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FARMERS' PERCEPTIONS OF CLIMATE CHANGE ENVIRONMENTAL STRESS AND ADAPTATION STRATEGIES IN OGOOUÉ-IVINDO GABON

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ABSTRACT

Climate change is increasingly disrupting seasonal patterns in Gabon, threatening subsistence farming and farmers' psychological well-being. This study examines perceptions of climatic disruptions, their agricultural and psychological consequences, and local adaptation strategies in Ogooué-Ivindo Province. Combining geographical and environmental psychology perspectives, the research draws on participant observation, documentary analysis, and 38 semi-structured interviews conducted in January 2025 in five villages: Latta, Ebessi, Massaha, Ebyeng, and Ekobakoba. Interview data were manually coded and organized thematically. Respondents most frequently mentioned extreme heat (38 mentions), insufficient rainfall (36), and deforestation (30). They associated these environmental changes with disrupted agricultural calendars, crop damage, declining yields, and increased uncertainty over household food supplies. Nearly all respondents reported stress and fear, alongside accounts of discouragement, sadness, and anxiety concerning their livelihoods. Farmers described two main adaptation strategies: replanting damaged plots and replacing vulnerable crops with more heat-tolerant crops, particularly cassava. Although these practices help maintain production, they increase household labor demands and provide limited responses to rainfall shortages and forest degradation. The findings highlight the intertwined ecological and psychological dimensions of agricultural vulnerability. They support stronger forest management, sustainable agricultural practices, institutional assistance, and the integration of psychological and community support into rural development policies. Such measures could strengthen farmers' adaptive capacities while safeguarding food security and their relationships with the forest environment.

Keywords: Climate change; Subsistence farming; Environmental stress; Adaptation strategies; Ogooué-Ivindo; Gabon.

1 INTRODUCTION

The United Nations Conference on Environment and Development (UNCED), also known as the Rio Earth Summit, held in Rio de Janeiro, Brazil, from June 3 to 14, 1992, marked the expansion of social science research on sustainable development. This concept is defined as "development that meets the needs of the present without compromising the

ability of future generations to meet their own needs." In other words, it involves reconciling tensions between nature and human society and identifying new forms of interdependence between human progress, environmental protection, and the well-being of present and future generations.

Our study of farmers' perceptions of climate change, environmental stress, and adaptation strategies in Ogooué-Ivindo, Gabon, forms part of this global awareness-raising effort. In recent years, international climate meetings have increasingly recognized that agriculture must be prioritized in negotiations because agricultural and climate issues are closely interconnected. [1] note that "Articles 2 and 4 of the Convention (UNFCCC), adopted in 1992, refer to the relationship between climate change and agriculture." Previously given limited attention, agricultural concerns now occupy a central position because:

"Ongoing climate change, associated with increasing atmospheric carbon concentrations, is on an entirely different scale. It introduces increasingly intense and frequent hazards: irregular seasonality, rainfall occurring at different times or with different distributions, extreme events, temperatures altering harvest dates, and new or more active pests and pathogens. These diverse impacts have major consequences for food security, collectively imposing a new constraint on farmers and livestock keepers worldwide" [2] (translated from French).

However, climate impacts vary across the world and even within individual countries. Countries in the Global South are particularly vulnerable [3], despite being among the lowest emitters [4]. Over recent decades, sub-Saharan Africa's vulnerability to climate variability and change has therefore become a prominent concern for researchers, institutions, and the media [5]. Nevertheless, studies of rainfall variability in tropical regions, particularly the Congo-Gabon region, remain relatively scarce [6].

General climatological data indicate that this region, characterized by bimodal rainfall regimes, receives annual precipitation of 1,200-1,300 mm, decreasing from the coast toward the interior. Climatic changes directly affect predominantly subsistence and family farming, reducing productivity and threatening food security in Gabon, where dependence on imports reached approximately 80% in 2023 [7].

Agriculture, originally defined as an act of production [8], is the broadest term used to describe the many ways in which crops and domestic animals sustain the world's human population by providing food and other products [9]. Equatorial forest within the Congo Basin covers 85% of Gabon, which has a climate favorable to agriculture and numerous other natural assets, including a dense river network, locally fertile soils, and distinctive biodiversity. Nevertheless, the country faces serious food and nutrition security challenges amid climate change and increasing natural resource scarcity.

