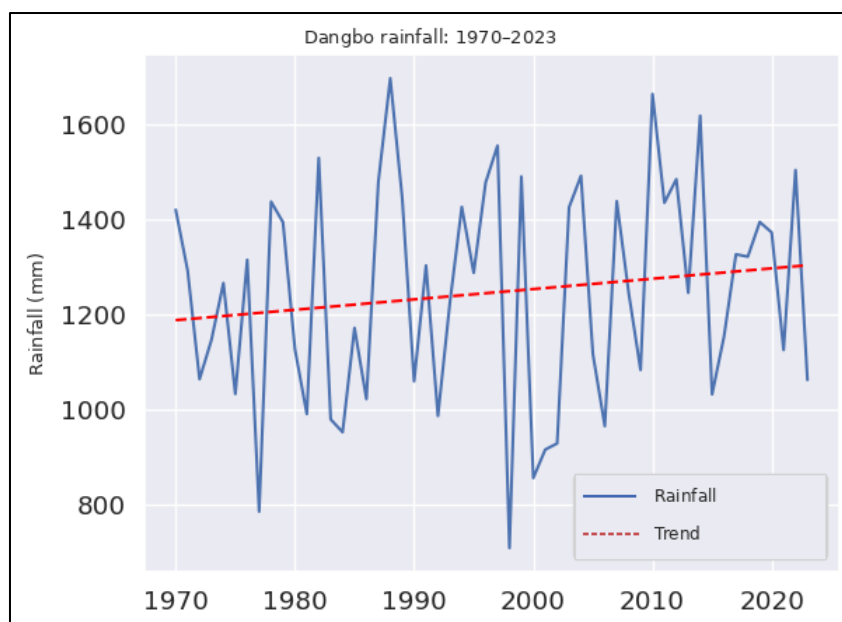


Figure 2: Trend in annual rainfall over the period 1970–2023

3.1.2 Variability in Rainfall and Temperature

Historical climate data for the commune of Dangbo reveal considerable variability in rainfall and temperature regimes, with significant changes observed over recent decades. Figure 3 presents the commune's mean monthly rainfall regime over the period 1970-2023.

The rainy season generally extends from March to October, but the distribution of rainfall over the year shows periods of heavy rain followed by prolonged dry spells, creating considerable variability. June and September see peak rainfall, representing the wettest periods; however, this relative regularity is increasingly disrupted by extreme droughts and variations in rainfall intensity, which affect crops and water resource management.

The dry season, which lasts from November to February, is characterized by high maximum temperatures and low relative humidity. Mean maximum temperatures range from 29°C in March to 25.3°C in August, with a thermal amplitude reaching up to 3.7°C, indicating a marked difference between daytime and nighttime temperatures. This intense heat, particularly pronounced in March and April, complicates crop management and the maintenance of water reserves.

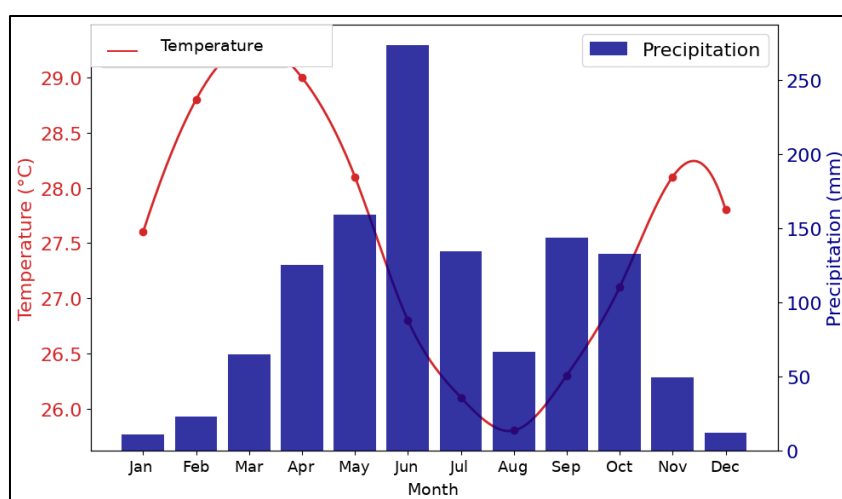


Figure 3: Mean monthly rainfall regime of Dangbo commune (1970–2023)

3.2 Extreme Climate Events and Differentiated Social Vulnerability

3.2.1 Floods: Exposure and Social Vulnerability of Households

Rises in the Ouémé River are a recurrent phenomenon in Dangbo, affecting both residential and agricultural areas. These floods are especially severe during the rainy season, when heavy rainfall causes the river level to rise, with major repercussions for the daily lives and safety of local populations.

