Humanities and Social Sciences
2025, Vol. 13, No. 5, pp. 398-407
https://doi.org/10.11648/j.hss.20251305.11

Research Article

Analysis of Communities' Resilient Strategies in the Face of Climate Variability and Change in the Urban Commune of Diffa

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Abstract

This study aims to analyse the strategies employed by communities to build resilience in the face of climate variability and change in the urban commune of Diffa. This commune is affected by climatic phenomena with environmental, social and economic consequences. In order to cope with the adverse effects of these phenomena, communities that depend on agriculture and livestock farming have implemented local resilience strategies over several decades. A field survey was conducted to analyse these resilience strategies. The survey collected data on people's perceptions of the seasons, identified climate risks and impacts related to production activities, and analysed vulnerability to climate change, as well as adaptation and resilience actions and initiatives. The data were processed, analysed and synthesised to identify different trends and directions. The expected results were obtained, enabling the research questions to be answered and the objectives to be achieved. Indeed, as part of local risk management, communities have developed and implemented several strategies to respond to the impacts of climate change and ensure sufficient production. These strategies focus on environmental restoration and conservation, improving farming practices, developing irrigated crops, using improved varieties, diversifying crops and controlling crop pests. There are also actions related to livestock farming, such as storing and conserving straw, fodder and agricultural residues; introducing new resistant species; limiting herd size; and carrying out vaccination campaigns. The municipality's current situation is characterised by vulnerable households and insufficient stakeholder capacity to respond to climate challenges, hence the need to strengthen resilience.

Keywords

Climate Change, Climate Variability, Risks, Vulnerability, Strategies, Resilience

1. Introduction

As a Sahelo-Saharan country, Niger in general and the urban commune of Diffa in particular have been confronted with the phenomena of climate variability and change for several decades, and is one of the regions most exposed to related changes. Over the next few years, the region will experience higher-than-average global temperatures and greater inter-annual variations in precipitation, leading to more extreme droughts and torrential rains [13].

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Received: 18 July 2025; **Accepted:** 5 August 2025; **Published:** 29 August 2025

The 4 (th) report of the Intergovernmental Panel on Climate Change (IPCC) states that the earth is subject not only to natural variations in climate, but also to climate change due to anthropogenic activity [6].

The consequences of climate disruption are environmental, social and economic [3].

To cope with the severity of these phenomena, communities have embarked on a process of reflection on resilient strategies to meet this challenge [6]. Thus, what has seen the adoption of long-term strategies that will require a decisive collaborative effort to deliver solutions that sectors offer in the face of climate [2].

Indeed, the urban commune of Diffa is characterized by climatic variability, which poses a problem for the survival of its communities. These communities depend on natural resources for their livelihoods, particularly through agriculture and livestock farming. Climate change is leading to environmental degradation, declining agro-pastoral yields and recurrent food crises, creating a situation of vulnerability whose resilience is challenged by a variable climatic regime [14]. Faced with these climatic phenomena, communities are developing new strategies to manage their living conditions and ensure food security for their households and livestock [4].

It is in this context of climatic vulnerability that the present study focuses on the analysis of community resilience strategies in the face of climate variability and change in the urban commune of Diffa.

In view of the above, what are the various resilient strategies developed and implemented by communities to cope with climate variability and change perceptible in the urban Commune of Diffa?

From this main question flow other essential questions What are farmers' perceptions of climate variability and change in the urban commune of Diffa?

What are the risks and impacts of climatic phenomena on the production activities of people in this commune?

What climate risk management and resilience strategies have been developed in the urban commune of Diffa?

In order to elucidate the research question, the following hypotheses were formulated:

The populations of the urban commune of Diffa have a perception of Climate Change;

The impacts of climate variability and change enable the populations of the urban commune of Diffa to develop resilient strategies;

The identification of climate risks and the vulnerability of communities contribute to the implementation of effective, efficient and sustainable local strategies for the management of risks and crises linked to climate variability and change.