A major contradiction emerges: while Congo Basin countries are urged to preserve their forests as "carbon sinks" to combat climate change [10], these same climatic changes undermine farmers' livelihoods. Their adverse effects have also generated stress, fear, and concern among rural and urban Gabonese farmers, for which lasting solutions appear to remain unavailable [11], [12]. Against this background, the study was conducted in several villages in Ogooué-Ivindo Province to understand farmers' experiences and concerns and the resilience measures they adopt to cope with climatic disruptions and reduce household vulnerability.

The research asks how climate change affects subsistence agriculture and farmers in this province and which resilience or adaptation strategies they adopt in response. Its objective is to show how microclimatic conditions adversely affect farming activities and farmers' mental and psychological health. Such seasonal disruptions include dry or rainy seasons occurring at unexpected times, excessive or insufficient rainfall, and droughts that begin earlier or last longer. They directly affect agricultural practices organized around the climatic calendar. The hypothesis is that climate change negatively affects subsistence farming and increases farmers' psychological vulnerability by fostering stress, fear, and discouragement that may affect their health.

2 METHODOLOGICAL APPROACH

2.1 Study area

The study was conducted in Ogooué-Ivindo Province. Its climate is described as a "transitional equatorial climate typical of central Gabon, with two clearly defined rainy seasons, a long dry season from June to August, and reduced rainfall in December/January. Rainfall ranges from 1,400 to 1,900 mm" ([13] translated from French). According to [14], Ogooué-Ivindo lies in northeastern Gabon and covers 46,075 km^2, making it the country's largest province. The 2013 General Population and Housing Census recorded 63,293 inhabitants, corresponding to a very low population density of approximately 1.4 inhabitants/km^2[15]. Its landscape comprises plateaus, hills, and several upland areas, almost entirely covered by dense forest. Predominantly ferralitic and leached soils help explain the prevalence of shifting slash-

and-burn agriculture [16]. Fieldwork was conducted in five villages: Latta, Ebessi, Massaha, Ebyeng, and Ekobakoba (Figure 1).

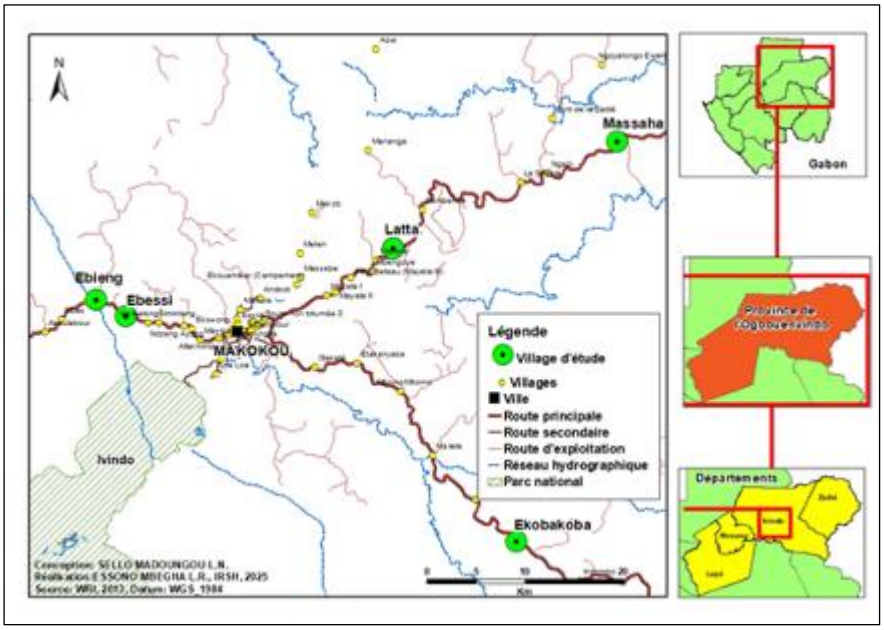


Figure 1: Location of the study villages in Ogooué-Ivindo

According to [17], Ogooué-Ivindo Province is divided into four departments: Ivindo, Zadié, Mvoung, and Lopé. The study villages are located in Ivindo Department.

