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Climate Change Vulnerability Assessment through Coping Strategies Index in Tillaberi region in Niger

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ABSTRACT

Climate change vulnerability of four villages in the Tillaberi Region of Niger was analyzed through a coping strategy index (CSI) determination. It concerned the villages of Dioga and Magou, in the commune of Torodi and those of Zori Bangou and Tokobinkani Zarma in that of Hamdallaye.

Two types of indices were measured, one in relation to food security, and the other with assets and livelihoods. They reflected different values between the villages of the two municipalities and the two municipalities from 2015 to 2016. The value of the CSI in relation to the food security of the two municipalities in 2016, represents half of the score 2015, reflecting a decline in food vulnerability for this period. The CSI for assets and livelihoods for 2016 is 6.93, higher than 2015 one (6.32), indicating a greater diversification of livelihoods. In addition, the coping strategy index for the food aspects is higher in the villages of Hamdallaye with 55.5 and 41.9 respectively in 2015 and 2016, than in those of Torodi respectively 46.91 and 22.6, for 2015 and 2016, reflecting a higher vulnerability in Hamdallaye.

For the CSI in relation to the assets and livelihoods, there is no significant difference between the two villages of Torodi and one of the two villages of Hamdallaye (Zori Bangou). Torodi, located further South with higher rainfall and greater livelihood diversification, has lower vulnerability criteria in relation to the food aspects than Hamdallaye in the north. Thus, there is an increase in vulnerability from south to north inversely proportional to the increasing rainfall gradient.

Keywords: Climate Change, Climate Vulnerability, Survival Strategies Index, Adaptation Capabilities; resilience

Abbreviations: CSI: Coping strategy index; IPCC: International Panel on Climate Change; COPs: conferences of the parties; BRACED PRESENCES: Building Resilience and Adaptation to Climate Extremes and Disasters

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Introduction

The environmental context of these last decades remains characterized by the strong variability of the meteorological parameters. This implies changes in climatic situations, with significant consequences for the lives of people and their livelihoods. The villages of the communes of *Torodi* and *Hamdallaye* located in the region of *Tillabéri* in Niger are not spared. It is one of the most drought-prone areas because of its location in the Sahelian zone. The International Panel on Climate Change [1] (IPCC, 2015) indicates in its report on climate change models, a global warming trend with effects observed in all sectors of socio-economic life (agriculture, health, infrastructure, energy, ...) and the environment. Thus, it is predicted that climate change will reduce world agricultural yields by 2% per decade during the 21st century, while world food demand will increase during that same period by 14% per decade until 2050 (IPCC, 2015). Increases in temperatures are expected between + 0.3 ° C and + 4.8 ° Cover the period 1986-2005, which could bring the Earth's temperature up to an average of 3 ° C by 2100 (IPCC, 2015) ¹. Stakeholder recommendations are made at the Annual Global Conferences of the Parties (COPs). These fora represent frameworks for reflection on the conclusions of experts, and give alerts to states and institutions for actions. The commitments of the actors at these meetings give rise to proposals for practical measures to either minimize the effects of climate change (mitigation), or develop strategies to cope with them or better live with its effects, that is to say to adapt to it.

However, the problem in the development sector lies in targeting vulnerable people, households and villages to climate change in order to implement effective and sustainable adaptation strategies.

The term "adaptation strategy", first used by [2] Radimir *and al.* (1990) in the food security literature, refers to the measures and attitudes observed by individuals, households and communities in situations of shock or stress of a different nature. These strategies are called "coping strategies" when basic resources are scarce and the situation creates unsustainable practices in terms of efficiency.

Practitioners at different levels use a variety of approaches not only to determine the impact of climate change on activities, but also to determine levels of vulnerability in a context of precarious food security.

The objective of this study is to compare the climate vulnerability of the villages and communes of this area in Niger through the determination of coping strategy indexes (CSI) to help target areas of climate vulnerability [3] Daniel Maxwell and Richard Caldwell (2008). This will take into account the importance of assets and other livelihoods ownership in determining the level of climate vulnerability of individuals, households and other specific groups such as farmers and agro-pastoralists.