The most pronounced flood periods generally occur during May and June, when rainfall peaks. According to historical climate data, floods occur on average 5 to 7 times per decade in Dangbo, mainly during these months of heavy rain, submerging low-lying land and residential areas. Of the 183 households surveyed, 87% reported having experienced significant flooding in their residential or agricultural areas over the past five years, most of these events occurring in May and June. Among the 38 key informants interviewed, 73% indicated that rises in the Ouémé River occur mainly at the end of the rainy season, with repercussions for infrastructure and population displacement.

Considered in isolation, these figures describe a hazard. Related to household location, given that low-lying areas are often occupied by households with the least landholding capital, they trace a social geography of risk: exposure to flooding is not uniformly distributed across the commune but overlaps with pre-existing social and economic positions, in line with what Blaikie et al. (1994) term “unsafe conditions” specific to certain groups.

3.2.2 Riverbank Erosion and the Weakening of Agricultural Landholdings

Erosion of the Ouémé River's banks in Dangbo is a matter of concern, aggravated by repeated flooding and other environmental factors. It leads to the loss of agricultural land and affects local fauna and flora, profoundly altering riparian ecosystems. It manifests as the progressive wearing away of the riverbanks, where floods and high water levels carry off fertile soil; periods of heavy rainfall and rapid rises in the river exacerbate this phenomenon, particularly following extreme climatic events.

Agricultural land near the river is the most affected, particularly during the May and June floods. This degradation results not only in the loss of arable land but also in changes to water quality that disrupt aquatic habitats. Compounding river flooding, one of the main drivers of erosion, are social practices themselves constrained by demographic and economic pressure: 59% of respondents believe that vegetation clearing for farming and construction has reduced the soil-stabilizing cover, making the banks more vulnerable to flooding and erosion, while 37% point to the worsening effect of global warming and increasingly extreme rainfall. Of the 183 households surveyed, 72% reported that riverbank erosion has directly affected their agricultural land, with land loss particularly severe in the lowest-lying areas. Among key informants, 58% confirmed that erosion has caused substantial material losses, including the destruction of infrastructure such as roads and bridges, which has hindered trade and mobility in the region.

Riverbank erosion thus appears less as a mere geomorphological phenomenon than as a direct threat to a central asset of rural livelihoods, land, in the sense of the Chambers and Conway (1992) framework: its loss durably undermines the affected households' capacity to remain in farming, even should rainfall return to normal.

3.2.3 Droughts and the Destabilization of Livelihood Systems

Prolonged drought periods have become a recurrent phenomenon in Dangbo, notably following periods of heavy rain, creating climatic discontinuities with negative effects on agriculture and water resources. Often unanticipated, they are particularly pronounced at the end of the rainy season and the beginning of the dry season, which heightens local populations' vulnerability to climatic fluctuations.

Drought in Dangbo is characterized by a prolonged absence of rain combined with high temperatures, leading to reduced soil moisture and water stress for crops. It primarily affects food crops such as rice, maize, cassava, and legumes, as soils become increasingly arid, which compromises seed germination and crop growth. Earlier flooding, while beneficial to farmland in bringing water, is often followed by a prolonged dry period, making agricultural planning difficult; farmers report that this alternation between excessive rain and severe drought disrupts the cropping cycle and reduces yields.

The participatory approach made it possible to quantify the effects of drought as perceived by households and key informants: 68% of farmers surveyed report a decline in agricultural yields during drought periods, with particularly high losses for maize and rice, and a 40% to 60% drop in production compared with wetter years. Moreover, 55% of farmers report that the prolonged dry period following heavy rains affects crop planning, making it difficult to prepare land and sow during the dry season, a constraint that weighs first on households least able to stagger their cropping cycles or diversify their sources of income.

