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Indicative Elements for Improving the Resilience of Food Security to climate risks in Burkina Faso

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Abstract
Context: *In Burkina Faso, the deterioration of food security has multiple repercussions that lead to environmental, social, economic, institutional and political setbacks or difficulties. The climate, in particular droughts, is the main factors in the deterioration of this food security. The purpose of this article is to propose a set of benchmarks of impacts and resilience needs to improve governance processes and prevention of adverse climate effects on food and nutrition security in Burkina Faso.*
Materials and methods: *The research methodology (Climprospect) that we used is an innovative approach which includes the mapping of climate risks in a given space, the evaluation of the direct and indirect impacts of climate risks and the development of classes of needs in resilience. It is particularly important that all the components of food security are taken into account in the analysis, that is to say the integration of a fifth component namely the Governance of food security institutions. The scientific analysis was supplemented by a participatory approach with sixteen (16) institutions, including five (5) international and eleven (11) national, to integrate local perceptions of the challenges of food security to be met in the face of the effects of climate change.*
Results: *the main results of this study are the direct and indirect impacts of droughts on food security generated, their repercussions on the environmental and socio-economic components, thus making it possible to build resilience paths of absorption, adaptation and transformation for short, medium and long term planning for Burkina Faso. The scientific results obtained fit perfectly with the perceptions of the actors.*
Conclusion: *The results corroborate the work of several authors, who have analyzed the food security situation in countries experiencing the same realities as Burkina Faso. However, their analysis does not include a fifth component, namely the governance of institutions. As a result, the recommendations were not yet robust enough to bend the food insecurity curve in Burkina Faso.*

Keywords: *absorption, adaptation, degradation, benchmarks, droughts, transformation.*

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I. Introduction

Food security is one of the main challenges for social and economic development in Burkina Faso (FAO, 2013; Ouedraogo and al., 2015; MEF, 2016; Ouedraogo and al., 2018). In addition to the humanitarian consequences, food and nutrition security crises have environmental, social economic and politic repercussions on the country and its populations (Banque mondiale, 2013). As Palazzo and al., (2016) pointed out, in Burkina Faso as in all Sahel countries, climate and disaster risks are one of the main constraints to achieving sustainable food security. This influence of climate on food and nutrition security results mainly from the combination of three factors: the essentially rain-fed nature of agriculture, a precipitation regime characterized by a great spatial and temporal variability, recurrent episodes of droughts and floods, and multiple deficits in the prevention and management of food crises.

In order to create conditions for sustainable food security, the government of Burkina Faso has opted to develop and implement food security policies and strategies. The current food and nutrition policy covers the period 2019-2027 (MAAH, 2017). The overall objective is to ensure sustainable food and nutrition security by 2027. It is structured in five (5) strategic axes: (i) sustainable increase in food availability through sustainable intensification of crop production, improved control of water resources, creation of an enabling environment for sustainable agricultural investment and strengthening of technical and organizational capacities of farmers' organizations; (ii) improving the physical and financial accessibility of populations to food product information that will open up food production and consumption areas, increase storage, processing and marketing

infrastructures, improve opportunities income and improving the functioning of the food markets; (iii) improving nutritional status of populations by improving household dietary diversity and ensuring food safety; (iv) strengthening the capacity to prevent and respond to food and nutrition crises by strengthening the system for preventing and managing economic crises in line with the requirements of the resilience of the communities and vulnerable households; (v) strengthening governance in food and nutrition security by developing communication and advocacy for food and nutrition security.

Several achievements in food security result from different food security policies (WACSAA, 2015; Williams and al., 2015; Zougmoreand al., 2016; MAAH, 2017). We can mention: i) a substantial increase in agricultural productivity, the development of small agricultural irrigation, the consequent constitution of national physical and virtual stocks of food security; ii) the opening up of areas of food production and consumption, the significant increase in the number and capacity of storage, processing and marketing of food products, the effective establishment of *Système d'Information sur les Marchés (SIM)* (market information system), improving income opportunities for thepopulation; (iii) improving household dietary diversity and food safety; (iv) *Système d'Alertes Précoces (SAP)* (early warning system) program for climatedisasters and food crisis response; (v) the creation of the *Secrétariat Exécutifdu Conseil National de Sécurité Alimentaire (SE-CNSA)* (executive secretariat ofthe national council for food security); (vi) the creation of a support structure, namely the *Conseil National de Secours d'Urgence et de Réhabilitation(CONASUR)* (national emergency relief and rehabilitation council); (vii) thecreation of control shops for free distribution of food products to the most vulnerable and sales at subsidized prices; (viii) the creation of the *SociétéNationale de Gestion des Stocks de Sécurité alimentaire (SONAGESS)* (nationalsociety of management of food security stocks).

In Burkina Faso, the alteration of rainfall patterns and the increase in the frequency and intensity of extreme climate events suggest an exacerbation of the effects of climate change on food and nutritional security (Boansi and al., 2018). Burkina Faso should better take into account the issues of climate change in the governance of food security in order to preserve the gains and development prospects of the food security sector (Zougmore and al., 2016; Partyand al., 2018). Such an exercise requires the mobilization of available scientific knowledge and robust decision-making tools in line with the specificities of the local environmental, social, economic and technological contexts (Baptista and al., 2013; Badolo, 2015; Boansi and al., 2018).

The overall objective of this study is to propose impact and resilience need benchmarks that can be used by policy makers to improve food security responses to climate change. Specifically, the aim is (i) to characterize the impacts of climate on food security in Burkina Faso, (ii) to determine the resilience needs, and (iii) to propose appropriate solutions for the reduction of food insecurity.

As used by Badolo (2015), Sanou and al., (2017), the research methodology we used is innovative. It includes a mapping of climate risks in a given space, the assessment of the direct and indirect impacts of climate risks and the development of the different categories of resilience needs to be solved. It is particularly notable as all the components of food security are taken into account in the analysis. The scientific analysis was complemented by a participatory approach to integrate local perceptions food security challenges in the times of climate change.

II. Material And Methods

The methodologycombines an innovative scientific approach and a participatory approach involving the populations concerned.

2.1 Study Area

The study involves the entire country of Burkina Faso. As a Sahelian country with a predominantly semi-arid climate, Burkina Faso faces relatively difficult agro-ecological conditions due to climatic deterioration and increasing anthropogenic pressure (Roudier and al., 2011; Samandoulgou and al., 2019). The climate is of Sudano-Sahelian type with irregular rainfall, with a declining trend in recent years, unequally distributed over the territory with progressive annual average rainfall from north to south (SP/CNDD, 2016), ranging from less than 600 mm per year (about 25% of the territory), 50% of the territory with a rainfall of between 900 and 1000 mm, and 25% of the territory with 1000m and more. This situation, as illustrated in Figures 1 and 2, augurs an exacerbation of climate and environmental constraints for the national economy, especially for rain-fed agricultural production which aims to ensure food security.