Methodology

The approach consists of evaluating the Coping Strategy Index (CSI) initially used by the word Food and Agriculture Organization (FAO) and the National Early Warning System (EWS) of Niger, to measure vulnerability to food insecurity [4] Andres L, Lebailly P, (2011). An adaptation of this index, used exclusively for the evaluation of dietary criteria related to the households' vulnerability, is made and extended in this study to household assets and livelihoods. The two kinds of coping strategy indexes used in this study are relative to the food and the other to the assets and livelihoods. It aims to compare the capacities of people and their livelihoods to cope with the effects of climate change, which can cause multiple shocks.

¹ Notre Planete Info : Changement climatique : les prévisions du GIEC, [https://www.notre-planete.info/terre/climatologie_meteo/ changement-climatique-GIEC.php](https://www.notre-planete.info/terre/climatologie_meteo/changement-climatique-GIEC.php)

Choice of sites

The study took place between June and October 2016 at the villages of *Dioga*, *Magou*, *Tokobinkani Zarma* and *Zori Bangou*. The first

two are located in the commune of Torodi and the two others in that of Hamdallaye in the region of Tillabéri in the far west of Niger. (Figure 1).

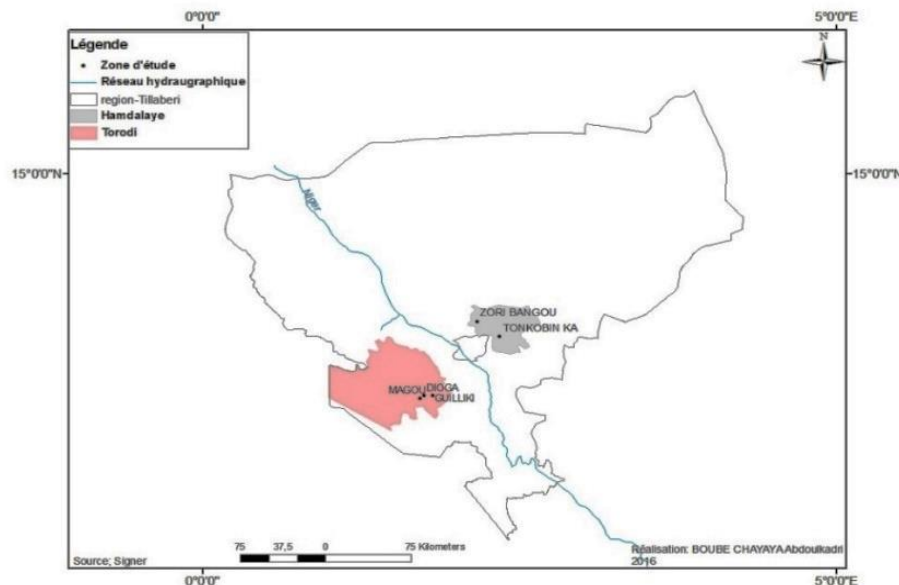


Figure 1: Map of the Tillabéri region with the study area in the two communes, Source: BOUBE CHAYAYA A. (2016)

The choice of villages is based on three (3) criteria. That are: (i) the fact that a climate change adaptation or resilience project is part of the intervention areas to see the impact of the adaptation strategies promoted on vulnerability reduction of communities; (ii) the existence of a rainfall gradient between the two communes, taking into account the position of rainfall isohyets in Niger; and (iii) the fact that the two communes were the subject of a reference study conducted in 2015 by a CARE International project in Niger. This study using the same approach in the same area can serve as a basis for comparison for this study.