3.3 Perceptions and Strategies of Local Actors in the Face of Risk

Farmers and fishers in Dangbo report a significant decline in agricultural productivity and fishery resources due to the climatic variations observed in recent years. Changes in rainfall distribution, particularly prolonged dry spells and irregular rains, are perceived by respondents as the main drivers of poor harvests and declining fish stocks. This perception is, in itself, an important sociological datum on how communities rank the causes of their vulnerability.

3.3.1 Agriculture: Declining Yields and the Reshaping of Practices

Farmers report reduced agricultural productivity linked to changes in rainfall regimes. Prolonged drought, followed by sudden, excessive rain, disrupts cropping cycles, particularly for rice, maize, and other essential food crops, worsening food insecurity in the region. Survey results show that 83% of farmers surveyed report that declining agricultural yields are linked to climatic variations; 74% specifically cite changes in rainfall distribution as the main factor behind these poor harvests.

3.3.2 Fishing: The Weakening of Fishing-Based Livelihoods

Fishery resources are also affected by climate change. Fishers observe a decline in fish stocks in the Ouémé River, owing to fluctuating water levels and changes in water temperature; increased flooding disrupts fish breeding habitats, reducing their numbers in traditional fishing grounds. Among those surveyed, 68% of fishers report a decline in fish stocks, particularly following frequent flooding and variations in water temperature, considerably affecting the incomes of families dependent on fishing.

Local communities express strong concern regarding flooding of the Ouémé River and soil erosion, whose direct repercussions for food security and livelihoods cut across the commune's two structuring economic activities. Of the 183 households surveyed, 79% report that frequent river flooding directly affects their agricultural production, destroying crops and damaging cultivated land; 63% of farmers indicate that soil erosion is a growing problem, particularly in areas close to the riverbanks.

4 DISCUSSION

4.1 Climate Change, Agriculture, and Social Vulnerability in Dangbo

Climate change directly affects agriculture in Dangbo: rainfall variability and high temperatures reduce rice, maize, and cassava yields, while frequent droughts and floods disrupt cropping cycles. Sultan (2016, p. 524) shows that such variations reduce agricultural productivity in West Africa owing to irregular rainy seasons; in Dangbo, climate data indicate precisely a reduction in the duration and regularity of rainfall, and Lawin et al. (2019, p. 8) confirm that such anomalies negatively affect yields, particularly for rice and maize.

The participatory survey reveals that 73% of farmers report declining yields, mainly due to changes in rainfall distribution. Apuri et al. (2025, p. 4) stress the importance of adapted agricultural practices and sustainable soil management; Kongatoua (2025, p. 47) adds that rural vulnerability is aggravated by poor water resource management and a lack of agricultural infrastructure. These findings align with the reading proposed by Adger (2006): the vulnerability observed in Dangbo does not result from the climate hazard alone, but from its combination with high economic sensitivity, dependence on poorly diversified rain-fed crops, and adaptive capacity constrained by inadequate infrastructure.

Climate change thus seriously threatens agriculture in Dangbo, but this threat manifests socially in a differentiated manner, depending on whether households possess the assets, land, financial, or social, that allow them to diversify their crops or cushion a poor harvest. Katikiro et al. (2014, p. 99) recommend adopting resilient agricultural practices and crop diversification as adaptive measures, which, in Chambers and Conway's (1992) terms, amounts to recommending a broadening of the asset portfolio households can mobilize rather than a mere isolated technical response.

4.2 Fishery Resources and the Reshaping of Livelihoods

Dangbo's fishery resources are affected by climate change through variations in the level and temperature of the Ouémé River's water, which disrupt fish reproduction and distribution. Katikiro et al. (2014, p. 103) show that such changes alter aquatic habitats, reduce stocks, and upend fishers' incomes; in Dangbo, frequent flooding and thermal fluctuations degrade spawning grounds and destabilize the ecosystem. Subervie (2007, p. 47) notes that declining catches lead to falling incomes and price instability in local markets.

