Assessing climate change vulnerability and its effects on food security: Testing a new toolkit in Tanzania

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CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

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Acknowledgement:

The methodology in this study was adapted from a version developed for GIZ and the National Commission of Protected Areas (CONANP) in Mexico, which has already been tested in 5 communities (Newsham *et al*., 2012 a,b,c; Quintero *et al.* 2012; CONANP & GIZ, 2014).

Abstract:

The working paper presents a new toolkit for the implementation of a participatory vulnerability assessment (PVA) in rural localities, by introducing the methodology, as well as the findings, from a pilot study in Sokoine (Zepisa, Hombolo Ward) in Tanzania. It is based on a participatory methodological approach and follows a multidimensional conceptualisation of social vulnerability to climate change. The methodology is designed to equip project implementers who have limited resources to assess the occurrence and consequences of climate impacts on local livelihood strategies and food systems. It will assist them in understanding local views on how climate change may affect them, what kind of coping strategies are already in place and how their adaptive capacity can be enhanced through measures that are tailored to the profiles of different local groups.

1. Introduction

One of the key consequences of climate change is its impact on poor people and their livelihoods, particularly those living in already stressed areas. Extreme climate events and climate variability already affect production and access to food for different social groups, often with negative consequences. In order to reduce vulnerability to these increasingly frequent climate events it is vital to understand how social, political and economic factors constrain or enable people's access to resources, to improve their livelihood strategies and food security. Local actors and organisations that aim to implement adaptation at the local level often lack the tools to investigate the multiple dimensions of vulnerability.

To provide for this need, a toolkit was developed and tested in a collaborative venture between Bioversity International and IDS (Institute of Development Studies, UK). It is a step-by-step manual to implement a participatory vulnerability assessment (PVA) among rural people. The toolkit can be used by researchers, practitioners or local actors to understand the root causes of vulnerability and how these exacerbate the consequences of local impacts of climate change on people's lives and their food security. This can then support the design of risk management and adaptation measures that take account the (non-climatic) factors that cause vulnerability and constrain or enable adaptation. Instead of starting from an assumption that climate change is the main factor that puts livelihoods under stress, the methodology aims to identify the multiple underlying social, economic, political, cultural and gender-specific factors that cause vulnerability and might (or might not) be exacerbated by climate change. In order to do so we analyse what have been identified as the five dimensions of social vulnerability:

1. Livelihood strategies
2. Wellbeing
3. Individual adaptive capacity
4. Collective adaptive capacity
5. Governance and power relations

Each of these exist on a scale from a high to low level of vulnerability, so the multiple dimensions of vulnerability are reflected in showing how a person, household or locality has different characteristics depending on where they are for these five dimensions. These are assessed in relation to differentiated access and control over resources at the local level by different social groups, and how the five dimensions are affected by climate-related impacts and what the consequences for the local food system is.

The objective of this paper is to introduce this multidimensional approach to understanding local vulnerability to climate impacts, and share the main findings, as well as lessons learned from piloting a 'rapid' version of the toolkit in Sokoine (Zepisa, Hombolo ward) in Tanzania in October 2013. The pilot formed part of an existing project aimed to improve food security through the distribution of drought-resistant local seed varieties. Immediately following this introduction, section two starts by describing the conceptual background and multidimensional understanding of vulnerability, which underpins the participatory methodology described in the following section. The fourth section contains the detailed findings from the fieldwork in Tanzania. This section is structured according to the five dimensions of vulnerability described in section two, and serves as an example for a field report for anyone who would like to replicate the methodology. The last section concludes some insights and reflections on the contribution the methodology makes to understanding vulnerability and the complex relations between climate impacts, livelihoods and response strategies at the local level. It also highlights the 'added value' of doing a PVA by

comparing it to a household survey that was implemented as part of the project in the same locality. The conclusion summarises some of the main findings and highlights how the toolkit can assist practitioners and researchers in analysing vulnerability at the local level and to integrate a social lens into their adaptation planning processes.

2. Multidimensional vulnerability analysis

The focus of this vulnerability analysis lies in understanding the interrelations between climate impacts and the vulnerability of livelihood strategies and food systems at the local level. These include feedback loops and getting to grips with them is one of the key factors to understanding vulnerability to climate impacts.[1] The participatory methodology is aimed primarily at understanding the social, political and economic dimensions of vulnerability at the local level. The social vulnerability analysis thus encompasses these issues by identifying which resources people need for their livelihood strategies, who has access to these resources and how they are distributed within the community. It also examines local capacity to act on climate change and the different types of effects climate change has on these resources, livelihood strategies and the food system. While it provides qualitative information about aspects of the local environment, it can also be used as part of a broader analysis that includes climate projections.

The social vulnerability analysis has two other core characteristics. First, it is a sensitivity analysis tool that focuses on understanding current and historical resilience (or lack thereof), that is, capacity to withstand, recover from and adapt to climate impacts. It does this because the climate projection information provided for the local level is often not a reliable basis for decision-making. Second, it is about disaggregating vulnerability to climate impacts, according to gender, ethnicity, socio-economic class and other variables: by avoiding the mistake of treating communities as if they were homogenous entities, it permits interventions to be more effective and generates data on the politics behind the current distributions of poverty and access to available resources.

Sensitivity analysis

Global and regional climate change projections cannot easily be applied at the local level. Climate projections at a synoptic level make it nearly impossible to determine the probability and impact of a climate projection in a particular location (see e.g., Wilby and Dessai 2009). Projections at global and regional levels often provide average climate values, which do not reveal the implications of climate change that are related to variables associated with a specific time and space.

In order to manage this uncertainty related to climate models, vulnerability can be assessed in relation to sensitivity analysis. In other words, instead of trying to assume what the climate scenario can tell us about the locality, current livelihood and food systems are assessed to see in what ways they are sensitive to different types of climate impacts. This can also be used in contexts where no climate projections are available. This approach reduces the reliance on the accuracy of global and regional projections of climate trends, since the entry point for analysis is the identification of the units within a system (social or environmental) that are exposed to certain impacts, and the level of their sensitivity to these impacts on the basis of current and past experience. The sensitivity analysis also allows us to identify the factors which determine whether a system is sensitive to climate impacts. Interventions can thus focus on these factors in order to make the system more resilient to different (uncertain) climate change scenarios. The focus lies

[1] We use the term climate impacts rather than climate change because no specific attribution can be made for most aspects of climate as it affects localities. Instead we propose to deal with climate impacts, which include aspects that people are already used to, as well as assessing sensitivity of livelihoods and crops to possible changes that are occurring with climate change.

more on strengthening the resilience of the system, rather than on predicting the exact impact of climate change. This makes it possible to reduce the challenges posed by uncertainty implied in global and regional climate change projections. Identifying thresholds to climate stress is important in order to understand the character and the magnitude of the impact on the socio-ecological system, as well as the level of resilience of the system and its ability to respond.

The participatory vulnerability analysis provides the tools to identify the different factors needed to ensure functioning livelihood strategies, food security and maintenance of ecosystem services within the community. The sensitivity of these different components to the identified climate shocks and stresses is evaluated through a participatory methodology. This sensitivity analysis supports adaptation measures that focus on strengthening the factors that are most important for livelihood strategies, ecosystem services and food systems, to make these more resilient to different types of climate impacts.

Vulnerability

Vulnerability is the likelihood that an event will cause harm to a defined entity. It therefore involves two key components: the factors that cause that likelihood (which in this context are regarded as political, economic and social processes that raise or lower the level of risk), and the event itself, which here is focused on hazards and trends related to climate change. The entity which is exposed to risk can be a person, household or 'community', depending on the goal and activities being carried out. We can also paraphrase a widely-used definition: by vulnerability we mean the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the effects of a hazard or trend related to climate and climate change (adapted from Wisner *et al*. 2004). The vulnerability approach used here is a version of political ecology in which the allocation of vulnerability is determined largely by the systems of power that structure society in terms of unequal exposure to risks and opportunities (see Cannon 2008; Hulme and Sheppard 2003; Eriksen and O'Brien 2007; Tanner and Mitchell 2008). Climate change represents one example of this pattern of unequal distribution, since different levels of vulnerability to climate change exist, depending on social, cultural, political and economic conditions (Wisner *et al.* 2004). It is these differentiated vulnerability patterns, in conjunction with the effects of a natural hazard, which need to be taken into account if we are to generate a comprehensive and robust analysis of vulnerability to climate (and other) impacts.

This vulnerability assessment aims to understand the complexity of factors that make certain people more vulnerable than others, by identifying which resources people need for their livelihood strategies, who has access to these resources and how they are distributed within the system. Extreme climate events and climate variability are already undermining food security by exposing food systems to shocks and stresses. These affect production and access to food of different groups, often with negative consequences (Ericksen 2008; HLPE 2012). Local food systems play a crucial role in providing (or not) food security, in particular in relation to three food security outcomes: ***availability*** (distribution and exchange networks, including the need for a stable supply of food), ***access*** (affordability, distribution) and ***utilization*** (social and nutritional values of food, food safety). Malfunctioning of food systems in providing these outcomes can be caused by a range of factors, such as social, political, economic and ecological factors which determine whether certain people have (or do not have) access to food within a system.

Taking the above factors into account, it is crucial to highlight, through the vulnerability analysis and the emerging adaptation measures, that the impact of climate change has to be disaggregated according to the risk profiles of different groups of people, depending on their exposure to and also on the social, economic and political drivers of vulnerability. These different drivers of vulnerability to climate change are captured

in the Dimensions of vulnerability (DoV) framework, which forms the conceptual underpinning of the vulnerability toolkit.