Data collection

The population base used to calculate the sample is taken with reference to the general census of the population and habitat of Niger [5] (Republic of Niger, 2012). The minimum size of the sample of households is determined by the formula:

$$n = \frac{z^2 \cdot p(1-p)}{e^2}$$

n: is the size of the sample, *z*: is a constant resulting from the normal distribution according to a certain confidence level (95% and $z = 1.96$), *p*: is the percentage of people with the observed character = 65; 17% (similar proxy indicator: % of "very vulnerable" and "extremely vulnerable" households according to studies on the security of living conditions of households); *e*: is the sampling error margin chosen ($e = 5\%$).

Considering these parameters, the sample size is 204 households for the two municipalities. The sample was corrected taking into account the risk of rejection $Q = 5\%$. An individual tool is administered for data collection, during the interviews to see the individual dimension of climate vulnerability (in relation to the use of coping strategies) and the strategies used to "adapt" to different crises.

The initial reference situation established in 2015 was considered in this research, based on

which the choice of households is made randomly in the selected villages vulnerable to climate change. The criteria considered for village selection are areas with social and environmental vulnerability not covered by other projects of other resilience support organizations. Group discussions of men and women were conducted to determine the vulnerability criteria and the severity levels of each criterion according to the perception and socio-cultural reality of the area.

A characterization of the household classification criteria by level of vulnerability is done by asking whether the household has applied or not each of the vulnerability criteria indicated in a list of possible criteria. This is based on adaptation practices in the area of 14 criteria for the food aspects CSI and 12 for that of assets and livelihoods. A score of 0 to 4 points, discussed in village assembly allowed assessing the level of severity that characterizes each proposed vulnerability criterion. The frequency of weekly use of the food criterion as a strategy in the household, and that for the last three (3) months for the use of assets and livelihoods strategies, affirmed by the household head respondent, is indicated in response to the household questionnaire.

Data analysis

The coping strategy indexes (CSI) in relation to the food aspects are determined from the frequency of the days of use of a food criterion and the severity of the use of the criterion according to the assessment in village assembly. The sum of the products of gravity (measured on a scale of 0 to 4 points) and the frequency of the criterion use for each sampled household, gives a coefficient whose sum for all the persons interviewed represents the value of the coping strategy index for the village.

CSI for food aspects = $\Sigma (g \times f)$

g = severity of the survival criterion indicated on a scale of 0 to 4 points

f = weekly use frequency of the survival criterion (c), "c" of between 1 and 14, f is between 0 and 7.

The high values of the coping Strategy Index for the food aspects reflect poor adaptation capacity.

The value of the assets and Livelihood coping strategies Index is obtained by summing the coefficients calculated from the product of the Livelihood Use Criteria by its severity.

CSI for assets and livelihoods = $\Sigma (g \times f)$

g = severity of the survival criterion indicated on a scale of 0 to 4

f = frequency (f) of quarterly use of criterion (c) of survival, "c" between 1 and 12, f = 1 or f = 0.

The value "1" of the frequency is attributed for the case of use of the coping criterion, and "0" in case of non-use of the criterion. In this approach, high values of the Livelihood Strategies Index in relation to assets and livelihoods indicate opportunities for diversification of strategies and thus greater adaptability.

Results and Discussions

Survival strategies and coping skills

Regional level

Adaptation refers to effective and sustainable strategies in place of coping strategies that are ephemeral in effectiveness and used in the absence of alternatives to shocks or climate stress. The coping strategy index in relation to food security is 30.08 for the two municipalities in 2016 (Figure 2). It represents half of the average score of the same index for households in the 12 municipalities targeted by [6] CARE in 2015 which is 64.71.