1) Analyze people's perceptions of climate variability and change;
2) Identify potential climate risks in the urban commune of Diffa;
3) Identify the impacts of climate risks on production activities;
4) Analyze the vulnerability of populations and their production activities to these phenomena;
5) Analyze the various resilient strategies of populations in the face of climate risks, with a view to strengthening their resilience capacity;

The general objective of this study is to analyze the various resilient strategies adopted by communities in the face of climate variability and change in the Diffa commune.

To achieve this objective, the following specific objectives have been defined:

Analyze the climate risk management mechanism in the urban commune of Diffa.

2. Materials and Methods

2.1. Materials

For this study, survey and interview forms were used to collect data in the field.

The following tools were also used to complete the data collection:

A camera for taking images,

A computer for writing up the work;

Data processing software, notably Word (for document entry), Excel spreadsheet, for statistical analysis and graphics, and finally QGis software is used for cartographic work.

2.2. Methodology

The methodological approach of the present study is based on several main axes, namely bibliographical research, landscape observations, surveys and interviews, data collection, processing, analysis and interpretation of the data collected.

In the context of these surveys, and given the impossibility of interviewing all the populations in the urban commune of Diffa, the sample was constructed taking into account several criteria such as accessibility, vulnerability to climate variability and change, and the number of years lived in the area. Thus, six (6) administrative villages (Lada, Boulongouri, Bagara, Djorikoulo, Boulongou Yaskou, Digargo and Awaridi) and four (4) urban districts (Diffa-Koura, Sabon-Carré, Diffa-Château and Garin-Dole) were considered.

In each village and district, five (5) interviews and two (2) focus groups were conducted, one with men and the other with women. The average number of people per focus group was ten (10). The present study is thus based on a sample of 250 farmers in various agro-ecological zones of the urban commune of Diffa. This made it possible to collect the opinions of local stakeholders, whose minimum age of those surveyed and or interviewed is around ≥ 30 years.

To these were added a dozen resource persons in technical services, NGOs and projects operating in the commune.

Semi-structured interviews with resource persons were

conducted, which also enabled us to gather important information on perceptions of climatic phenomena, knowledge of risks and their impacts, population vulnerability and the resilient strategies developed.

3. Results

3.1. Analysis of Perceptions of Climate Variability and Change

People's perception of climate variability and change remains diverse and varied. Indeed, the changes perceived by farmers are limited to extreme phenomena, such as recurrent droughts, increased flooding, rainfall irregularity, temperature variation and disruption in the length of seasons throughout the year. These changes can also be seen in the shifting of sowing periods, the disappearance of temporary watering points, the degradation of natural resources and the gradual disappearance of biodiversity. There is also a drop in agricultural and forage yields, and significant changes to the landscape's physiognomy. The repercussions of climate variability and change are also felt in the impoverishment of households and the social fabric, and in the loss of trust and mutual distrust between and within local communities.

3.2. Production Activities

Within the framework of this study, all respondents (100%) affirmed that agriculture and livestock breeding are the main activities of the commune's populations. Nevertheless, other activities such as fishing, handicrafts and trade are also practiced, given the role and importance they play in the commune's economy. The distribution of activity sectors in the commune is as follows:

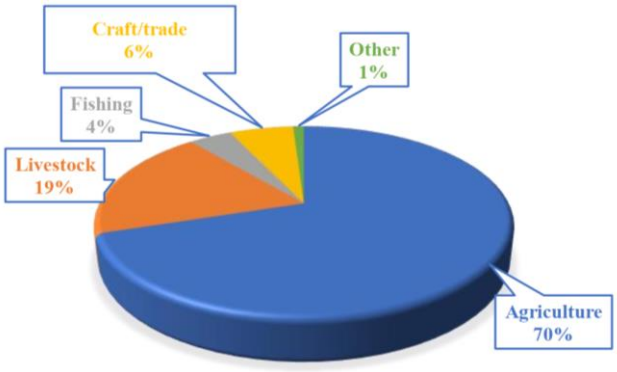

Figure 1. *Distribution of business sectors in the commune, Source: survey, 2022.*

Analysis of the diagram showing the distribution of activity sectors in the urban commune of Diffa shows that agriculture accounts for around 70%, followed by livestock breeding 19%, fishing 4%, handicrafts and trade 6%, and the remaining 1% (masonry, gathering, wood and fodder collection...).