Dimensions of vulnerability

Vulnerability has been defined in relation to five "dimensions", which could relate to the characteristics of a person, household or locality based on their conditions and how they may be affected by different types of risk (climate and non-climate related). These include the patterns of access to and control over resources that may be needed for adaptation. These dimensions of vulnerability (DoV) have been adapted from the analytical framework that was used in a study conducted for GIZ-CONANP in Mexico (Newsham *et al*. 2012a, b, c; Quintero *et al*. 2012).

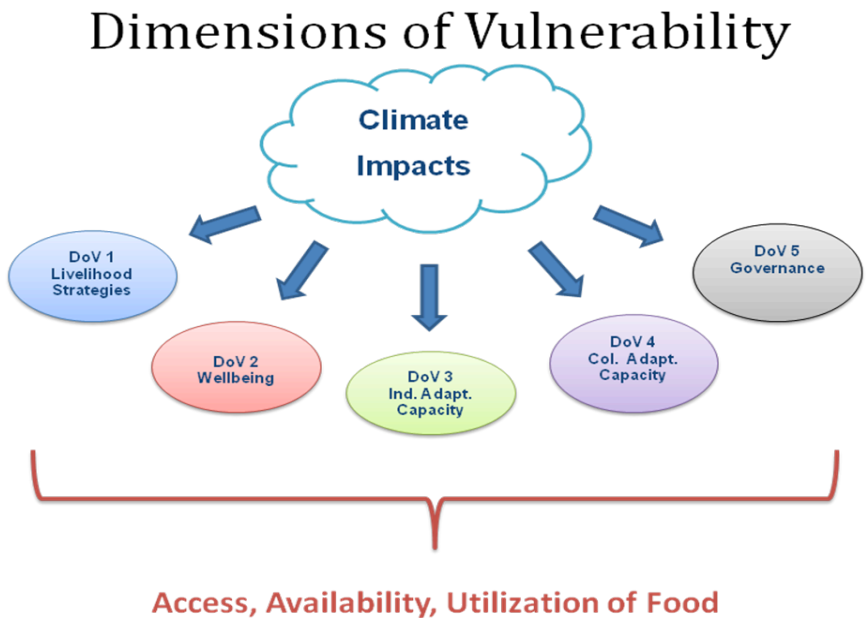


Figure 1 Conceptual framework for the components of the participatory vulnerability analysis

DoV 1 – Livelihood strategies

The first dimension comprises the various livelihood activities that people undertake. It is particularly important to understand what the most significant activities are for food security at the household level. These can be directly related to the production of food for the household (e.g. farming), cash crops such as coffee, or income-generating activities which are vital for purchasing food. This includes an analysis of the different assets (e.g. financial, human, natural) that are needed for different livelihoods and what the patterns of access and control over these assets are. For example, if a farmer cannot obtain the credit needed to buy new seeds, this lack of control over the financial assets is essential for the livelihood activity and can increase vulnerability.

By assessing the livelihood strategies it is possible to match them to the effects of different types of risks, including climate-related problems. This is then the basis for sensitivity analysis that checks different aspects of the livelihood against how it may be affected by different types of climate trends and shocks. Each

livelihood activity (and the resources and assets on which it is based, such as water for crops) can be assessed against different stresses.

Research questions:

- What livelihood strategies exist at the local level?
- What is their importance for food security at household level?
- Which resources and assets are important for these livelihood strategies? Who can access these and who controls them?
- Which livelihood strategies are the most important ones for different groups of people within the community (including according to gender, ethnicity, age, socio-economic status)?
- How are the different livelihood strategies affected by climate impacts, extreme weather events and climatic tendencies?

DoV 2 – Wellbeing

This dimension looks at wellbeing indicators as defined by the community members themselves. Wellbeing is largely determined by the 'size' (i.e. income or subsistence generated) and quality of the livelihood strategy. If people do not have not sufficient income (or too little land for subsistence) their wellbeing will be negatively affected, and food security will be poor. Indicators of wellbeing are context-specific and can range from socio-economic indicators (e.g. income, nutrition, health), to environmental (e.g. 'clean air') or emotional (e.g. 'family life', safety). Based on these local wellbeing indicators, groups with different levels of wellbeing are identified within the community, . and the extent to which their livelihood strategies allow them to obtain a certain level of wellbeing and obtain sufficient food and meet other basic needs (e.g. health services, schooling, safety) are assessed. Whether or not their livelihood strategies manage to meet people's basic needs depends largely on the income and subsistence generated by the livelihoods (covered in DoV1). But in addition, climate-related factors may bring changes that affect their wellbeing and the sustainability of their livelihood strategies, such as health impacts from changes in disease vectors, water and sanitation and changes in temperature, which ultimately impact on their levels of food security and nutrition.

Research questions:

- What are the local indicators and categories of wellbeing?
- What is the distribution of wellbeing across people within the locality?
- Within the locality, what is the proportion of households for each wellbeing category?
- Which households are considered to be more vulnerable and less able to adapt, and why?
- Which households are food secure, and why?
- Which households are not food secure, and why?

DoV 3 – Adaptive capacity of individuals and households

This dimension of vulnerability analysis explores the (limits of the) current level of capacity at the individual and household level to deal with the climate impacts experienced in the area. This includes identifying current response and coping strategies that people in the location are already implementing. It requires understanding their effectiveness, analysing which resources are needed to implement these strategies, as well as identifying who has access to them. This individual and household capacity is largely determined by the level of resources and flexibility inherent in the livelihood strategy. Income from the livelihood affects the ability to invest in changes, and precautionary measures. Types of assets used in the livelihood determine

whether it can continue under stresses and shocks from climate (e.g. the effects of climate changes on water supply, pests and crop diseases). The significance of this DoV is to assess what level of resources the household has and is willing to invest in adaptation, so that the level of external support for adaptation can be judged and appropriate measures provided through outside agencies (e.g. new water supply or conservation measures, crop disease control, new seed varieties that are not available to the people themselves).

Research questions:

- What strategies do individuals and households use to respond to climate impacts?
- What are the limits of the capacity at the local level either to withstand or otherwise respond to climate impacts?
- What implications do these capacities and limits have for food security and nutrition?
- Which level of access do different groups within the locality have to the resources needed for adapting to the consequences of climate impacts?
- What levels of control over livelihood strategies and resources do different groups within the locality have in order to adapt and diversify in the face of climate change?

DoV 4 – Collective adaptive capacity

The idea of collective adaptive capacity is that through collaboration and co-operation between different institutions, people and groups, more can be achieved than through the actions of individual people and households. Part of this can be understood as "collective protection". Collective protection is used in relation to hazards (shocks) to support people – not only in emergency relief but also in preparedness. Examples of collective protection from hazards include warning systems for hurricanes and floods. Collective capacity to protect from shocks and adapt to change also involves the ability of the community and its members to influence the processes that directly affect them, such as the design and implementation of adaptation measures. This collective adaptive capacity cannot be achieved by individuals or households alone: the people are dependent on the good functioning of the institutions that can (or not) provide such protection and collective adaptation. Such institutions can include local citizen volunteer groups, Red Cross Red Crescent, NGOs, local and national government. Collective adaptive capacity is determined largely by the type of governance and power relations assessed in DoV 5. For example, if it is difficult for civil society organisations such as NGOs, CBOs (community based organisations) to operate because they are mistrusted by government or there is conflict that makes them exposed to danger, then collective protection measures are very difficult to implement.

Research questions:

- What collective activities do people engage in that can assist people in dealing with climate impacts (e.g. pooled labour, food loans/gifts, making land/other resources available in times of hardship etc.)?
- Through which institutions are these practices and strategies implemented?
- On what basis can people be involved in or access these institutions? How much access do groups within the location have relative to each other (e.g. according to gender, ethnicity, class, caste)?
- What are the limits of the collective capacity at the local level either to withstand or otherwise respond to climate impacts?
- What implications do these capacities and limits have for food security and nutrition?

DoV 5 – Governance and power relations

The final dimension of vulnerability relates to governance systems and the operation of formal and informal power. These are highly significant in deciding if people have good collective protection (e.g. flood protection measures, warning systems) and adaptation strategies (e.g. livelihood diversification) as assessed in DoV 4. People are dependent on good governance to ensure that the ways they are affected by power is beneficial for hazard preparedness and post-disaster response. But it is also important in determining how resources and assets are allocated between different groups and places on the basis of who is in control of assets and how income and welfare is distributed. This also affects nutrition and food systems (and well-being generally as in DoV1) for instance in how land is allocated, or whether or not (and why) an area gets electricity or a road.

Research questions:

- Who are the different actors, internal and external, that affect vulnerability in each location?
- How do power systems operate to make different groups of people more or less vulnerable, more or less able to adapt to climate change?
- Which actors and institutions are the most likely to be called upon to assist with climate change adaptation?
- Which actors and institutions are the most relevant to implement food security and nutrition interventions?
- How good (or bad) are the relations between the people in this location and these actors and institutions?
- How capable, responsible and sensible are the different actors and organizations within and outside of the location to reduce the vulnerability of different groups to climate impacts and increase the adaptive capacity at the community level?