The decline in the value of this index between 2015 and 2016 indicates a decrease in the use of coping strategies by people in the two municipalities during this period, reflecting a decrease in the level of food vulnerability between the two years. Several scenarios can explain this situation: good rainfall and a significant harvest of crops during the 2015 rainy

season; or the preliminary effects of the intervention of the project to support climate resilience in the villages of the two municipalities. This decrease in vulnerability could also result from the combined effects of the two situations when we consider the rainfall recorded at 538 and 636 mm respectively at *Dioga (Torodi)* and *Zori Bangou (Hamdallaye)* in 2016 (CARE, 2016). In addition, actions are made in the four project intervention villages to support resilience and adaptation to climate extremes and disasters called BRACED

PRESENCES" implemented by CARE. This project's focus is promoting access and use of climate information for adaptation decision-making and resilient livelihoods. For example, early-improved seeds were made available to producers to mitigate the risk of drought. These varieties are also very productive, which allowed for good productions from the harvest of 2015, a year 2016 with less risk of food insecurity, therefore less vulnerability as evidenced by the 2016 CSI values (Figure 2).

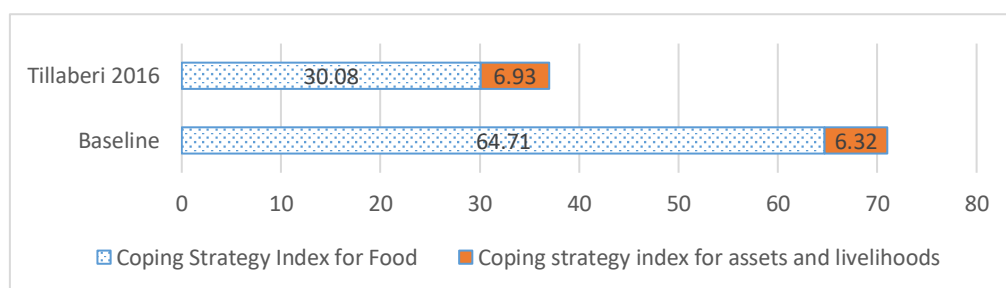


Figure 2: Value of Coping Strategy Index (CSI) for the Tillabéri Region between 2015 and 2016

The Tillabéri Region coping strategy index for assets and livelihoods in 2016 is 6.93 slightly above 6.32, the average value calculated by CARE in 2015 at 23 agricultural and agro pastoral villages in the Tillabéri region. The difference shows a slight upward trend in the use of assets and livelihoods strategies between 2015 and 2016. This attitude is at the same time linked to the possession of assets that could be mobilized to cope with the situation. Crisis and the possibility of diversifying strategies. In fact, support for community resilience through this project is done through the strategy of social reconstitution of livestock, the production of vegetable crops and the development of income-generating activities for the benefit of women. This activity allows them to continue their savings through the women's saving groups. Support for cereal banks stocks and the governance capacities strengthening of these banks are also carried out.

All these actions have resulted in the availability of resources and goods that can be used in place of coping strategies based on the

decapitalization of household assets. Thus, [7] Dercon (2000) states that households can self-insure, accumulate assets during "good" years and deplete these stocks in "bad" years. This indicates an increase in resilience capacities, mobilization of forms of strategies, including those that have negative effects on environmental and economic resilience (sale of wood and straw, sale of land and other productive assets such as breeding animals). For [8] CARE (1999), Faced with an unfavorable and unproductive environment, households develop a range of strategies to cope with.

Communal level

The CSI for assets and livelihoods, which is 5.11 for the commune of Hamdallaye, has a lower value than the commune of Torodi, which is 7.4, which confirms the low diversification of livelihoods in *Hamdallaye* in relation to *Torodi*. Both values reflect a greater use of strategies involving the possession of assets and livelihoods in *Torodi* compared to *Hamdallaye*. The low CSI values for assets and livelihoods,

as in the case of *Hamdallaye*, show a restriction of resources and opportunities for diversification of strategies leading households to use more options for negative strategies and the availability of environmental resources. .

On the other hand, the CSI for the food aspects of the two communes decreased between the

two years for the two municipalities from 46.91 to 22.16 for the municipality of *Torodi* and from 55.5 to 41.9 for that of *Hamdallaye*. (Figure 3). This decline in the CSI indicates a decrease in vulnerability for both municipalities during this period with higher values for *Hamdallaye* compared to *Torodi*.