3.3. Climate Risks

Climate variability and change pose a threat to the development of production activities in the urban commune of Diffa. Indeed, the respondents (65%) assert that climatic uncertainties have an influence on the dynamics of production systems, mainly agricultural and pastoral. These risks can be described in terms of their consequences, duration, extent and frequency of occurrence. The main risks identified, together with information on their occurrence, are summarized in the following table:

Table 1. *Identification of climate risks and potential impacts.*

Identified climate risks Climate	Climate impacts	Duration	Extent	Frequency
Irregular rainfall	Water shortage, Frequency of dry spells, Difficulty irrigating, destruction of crops, Delayed growth of seedlings and crops, Soil drying out, Decline in agricultural and fodder production; Drying out of grass and straw, drying up of streams and water sources, difficulty watering livestock	10 to 25 Days	Local, Regional	Regular
Temperature rise	Drying up of soil and waterways, Difficulty with irrigation, Decrease in yield; Decrease in forage production, Destruction of forage and crops	Variable	Regional, Global World-Wide	Strong
Flooding	Decreased production and crop loss,	20 to 30 Days	Local, Regional	Regular

Identified climate risks Climate	Climate impacts	Duration	Extent	Frequency
	Decreased cropland, Development of crop pests and diseases; Loss of fodder, Decreased grazing land, Increase in animal diseases.			
Violents Winds	Silting up of waterways, Wind erosion, Destruction of crops and fodder, Decline in agricultural and pastoral production, Destruction of woody plants.	Variable	Regional	Regular

Source: survey, 2022

4. Analysis of Resilient Strategies

Climate variability and change are affecting the living conditions of vulnerable populations in the urban commune of Diffa. To cope with the risks associated with these climatic phenomena, communities are reacting to preserve and maintain their livelihoods. This has led to the emergence of practices and actions aimed at maintaining or supporting production systems in the fields of the environment, plant and animal production, and community organization and management of the natural resources at their disposal. Indeed, the resilient strategies used by communities are manifold and take into account the constraints and socio-economic and cultural conditions of the different zones. These strategies enable them to strengthen their ability to respond and adapt to shocks, but also to improve in order to meet their basic food needs. They are as follows.

4.1. Information and Awareness

Raising awareness and sharing information are essential to the implementation of resilience strategies. They enable communities and decision-makers to disseminate initiatives that are already underway. The challenge is to stimulate reflection, inspire local innovation and strengthen opportunities for collaboration around activities that reduce vulnerability and build capacity in the face of climate variability and change.

4.2. Action on the Environment

The impacts of climate variability and change have made soils vulnerable to degradation. To cope with these consequences, communities have developed actions to restore degraded soils and manage their fertility. This has led to the use of techniques to restore and conserve degraded soil and land, such as zai or tassa, half-moons and reforestation operations. These works were carried out in the localities of MATAOU, BOULONGOU YASKOU, MAMARI FORAGE, AWARIDI DIGARO, ADJIRI and KANGOURI, as shown in the following photographs.

Figure 2. *Construction of Zai, half-moons and reforestation operations in the Diffa commune.*

We have also built protective dykes and hydraulic structures against flooding at LADA and BAGARA, to protect the river watersheds. These techniques can play a role in flood risk management. They are thus options for strengthening resilience in the face of climate variability and change.

Figure 3. *Construction of a dam and dike at LADA, Diffa commune.*

Reforestation enables the reconstitution of woody formations, limiting wind and water erosion at the surface. Trees can also improve soil quality by fixing nitrogen and fertilizing the soil.