3. Participatory methodology

Participatory approaches emerged in the 1970s and 1980s, and are based on a discourse that places people and their empowerment at the centre of development. Robert Chambers pioneered participatory methods for development through Participatory Rural Appraisal (PRA), which focuses primarily on the local participants as the centre and main actors in the research process. Local people not only generate the information, based on their own experiences, but also become the analysts and evaluators of the outcomes produced. This idea is directly opposed to a top-down dichotomy, where the external actor predefines the problem without taking into account the local realities. In order to do so, PRA makes use of visual tools, such as diagrams, maps, ranking tables, which serve as the basis for discussion and analysis by the participants themselves. They are framed and implemented in a way that allows those who are usually marginalised to participate in the production and analysis of information. Participatory approaches change the role of the outsider as the 'expert' into the facilitator and catalyst of local knowledge, based on the experiences and realities of the local communities. This requires a high disposition to be self-reflective, willing to ‘unlearn’ preconceived ideas and embrace local knowledge (Chambers1989, 1997).

Based on these principles of participation, the methodology aims to analyse vulnerability in its social, cultural, economic and political context from the local perspective. In order to engage with the local people to generate and analyse the information collectively, a set of PRA tools were selected and adapted to answer the questions set out by the DoV framework. These tools (see Table 1) were implemented in a particular sequence, to gradually build up and triangulate information through participatory dynamics, semi-structured

interviews secondary sources (such as meteorological data). In order to analyse gender-specificity of livelihood activities undertaken, access to resources as well as perceived risks, the group exercises were conducted with women and men separately.

Whilst the group exercises allowed understanding the interrelations of different factors, based on the perspectives of the collective, the semi-structured interviews allowed in-depth conversations with individuals or smaller groups on specific topics. Where there are high levels of inequality and social exclusion, semi-structured interviews can open a more confidential and private space for discussion. In this case, the objective was to identify vulnerable households during the group exercises who would be interviewed separately to understand their particular vulnerability context in a more private setting. Within the timeframe of the field visit it was possible to undertake two interviews with households identified as extremely vulnerable, as well as two semi-structured group discussions with a group of traditional healers to understand indigenous climate knowledge, and a group of women to analyse the local food system.

Table 1: PRA tools

Method	Objective
Transect	Get to know the community and the main social and ecological characteristics
Community map	Identify the main features and households of the community
Historical timeline and climate trends	Identify the main historical and climatic events in the past and the consequences/responses
Wellbeing ranking	Identify local indicators and categories of wellbeing Identify how different households access food Identify households that are food insecure and elements that increase their vulnerability to being food insecure Analyse how these factors are related to climate impacts
Livelihood strategies and seasonal calendar	Identify main livelihood strategies Identify whether they are dependent on certain types of climate Identify periods of limited access to food and causes for shortage
Changing farming practices (focus group with farmers) Crop preference ranking	Identify how farm practices have changed and why Identify different types of crops and reasons for preferring some over others
Climate risk ranking and coping mechanisms matrix	Identify main climate impacts in community Identify how they impact on different livelihood strategies, as well as on access to food Identify local capacity to adapt and limits to adaptation
Food markets diagram	Identify the causal links between internal and external actors and access their role in food markets Analyse production processes and how these are vulnerable to climate impacts
Venn diagram	Identify main internal and external actors who influence decision-making within the community

In general, there are limits to what a PVA can achieve, particularly if implemented as a short-term intervention with limited time. It is a preliminary analysis of the main factors that make different groups of people within a locality vulnerable to risks, including climate-related ones. The data needs to be triangulated with other data sources taking a mixed methods approach, as well as validating it with different actors within and outside of the locality in order to make the analysis more robust (Holland and Campbell 2005; Mikkelsen 2005). In this process it is important that project planners commit to genuine and inclusive participation by the local people, in order to create local ownership over the process rather than just extracting information.

In the case of Sokoine, the PVA was tested in the context of an existing project, which limited the scope of influence it could have on designing the project interventions, but allowed to come to interesting findings when comparing the two data sets. Ideally, a PVA should take place in the initial phases of the project planning to undertake a scoping of the vulnerability profiles of different groups at the local level, and start to build a relationship with the people. Before implementing the vulnerability assessment, relevant stakeholders should be identified at different levels, in order to include them in the process from an early stage. Likewise,

a thorough review of the existing information on the locality and region should be undertaken (census data, meteorological data, and academic studies). This will complement the data obtained through the PVA.

The findings from the PVA then help to identify entry points for possible adaptation measures, based on the locally identified risks to livelihood strategies of different groups within the locality. The PVA allows to build on the existing adaptive capacity and local knowledge, and to integrate it into adaptation planning processes. The PVA is not in itself a planning to tool to choose and design adaptation measures, but it feeds into these processes and can be combined with other tools that are specifically designed for that purpose (e.g. IISD's CRiSTAL).

4. Fieldwork findings

The methodology was tested in Tanzania, in a sub-village called Sokoine (Hombolo Ward, Dodoma Urban District). The research site is part of the project 'Varietal Diversification to Manage Climate Change Risk in East Africa' which is implemented by Bioversity International, ABCIC and partner organizations in Tanzania and Kenya. The project aims to research different types and characteristics of sorghum, cowpea and pigeon pea in the research sites, to design and test diversification strategies with farmers which can increase their resilience to climate change. The participatory research conducted in Sokoine primarily aimed at testing the methodology in this site and at training the members of the project team in its implementation.

The research site

Hombolo Ward is a conglomeration of four villages, namely Hombolo Bwawani, Hombolo Makulu, Mkoyo and Zepisa, which each consist of several sub-villages. Sokoine is one of the sub-villages belonging to the Zepisa village located 10km north-west of Hombolo town and about 30km north-east of Dodoma, the capital of Tanzania.

Sokoine sub-village consists of 190 households (approx. 1,300-1,500 population, assuming one household has six to seven family members) and the people said the Sokoine was established in 1972, when people started to settle around an open well.

The village has two open wells, which are free to use, and water from different taps, which is charged TSH 50 (about 3 cents US) a bucket by a water committee. The money is used for maintaining the pipes, which are connected to a tank that stores water from the Hombolo dam. The tap water is considered to be salty and not as appropriate for cooking as the water that is free and comes from the wells. Women fetch the water, at least twice a day, and have to queue at the wells.

Sokoine sub-village has a primary school, whilst the secondary school is in an adjacent sub-village, called Hombolo A (in Hombolo Bwawani village). Dropping out of school was described as common, yet the reason was not identified (nor whether it affected girls more than boys). There is no permanent health clinic in Sokoine, however, the village leader’s office serves as a meeting point for mobile health services that come periodically. There are three churches in Sokoine sub-village.,People still practice some of their indigenous beliefs and there is a sacred site within the sub-village, which is used for ceremonies to pray for rain in December.

On Mondays traders converge at *Gulio* (an open market) on the edge of the sub-village where they sell surplus purchased from small producer households. To sell at the market vendors need to pay a tax. Women mentioned that they buy and sell *pombe* (local brew), tomatoes, pastries, salt, *bagia* (buns made of cowpea),

dried fish and shrimps, cassava (boiled), and meat (cattle, goat, pig). Apart from the market there are also three shops in the sub-village. One of the most lucrative businesses is considered to be producing and selling *pombe*.

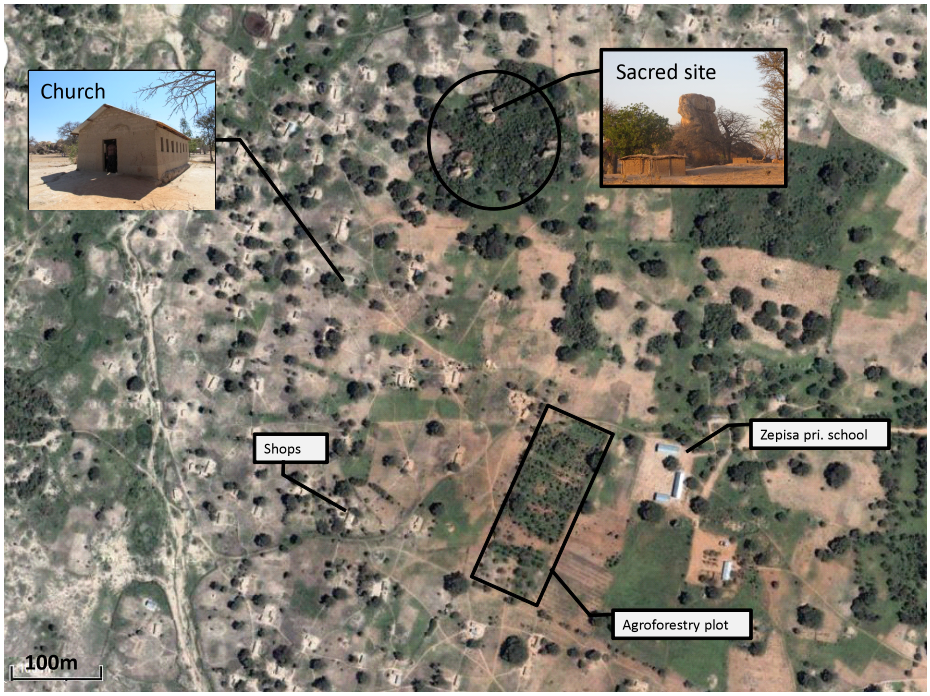


Image 1: Sokoine village map

There are three types of soil in Sokoine sub-village: red, clay (*Mbuga*) and sandy soil. The type of soil determines whether the land is used for housing or agriculture. Clay soil is considered to be a better foundation to build houses on, whilst sandy and red soils are mainly used for agriculture. Some crops grow better on certain soil types; sandy soil is considered to be particularly good for pearl millet, groundnut and cowpea. Clay soil is considered to be very fertile allowing crops to be grown without the need for additional fertiliser. It is also particularly good for maize and sorghum.