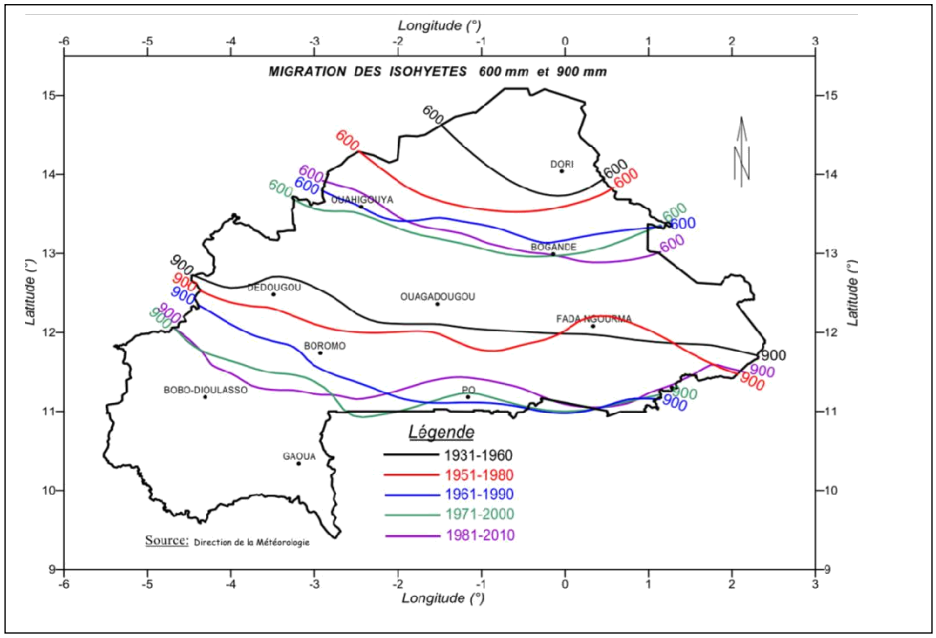


Figure 1: Migration of isohyets

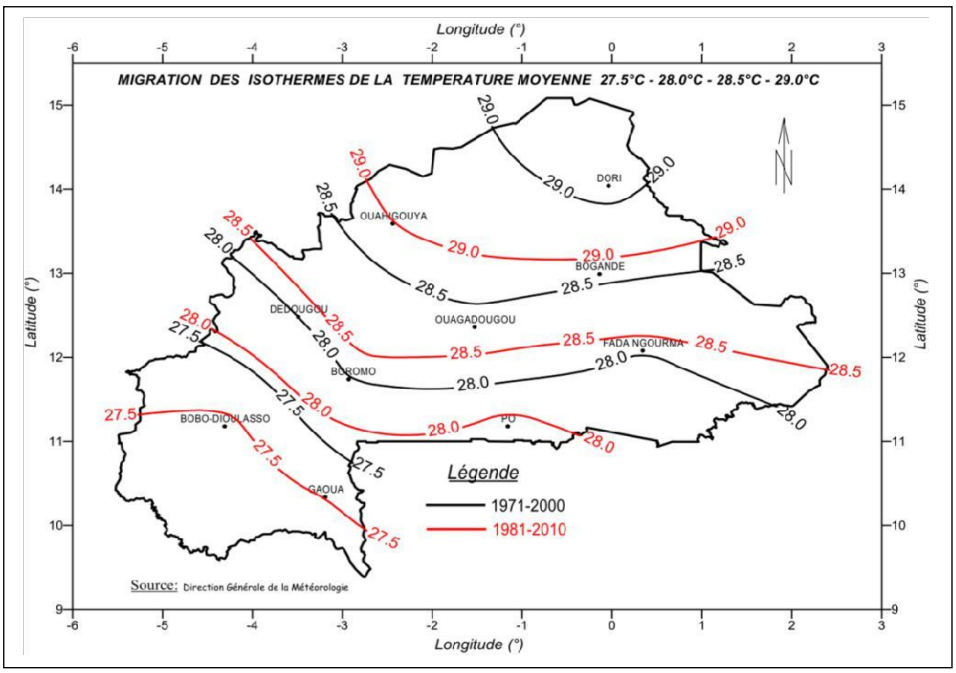


Figure 2: Migration of isotherms

Source: National Agency of Meteorology

Burkina Faso is particularly concerned by the phenomenon of desertification and land degradation (Sigueand al., 2018; Belem and al., 2018). The risk of land degradation is increased because of the effects of climate and the anthropogenic pressures (see Figure SM3), and the possibilities of the finding productive land diminish over time (Clavel and al., 2008; Banque Mondiale, 2013; Bamba and al., 2015; Binam and al., 2015). In Burkina Faso,most degraded areas are found in the Sahel (57%), the North (29%) and the Center North (29%) regions. These areas also correspond to structurally deficit areas in terms of food availability. The risk of degradation is high on about 37% of the country's land (CSAO and CILSS, 2008).

Figure 3 shows new areas (East and West) at high risk of land degradation likely to negatively impact national agricultural productivity.