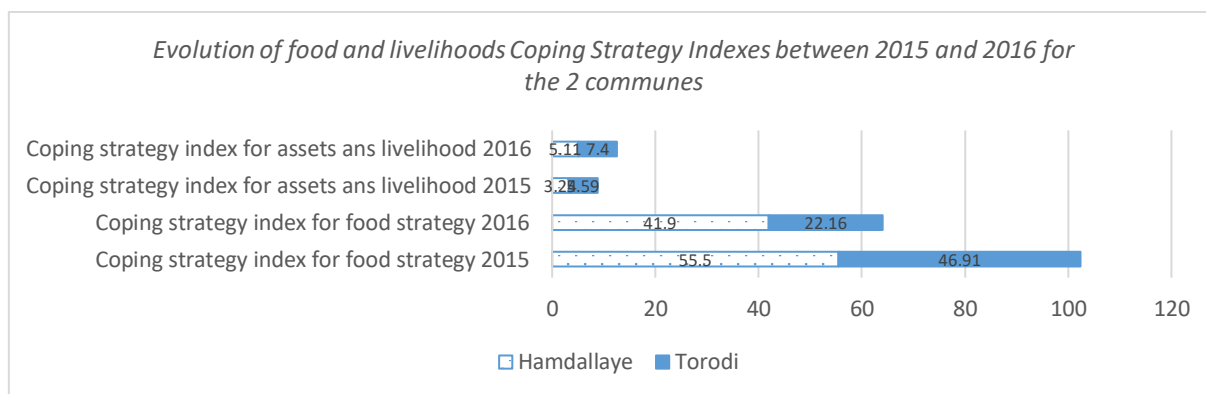


Figure 3: Evolution of Food and livelihoods Coping Strategy Indexes between 2015 and 2016 for the 2 communes

In the end, the two kinds of index show differences between the two communes with a situation of vulnerability lower than the average of these 12 communes in 2015 in the *BRACED PRESENCES* project intervention villages of the in the *Tillaberi* region. A difference in vulnerability appears between the two communes with *Hamdallaye* in the north more vulnerable than *Torodi*.

Criteria for coping strategy indexes related to food aspects represent the attitudes used in food stress situations. The dominant criteria of the CSI for livelihoods in *Hamdallaye* villages are linked to the sale of breeding animals, the labor force and the departure of more than usual assets (exodus). The sale of breeding animals indicates the practice of breeding, especially the fattening of male species, especially rams and calves, which are resold a few months later to cover household expenses. The sale of the labor force and the departure of assets more than usual result in the practice of exodus to the urban centers of which *Niamey* is the nearest center. These trips are seasonal and ensure the transfer of financial resources during the period

of food crisis. Indeed the proximity to the head quarter is favorable to the movement of resources.

The livelihoods identified in the villages of *Torodi* commune are the exploitation of fields, animals and especially gardens around rivers like *Mago* and *Goroubi*, tributary of the Niger River. Thus, market gardening can replace many practices used in crises. These are strategies such as the sale of productive and non-productive assets as well as the sale of breeding animals and that of wood and straw. A breakdown of the criteria values contributing to the determination of this index is given in Figure 4. More specifically, the criteria contributing to the determination of these values are the sale of the labor force during the production season, the departure of more than usual assets and the sale of breeding animals. These strategies represent a valuation of the human resources for the first two, and animal for the last one. The negative factor of these strategies is that they do not allow the person in vulnerable situation to use his time to cultivate his own field on the one hand, and on the other hand, the decapitalization of the breeding

animals represents a handicap for the reconstitution of the herd. Both of these situations increase household vulnerability due to the lack of exploitation of production opportunities for the current year. As a result, even if the weather conditions predict good rainfall situations, these practices keep the household in a situation of recurrent vulnerability.