2.2 Methodology

The study primarily uses qualitative data. Two disciplinary approaches - rural geography and environmental psychology - were combined to address the research question. The first analysis of climatic phenomena and farmers' adaptation practices. The second, environmental psychology, enabled examination of farmers' perceptions of climate change, its perceived effects on mental health, and the psychological consequences of these conditions.

2.2.1 Research tools

First, participant observation was undertaken in the study villages in January 2025 through several rural activities. These included accompanying farmers to their fields to observe the effects of climatic disruptions on crops and soils during what should have been the short dry season, as well as documenting adaptation practices. Forest walks also enabled observation of vegetation conditions used to guide agricultural site selection. This field-based approach improved understanding of the climatic phenomena reported by rural communities, particularly seasonal disruption, rising temperatures, and rainfall shortages or excesses. Negative effects were observed on crops, natural resources, and farmers.

Second, a documentary review identified bibliographic sources useful for understanding and analyzing the research issue. Articles, reports, periodicals, books, and dissertations were consulted, including the volume by [18] and the article by [19].

Finally, a series of semi-structured interviews was conducted in the study area. Semi-structured interviewing, defined as a data collection technique that supports qualitative and interpretive approaches, particularly those grounded in interpretive paradigms [20], proved particularly valuable. It made it possible to gather socio-economic information about farmers, explore their perceptions of climate change, examine its psychological impacts on them, and identify the resilience strategies they have adopted. Consequently, the semi-structured interviews were conducted in January 2025 in the villages of Latta, Ebessi, Massaha, Ebyeng, and Ekobakoba, which were randomly selected based on their accessibility in the field. Initially, these villages were selected because of the interest in community-based hunting management as part of a separate research project. These same villages subsequently proved relevant for investigating climate change, which is a recurrent and substantial concern among farmers. Only individuals who agreed to participate in the interviews were included. The social climate associated with human-elephant conflict in the province restricted farmers' availability, as some had become hostile to requests to participate in scientific studies (Table 1).

Table 1: Distribution of interviews by village

Village	Number of interviews
Latta	5
Ebessi	8
Massaha	7
Ebyeng	9
Ekobakoba	9
Total	38

Source: Field surveys, January 2025

A total of 38 oral semi-structured interviews, each lasting 30 minutes, were conducted in five villages with individuals for whom agriculture was either their principal activity or a secondary occupation. Responses were recorded in a notebook. Respondents' ages were also collected to relate their accounts to their life experience and assess whether their observations and perceptions reflected long-term exposure to climatic phenomena (Figure 2).