Figure 4. *Seedling production and reforestation operation in the commune of Diffa.*

The techniques mentioned above help to restore and conserve degraded land and soil. In addition, thanks to support from the State and its partners, local communities have developed practices that consume less wood energy, notably

through the promotion and use of existing technologies such as improved stoves and the introduction of butane gas, as well as new technologies (use of alternative energies such as solar stoves). This has enabled farmers to reduce pressure on the commune's woodland formations.

4.3. Action on Agriculture

Agriculture is extremely vulnerable in the urban commune of Diffa due to the degradation of arable land and rainfall deficits. Faced with these consequences, several adaptation options aimed at improving the resilience of agricultural systems have been implemented, particularly at technical and strategic levels.

4.3.1. Improving Farming Practices and Developing Irrigated Crops

The irregularity of rainfall in time and space has called into question farming practices in the commune. To manage agricultural production, inappropriate cultivation practices have been abandoned in favor of practices better adapted to the context of climate variability and change. These practices involve modifying and redefining agricultural calendars based on sowing and harvesting dates, harmonizing seasons according to local knowledge, cultivation and fertilization techniques, new field ploughing techniques using tractors and ploughs, canalization and parcelization, water drainage for irrigation and the practice of Assisted Natural Regeneration (ANR) to ensure sustainable agricultural practices [16].

As for long-cycle farming practices, the local populations living along the Komadougou River have emphasized the promotion of irrigated and off-season crops through the use of motordriven pumps, the construction of water catchment structures and the construction of agricultural and market garden boreholes. ONAHA's hydro-agricultural schemes, the Boulongouri irrigated perimeter and those of other private developers (Mangari rice) are examples to be cited in the commune [15].

Figure 5. *Field irrigation system (nursery site) in the urban commune of Diffa.*

Figure 6. *Boulongouri irrigated perimeter in the urban commune of Diffa.*

4.3.2. Development of Improved Varieties and Crop Diversification

To cope with the demands of certain climate variability and change effects that threaten livelihoods, local communities are multiplying resilience initiatives. These include the use and dissemination of improved varieties that are better adapted to water stress and heat, and the introduction of short-cycle crops to the detriment of long-cycle crops that no longer respond to the climatic context, thus optimizing yields.

In order to adapt to climatic variability, local farmers are diversifying crop varieties to better contribute to soil fertilization and increase crop yields. They also practice the system of associated crops to mitigate the risks of low production.

Figure 7. *Diversification of market garden crops in the urban commune of Diffa.*

Figure 8. *Market gardening in the urban commune of Diffa, 2023.*

4.3.3. Controlling Crop Pests and Amending Fields

One of the problems facing farmers in the urban commune of Diffa is the development of crop pests such as locusts, aphids, caterpillars, whiteflies and other insects. Recently, new species of crop pests have appeared, such as nematodes and thrips, whose causal agent has not yet been clearly identified. In response, farmers have implemented a number of strategies to combat these pests, including reducing the number of watering days (to reduce humidity), isolating fields with empty strips to reduce risk, using smoke (fumage) to chase away insects, and using phytosanitary products.

Farmers also improve their fields by adding organic matter and fertilizing elements (animal manure, compost, green manure and mineral fertilizers).

4.3.4. Fallowing and Restoring Degraded Land

Widely used in the past, fallowing is little practiced today in the urban commune of Diffa, due to the increase in population and the need for cultivated land.

In fact, fallowing is a practice that contributes to improving soil structure and fertility, encouraging the accumulation of organic matter in the soil, increasing soil water retention capacity and boosting agricultural production. Faced with the degradation of arable land, actions to restore and conserve soil and degraded land, such as zai or tassa, half-moons and plots, have been carried out in the commune (Figure 8). These actions have had a positive impact on environmental protection, soil fertility and increased fodder and crop production.

4.4. Action on Livestock

Cyclical droughts and recurrent floods have hampered the development of livestock farming in the urban commune of Diffa. The rapid drying up of watercourses, the reduction in grazing areas, the inadequacy of fodder and watering points, and the appearance of new climate-sensitive diseases are all indicators of climate variability and change. With the irregularity of rainfall and the resurgence of flooding, forage resources are experiencing quantitative and qualitative degra-

dation, limiting primary productivity.