Overall, for both communes, the sale of the labor force (labor) to buy food is the most dominant criterion in the use of livelihood strategies in

relation to assets and livelihoods. It is higher with 2.47 for villages in *Torodi* commune and 1.28 for villages in *Hamdallaye* commune. This indicates a more developed livelihood potential in *Torodi* Commune. In this municipality, the departure of assets more than usual, second criterion is also higher (2.15) compared to that of *Hamdallaye* (0.92). The sale of breeding animals is the third criterion contributing to this CSI with values of 1.51 and 1.48 respectively for the municipalities of *Torodi* and *Hamdallaye* (Figure 4).

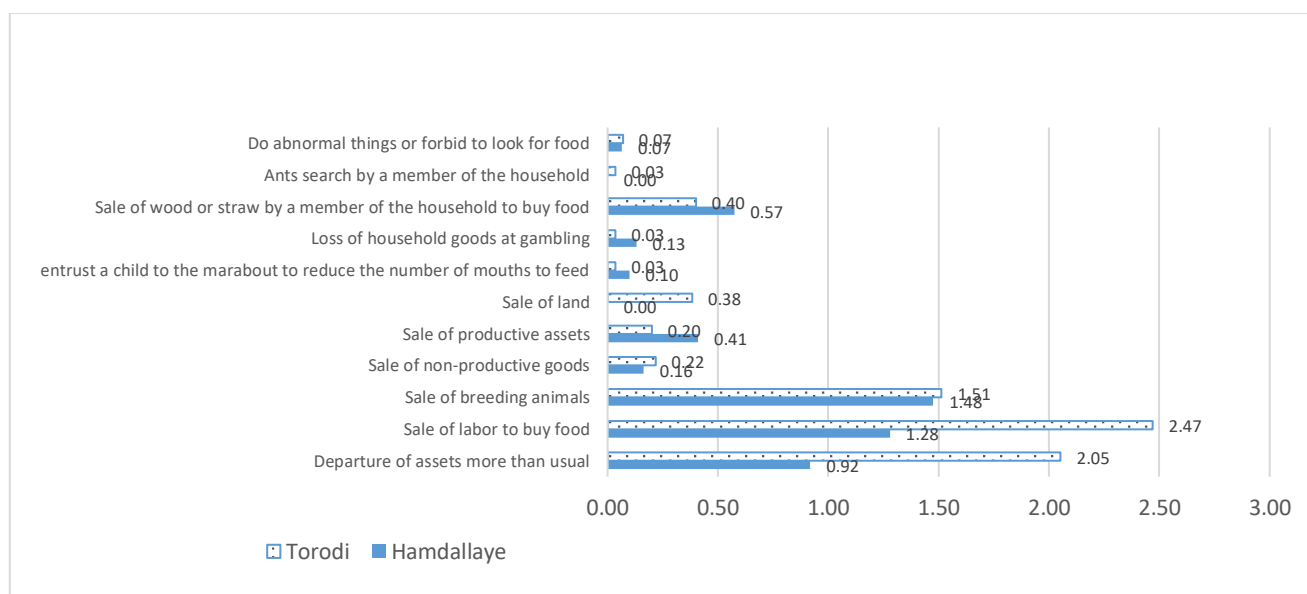


Figure 4: Value of the different criteria used in the relative CSI determination for the assets and livelihoods of the two communes in 2016

The livelihood components contributing to the strategies implemented here are the sale of the labor force, the departure of more assets than usual, and the sale of breeding stock. Then the sale of wood and straw for income acquisition to use for food purchase. Sales of the productive and non-productive assets are realized as well as those of the production lands only for *Torodi* commune.

For the villages of *Hamdallaye* commune, and in particular the community of *Tokobinkani Zarma*, the consumption of less preferred foods and food shortage is very high with maximum scores for the two communes of 7, 84 and 12, 13. This indicates a way of using these survival strategies

because of their high environmental vulnerability because of their location in the more arid part of the area. As a result, there is less scope for using other resources to better adapt to the effects of climatic climate change, which makes climate risks higher in this municipality.