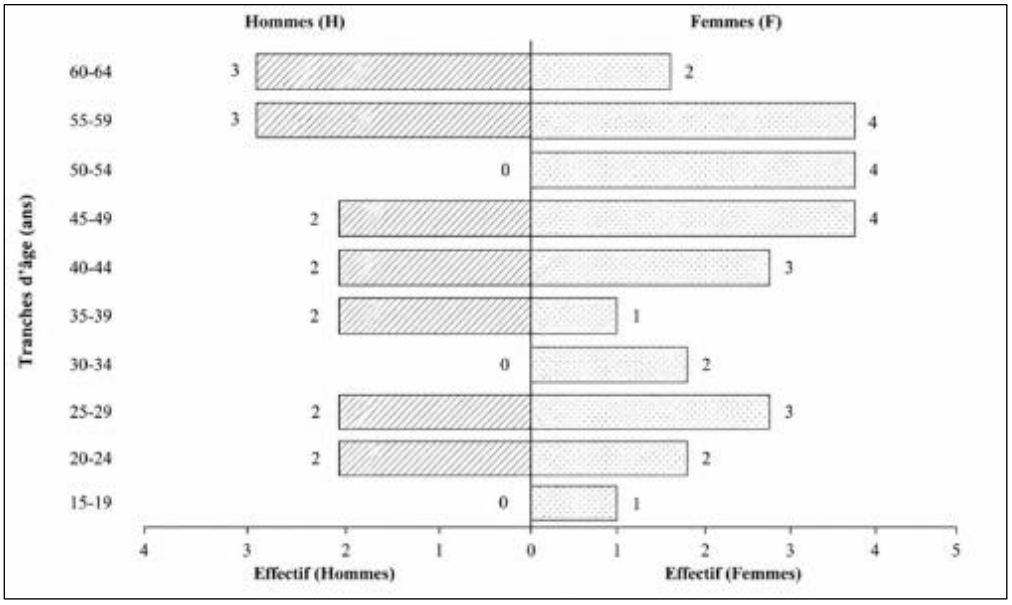


Figure 2: Age pyramid of respondents

The age pyramid for the 38 respondents shows variation across age groups. Individuals aged 45–65 years are the most represented, with a strong presence of women, reflecting their substantial involvement in agriculture. Their representation is useful for understanding long-standing farming experience, perceptions of climatic phenomena in their respective villages, and the associated psychological effects. Conversely, the limited participation of young men and women aged 15-30 years may indicate less interest in farming within this age group. Figure labels: men (left); women (right); age groups in years; number of men; number of women.

2.2.2 Data processing

Interview data were manually processed and coded, then organized according to the main emerging themes. This procedure identified the analytical objectives, the variables examined, and the indicators through which respondents described climate change. Table 2 presents the resulting analytical framework.

Table 2: Data processing and analysis

Analytical objectives	Variables examined	Indicators mentioned
Identify villagers' perceptions of climate change	Perceptions of climate change	Extreme heat, desertification, insufficient rainfall, drought, biodiversity loss, bushfires, irregular seasons, declining soil fertility, deforestation
Analyze climate change impacts on agriculture	Agroecological impacts	Disrupted agricultural calendar, declining yields
Analyze manifestations of environmental stress	Environmental and psychological stress	Loss of motivation, fear, mental fatigue, persistent sadness, feelings of worthlessness
Identify local adaptation strategies developed by farmers	Adaptation strategies	Replanting, crop replacement

The table identifies four main themes in farmers' accounts, based on the indicators mentioned in their responses. These themes underpin the findings: perceptions of climate change, agroecological impacts, environmental and psychological stress, and adaptation strategies.

3 RESULTS

The analysis conducted using the methodology described above identified the themes presented in the following sections.

3.1 Perceptions of climate change and agroecological impacts

Agriculture is the principal economic activity in all study villages. Even men who hunt bushmeat also participate in agricultural work in some capacity. All respondents (100%) reported depending entirely on agriculture for their subsistence. Farming remains largely traditional and primarily serves household food needs. Consequently, any disruption directly affects farmers' living conditions and increases their vulnerability.

This largely unmodernized agriculture is increasingly affected by climatic disruptions, as all respondents described in their own terms. Given the limited formal education of several participants, the term "climate change" was not used directly in interviews. Instead, questions referred indirectly to the phenomenon through agriculture and the environment: "Is agricultural production still the same as before?", "What difficulties do you currently encounter in farming?", and "Have you noticed changes in the forest?" Responses indicate that participants, most of whom were women farmers, perceived climate change through recurrent indicators: extreme heat, drought, absent or irregular rainfall, bushfires, deforestation, biodiversity loss, declining soil fertility, and desertification.

Nearly all women farmers interviewed, as well as men aged 45–65 years, reported substantial changes over time compared with their youth. Table 3 presents the frequency with which respondents mentioned each indicator.

Table 3: Frequency of mentions of climate change indicators

Climate change indicators	Number of mentions
Extreme heat	38
Desertification	15
Insufficient rainfall	36
Drought	12
Biodiversity loss	20
Bushfires	10
Irregular seasons	20
Soil fertility	25
Deforestation	30

Source: Field surveys, 2025.

Each interviewee mentioned several perceived climate change indicators, and this was taken into account during data processing. Respondents explained that the manifestations were numerous and pronounced, making it impossible to identify only one. These phenomena jointly disrupt their daily lives. The analysis therefore focuses on the three most frequently mentioned indicators, which appear to be perceived as the most harmful to crops, the environment, and consequently mental and psychological health: extreme heat, insufficient rainfall, and deforestation.