The survey reveals that 68% of fishers report declining stocks, attributed to fluctuations in water level and temperature, which heighten their economic vulnerability and push communities to diversify their activities to strengthen resilience. This diversification, often toward small-scale trading or farming, resembles an asset-portfolio strategy in the sense of Chambers and Conway (1992): unable to act on the climate hazard itself, households reshape their livelihoods to reduce their dependence on a single resource that has become uncertain.

4.3 Riverbank Erosion: An Ecological and Socially Constructed Problem

Erosion of the Ouémé River's banks constitutes a major challenge in Dangbo, where recurrent flooding engulfs agricultural land and infrastructure. Ezin (2014, p. 220) explains that flooding carries off fertile soil, reducing land productivity and threatening food security; the survey conducted among 183 households reveals that 72% have lost plots, mainly under rice, maize, and cassava, worsening their economic difficulties. Subervie (2007, p. 135) confirms that this loss of cultivable land increases population vulnerability and food insecurity.

In keeping with the reading proposed by Blaikie et al. (1994), riverbank erosion in Dangbo is not merely a geomorphological phenomenon: the 59% of respondents who attribute it in part to deforestation for farming and construction point, without naming it as such, to “dynamic pressures”, demographic pressure, the shrinking of available land, that transform a natural hazard into a socially aggravated risk. Riverbank erosion thus appears as both an ecological and a socio-economic problem, one that calls for integrated risk management to strengthen community resilience.

4.4 Social Capital, Local Knowledge, and the Governance of Adaptation

Adaptation in Dangbo rests on integrated management combining sustainable agricultural practices, resilient infrastructure, and local knowledge. The World Bank (2023, p. 10) stresses that such strategies reduce vulnerability to floods, droughts, and erosion. On the ground, resistant rice varieties are being replanted and dwellings are being raised in flood-prone areas; these measures limit agricultural losses and protect household assets. CIRAWA (2025, p. 18) shows that agroecology, agroforestry, and sustainable soil management, combined with traditional knowledge, restore fertility, increase biodiversity, and mitigate erosion.

These practices are not simply a matter of individual ingenuity: they rest on community training sessions that disseminate this knowledge and strengthen the collective capacity to anticipate risk. Read through Bourdieu's concept of social capital (Bourdieu, 1980), these dynamics show that Dangbo's resilience rests as much on the density of village solidarity networks and on the authority of village chiefs and community leaders, essential relays for disseminating practices, as on the technical resources available. Following Olivier de Sardan's (1995) warning against development approaches that presume rural populations to be passive as a matter of principle, Dangbo's populations here appear as active producers of adaptive knowledge and practices, ones that public policy would do well to recognize and support rather than supplant.

The holistic, participatory approach observed in Dangbo, combining nature-based solutions, agricultural innovation, and local knowledge, thus enhances resilience to future climatic fluctuations, provided that risk management policies explicitly build on this existing social capital rather than bypassing it through purely technical or centralized arrangements.

5 CONCLUSION

This study highlights the contribution of a development sociology perspective to understanding climate risk in Dangbo. Climatic variations, floods, droughts, riverbank erosion, affect agriculture and fishing there, but their effects can be fully understood only by relating them to the social and economic positions of the households that experience them: differentiated exposure according to location and available landholdings, sensitivity linked to dependence on poorly diversified activities, and adaptive capacity unevenly distributed according to access to solidarity networks, local knowledge, and community resources.

Future climate projections reinforce these concerns and suggest an intensification of extreme events in the coming decades. The study nonetheless demonstrates the real agency of Dangbo's communities: day to day, they mobilize a repertoire of strategies, resistant crop varieties, raised dwellings, agroecological practices, diversification of activities, that draws on community social capital and on local knowledge transmitted and adapted over time.

This argues for adaptation strategies that combine integrated natural resource management and improved risk-prevention infrastructure with genuine investment in community organizational capacity and local risk governance, village chiefs, community leaders, village associations, rather than confining themselves to purely technical responses. Only on this condition will climate resilience policies be able to build on the social resources that Dangbo's populations have themselves developed, rather than supplanting them.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of Conflict of Interest

The author declares no conflicts of interest regarding this manuscript.

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