The following section contains a detailed description of the findings from the different participatory tools implemented. Since a rapid version of the methodology was tested in Sokoine, the following tools were implemented: community map, seasonal calendar, wellbeing ranking, climate risk ranking and coping mechanism, Venn diagram and institutional mapping, and crop preference ranking. Focus group discussions were undertaken with traditional healers and women, and one semi-structured interview was undertaken with a family member of a woman who was considered to be particularly vulnerable due to her low asset levels and dependence on informal social safety nets. The findings from the different methods were collected and analyzed in accordance with the DoV framework.

4.1. Livelihood strategies (DoV 1)

- *What are the principal social and agro-ecological characteristics within the community (e.g. infrastructure, institutions, natural resources, soil quality)? What is their importance for different livelihood strategies?*

Fields are situated both inside and outside the village. The amount of land each household owns is considered to be an indicator of wellbeing, as defined by the male participants. The average size for

landholdings is between one and two acres (1 acre = 4,046m2). People who own more than five acres are considered to be well-off (Table 5). At the other extreme are people who have no land and whose livelihoods depend on working for others. Land can either be bought or inherited from the parents, who decide how to allocate the land between their sons and daughters. Generally, land titles are obtained through inheritance and ownership of inherited land is recognized and can be converted into an official land title.

Something that could not be explored further, due to the limited amount of time, is whether, in addition to the size of the land, soil quality can also be considered an indicator of wellbeing due to higher productivity. People with access to less fertile soil could be more vulnerable and more prone to food insecurity due to low yields, which can be exacerbated through climate impacts. Land ownership and its relation to vulnerability is another issue that could be explored in more detail in future research work. In one case a family member 'donated' two acres of land to his unmarried sister and her children, for her to sustain herself. Yet, this is not enough for her to feed herself, and in bad years she depends on her brother for food. In another case, someone who was considered to be particularly vulnerable was a man who did not possess land and worked as a casual labourer for others. Despite being landless this man considers himself to be 'a farmer', which could be an indication of the high importance attributed to having land and doing farming.

Image 2: Women's FGD conducting a community mapping exercise; and Image 3: sacred sites in Sokoine sub-village

- *Which livelihood strategies are the most important for different groups of people within the community (e.g. according to gender, ethnicity, age, socio-economic status)?*

Agricultural activities

Farming is the main and most important livelihood activity in the village. The main food crops are sorghum (*mesyia* is the most popular variety), maize and pearl millet, whilst the main cash crops are sesame, sunflower and groundnuts. The main food and cash crops are the same for male and female groups, with some differences in the ranking. Pearl millet was considered to be the most important crop in the male group (9 out of 13 votes), whilst maize was the most important crop in the female group. Other crops and vegetables include cucumber, water melon, gourd, pumpkin, bambara nuts, rice, cowpea, cassava, and green gram.

Table 2: Seasonal calendar (men)

	Votes	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep
Rainy season (ifuku)						x	x	x	x	x					
Dry season (ibahu)		x	x	x	x						x	x	x	x	x
Pearl Millet (Food crop)	9	LP	LP	LP, M	M, PS	PS, W1	W1, W2	W2	HV (g)	HV (g)		T	T+ST+SL	ST+SL	
Maize (Food crop)	8	LP	LP	LP, M	M, PS	PS, W1	W1, W2	W2	HV (g)	HV (g)			T	ST+SL	ST+SL
Sorghum, masea (Food crop)	6	LP	LP	LP		PS	W1	W2	HV	HV	T	T		ST+SL	
Sorghum, lugugu (Food crop)	6	LP	LP	LP			PS, W1	W2		HV	HV	T	T	ST+SL	
Sesame (Cash crop)	4	LP	LP	LP		PS	PS, W1	W2		HV	T+SL	T+SL			
Sun flower (Cash crop)	3	LP	LP	LP			PS	PS, W1	W2	BS	HV+T+ST+SL	SL	SL	SL	
Groundnuts (Cash crop)	2	LP	LP	LP		PS	PS	W2		HV+T+ST	SL	SL	SL	SL	
Charcoal making	7	xx	xx	xx	xx	x					x	xx	xx		
Wood timber making	6	xx	xx	xx	xx	x					x	xx	xx		
Collect Baobab fruits in wild and sell (5 points)	5	xx	x	x	x	x					xx	xx	xx		
Fishing in the lake	4	x	x	x	x	x	x	x	x	x	xx	xx	xx		
Food scarcity					x	x	x	x							
Food depending on cash		0			x	x	xx	xx							
Foods for famine periods (Cowpea leaves, Cassava stems, wild fruit "saka")								xx							
Points: each person has 3 counts															

Code: LP (Land preparation), M (Application of animal manure), PS (Planting seeds), W1 (Digging; 1st weeding), W2 (Weeding), BS (bird scaring), HV (Harvesting), T (Threshing), ST (Storing), SL (Selling).

Other livelihood strategies ranked (number of votes in brackets), but not analysed were: pot making (3), migration (3), yoke making (carpentry work) (3), firewood collection and selling (2), wild bird hunting and selling (2), casual labour (2), making salt using soil (1)

Table 3: Seasonal calendar (women)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rain			Xxx	xx	x	xxx	x					
Drought	xxx	x						x	x	xx	xxx	xxx
Maize	LP,	LP,PL	LP,PL,W1	PL,W1	W1,W2	H+G		H+G	H+G	D	T	T
Sorghum	LP	LP,PL	W1	W1	W1, W2	W2, BS	H+G, BS	H+G	H+G	DT	DT	
Millet	LP	PL	W1	W1	W1, W2	W2, BS	BS	H+G	D, T	D,T	D, T	
Peanuts	LP		PL	PL, W1	W1, W2	W2	H+G	H+G	D, S	D, S	S	S
Sun flower	LP	PL	W1	W1	W1, W2	W2			H+G+S	H+G, S	H+G, T, S	T,S
Sesame	LP	LP	PL	PL	PL, W1	W1, W2	W2	H+G, D	T	S		
Selling NR	B, FW Ch	FW, Ch	FW, Ch Z	FW, Ch	FW, Ch	FW, Ch, F	B, FW, Ch, F	B, FW, Ch	B, FW, Ch	B, FW, Ch	B, FW	B, FW
Casual labour[2]												
Small business	x	x	X	x	x	x	x	x	x	x	x	x
Food scarcity			Xx	xx	xxx	x						

B = baobab
BS = bird scaring
Ch = charcoal
D = drying
F = fulu (local fruit)
FW = firewood
LP = land preparation
PL = ploughing
S = selling
T = threshing
W [1,2] = weeding
Z = zambarao

Despite the fact that some participants have a preference for eating pearl millet and that it is more drought-tollerant than maize, farmers still do not grow it for the following reasons: pearl millet is too sensitive to bird attacks, it has lower marketability than maize, and the type of soil is more suitable for maize. Maize, on the other hand, is more drought-sensitive and thus tends to fail more often, however, the market price is better and it is less affected by bird attacks. Farmers thus decide to plant maize and leave it up to chance whether or not the rainfall will be timely and sufficient for high maize yields. Despite being more risky, the rewards are higher than for pearl millet, which would need very labour-intensive bird-scaring techniques to ensure a good yield. There also seems to be a generational difference between preferences of maize over pearl millet as a main food crop. Older farmers prefer to go back to traditionally grown crops (if the bird problem were solved), such as pearl millet, whilst the younger generation likes to consume maize. Older participants acknowledged that sorghum and pearl millet are more nutritious than maize.

Both groups mentioned that the burden of work in the field was shared between men and women, but the type of work can be different. The men start working on the land from August onwards to prepare the soil, and the women join later in October to collect crop residues and clean the fields.

This is, however, the only difference that could be observed in terms of a gendered division of agricultural labour activities. Both groups tended to say that men and women worked equally in the field, yet this is an area for further investigation since a slight hesitation from women was observed while commenting on this.

Livestock keeping

Livestock keeping is an activity that was mentioned by both men and women as important, yet it did not rank as one of the most important ones in any of the groups. However, it was possible to observe livestock activities in Sokoine, such as pastures outside the sub-village. Some livestock keepers prefer to keep the animals them within their homestead during the night while others have separate fenced areas outside the village to keep the animals during the night. Prior to the PVA, focus group discussions and household surveys had been undertaken as part of the project with participants from different sub-villages (including Sokoine). These revealed that the number of livestock has increased in the area, and this has had a negative impact on the cultivation of the crops by "hardening the soil" and "drying vegetation" (see FGD report, p.67-68). Participants even suggested that there needs to be a clear demarcation between pastureland and agricultural fields to reduce the damage. This is an issue that did not emerge during the participatory workshops and it needs to be investigated whether this is a problem that also applies to Sokoine.