These initiatives focus on the development of fodder crops through techniques for the conservation and recovery of degraded land, and the storage and conservation of straw, fodder and agricultural residues. Other adaptation measures include reducing herd size in favor of young ruminants, introducing new resistant species, night grazing and vaccination campaigns. There is also the production of multi-nutritional blocks with the support of technical services.

4.4.1. Reducing Herd Size and Introducing Resistant Species

Given the shortage of fodder resources, one of the strategies developed by farmers (80%) is to limit the size of their herd by selectively selling animals. When the herd becomes large, farmers are unable to meet the food and health requirements of their animals in the event of epizootic disease or drought. Hence the need, on the one hand, to reduce the size of the herd by selling off older, sicker and less resistant animals, in order to face up to the current challenges and be able to manage it better. On the other hand, farmers are introducing resistant animal species to adapt to extreme variations.

With the income from the sale of their animals, livestock farmers are able to purchase livestock feed (wheat bran, cottonseed, cattle cake, fodder, etc.), vaccinate their animals and meet the vital needs of their households.

Figure 9. *Fodder and agricultural residue storage system in the commune of Diffa.*

4.4.2. Forage Conservation and Production of Multi-nutritional Blocks

To alleviate the shortage of livestock feed in the dry season, communities, particularly livestock breeders (100%), have developed the technique of fodder conservation through the storage of straw, agricultural residues and the manufacture of livestock feed. These techniques make it possible to feed animals in the dry season, while reducing the loss of livestock through starvation.

On the other hand, given the ever-increasing need for livestock feed, farmers have also developed the technique of making multi-nutritional blocks (vitamins, lickstones, urea straw, etc.) with the support of livestock technical agents and partners. These multi-nutritional blocks are very rich nutritional supplements, which will make it possible to supplement nutritional deficiencies in livestock feed, while improving animal health.

5. Discussions

The aim of this study is to analyze community resilience strategies in the face of climate variability and change in the urban commune of Diffa. These strategies help to secure people's livelihoods in order to ensure sufficient production [9]. The effects of climatic phenomena are perceived by communities through indicators. In our analysis of current climate conditions, several indicators show that climate variability has a strong influence on production activities. Indeed, the impacts linked to climatic risks mentioned by the populations relate to rainfall irregularity, variation in average temperature, wind movement, soil impoverishment, seasonal start-up, flooding and drought [17].

Climate impacts force communities to develop and implement resilient strategies that are responses to the consequences. These include actions on the environment through techniques for restoring and conserving degraded soil and land; actions on agriculture through improved cultivation practices, development of irrigated crops, development of improved varieties, pest control, crop diversification and field fertilization; actions on livestock through techniques such as reducing herd size, conserving fodder and agricultural residues, nomadism [1].

These results are similar to those obtained by some scientific research. According to, JEAN, B. K., and YVETTE, O. D., 2016, several works note that Global Climate Change is translated locally by several evolutions that modify production conditions and the difficulties linked to climatic fluctuations are at the basis of a dynamic of agricultural production and consequently of food security [2]. These results concur with those of SEYDOU, W., 2020, who showed that climatic situations detrimental to agricultural production have impacts on farmers involved in rain-fed agriculture. They lead to