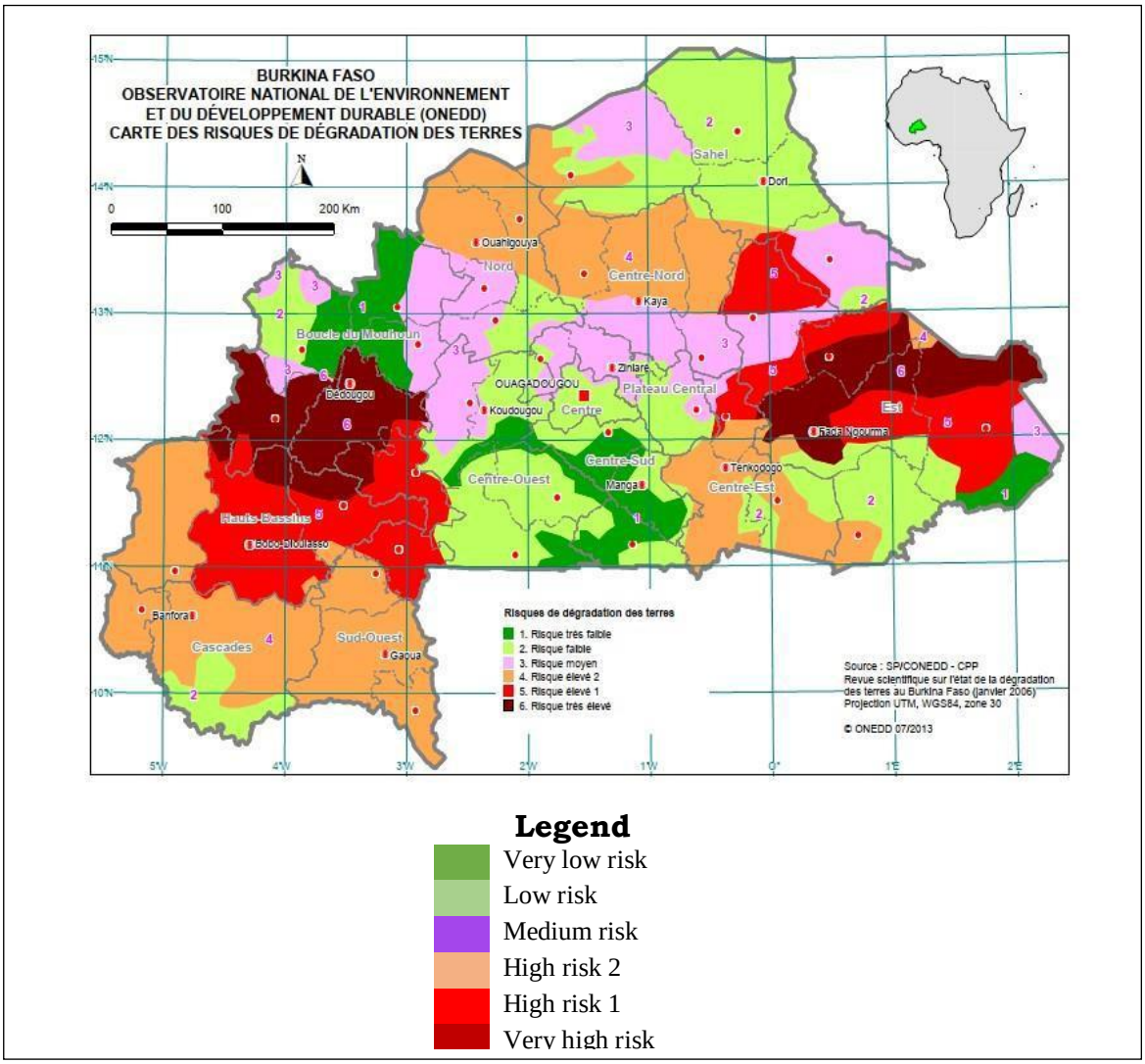


Figure 3: Land degradation risks

BURKINA FASO
OBSERVATOIRE NATIONAL DE L'ENVIRONNEMENT ET DU DEVELOPPEMENT DURABLE (ONEDD)

CARTE DES RISQUES DE DEGRADATION DES TERRES

Source: SP/CONEDD-CPP
Revue scientifique sur l'état de dégradation des terres au Burkina Faso (Janvier 2006)
Projection UTM, WGS84, zone 30

BURKINA FASO
NATIONAL OBSERVATORY FOR THE ENVIRONMENT AND SUSTAINABLE DEVELOPMENT (NOESD)
LAND DEGRADATION RISK MAP

Source: SP / CONEDD-CPP
Scientific review on the state of land degradation in Burkina Faso (January 2006)
UTM projection, WGS84, zone 30

Figure 4 maps the vulnerability of households to food insecurity in Burkina Faso. It is noted that only in 62.23% of the provinces of the country, household food insecurity prevalence is less than 20%. The rest is estimated at a prevalence rate of more than 40%.

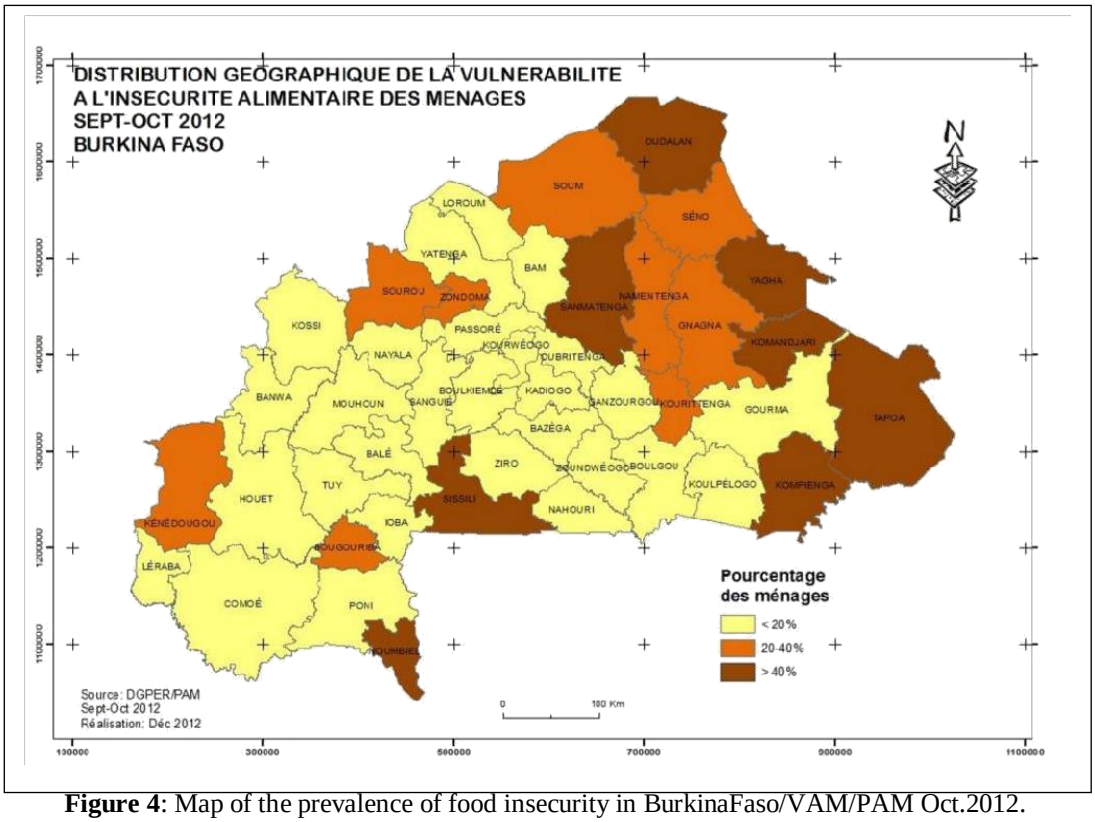
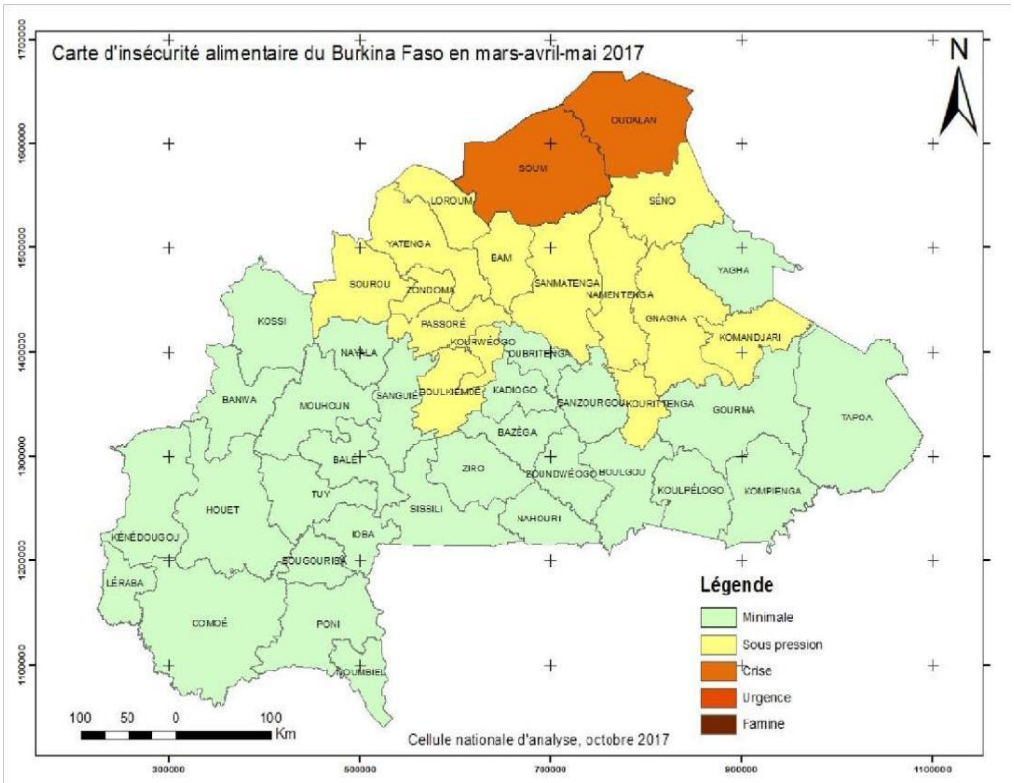