3.1.1 Extreme heat

A heatwave is a period of unusually high daytime and nighttime temperatures lasting several consecutive days and exceeding the seasonal norms of the region concerned. Farmers described recurrent extreme heat associated with rising temperatures as their most feared climatic hazard because it damages vegetables and other food crops, including cassava and banana, particularly during planting. Because cultivation practices are strongly climate-dependent, extreme heat both exhausts farmers and adversely affects crops that do not require excessive temperatures to grow. Referring to this heat, a farmer in Latta stated: "It is as if fire has descended upon us. It was not like this before."

3.1.2 Insufficient rainfall

Insufficient rainfall followed extreme heat in respondents' accounts of climate change indicators, with 36 mentions. It refers to a prolonged period during which precipitation falls below seasonal norms, resulting in water shortages. Donnéesmondiales.com reports that "in 2025, February was the driest in 17 years, with only 3.37 liters of precipitation (3.33 L/m^2 in 2008)." Rainfall shortages also affect village crops.

A woman farmer in Massaha explained: "Sometimes we wait for the rains before we start planting, but nothing comes. Sometimes we have already planted and wait for the rain to make the crops grow in the fields, but only a little falls, and then nothing." This illustrates the close dependence of subsistence farming on rainy and dry seasons. Table 4 presents the seasonal cropping calendar.

Table 4: Seasonal cropping calendar for food crops

Period	Operation	Crops	Season
June–late August	Clearing		Long dry season
Mid-July–August	Tree felling		Long dry season
Mid-August–mid-September	Burning and preparation of planting material		Long dry season / onset of rains
September–November	Planting	Groundnut, maize, cassava, banana, vegetables	Long rainy season
Mid-November–December	First weeding	Groundnut	Long rainy season
January	First harvest	Groundnut, maize	Short dry season
January	Planting	Squash	Short dry season
January–February	Second weeding	Banana	Short dry season
March–April	Second harvest	Groundnut	Short rainy season
From August	Pre-harvest	Cassava	Long dry season
From August	Harvest	Banana	Long dry season
July–September	Harvest	Squash	Long dry season / onset of rains

Source: Field surveys, 2025.

This calendar is generally followed by Gabonese farmers, although cultivation operations vary according to crop variety. For example, two groundnut varieties are planted at the same time, but one is harvested after three months, in January, and the other after six months, in March–April. Similar differences occur between six-month and one-year cassava varieties, whether sweet or bitter. By altering seasonal patterns, climate change therefore destabilizes cultivation operations.

3.1.3 Deforestation

Deforestation refers to the permanent or long-term reduction of forest area through human activities or natural processes, involving conversion to other land uses such as agriculture, urban development, or mining. In other words, vegetation disappears and is often replaced by other forms of land development. Human destruction of natural ecosystems thus intensifies unusual environmental phenomena.

Respondents in the villages of Ivindo Department also perceived deforestation as a manifestation of climate change (30 mentions). They reported that forest cover was progressively declining compared with the past. This change also affects agricultural site selection, since forest vegetation has traditionally been viewed as an indicator of soil fertility.

Respondents further attributed human–wildlife conflict, particularly conflict with elephants, to deforestation. They explained that declining forest food resources drive elephants toward fields and settlements, where they destroy crops. Farmers did not regard themselves as responsible for deforestation, stating that they maintain inherited farming practices and ways of inhabiting the forest and using natural resources. Instead, they primarily attributed forest degradation to logging, mining, oil, and agro-industrial companies, whose activities clear extensive forest areas and cause considerable environmental damage. In their view, this situation increases elephant movements in search of food, which are now greatly feared in rural Gabon and more broadly across Congo Basin forests.

3.2 Environmental and psychological stress associated with climate change

Climate change also has emotional, social, and psychological consequences for rural populations, particularly village farmers. To examine these consequences for mental and emotional health, participants in all study villages were asked: “How do these climatic changes affect you?” When necessary, the question was rephrased as: “How do you feel about all these changes in your daily life?”

Nearly all respondents mentioned stress, followed by fear, experienced throughout agricultural activities. Climatic irregularities create stress from the stages preceding production through those following it, since farming follows the seasonal cropping calendar presented above. Farmers therefore described living under persistent stress.