The fact that participants did not rank livestock-keeping as one of their main livelihood strategies and did not mention it in more detail during the discussions might have been due to the fact that the questions were focused on activities within the village boundaries and most of the livestock-keeping activities take place outside. Also, the research team had a particular interest in crop characteristics and farming, which might have biased the questions towards agriculture. Traditionally the *Wagogo* (the tribe inhabiting the area) have a long tradition of hunting, gathering, and animal keeping, as they have traditionally lived in semi-arid or arid areas, and only recently turned to agriculture. Livestock (chicken, cows and goats) tends to be kept as insurance for difficult times; they are sold to generate cash when needed. There seem to be livestock keepers with herds of more than 100 cows, yet these differences in assets between households and how they affect the level of vulnerability of different people, did not come out clearly in the workshop due to time limitations.

Non-agricultural activities

Several non-agricultural activities were identified, which form part of the diverse livelihood strategies of people in Sokoine. These are considered to be particularly important during the driest months (July - November), as a source of food and income, and also in case of harvest failure and in times of food insecurity.

The income-generating activities conducted by both men and women are charcoal making, selling and collecting wild fruits (*fulu, mbefu, zambalao, baobab*) and casual labour. Activities considered by the male group to be predominantly male are: making wood timber, fishing, migrating, carpentry, hunting and selling wild birds[3], and making salt using soil. Predominantly female activities are pot-making, and producing and selling baked goods.

Another important income generating activity was considered to be ownership of "small businesses", such as selling agricultural products like potatoes, tomatoes, milk, local cheese, vegetables, local brew and fodder. In

[3] The wild birds mentioned were local types of wild pigeon (names in kigogo: ngungulima, mziwalusanga, nziuo lukati).

many cases these products are found far from the village and people need to walk long distances to fetch the vegetables or other products to be sold in the village. Small businesses are run throughout the year, yet some of the products are seasonal whilst others (baobab fruit, *saka*) are available all year and are thus crucial sources of food and income in scarce times.

- *Which livelihood strategies are the most important ones for food security at the household- and community-level?*

The most important livelihood activity for the households' and the community's food security is farming. Yet, it is also the most sensitive activity to climate impacts due to a lack of adaptive capacity and strategies which help local farmers reduce their vulnerability (e.g. more drought-resistant crops or less labour-intensive strategies to combat birds). In order to cope in times of food scarcity, particularly during or after a prolonged dry season, households engage in a range of activities to meet their food needs. The main ones are selling assets, such as livestock, or natural products such as firewood, to generate income. Simultaneously, wild fruits are collected to meet the immediate food needs of the household. Some participants mentioned particularly wild fruits (soka), cowpea leaves and cassava stems as important foods during the prolonged dry season. The non-agricultural activities are thus crucial to bridge the food gap between the time when household stocks are finished and the next harvest.

Some of these coping mechanisms, however, exacerbate the situation of food insecurity in the long term. Due to the lack of sufficient food for the whole year, farmers tend to eat all their crops without leaving enough good quality seeds for the next season. This puts them into a situation of vulnerability due to immediate food needs, since they depend on others to provide them with seeds for the next year. The affordable seeds are often of low quality and uncertain origin, whilst the high quality ones are either expensive or require to travel to places like Dodoma, which in itself incurs a high cost and is not feasible for everyone (see section below).

Another coping mechanism, which has negative effects on the agricultural productivity but is crucial for meeting immediate food needs, is green harvesting. Green harvesting means that the plant is harvested for consumption, before the crops are fully matured. This can be done with maize (grain), sorghum and pearl millet (grain and steam), cowpea (leaves), pumpkin (flowers and leaves), bottle gourd (fruits), and cucumber (leaves). Farmers try to plant a combination of different crops, some of which can be harvested earlier, in order to spread the risk of losing some crops due to particular crop-specific risks. The different maturing times also provide them with food throughout a longer period. For example, the traditionally cultivated crops such as *cucurbits* (edible gourds, pumpkins, watermelon and cucumber), cowpeas, bambara nuts and ground nuts mature earlier and are therefore consumed before maize, sorghum and pearl millet.

Apart from producing and collecting food, selling assets and engaging in small businesses like the ones mentioned, there are no other sources of food or income, as e.g. food aid provided by the government. There used to be a Mother Teresa charity, which provided food aid particularly to women and children, yet this support stopped in 2010.

- *How are the different livelihood strategies affected by climate impacts, extreme weather events and climatic tendencies?*

The major climate-related impacts identified by both male and female participants in a risk ranking exercise were prolonged dry season (drought), increased temperature, pests and strong wind. Climate impacts were explained as events caused by changes in the climate that have negative or positive effects on their livelihood

strategies. Interestingly, women associated human diseases (cancer, malaria, typhoid) as one of the main risks and mentioned that this has the most negative influence on all their livelihood strategies, since illness prevents them from doing any other activity. It was captured in the risk ranking matrix (see table 5), yet the group discussion focused on the other three climate-related risks. Apart from those four main risks, the male group also mentioned floods, deforestation and soil erosion.

In general the climate risks affect the yield, as well as the quality of the seeds and the soil. This has direct or indirect effects on the whole village, either by not having enough food for the household or not having enough food to buy or sell (as both households and shopkeepers). The most climate risk-sensitive crops are considered to be maize and sesame. The male participants also commented that deforestation and soil erosion are additionally straining the availability and quality of the natural-resource base of the village.

Climate impacts including droughts, pests and erratic rain have an impact on the choice of crops cultivated by farmers. Though highly affected by drought, farmers cultivate maize because it fetches a good price in the market and when the weather conditions are favourable, it yields high outputs. It is also preferred by young people for food, over sorghum and pearl millet, and is not affected by birds. An interesting observation was that the 'traditionally cultivated crops'[4], such as cucumber (matango), bottle gourd, water melon, cowpea, pumpkins, Bambara nuts have multiple uses and are less climate- and pest-sensitive. Yet, people want to cultivate crops that have the potential to have higher yields and provide greater revenues, despite the fact that they are more vulnerable to climate risks and losses are high and frequent. The entire community is affected by the above mentioned risks including farmers, livestock keepers and business men who depend on selling crops for their livelihood. People who do not produce themselves are indirectly affected by higher food prices and less food to share with their social network.

The table shows the matrix produced with the male group. It indicates the level of damage climate risks can have on the most important crops and livelihood activities as considered by the participants. The crops and livelihood activities are ranked in order of importance to the participants, from the top down and from the left to the right. In particular we included the three major food crops (first three) and the three major cash crops (last three). The most climate risk-sensitive crops are considered to be maize and sesame.

[4] Defined as being the crops that have been cultivated for a long time in the region.

Table 4 Climate risk ranking (men)[5]

Crops		Prolonged dry season ("drought")	Increased temperature (too much sun)	Strong wind	Pests[6]
Pearl millet	Impact	2: Reduce harvest, grain size	1: Dry up, Small panicles and grains.	2: Crop fell down	3: No harvest
	Most affected	Community, Animals	Community, Animals	Farmers	Farmers
Maize	Impact	3: Reduce harvest,	3: Reduce harvest, immature grains	2: Little harvest	2: No harvest
	Most affected	Whole community, Animals	Community,	Farmers	Farmers
Sorghum	Impact	2: Reduce harvest, grain size	2: Dry up, Small panicles and grains.	0: Not affected	3: No harvest
	Most affected	Community, Animals	Community, Animals		Farmers, Community
Sesame	Impact	2: Reduce harvest,	3: Dry up, little harvest.	2: Crop fell down, doesn't flower	3: No harvest
	Most affected	Farmers	Farmers, Business people	Farmers, Business people	Farmers, Community
Sunflower	Impact	2: Reduce grain size, Little oil content.	2: Small panicles and grains, immature grains, little oil.	1: Fall down and eaten by termites.	2: Reduce harvest
	Most affected	Business people, Farmers, Animals.	Business people, Farmers, Animals.	Farmers, Business people	Farmers, Business people
Groundnuts	Impact	3: Reduce harvest,	3: Dry up, No harvesting	0: Not affected	1: Reduce harvest
	Most affected	Farmers, Animals	Business people, Farmers, Animals.		Farmers, Business people

0=no damage, 1=small damage, 2=moderate damage, 3=high damage

Prolonged dry season ("drought")

The most damaging climate impact was considered to be "drought". This refers to the phenomenon of later onset of rain, as well as changes in rainfall patterns, which leads to an extension of the dry season. Older village members remembered how 20 years ago the rain used to start in October and end in May. Now it starts earliest in November and only lasts until March. The meteorological data did not confirm this, and showed that the rain has started around November in the last 30 years According to participants, the intensity

[5] When compared to the meteorological data from the weather station in Dodoma, there are clear differences between the data and the local perceptions on changes in rainfall, length of dry season and wind speed (see section 5 for a discussion on the discrepancy between different types of data).

[6] Pests such as birds and insect (*viwavi jeshi*) that affect crops

and type of rainfall has changed from being more regular and gentle to coming in strong showers. Nowadays the rain starts in November (but sometimes later) and stops in December, then starts again until it finishes in March.

The prolonged dry season has a direct effect on food security, since it affects the productivity of their crops and reduces the availability of food that is produced for the households' consumption, as well as affects the amount of surplus that could potentially be sold to generate cash. This affects the people with small landholdings the most, whilst others (e.g. shopkeepers and surplus farmers) benefit from it since they can sell their goods at higher prices. Furthermore, drought affects other livelihood activities, like casual labour for agricultural activities, since potential employers have less work and money to hire people. The demand for work at a local level goes down in the dry season, whilst the need for income-generating activities is the highest to be able to buy food. Drought also affects the people relying on selling natural products in times of food scarcity to sell and consume, since it also affects wild fruits and vegetables, including baobab.