Figure 4: Map of the prevalence of food insecurity in BurkinaFaso/VAM/PAM Oct.2012.

DISTRIBUTION GEOGRAPHIQUE DE LA VULNERABILITE A L'INSECURITE ALIMENTAIRE DES MENAGES	GEOGRAPHICAL DISTRIBUTION OF HOUSEHOLD FOOD INSECURITY VULNERABILITY
SEPT-OCT 2012	SEPT-OCT 2012
BURKINA FASO	BURKINA FASO
Source : DGPER/PAM	Source: DGPER / WFP
Sept-Oct 2012	Sep-Oct 2012
Réalisation Déc 2012	Realization Dec 2012
Pourcentage des ménages	Percentage of households

Figure 5shows the level of food stress in Burkina Faso, with 35.55% of people living a situation of food insecurity in 2017 (MAAH, 2017).



Legend
Minimal
Under Pressure
Crisis
Emergency
Famine

Figure 5: Food insecurity trends in 2017

Carte d'insécurité alimentaire du Burkina Faso en mars-avril-mai 2017	Burkina Faso food insecurity map in March-April-May 2017
Cellule nationale d'analyse, octobre 2017	National Analysis Unit, October 2017

2.2 Impact Evaluation Method: Description of Model

The methodological approach that is used to generate impact benchmarks is Climprospect (Badolo, 2015). It is a tool for analysing the interactions between climate change and development (UICN, 2011). Climprospect is widely used for integrating climate change adaptation into local development plans in Burkina Faso and Niger (AGRHYMET/CILSS, 2014). It consists of two distinct parts. The first part is devoted to a scientific theoretical approach based on the formulation of the methodological units.

Figure 1 gives a schematic illustration of the methodological units of this model. In a schematic way, the different methodological units allow respectively: a) establish the basic parameters of the study (mathematical analogs of risk mapping systems), b) develop climate risk impact benchmarks (table of impacts, impact spectra, socio-economic impactenvelopes, families of impacts), and c) generate the classes of resilience requirements of the systems under consideration.

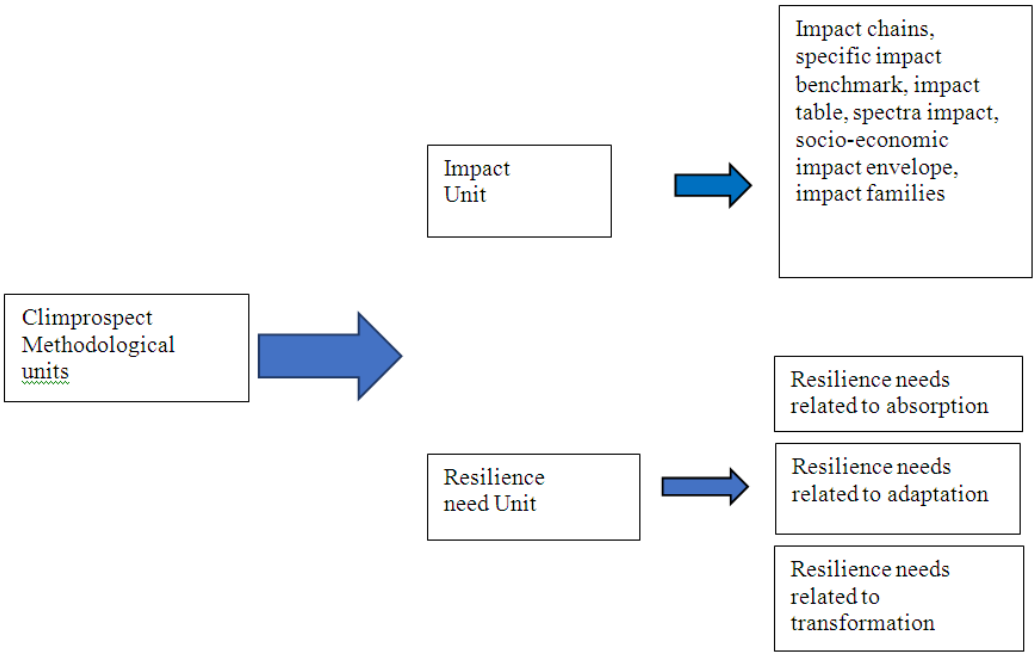


Figure 6: Schematic illustration of the Climprospectmethodological units

The figure 7describes the implementation of Climprospect to generate the various decision support frameworks.