In Ekobakoba, one farmer stated: “We are afraid all the time. We do not know whether what we plant will grow or whether we will have food. But this is the only work we have here. How are we supposed to cope with all these changes?” Another participant in Massaha explained: “Farming is discouraging nowadays. Sometimes I feel sorry for my wife, who plants so much, but with the intense heat and the rains becoming strange, it is difficult. And when elephants come and eat our crops as well, we no longer know what to do.”

Fear, anxiety, sadness, and even anger appeared in respondents’ accounts of climate-related emotions, revealing continuing psychological distress. The situation also evoked nostalgia, particularly among older farmers seeking to preserve memories of the favorable farming conditions of their youth. They felt that changes were accelerating without improvement, leaving them uncertain about the future of farming. Such emotional conditions may contribute to psychological disorders that, if unaddressed, may also have physical manifestations.

3.3 Farmers’ resilience strategies in response to climatic hazards

In addition to extreme heat, insufficient rainfall, and deforestation, respondents identified declining soil fertility, drought, biodiversity loss, bushfires, and desertification as indicators of climate change. Although each adversely affects cultivation, farmers continue to grow crops and seek adaptation or mitigation strategies to limit impacts on subsistence agriculture, the foundation of the rural economy.

Subsistence farming primarily provides food for rural households. Although seasonal, its income also helps meet everyday needs. Recognizing this importance, many farmers reported adopting two new strategies in response to extreme heat: replanting and crop replacement.

- According to respondents, replanting involves planting again on plots damaged by high temperatures to maintain production.
- Crop replacement, a related strategy, involves introducing more robust crops, such as cassava, on degraded plots because they are better suited to intense heat.

Although these strategies help restore yields, they remain laborious and exhausting, requiring greater involvement of household labor to reduce individual workloads. They are clearly adaptation measures, and their implementation also depends on farmers’ psychological resources and resilience.

At present, farmers have not established agricultural adaptation measures to address rainfall shortages and deforestation. Nor have they implemented substantive mitigation measures to reduce greenhouse gas emissions. Some reported selecting trees carefully when preparing fields or leaving land fallow to allow soil regeneration. However, these efforts remain limited and often ineffective: fallow periods are too short, and the selection of trees for felling is not always appropriate.

Practices such as agroforestry, discontinuing slash-and-burn cultivation, and using improved, resistant varieties could provide more effective resilience strategies and help make farming systems more sustainable. Meanwhile, the damage associated with these hazards causes considerable distress: many farmers experience persistent anxiety, some become ill, and others leave their villages or abandon agriculture because, as they put it, "we are no longer certain of anything." To sustain agriculture and safeguard food security, farmers therefore need psychological and community support alongside their resilience strategies, as well as awareness-raising and practical assistance.

4 DISCUSSION

Extreme heat, insufficient rainfall, and deforestation were the main climate change indicators identified in interview data, illustrating environmental hazards that negatively affect food production. Extreme heat was the most feared climatic hazard in the study villages. Respondents perceived it as the principal threat because of its effects on crops and health. Research by [21] confirms that other farmers in the same study area, Ivindo Department, share this assessment.

Similar effects occur elsewhere. In Burkina Faso, the 2024 heatwave, with temperatures reaching 45°C, caused crops to dry out and resulted in human deaths [22]. According to [23], rising temperatures will have major effects by 2050 on maize, millet, and sorghum, three cereals essential to African economies and diets. In France, rising temperatures are already changing crop cycles and production areas [24]. Farmers in the study villages are therefore not alone in their concern about extreme heat.

Insufficient rainfall was the second hazard identified. It disrupts seasonal patterns and, consequently, the agricultural calendar (Table 4). During rainfall deficits, crops experience water shortages [25]. The same author explains that:

"January precipitation patterns are characterized by the spatial spread of low rainfall, representing between 0 and 5% of annual precipitation, across the entire northern part of the country (Bitam, Mitzic, Makokou, Mekambo). This northern low-rainfall zone is interrupted toward the center of the country by a wider rainy belt where rainfall represents between 6 and 9% of annual precipitation" ([26] translated from French).