Food-related coping strategy for the four villages are dominated by criteria such as the use of scarcity foods (wild plant harvesting) with a score of 12.13 with higher values for *Hamdallaye* communities. Then eating less favorite foods with a score of 7.84 for the same municipality. Always in *Hamdallaye* commune, the score for the decrease in the number of meals taken per day is 4.11 and that for the reduction in daily food

rations of 3.84, indicate the frequent use of these two practices (Figure 5). The same is true for the reduction of rations by adults (score of 3.84) for the benefit of children and the waiver of debt repayment in order to be able to buy food with a

score of 3.11 (Figure 5). The score of this last criterion shows the emergency of prioritizing food consumption in crises instead of payment of debts.

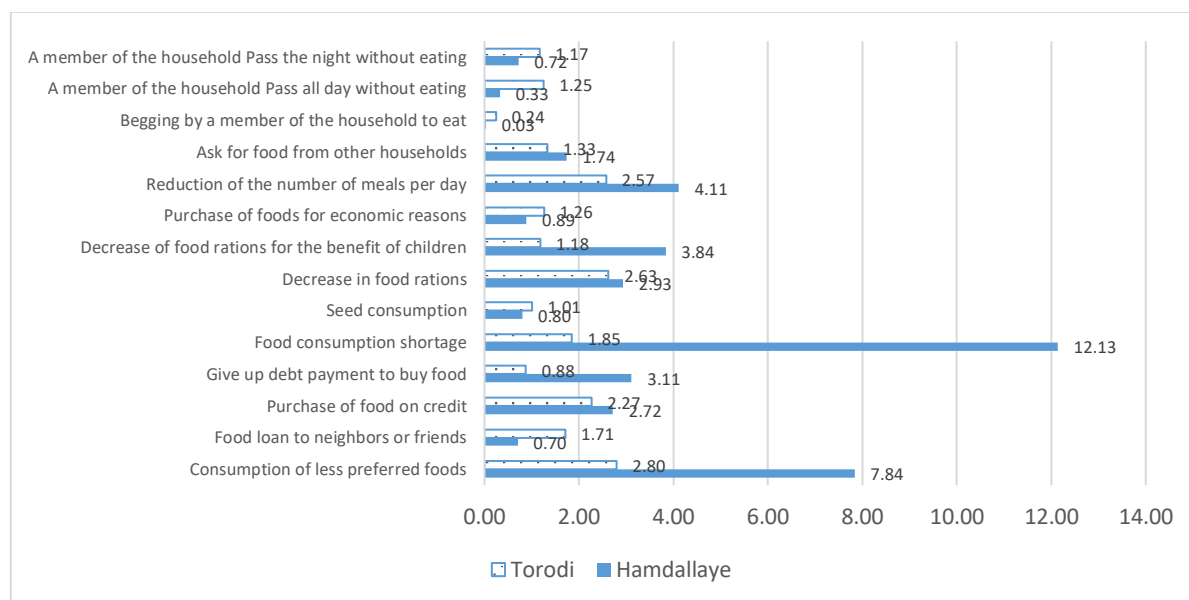


Figure 5: Value of the different criteria used in the CSI determination on food security for the two municipalities (2016)

For all these criteria related to the food CSI, the scores of *Hamdallaye* commune are significantly higher than for *Torodi*. The only criteria for which *Torodi* has higher scores than *Hamdallaye* are food loans from neighbors or friends (1.71), spending the night or day without eating (with scores of 1.17 and 1.25), and seed consumption before the sowing season with a score of 1.01. However, the low values of these scores do not make it possible to change the meaning of the global values of the CSI for the two communes.

The strong signs of coping strategies related to the food aspects in the villages of *Hamdallaye* commune result from the lack or under-exploitation of other natural potentialities such as ponds and rivers. Indeed, these natural resources represent great opportunities for the diversification of production, as in the villages of the municipality of *Torodi*.