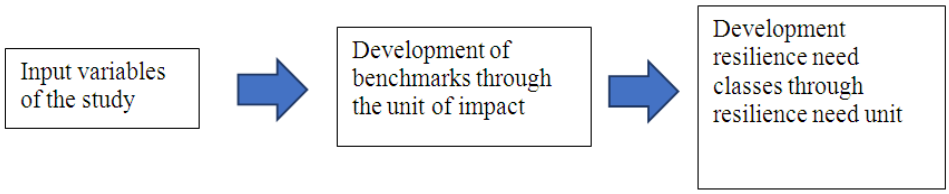


Figure 7: Implementation schema of Climprospect

The Climprospect methodology requires two input variables, which are the system vector (e) and the risk vector (r).
The vector e (e1, e2, …, em) is an analogue or mathematical equivalent of the studied system. The components e1, e2, …, em of (e) are by definition the main components of the studied system.
The dimensions of food security in Burkina Faso that will be considered in this study are, respectively, the food availability, the economic accessibility to food, the marketing systems for agricultural products, and the use of food (nutrition-sanitary-food quality) and governance of food security. They are used to specify the components of vector (e), at the scale m = 5 and are:

- e1: food availability;
- e2: economic accessibility to food;
- e3: marketing systems of food products;
- e4: food use (nutritional-sanitary-food quality);
- e5: governance of food security.

The vector (e) associated with food security in Burkina Faso is thus a five-dimensional vector. This indicates that the vulnerability or resilience patterns of food security in Burkina Faso are to be found in practice in a five-dimensional state space.

The components of the climate risk vector r (r1, r2, …, rk) are the climate and disaster risks that repeatedly and significantly affect the studied system. The adverse effects of climate risks on food security in Burkina Faso and elsewhere have been the subject of several studies based on scientific and participatory approaches (GIEC, 2007; Lipper and al., 2014). By referring singularly to Burkina Faso's national action plan for adapting to climate change, developed in 2014 from a participatory process involving grassroots populations, we have selected as components of the vector r:

- r1: droughts;
- r2: floods;
- r3: parasitic attacks.

These components of the vector r are also the risks perceived and expressed in order of importance by the actors when collecting the information in the field.

The impact unit is the methodological approach for developing different categories of impact benchmarks. These include impact chains, impact families, specific impact benchmarks and socio-economic impact envelopes. In general, the impact benchmarks considered here are in the form of vectors or subsets. This is one of the peculiarities of the methodological framework of this article. For more readability, we will choose to present the contents of subsets in tabular form. The first category of impact benchmarks includes impact chains. For a component ei (i = 1, 2, …, 5) of the vector (e) and a component rj (j = 1, 2, 3) of the risk vector (r).
A chain of impacts is of the form: cij= eirjd0, eirjd1, …, eirjdp
p is the length of the chain:
1°) eirjd0 is the direct impact of rj on ei;
2°) eirjd1 is the indirect impact of order 1; it is the most important immediate repercussion of eirjd0;
3°) eirjd2 is the indirect impact of order 2; it is the most important immediate repercussion of eirjd1;
… ……
p°) eirjdp is the indirect impact of order p, it is the most important immediate repercussion of eirjd (p-1);
The second category of benchmarks or subsets of impacts includes families of impacts. For a climatic risk rj (j = 1, 2, 3), a family of impacts of order h (h=1, 2, …, p) is a vector obtained by a combination of impact chains:
frjdh= (e1rjdh, e2rjdh, …, ekrjdh)
By definition, a family of impacts is composed of the impacts of the same order of a climate risk on the components e1, e2, …, e5 of the vector (e) respectively.
Let "l" be a determined number, the impacts of the same order for the components of the vector (e) are: e1r1dl, e2r1dl, e3r1dl, e4r1dl, e5r1dl.
The third category of repositories or subsets of impacts relates to the specific impact benchmarks. For a risk rj (j=1, 2, 3), a specific referential of impacts d is the composite subset of the direct and indirect impacts of rj. It is obtained by the summation (the union) of the chains of impacts. For j=1, dr1e is given by:dr1e= c11 U c21 U c31 U c41 U c51
The fourth category of impact benchmarks consists of socioeconomic impact envelopes. An impact envelope consists of impacts of the same type. In this study are considered envelopes of social, environmental, economic, institutional and political types. Figure 8 illustrates the socio-economic impacts considered.

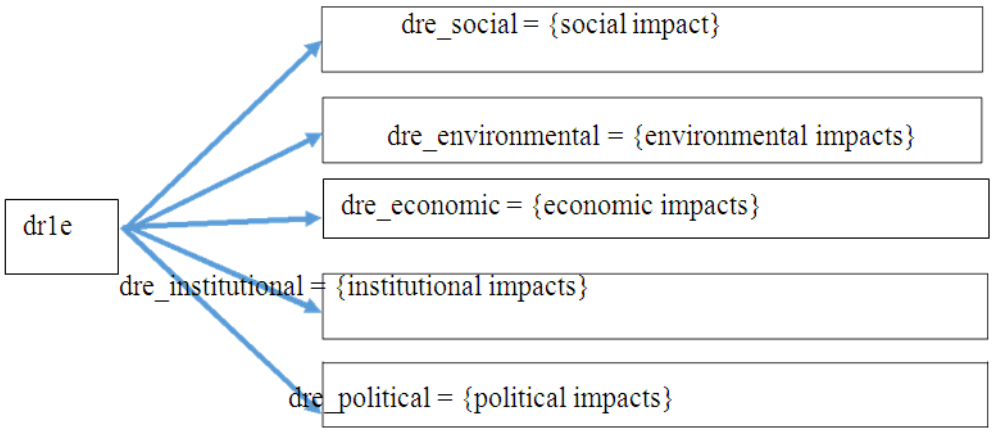


Figure 8: Types of socio-economic impacts

The resilience needs unit is used to develop the three classes of resilience requirements for food security, following the diagram in Figure 9.