Strong wind

Strong wind affects crops by breaking the plant. Maize is strongly affected, whilst sorghum is hardly affected by wind. Pearl millet suffers, yet when it falls it still maintains some tillers. Sesame and sunflower are moderately affected.

Small businesses are not directly affected by wind, although the wind contributes to dusting and contaminating the goods which makes it more difficult to sell them. The wind however also has positive effects in terms of facilitating the collection of wild fruits or wood, since it makes them fall to the ground.

Pests and diseases

Maize is moderately affected by pests, particularly stem borer larva and cutworms (moth larvae). Cutworms eat the plant at the bottom of the stem, which makes it fall whilst stem borer go inside the stem and weaken the plan.

Sorghum and pearl millet are not affected by diseases, but are badly affected by birds and beetles (*Calidea dregii*). The birds can be scared away, but there is little remedy against beetles, which are considered to be a problem. There are no beetles during the dry season and the beetle population seems to increase with the rain. Beetles are a recent problem that started six years ago, but the reason for this is not clear. The bird population used to be controlled by the government by using poison, but according to the locals this intervention stopped a few years ago and since then the bird population increased again. However, other sources informed us that the programme is in principle still ongoing but not as frequent and reliable due to an insufficient amount of planes used for spraying avicides in the region. Sesame tends to get a viral disease which causes stunting of the plant. This disease is also considered to be a new phenomenon. Sunflowers are not affected by diseases, but by birds and rodents which eat the plant. They also get powdery mildew, which is a major problem for sunflowers. Groundnuts are eaten by rodents and also get a rosette viral disease, but the impact is not so significant.

The pests and diseases also moderately affect other resources like wild fruits. Small businesses and casual labour are affected indirectly through lower yields and less demand for labour.

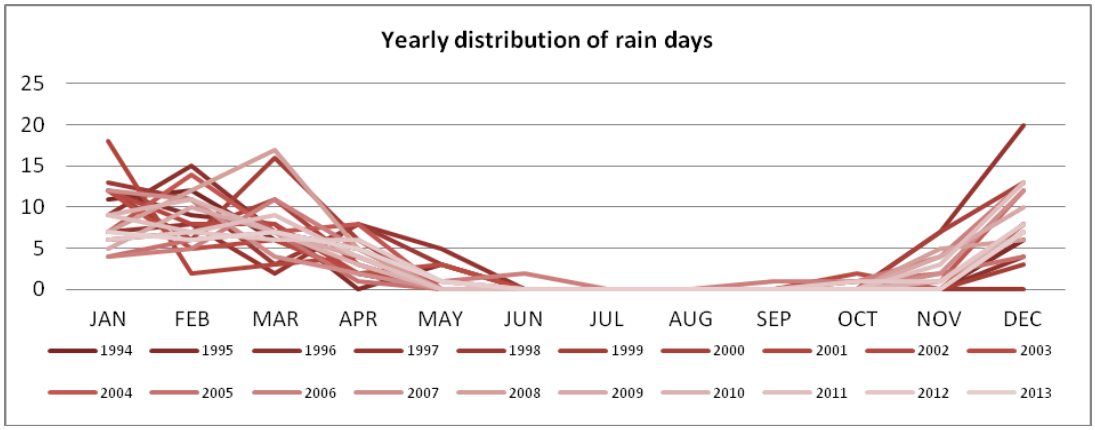
High temperature

The male group also mentioned high temperatures as a climate risk, but this was closely intertwined with the prolonged dry season. It was mentioned that an increase in the temperature can result in an increase of insect pests like stem borers.

Box 1. Local knowledge vs. meteorological data

One of the objectives of the participatory assessment is to understand what local people consider to be the main climate-related impacts that affect their livelihood strategies and food security. This information then needs to be complemented with meteorological data (if available), since people's perceptions of past weather can be inaccurate. For Sokoine, data is available from a weather station in Dodoma, about 20km away.

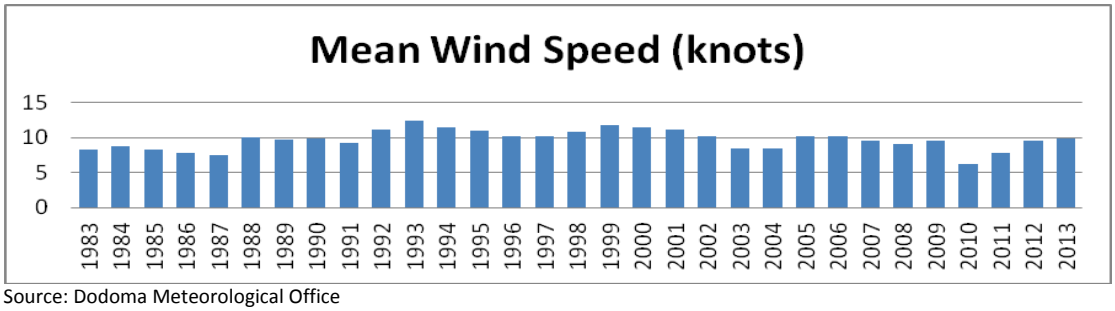
What was noticeable is that the perceived climate-related risks did not match the meteorological data. The local people identified a prolonged dry season, an increase in pests and diseases and increased wind speed as major risks to their livelihoods and farming. The meteorological data however does not confirm that the dry season has got longer in the last 30 years or that the wind speed has increased. In both cases there is a certain degree of variability throughout the years, but there is no clear trend towards an increase in more recent years.



Source: Dodoma Meteorological Office

This discrepancy is interesting, yet it does not mean that the local perceptions should be discarded as "false". It should rather lead to reflecting on how these discrepancies came about. One potential and common reason could be that the local people are aware of the purpose of the study, being to analyse the effects of "climate change". Hence, it could be that locals try to give the answers that the research team is looking for. It is thus important to not take climate change as an entry point for the discussion with the participants and also to be willing to accept that climate change might actually not be one of the main issues affecting the local livelihoods.

That being said, the fact that there might be no changes in terms of an increased dry period or stronger wind, does not mean that these phenomena do not affect local livelihoods. Hence, local perceptions are valuable for what they are: locally perceived risks that have direct consequences on their livelihood activities, and which they cannot respond to adequately due to low adaptive capacity. Local knowledge in itself is highly valuable, if triangulated properly across actors and groups, and, in comparison to 'scientific' knowledge, provides contextual information on how climate events affect a specific locality and group of people.



Source: Dodoma Meteorological Office

4.2. Implications of climate impacts for local wellbeing and food security (DoV 2)

Research questions:

- *What are the local indicators and categories of wellbeing?*
- *What is the distribution of wellbeing across intra-community groups?*
- *Within the community, what is the proportion of households for each wellbeing category?*
- *Which households are considered to be more vulnerable and less able to adapt, and why?*

When asked about what local indicators for 'being well' were, men mentioned (in order of importance) 1) size of land and soil fertility, 2) food, 3) permanent house, 4) education, 5) health. The following indicators were mentioned but only received 2 or less votes by the group: family, skills and knowledge, working for projects, own transport e.g. car, motorcycle, own shop, good cloth and dressing, number of animal.

The women said that the most important indicators of wellbeing were: 1) owning a business, 2) children, 3) enough food, 4) a good house, and 5) good education. Indicators that received few or no votes were: livestock, sufficient money, size of the farm, good health.

Based on these indicators, participants mentioned what the opposite of 'being well' for each of them was. The space in between the extremes was filled with different levels of wellbeing for each indicator. Men mainly associated wellbeing with the size of land each household has, as well as the quality of the soil. This was considered vital since it is an indicator for how much a household can produce and what kind of crops they can grow. The type of house, being healthy, as well as the level of education obtained, were also considered to be indicators of wellbeing. Whilst having children was considered to be important, men said that the fewer the better.

Once the indicators and different levels were established, participants were asked whether the different levels of wellbeing categorised certain groups within the community, and how they would refer to them. The men had four categories for wellbeing in the sub-village, which were: good life (2%), better life (10%), normal life (85%), hard life (3%).

For the women, having a business was ranked as the top indicator of wellbeing. The best was considered to be a shop or agribusiness, followed in descending order by beer brewing/selling, selling fruits and tomatoes, selling baobab products *(mabuyu)*. Women seemed to consider the level of labour-intensity as one of the defining factors of how popular an activity was. Having a business was considered to be good, because it not only generated income, but was also not as labour-intensive as collecting firewood, for example. Having children was the second most important indicator of wellbeing (with a preference for three to four) and having enough food came third. The material from which the house is made, as well as the level of education were also considered to define a person's wellbeing. Women said that the three wellbeing categories in the village were rich (0%), middle (70%) and poor (30%). Initially they said that the majority of the village belonged to the poor category, however, they corrected themselves to not stigmatize themselves as poor, which is why the matrix indicates that the majority belongs to the 'middle' group.

Table 5 Wellbeing ranking (men)

Major indicators	Good life (2%)	Better life (10%)	Normal life (85%)	Hard life (3%)
Size of crop field	More than 5 acres	3-4 acres	1-2 acres	None
Soil fertility of the fields	Clay plus sandy soil	Cray soil	Sandy soil	
Food Sack *(gunia)* = 100kg of grain sack	More than 10 sacks	More than 5 sacks	More than 2 sacks	No food. Begging for foods
Stone house	Cemented house	Burnt bricks, soil wall but iron sheet roofing	General house made from soil	No house
Education	University and institute	Secondary school	Completed primary education and unfinished primary education	Adult education and no education
Health	Eating and working well	No illness	Know importance of hospitals; ability to pay for hospital expenses	Cannot afford to take care of their health expenses.
Family	3 kids	4 kids	5 kids	Not married, or no family

There was a big discrepancy between men's and women's wellbeing ranking, particularly in terms of how many bags of food indicated whether a household was doing well. In general, the female concept of wellbeing was closer to an 'ideal' situation, whilst the male one was a more realistic understanding of the current situation. No one in the community fitted the characteristics of the 'rich' group in the female calendar, since it was too far from reality.