Village level

The values of the overall coping strategy index (CSI) at village level show some diversity

between localities. Thus, the food-related CSI indicates a higher level of use of coping strategies in the villages of *Zori Bangou* and *Tokobinkani Zarma* (commune of *Hamdallaye*) compared to those of *Dioga* and *Magou* (commune of *Torodi*). This index is 48.71 and 36.42 respectively for the two villages *Tokobinkani Zarma* and *Zori Bangou*, significantly higher than for the villages of *Magou* and *Dioga* with values of 28.17 and 20.25 (Figure 6). This difference shows a greater vulnerability of the villages of *Hamdallaye* commune compared to those of *Torodi* commune. On the other hand, these values translate globally for the four villages, a decrease in the use of coping strategies compared to 2015 (CARE, 2015), thus a decrease in vulnerability between the two years. The increase in the use of coping strategies reflects a growing vulnerability that leads people to adopt various feeding practices, some of which are socially unsuitable but used because

of the difficult food context. For example, [10] Corbett (1988) indicates that households can change their food consumption by reducing food or reducing the number of consumers. This is the

case in the villages of *Hamdallaye* with food factors criteria corresponding to this rather high index (48.71 and 36.42).

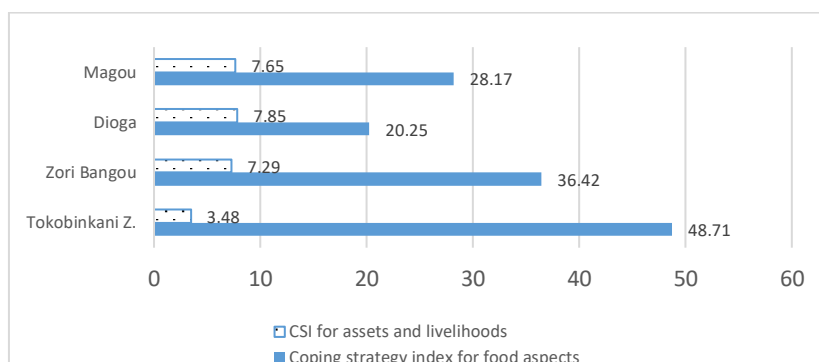


Figure 6: Coping strategy indexes for the villages of Torodi and Hamdallaye in 2016

The coping Strategy Index for the use of livelihoods and assets for the villages of *Dioga* and *Magou* (*Torodi* Commune) is 7.85 and 7.65 respectively (Figure 6). However, a high value of 7.29 of this index is also recorded for one of the two villages of *Hamdallaye* (*Zori Bangou*) bordering the values of those of the municipality of *Torodi*. The low CSI value for assets and livelihoods observed at *Tokobinkani Zarma*, the other village in *Hamdallaye* commune, is an expression of a low level of strategies diversification. This diversification concerns the use of community assets and other livelihoods, such as the sale of wood and straw, the sale of breeding stock, and agricultural and non-agricultural labor.

Conclusion

Determining the vulnerability of people and their livelihoods helps guide community-based targeting of development interventions. The same is true for the coping strategy index evaluation, which uses tools and components that are relevant and effective in assessing vulnerability. These indexes made it possible to identify vulnerability characteristics for various ecosystems in a context of proven climate change.

For the two communes examined, there is clearly a difference in the coping strategy index

values, which indicates an increase in vulnerability according to the decreasing rainfall gradient. The coping strategy index for food situation is higher for the communities of *Hamdallaye* in the north, compared to those of *Torodi* in the south.

The higher value of coping strategy index for assets and livelihood for villages in *Torodi* commune is a function of the increased opportunity to use assets and other livelihoods for resilience. This is all the more an opportunity for this agro pastoral commune where the place of livestock in livelihoods is a major asset in terms of diversification of opportunities to increase their resilience to climate change, unlike the commune of *Hamdallaye* which is dominated by agricultural practice with less option of diversification strategies. There is therefore a difference in vulnerability between the villages of the two communes because of their location in rainfall isohyets and opportunities for diversification of different strategies to adapt to climate change and variability.

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