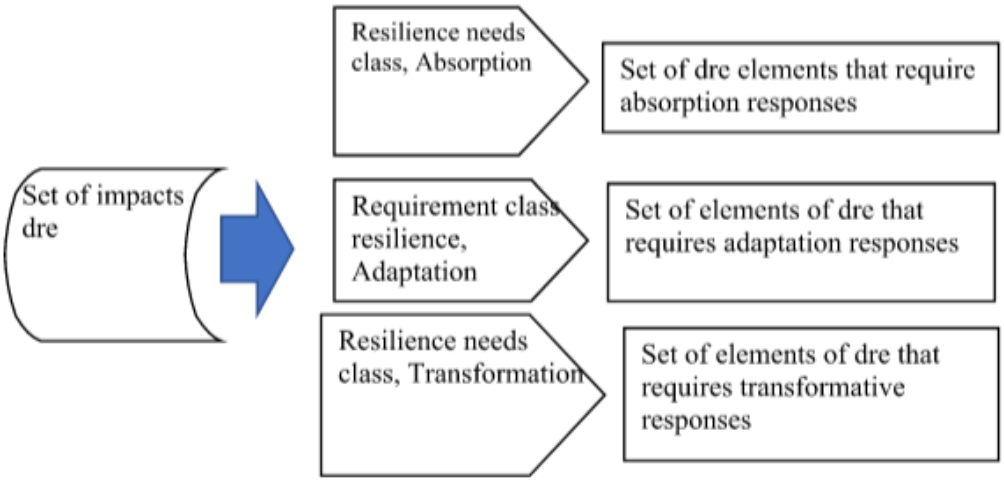


Figure 9: Diagram of generation resilience need classes

The second part is dedicated to the perception of the key actors in the management of food security in the context of climate change in Burkina Faso. The (drp) subset represents the impacts perceived by the actors.

2.3 Participatory Approach

With a view to contracting the proposed decision support frameworks, a survey was conducted among the main recognized stakeholders, in charge of governance of food and nutritional security in Burkina Faso.

The collection of information concerned the West African Economic and Monetary Union (WAEMU), the Embassy of Japan, the Ministry of Agriculture (the information and alert service on food and nutritional security), the National Society for Food SecurityStock Management (NSFSM), the Permanent Secretariat of Non-GovernmentalOrganizations *(PSNGO)*, the Economic and Social Council (ESC), the Permanent Secretariat of the National Council forSustainable Development (PS/NCSD), the Permanent Secretariatof the National Committee for Emergency Relief and Rehabilitation *(PS/NACOER)*, the Faso farmers' Confederation (FConf), the Livestock Crisis and Vulnerability Management Structure (*LCVMS)*, thePermanent Secretariat of the World Food Program (PS/WFP), the General Directorateof the Green Economy and Climate Change (GDGECC), the PermanentSecretariat for the Coordination of the Agricultural Sector Policies (PSCASP), the National Office of theRegional Chambers of Agriculture (NORCA), the NGO Action against Hunger, the Direction of the Formulationof Policies (DFP), the General Direction of Planningand Development of Irrigation (GDPDI).

For data collection, three dimensions of food security were considered: domestic production, state food security financing, and food security sector governance. A qualitative approach based on focused interviews was used according to Krueger and Casey' (2015) method.

The information collected in 2018 focused on the main aspects of food security, the significant and recurrent climate and disaster risks affecting the food security sector, the impacts of these risks, the vulnerability factors of agricultural production and the resilience options to promote. The participatory approach has been coupled with the judgment of the expert or scientific analysis. This allows for consensual decision-making (Ole Mertz, 2008; Oyekale and al., 2015).

2.4 Data Analysis

For the processing and analysis of the information collected, an excel spreadsheet was used. The results were subjected to a qualitative analysis of the impacts generated by the adverse effects of droughts on food and nutritional security. The types of impacts produced were characterized and evaluated by expert judgment, and the most relevant were selected.

III. Results

3.1 Direct and Indirect Impact spectra

The impacts generated are the main results of this study. The impact assessment shows that in Burkina Faso, droughts have adverseeffects on all components of food and nutrition security. The direct impact affecting the e1 component of food security is the decline in agricultural production. The direct impacts on the other components e2, e3, e4, and e5 of food security under the effects of droughts are, respectively, the increased degradation of the environment, the deterioration of the political climate, the deterioration of the nutritional qualities of food, and the increased solicitation of the institutions responsible for food and nutrition security.

In Burkina Faso, these direct impacts in turn have environmental, social, economic, institutional and political impacts on the different components of food and nutrition security.

The increasing pressure on natural resources, the increasing food import requirements, and the reducing economic growth are some of these indirect impacts.

The direct and indirect impacts dr1e of droughts on food and nutrition security are summarized in Table 1.

dr1e	Impacts
Subset of direct impacts	- decreased national food production, - increased environmental degradation, - deterioration of the political climate, - deterioration of the nutritional qualities of food, - strong reliance on institutions in charge of food and nutritional
Subset of indirect impacts	- decreased agricultural GDP, - declined supply of agricultural products, - declined agricultural income, - increased labour disputes, - exacerbated decline in economic activity, - increased budget deficit, - Increased indebtedness, - increased economic dependence - handicap to the process of economic and social development, - failure to achieve socio-economic development objectives, - increased imports of agricultural products, - increased financing needs specific to agriculture, - increased difficulties of access to food products, - weakening of existing national trade policies, - distortion of the food markets, - multiplication of socio-economic crises, - high prevalence of nutritional diseases, - high dependence on food aid, - increased consultative meetings, - loss of efficiency of the main actors responsible of food and - nutrition security, - inability of institutions to manage food crisis.

Table 1: Direct and indirect impacts of droughts on food andnutrition security

The result under (dr1e) shows that the impacts of droughts on food and nutrition security generate adverse changes for Burkina Faso, in the social, environmental, economic, institutional and political terms. In practice, (dr1e) can be a tool for measuring the pace and extent of the mitigation of climate influence on food and nutrition security coverage efforts, driven by development policies and initiatives of this sector in Burkina Faso. Specifically, it will follow the evolution of the (dr1e) set to the empty set.

Figure 10 shows the inter-annual evolution of agricultural production in the study area for a climatic variable. It highlights a correlation between the climatic profile and annual production, in this case the effects of the drought recorded on agricultural yields in 1990, 1997, 2000 and 2004.