Interestingly, livestock had been considered to be an indicator of wellbeing in the previous household survey, but did not rank as one of the most important wellbeing indicators in the participatory group exercises. The women mentioned livestock during the brainstorming exercise but then did not vote for it as one of the most important indicators. The same was the case for the male group, and our assumption is that this was due to how the questions were asked and since the wellbeing ranking followed the seasonal calendar where the main focus had been on farming practices.

The female group was generally more reserved in sharing information on wealth differences between groups of people within the community and to referring to themselves or others as poor. The male group seemed far more open and defining the wellbeing indicators with them allowed us to discuss with some of the men who were the most vulnerable people in the village. There were only a few people who were considered to be extremely vulnerable, with no assets of their own, such as house or land. They depended on help from their family, or employers for housing, income and food.

- *Which households are food secure, and why?*
- *Which households are not food secure, and why?*

The ability to provide enough food for the household was considered by both men and women to be vital for their wellbeing and it was closely correlated with the other wellbeing indicators. Access to resources such as land (quantity and quality), as well as the ability to have a reliable source of income, such as a business, were considered important livelihood strategies to produce food or have enough cash to buy it in times when the own reserves are finished.

In the time available to do this research we managed to obtain some indicators which help us identify the most vulnerable households in the village. However, to understand the causes and interrelations between the different vulnerability factors a follow-up exercise would be needed to conduct household interviews with those who fail to meet the wellbeing indicators identified in the group exercise.

In order to reduce the food gap, people consume the crops before they mature (green harvesting), for instance cowpea leaves and edible gourds. This, however, also affects the plant itself and reduces the potential crop yields for that year, which becomes a vicious cycle of trying to manage food needs through coping strategies that might reduce the productivity.

4.3. Adaptive capacity of individuals and households (DoV 3)

Prolonged dry season

In order to reduce the negative effects of the prolonged dry season, farmers practice crop rotation and intercropping e.g. simultaneously planting cowpeas and cassava or groundnut and sorghum. They also try to plant a number of crops at the same time to spread the risk of harvest loss and having crops with different maturing times. Particularly drought-resistant crops are sunflowers, cowpeas and sorghum. One of the challenges to diversifying their crops is the lack of access to different types of seeds. Sometimes seed stocks are eaten during hungry seasons, so households need to buy seeds for the next planting season.

They start to plant early in the dry season, to make sure that the seeds are in place before the first rain falls (this varies slightly depending on the type of soil) and also because it becomes very difficult to work the soil once it has rained. Since the soil is dry and compact they plough it, to increase the capacity of the soil to retain the water. They use animal manure as a fertiliser to increase the soil nutrients, but also to improve soil structure and to an extent the capacity of the soil to hold water.

Strong wind

A strategy to reduce the effect of wind would be to plant trees close to the fields to act as windbreaks. However this is not done since trees are thought to host birds which pose a bigger threat to the crops than the wind. Men and women said that they understand the value of trees in general for the ecosystem, and also to protect their fields from the wind, but they resist planting them near the fields due to the birds. In 2012, the government provided nine tree seedlings to each household, and most of the people planted them near to their houses to protect the roofs from the wind. However, only a few survived due to the dry season and lack of irrigation. The government[7] also planted trees close to the school and the community is not allowed to cut these, but there is a lack of communication on why they were planted and why it is forbidden to cut them.

Pests and diseases

[7] The programme was called Hifadhi Ardhi Dodoma (HADO) (Conserve the Land in Dodoma).

In the case of birds, the only strategy people have to reduce the damage they cause is by scaring them away, which is very time-intensive. The government used to provide avicides but according to the locals this has stopped (see above).

Locals currently have no strategy to combat the beetles affecting sorghum, but there seem to be pesticides to combat the viral disease on simsim and sunflower. A traditional form of pest management consists in burning the leaves of a certain tree around the field, has also been used. This scares away the grasshoppers and birds but not the beetles. Rats are eaten as a control measure, although some species are not edible. Worms are controlled by putting soil on the wormholes. To cope with pests the men implement bird scaring and apply pesticides on sorghum and pearl millet fields. The pumpkins offer a traditional remedy for repelling insects. They also mentioned planting many different type crops is an effective practice to reduce the risks of the pests. For insects, except groundnuts, the men's group mentioned using chemical pesticides is effective ways to prevent risks of the insect attacks.

High temperatures

One option to cope with the high temperatures is to plant more trees, but this again meets with resistance in the community due to the birds it attracts. Otherwise there is nothing the local people do or think they can do to adapt to this climate impact.

4.4. Collective adaptive capacity at the community level (DoV 4)

Local knowledge

In Sokoine people undertake certain collective strategies to reduce the negative effects of climate change, mainly by using informal mechanisms to coordinate agricultural activities or exchanging knowledge on traditional practices to combat certain pests. One of the collective strategies applied is to plant crops such as sorghum with other crops, so the loss of crops through birds is spread over several fields, rather than concentrated in one.

Local knowledge on traditional medicinal practices and pest control are passed on through a group of 15 traditional healers in Sokoine, who teach the community how to deal with crop storage pests. They also manage a communal medicinal garden, which hosts plants that are used as remedies for a variety of illnesses. Some of the local trees used for traditional medicine are: *mkambaku, mnandara, mlaigori, mzenye, baobab, mpundu, msaka msaka, mlonge, mchibe* (red or white varieties)*, muzuriga, mnyeche, mkambala, mkongo.* Traditional knowledge is also passed on by individuals, for example an elderly lady who uses traditional practices to scare away birds and pests.

Apart from seeking the knowledge of the traditional healers, several farmers use traditional weather forecast/early warning systems to guide their agricultural practices. A tree called *muwondo,* which starts greening one month before the rain starts helps farmers to decide when to start planting seeds. The baobab tree has a similar function, since it also starts turning green in anticipation of the rain. Some people can tell from the wind direction and temperature whether rain will come, e.g. wind blowing from west to east forecasts rain, while wind blowing from east to west forecasts a dry season. Sacred sites and practices still exist where people pray for rain and also sacrifice animals. Each community member contributes Tsh 1000 for the purchase of a bull to be sacrificed in December (only if the rain is late). The old man who conducts these ceremonies, inherited his powers and is believed to be able to see and talk to the community's ancestors. He lives in another village called Hombolo Makulu. Community members also use the services of the witchdoctor to reduce the wind, but women thought that the traditional practices were more effective than to pray for rain or to prevent wind.

There is declining interest in traditional knowledge and indigenous remedies for ill health, pests and weather information. There seems to be a generational gap in terms of knowledge and acceptance of it, with the younger generation being more sceptical of traditional methods.

Local seed exchange mechanisms

One of the main collective mechanisms in the village involves sharing and exchanging seeds. Apart from using their own seeds, the second most important source is the informal exchange mechanism between neighbours and between village people to buy or exchange seeds, but there are also more formal sources of seeds like the shops in Dodoma or government provision of seeds. The informal seed sources within the village are more popular, since they are more accessible in terms of price, but also because people trust the quality of the seeds they receive from farmers they know, rather than from farmers in villages that are further away and where they cannot see how the crops perform. The seeds from the market in Dodoma are meant to be the best quality, but they are more expensive and require travel to Dodoma. They rely on dealers to provide high quality seeds for cash crops like sunflower and sesame.

The bigger Zepisa village has set aside eight acres of land for agricultural research. The land is managed by an agricultural officer and is used for trials and training farmers. It could potentially be used for projects that aim to introduce new seeds, so farmers can see directly how they perform. Being able to see 'the mother of the seed', meaning the plant, seems to be of great importance to farmers for trusting the source and accepting new seeds.

4.5. Local governance structures and public policies (DoV 5)

Internal actors

The sub-village executive authority consists of the chairman, the village executive committee and 14 cell leaders**.** The sub-village authorities communicate decisions made at higher administrative levels, which pass from the national to the regional, district, division, ward, village level before reaching the sub-village**.** The sub-village executive authority represents the core authorities within the sub-village that every institution or actor within the village depend on**.** Different actors within the sub-village depend on each other, but the extent of interaction varies. Water wells managed by a water committee, churches, and schools are communal. There seems to be a strong informal safety net within the community made up of neighbours and family members that help the most vulnerable people (provide housing/shelter, food etc.).

External actors

There are several institutions and organizations outside of the sub-village that have relations with the community. Most of those mentioned by the local people are actors are nearby and within the village Zepisa or in Hombolo ward. Actors outside the sub-village differ in their importance and closeness to the community. Some are important but far from the community, some are small but of high importance.

There are several NGOs in Zepisa that are or have been providing support. The INADES Formation for example is a local NGO that works on natural resource management and innovative farming strategies. It has been collaborating with the group of traditional healers in Sokoine and has provided technical support in writing grant applications.