increased hydric and thermal stress on plants, resulting in lower yields of the main crops (maize, cowpeas, cassava, sweet potatoes and rice). This results in heavy agricultural losses and enormous loss of earnings. According to the latest IPCC forecasts in 2014, the climate is warming, and this has led to an increase in temperature in the Lake Chad region, although there is some uncertainty as to the extent of this increase. Current rainfall is likely to continue, but with more frequent extremes [18]. For CHEICK, T. S., et al, 2011, a sustainable response to climate change therefore requires mobilizing the expertise of grassroots communities [12]. The results of the work of JABRANE, M., and TAIQUI, L., 2014 reveal that the major challenge of socio-ecosystem resilience, therefore lies in the sustainability of the forest system [6]. This involves adaptive strategies encompassing various actions to conserve, manage and restore degraded soils and lands. The results obtained seem to match those of SEYDOU, W., 2020, that the resilience strategies developed by farmers to reduce the effects of climate change are: use of inputs, abandonment of long-cycle varieties and use of short-cycle varieties, crop association, installation of irrigation systems, rearrangement of the agricultural calendar to counteract the water deficits and excesses encountered by their crops [7].

In the urban commune of Diffa, risk management is thus an integral part of the production system. However, rainfall has been good in recent years (2010-2020) and agricultural yields are still low, hence the influence of other factors linked to climate variability [9]. According to AGRYMET, 2009, each species or variety is characterized by its temperature requirements during the different phases of its development. These requirements are expressed in terms of useful heat or degree-days [8]. The optimum temperature for plant development and growth is around 30 ℃. An increase in temperature will therefore result in a reduction in the total length of the cycle. Shorter cycles in the reproductive and ripening phases mean lower yields [10]. Crop response to temperature also varies from one species or variety to another, and the crop (response) is characterized by its temperature requirements during the different phases of its development. However, higher temperatures are conducive to an increase in the fecundity and growth rate of crop pests, and to the extension of their geographical ranges [11].

This study analyzed the various resilient strategies developed by communities to reduce the effects of climate variability and change in the Diffa commune. Indeed, the identification of climate impacts and risks, as well as the vulnerability of farmers, contribute to the implementation of effective, efficient and sustainable local risk and crisis management strategies. In this analysis, the actions and techniques selected testify to the convergence of the declarations provided by the communities [5]. The implementation of these strategies is the basis for a dynamic agropastoral production. In order to strengthen the resilience of communities to the effects of climate variability and change, options for strategies and projects/programs for professional integration are measures to reduce vulnerability. These results concur with those of JABRANE, M., and TAIQUI, L., 2014, who assert that the key challenge for resilience in the face of Climate Change therefore lies in building the capacities of local communities and territorial authorities for the governance of ecosystems and biodiversity [6].

6. Conclusion

For several decades, Niger in general, and the urban commune of Diffa in particular, have been confronted with the adverse effects of climate variability and change. These are reflected in the recurrence of extreme natural phenomena that affect the environment, biodiversity and human populations. Climate manifestations are perceived by communities through temperature increases, rainfall irregularity in time and space, wind movement, seasonal changes throughout the year, cyclical droughts and increased flooding. In this commune, the main activities of the population are agriculture and livestock breeding, which are directly dependent on climatic factors (one of the most decisive of which is rainfall), as well as the availability of land resources. One of the most direct climatic consequences in the commune is its impact on agriculture and livestock farming, with a direct effect on household food security. Indeed, to mitigate and limit the impact of climate risks on their activities, communities have developed and implemented several resilient strategies to ensure sufficient production. In addition, to reduce vulnerability, stakeholders will need to integrate the potential risks identified into local and communal development plans. Despite the existence of a climate risk prevention and management system, the resilience of the population of the urban commune of Diffa appears to be limited. The current situation is reflected in the vulnerability of households and the inadequate capacity of stakeholders to respond to risks. This situation needs to be remedied to strengthen their resilience over time, by mobilizing more funding for communities to develop their capacity. If warming trends continue, agricultural and livestock performance in the commune will be further affected by temperature variation and rainfall fluctuation.

Abbreviations

AGRHYMET	Regional Agro-hydrometric Center
ANR	Assisted Natural Regeneration
FAO	Food and Agriculture Organization
IPCC	Intergovernmental Panel on Climate Change
NGOs	Non-Governmental Organization
ONAHA	National Office for Hydro-Agricultural Development
UNICEF	Union Nations Of International Children's Emergency Fund

Conflicts of Interest

The authors declare no conflicts of interest.

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