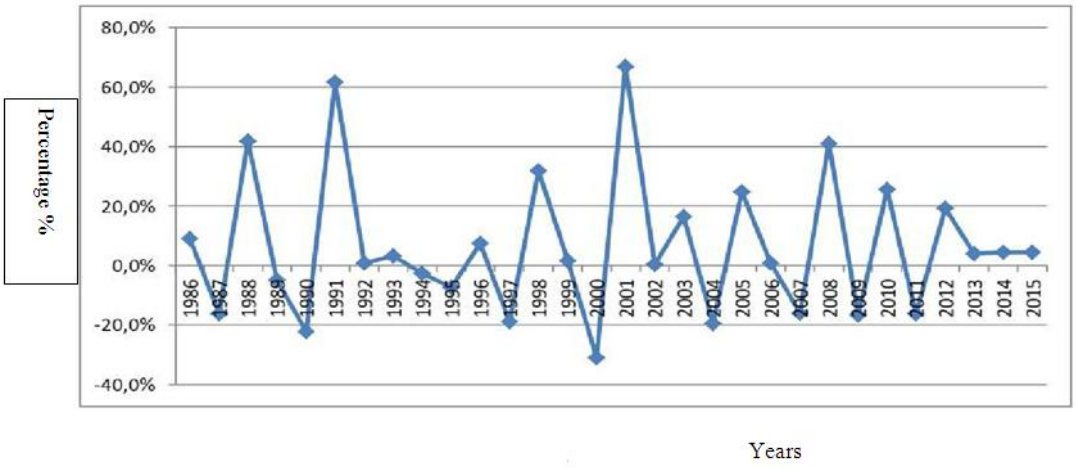


Figure 10: variation in cereal production in Burkina Faso from1987 to 2015 depending on rainfall.

3.2 Socio-economic impact Spectra

Socio-economic impact spectra are subsets formed of socio-economic impacts of drought impacts on food and nutrition security. They are identified in the large (dr1e) set and grouped by socio-economic category. These are benchmarks of economic, social, environmental, institutional and political impacts that can serve to guide the development of response or recovery solutions to be included in the development policies or initiatives of the food and nutrition security sector. In this article, only economic and social spectra were selected, given their importance in the context of Burkina Faso. The economic sub-group (dr1e) gives a global overview of the economic changes induced by the impact of droughts on food and nutritional security. The decline in agricultural GDP, the increase in the specific financing needs of agriculture, and the decline in the contribution of the agricultural sector to economic growth are examples of the economic impact of droughts on food and nutrition security. One of the major economic consequences of drought impacts is the reduction of agriculture's contribution to the national economy.

Figure 11 shows that there is a correlation between years of poor rainfall and years of food crises. This is particularly the case in 1973, 1985, 1996, 1998, 2001, 2005, 2010 which were years of drought and also years of food crises or famine in some regions of the Sahel, and Burkina Faso, particularly in the years: 1987, 1999, 2002, 2004, 2007 et 2009 (Janin, 2010).

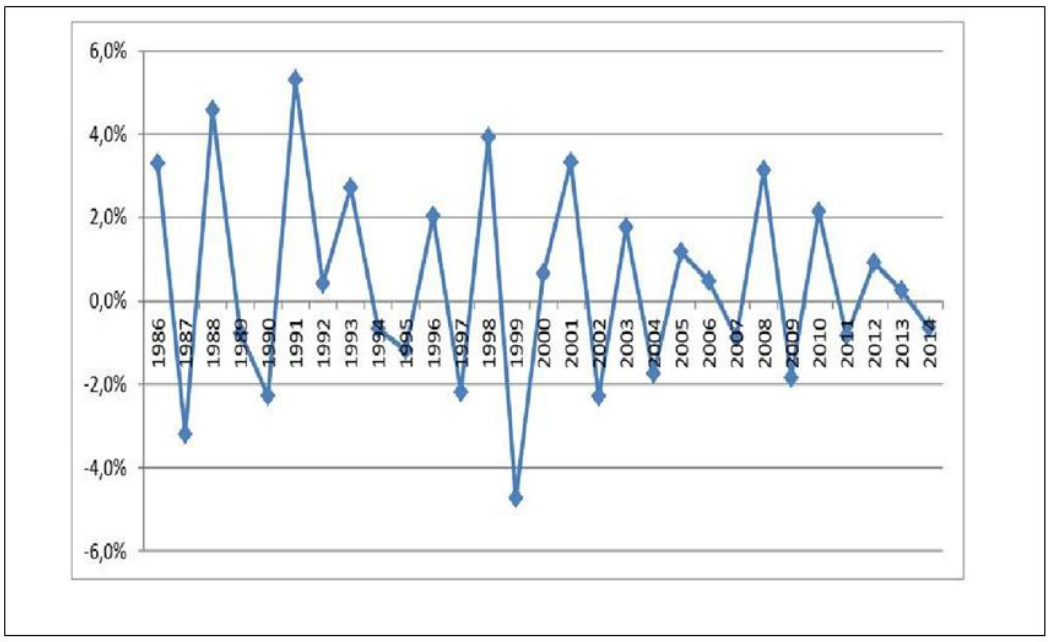


Figure 11: contribution of agriculture to Burkina Faso'seconomic growth from 1986 to 2014

The fragility of the social context of Burkina Faso dictates that priority should also be given to the social repercussions of droughts on food security. The social subset (dr1e) expresses various social regressions, changes in social demand, and disruptions in social action policies. Alterations in access to basic social services, increased casualization of rural households and increased reliance on humanitarian aid are examples of the identified social consequences of droughts on coverage efforts of food and nutrition security.

Table n°2 illustrates the economic impacts of droughts on food and nutrition security in Burkina Faso and the social changes generated.

	Impacts
Subset of indirect impacts	- decreased agricultural GDP, - widening of the market supply deficit in cropproducts, - agricultural products price hikes - decreased yield of rain-fed agriculture, - decreased agricultural receipts, - increased imports of agricultural products, - increased budget deficit, - increased indebtedness, - slowdown in the overall economic activity, - rise of economic dependence, - disruption of public spending forecasts for the agriculturalsector, - increased financing needs specific to agriculture,

	- erosion of national economic investment capacities, - increased poverty of agricultural households,
Subset of indirect impacts	- deteriorated access to basic social services, - disrupted social dynamics, - jobs losses, - increased migration of rural populations, - increased social charges for households, - increased casualization of rural households, - increased nutritional diseases, - deterioration of social climate, - increased dependence on humanitarian aid, - development of new food habits, - high prevalence of nutritional diseases, - deterioration of trade terms

Table 2: Economic and social impacts of droughts on foodsecurity

3.3 Actors' Perception

The impacts under the (dr1p) set are the recorded perceptions of food and nutrition security actors, in relation to the risks of drought. Declining agricultural yields, surge in food prices in supply markets and increasing demands for food support from Technical and Financial Partners are some of the direct and indirect impacts of droughts perceived by actors on food and nutrition security in the context of Burkina Faso. In addition, these impacts indicate that the socio-economic problems caused by climate risks to food security in Burkina Faso are likely to persist despite the multiple development strategies undertaken. These perceptions confirm the results obtained by the scientific analysis. Table 3illustrates this situation.

dr1p	Impacts
	- falling agricultural yields, - increasing financial difficulties in accessing food, - soaring food prices on supply markets, - increasing demand for food support from technical and financial partners, - loss of livelihoods of rural households, - difficulties in feeding for the poor, - increased mobilization of relief and emergency structures

Table 3: Impacts perceived by the main actors of food security

3.4 Resilience Needs

Efforts to improve the governance and resilience processes of food and nutrition security to climate risks in Burkina Faso should thus focus on food production and the economic accessibility of food products in the event of drought. The main measures below are results of our study.