Mékambo is a secondary town near the study area, where fieldwork took place in January, the same period the author identifies as a phase of low rainfall reflecting anomalous conditions. Villagers likewise complained of this climatic anomaly in January 2025. Rainfall is essential to season-dependent agriculture [27]. Its insufficiency reduces productivity and exacerbates Gabon's already concerning food insecurity. Although less frequently mentioned by respondents, drought also constitutes a major hazard [28].

Deforestation was the third hazard identified. As villagers reported, it substantially affects agricultural yields. Similarly, 67% of farmers in Ogooué-Ivindo had already expressed concern about it in 2023 [29]. Classified as a high forest cover, low deforestation (HFLD) country [30], Gabon remains relatively well preserved, but vigilance is necessary. The Amazon and other Congo Basin countries demonstrate that deforestation causes substantial biodiversity losses. It is both a driver and a consequence of global warming, making its reduction vital locally and globally.

These environmental hazards affect not only the environment and villagers' food security but also farmers' mental and psychological health. Stress, fear, fatigue, and discouragement generate continuing distress. The Intergovernmental Panel on Climate Change [31] notes that extreme weather events affect lives, livelihoods, health, ecosystems, and societies. Beyond Ivindo Department, climate change also substantially affects daily life. The 2003 European heatwave, with 15,000 deaths, illustrates its potentially devastating consequences [32]. Psychologically, extreme heat can also impair social relationships and intensify tensions [33].

The adaptation strategies described by respondents, including replanting and replacing crops with more resistant varieties, are relevant but limited. They remain insufficient because they are isolated and have limited long-term effectiveness. Collective approaches integrating crop rotation, resistant seeds, and water conservation would be more sustainable. In Burkina Faso, farmers undertake collective training to cope with climatic hazards [34]. However, such initiatives require funding and institutional support that are often beyond farmers' reach.

Beyond extreme heat, rainfall deficits, and deforestation, flooding, landslides, and soil infertility also disrupt life in Gabon [35]. In recent years, respondents surveyed by these authors particularly emphasized flooding as the most disruptive hazard, especially in urban centers.

This situation raises questions about societies' relationships with their environment. The environment is neither neutral nor devoid of values; it is culturally shaped and carries meanings integral to individual cognition and behavior (Getzel, 1975, as cited in [36]). Subsistence farming in Gabon, an ancestral practice closely tied to the seasons, is increasingly weakened by climate change and seasonal variability. These conditions challenge long-preserved agricultural knowledge and may undermine its continued use in rural Gabon.

5 CONCLUSION

This study of farmers' perceptions of climate change, environmental stress, and adaptation strategies in Ogooué-Ivindo, Gabon, drew on semi-structured interviews in Ebessi, Massaha, Ekobakoba, Ebyeng, and Latta. Its principal findings concern two dimensions. Geographically, extreme heat, rainfall deficits, and deforestation emerge as the main environmental disruptions adversely affecting subsistence farming and food security. These problems compel farmers to adopt resilience strategies, including replanting and crop replacement, which nevertheless remain insufficient. Psychologically, these hazards generate stress, uncertainty, and sometimes discouragement, affecting farmers' health and their relationship with cultivation. The findings support the initial hypothesis and indicate that farmers face both ecological destabilization and psychological strain.

Combining geography and environmental psychology showed that, beyond the technical aspects usually emphasized in analyses of climate change impacts, farmers' emotions and psychological condition must also be considered, as they directly experience these transformations. These anthropogenic changes also contribute to human–wildlife conflict, illustrating the complexity of human-environment relationships. Human activity must therefore be guided by responsibility, since it transforms and weakens nature. Seasonal variability, even when limited, is already sending warning signals from the Congo Basin, considered one of the planet's major ecological lungs.

These findings call for greater vigilance by public authorities, stronger legislation, and more concrete action both to protect the environment and to guide and support subsistence farmers in sustaining their inherited practices. The aim is to make these practices more resilient, effective, and sustainable while preserving communities' deep connections with their natural environment. Psychological support is almost absent from rural public policies, despite the substantial health consequences of agricultural difficulties. In some contexts, such distress can extend to suicide among farmers, including in several developed countries.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

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