Ideally, a situation of resilience of food security to drought is such that dr1e=ø. To build such a configuration, Burkina Faso should implement measures ofabsorption, adaptation and transformation of impacts. Absorption measures can reduce the repercussions of drought impacts on food security in the short term. All the impacts that could be affected by these measures constitute z_absorption.

The same is true for adaptation measures that make appropriate changes to better manage droughts impacts on food security.

Finally, for Burkina Faso, transformation measures constitute the benchmark for developing and implementing long-term initiatives. These are measures that manage the structural or fundamental causes of the sensitivity of food and nutrition security to drought.

The z_absorption, z_adaptation and z_transformation are the main results generated by the methodology for resilience of food security in Burkina Faso respectively in the short, medium and long term.

Table 4summarizes the impacts to be solved in the short, medium and long term.

	Impacts
z_absorption (short term)	- decreased national production, - deterioration of the state of infrastructure, - increased demand for food products, - increased transport costs, - increased intervention stocks, - loss of harvests, - increased imports, - increased contribution of food aid for food security, - increased food deficit.

z_adaptation (medium term)	- increased difficulties of setting up stocks, - amplification of the contribution of imports to food security, - reduction of food rations in agricultural households, - reduction of food security stocks, - decreased yields of national agricultural production, - reduction of agro forestry production, - loss of agricultural food security resources.
z_transformation (long term)	- increased difficulties of setting up stocks, - increased contribution of imports to food security, - reduction of food rations in agricultural households, - reduction of food security stocks, - decreased yields of national agricultural production, - reduction of agro forestry production, - loss of agricultural food security resources.

Table 4: Impacts to be solved in the short, medium and long term.

IV. Discussion

The impact benchmark provides a global overview of the direct and indirect impacts of droughts. In Burkina Faso, all e1, e2, e3, e4 and e5 components of food and nutrition security are sensitive to drought (CSAO-CILSS, 2008; Wanvoeke and al. 2016; MAAH, 2017). The impacts of droughts on these components alter the fundamentals of food and nutrition security, including agricultural production (Clavel and al., 2008; Garrity and al., 2010; Roudier and al., 2011; Lipper et al., 2014). This strongly suggests a careful consideration of all components of food security in the resilience plans of the sector (Lipper and al., 2014; Palazzo and al., 2016).

The elements of (dr1e) set also mean that the impacts of droughts on food and nutrition security induce adverse environmental, social, economic, institutional and political changes. These changes, which are deteriorations, setbacks and constraints, show that Burkina Faso is in a socio-economic context sensitive to the impacts of droughts on food and nutritional security. It is therefore recommended that the socio-economic impacts of drought impacts, particularly the institutional and policy implications, be better integrated into resilience plans for food and nutrition security (MEF, 2016). By integrating the multidimensional nature of food and nutrition security, and the successive repercussions of drought impacts, the impact families suggest an adjustment of approaches and practices in responses to the effects of droughts on food and nutrition security. It would be mainly to develop resilience solutions associated with families of impacts. In practice, resilience solutions should address the absorption of the repercussions of drought impacts, the adaptation in terms of preventing the effects of droughts on food and nutrition security, and the management of structural or fundamentalcauses of climate change sensitivity of food security to climate risks (Sanou and al., 2017).

Several previous studies have highlighted the adverse effects of droughts on food and nutrition security in the Sahel and particularly in Burkina Faso (GIEC, 2007; Yigo, 2011; Roudier and al., 2011; Martin and al., 2016). Grain deficits, disruption of agricultural markets, rising prices of agricultural commodities, drying up of water points, the disappearance of grazing areas, the development of malnutrition, socio-economic and political crises have been the main conclusions drawn.

This article integrates these results, and goes further by offering a better mapping of impacts and resilience needs through the concepts of direct and indirect impact chains, system vector and families of impacts (Badolo, 2015; Sanou and al., 2017).

Two aspects form the theoretical contribution of this research. The first aspect is taking into account the main dimensions of food and nutrition security in impact mapping. In the context of Burkina Faso, all these dimensions or components are sensitive to climate risks. A food and nutrition dimension that would not be taken into account in resilience processes would transfer sensitivity to other components. A multidimensional approach to food and nutrition security appears as an essential condition for efficiency and performance of vulnerability reduction processes. The decision-support framework is based on this logic in the approach.

The second aspect of the theoretical contribution of this research is related to the method of impact chains. For a given risk and component of food and nutrition security, this method establishes the direct impact of risk and the subsequent repercussions of that impact. The result is a better capture of the resilience needs of each component of food security at climate risk considered in its economic, social, environmental, technological, institutional and political aspects. The results presented could be improved by taking into account the perceptions of a wider and more secular public about food and nutrition security issues related to climate change. This target group would also include development actors and policy makers. Aspects to be considered particularly in strengthening the data collection exercise would include: a) environmental, social, economic, institutional and political impacts of climate risks, and b) needs and patterns of resilience. The perceptions of a wider audience of actors should pave the way for more information (Limantol and al., 2016; Oyekale and al., 2015; Kissou and al., 2018) and to further anchor the results of this research in their context.

V. Conclusion

The purpose of this article was to propose a set of new scientific decision support tools that could significantly improve the governance and resilience processes of food security to climate risks in Burkina Faso. The results presented are direct and indirect impact spectra, socio-economic impact spectra, set of actors' perceptions and a mapping of resilience needs. The proposed direct and indirect impact spectra relate to better transcription of absorption, adaptation and transformation response categories to be implemented efficiently in resilience processes.

Socio-economic impact Spectra reflects the changes made by droughts on food security. Local perceptions can help better contextualize scientific results. This article recommended an approach that could contribute in mapping resilience needs more successfully.

From a scientific point of view, the concepts, methodology and results presented are basic elements for a better mapping of the vulnerability of food security, a definition of the resilience frame that is more efficient. The results presented offer short, medium and long term resilience options for decisions-makers and actors working on food security governance.

The use of the results presented here raises again the problem of the relationship between scientific research and decision-making spheres. In Burkina Faso, like the Intergovernmental Group on Climate Change, there is no forum on the national scale for consultation on the results of climate research. It would therefore be beneficial if such institutions could be created.

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