The Mother Theresa NGO is also situated outside the village and used to play a major role in providing food aid to the village in times of food scarcity. However, this has stopped in the last years without informing the local people as to why. Other NGOs working on agricultural issues include ADP (a NGO related to the Anglican church) and Mwanzo Bora.

In terms of the provision of services, there are different hospitals outside the village in the Hombolo ward (Nunge and Mirembe), a secondary school, a police service, as well as the Guilo market which is an important point for the different sub-villages to exchange and sell/buy food once a week. There are also SACCOS (Savings and Credits Cooperative Society), but these are only accessible to wealthier households, since starting capital is needed to join them.

The Department of Crops and Livestock is also situated within the ward and the acting agricultural officer attended the participatory workshops. He showed great interest in the work and could be considered an important ally for any future interventions in the area. The Hombolo Agricultural Research Centre was mentioned, however, its presence in the sub-village is not yet considered to be significant.

The national government was mentioned several times in relation to different types of interventions and projects in the sub-village. However, its support seems to be sporadic and not always reliable. The government used to provide poison to combat the birds, which was appreciated by the local people. However, this support ceased in recent years and as a result the bird population has increased and poses a threat to the community's yields. The government has undertaken several tree planting projects in the village, such as a demonstration plot that is close to the school. Improved seeds provided by the government are considered to be of very high quality, yet they tend to provide them at the wrong time of the year when the planting season has ended. There had also been incidents in the past, when the seeds provided by the government did not perform as expected.

4.6. Summary findings

Climate impacts

1. Prolonged dry season (referred to as 'drought'): According to the perceptions of participants, 20 years ago the rain used to start in mid October and end in May. Nowadays it starts earliest in November and lasts only until March. The intensity and type of rainfall has changed from regular, gentle showers to more sporadic and heavy rainfall that falls over a few days.

2. Pest and diseases: All major food and cash crops (apart from groundnuts) are affected by birds. Apart from the birds there are a range of crop-specific insect pests and diseases that have increased in the past 20 years, according to the farmers. Some traditional remedies exist for pests, but these are not applied by all farmers. The pests were perceived as a climate change-related calamity that has negative consequences on their crops.

3. Strong wind: The third major impact was considered to be strong wind, which breaks the plant of the crops. However, the damage is not as devastating as that caused by pests and 'drought'.

Livelihood strategies

Of the set of livelihood strategies people in Sokoine engage in, farming is the most affected by the above mentioned climate impacts. The crops are affected in terms of the quantity produced and the quality of the

outputs (e.g. quality of oil from crops). This directly affects the availability of food at the household and community level, as well as the income generating potential for surplus sellers. One indirect effect of lower agricultural productivity is the reduced demand for casual labour on the fields, which is an important income-generating activity for the most vulnerable households in Sokoine.

Drought and pests have a direct effect on households' consumption, and reduce the surplus that could potentially be sold to generate cash. Farmers with small landholdings the most affected, whilst others (e.g. shopkeepers and surplus farmers) benefit from it, since they can sell at higher prices. Drought and food scarcity also affect those relying on collecting wild fruits and vegetables to sell and consume.

Food security

The main source of food for people in Sokoine is their own production. This provides them with food for the household, as well as goods which are exchanged with neighbours or sold to vendors to generate cash. According to the women, their own food production lasts 4-6 months to meet the food needs at the household level. The rest of the year they depend on buying food from the market, or processed flour from the maize mill. They exchange different types of crops with their neighbours and buy rice in the local shop. After harvesting vegetables, they dry some and store them for consumption in the dry season.

Food-scarce times are characterised by a shortage of the main food staple (maize, sorghum, pearl millet or cassava) with which their basic staple food *ugali* is prepared. This is usually towards the end of the rainy season, between February and March, when households' own food stocks are finished and the crops are not yet ready to be harvested. People in Sokoine usually eat three times a day but in food-scarce times they only eat once a day and rely on food such as wild fruits, cassava stems and cowpea leaves to overcome the shortage of *ugali* or *uji* (fermented porridge).These times are also characterised by food price rises on the local market due to low availability of crops. This particularly affects vulnerable households, who sell their crops in times of low prices, due to immediate cash needs, and then run out of stocks and need to buy food in times when the prices on the market are highest.

Coping mechanisms

Pearl millet used to be one of the most popular food crops, but due to its attractiveness for birds, productivity has been heavily affected and consequently its production has been scaled down. Furthermore, the only measure locals can take to protect their crops from birds is bird-scaring, which can only be done by being physically present at the field and is very time-intensive and has led to a switch from pearl millet to maize, despite maize being more sensitive to drought.

One of the locally identified remedies to protect the crops against the wind is planting trees, which can function as windbreaks. Yet local farmers reject planting more trees, since they provide a shelter for the birds that eat the crops. The natural windbreaks have also been eroded through the increase of firewood collection as a coping strategy to generate income in times of food insecurity.

One coping strategy people apply to reduce the food gap is called 'green harvesting' and consists in consuming the leaves of their crops, such as cowpea leaves, before the crop matures. This strategy helps in the short-term to address immediate food needs, but backfires in the long-term since it harms the plants and reduces the crop yields. Another coping strategy is livelihood diversification to seek additional income. Women for example collect water for elderly people for a small charge (100 TSH per 20l). People may also go outside the village to seek casual labour for short periods of time (1-2 weeks). The younger generation

tends to migrate for longer periods and sends remittances home, which is why having children (apart from their emotional/cultural importance) is considered to contribute to a household's wellbeing.

5. Key Insights

The pilot study in Sokoine had the dual purpose of firstly testing whether the methodology managed to obtain insights into the multiple dimensions of vulnerability, and how this could further our understanding of the interplay of factors at the local level that make people more or less vulnerable to climate impacts. Secondly, the pilot aimed to test a 'rapid' adapted version of a toolkit developed for a GIZ-CONANP-funded project in Mexico.

5.1. Multidimensional understanding of vulnerability

The combination of using participatory methods to undertake a vulnerability assessment that takes a multidimensional approach to vulnerability to climate impacts revealed the complex and non-linear links between climate impacts, livelihood strategies and response mechanisms. It led to an understanding of the incentive structures underlying the decision-making process of how to respond to climate impacts, which in some cases perpetuates vulnerability and increases the risk of becoming food insecure. This became particularly clear through the example of the bird problem and how a lack of resources to respond to this impact induces behaviour that increases the vulnerability of local farmers to climate impacts, such as the prolonged dry season.

In Sokoine, 'Bird pests' were considered to be the major impact that negatively affects the main food crops millet and sorghum. Now that the government avicide programme has ended, the only way locals can respond to the problem is by guarding the fields and scaring the birds away. However, the lack of human resources and time needed for this response mechanism influences people's decision to switch from the more drought-resistant millet to the more drought-sensitive, but less bird-sensitive maize. Manpower and time are precious resources needed for the diversification of livelihood strategies, which in itself is a coping strategy to diversify risk and maintain a cash flow that allows the purchase of food in times of scarcity. The decision to maximise leverage of this resource by switching from millet to maize leaves people in a situation where they are at the mercy of the increasingly unpredictable weather.

Local farmers' response strategies to a strictly speaking non-climatic factor (birds) increases their vulnerability to a climatic factor (prolonged dry season). They make a conscious trade-off between having more time to dedicate to other income-generating activities, which are crucial to maintain a cash flow to purchase food, and risking the loss of their maize harvest due to a prolonged dry season. Taylor (2011) observed the same pattern among farmers in South Africa who decided to abandon sorghum for maize, because protecting sorghum from the birds was too time-consuming. Children who have traditionally fulfilled this task are no longer available, due to increasing school attendance. The lack of available manpower to guard the fields, combined with a strong public policy push incentivising maize production, has led to a switch from climate-resistant, endemic crops to more climate-sensitive ones. Extending the analysis on Sokoine from the local level to the macro level, might reveal similar findings on the influences of agricultural policies on farmer behaviour, which can exacerbate vulnerability in the long term. Complementing the local vulnerability analysis with further data on human and environmental influences outside of the locality would allow a more systemic analysis of the interrelation of factors at multiple levels (Turner *et al.* 2003).

The DoV analysis provides an understanding of changes in the sensitivity of systems, as well as links and pressures from overall livelihood provision and labour constraints. This allows to go beyond a simple risk-hazard model with linear, one-directional relations between cause and effect, and look at the adaptive capacity based on available resources and how lack thereof can lead to responses to a particular hazard that perpetuates vulnerability to another. This expands the analysis from a focus on sensitivity to climate risks and coping capacity, to an analysis of the social, physical and institutional factors that affect changes in the sensitivity of a system (Turner *et al*. 2003; Birkmann and Wisner 2006). The DoV approach broadens the scope of analysis by looking at the range of factors that underpin vulnerability to risks, rather than parting from the assumption that climate change is the main risk for livelihoods at the local level.

The participatory methodology also allows understanding motivations behind behavioural changes and response strategies that might not seem plausible from a strictly 'climatic' perspective. The unmanageable risk posed by the bird population, for example, further influences the behaviour of the people towards other potential adaptation strategies, such as planting and maintaining trees and bushes as natural shields against the wind. This resistance to provide shelters for the birds could also explain the low local buy-in and lack of support for reforestation programmes led by the government. Understanding the range of factors, including psychological and socio-cognitive ones underpinning farmers' behaviour, are an important point of departure to engage in a dialogue with local people on how agricultural practices can adapt to become more resilient to a holistic set of risks (Grottmann and Patt 2005).

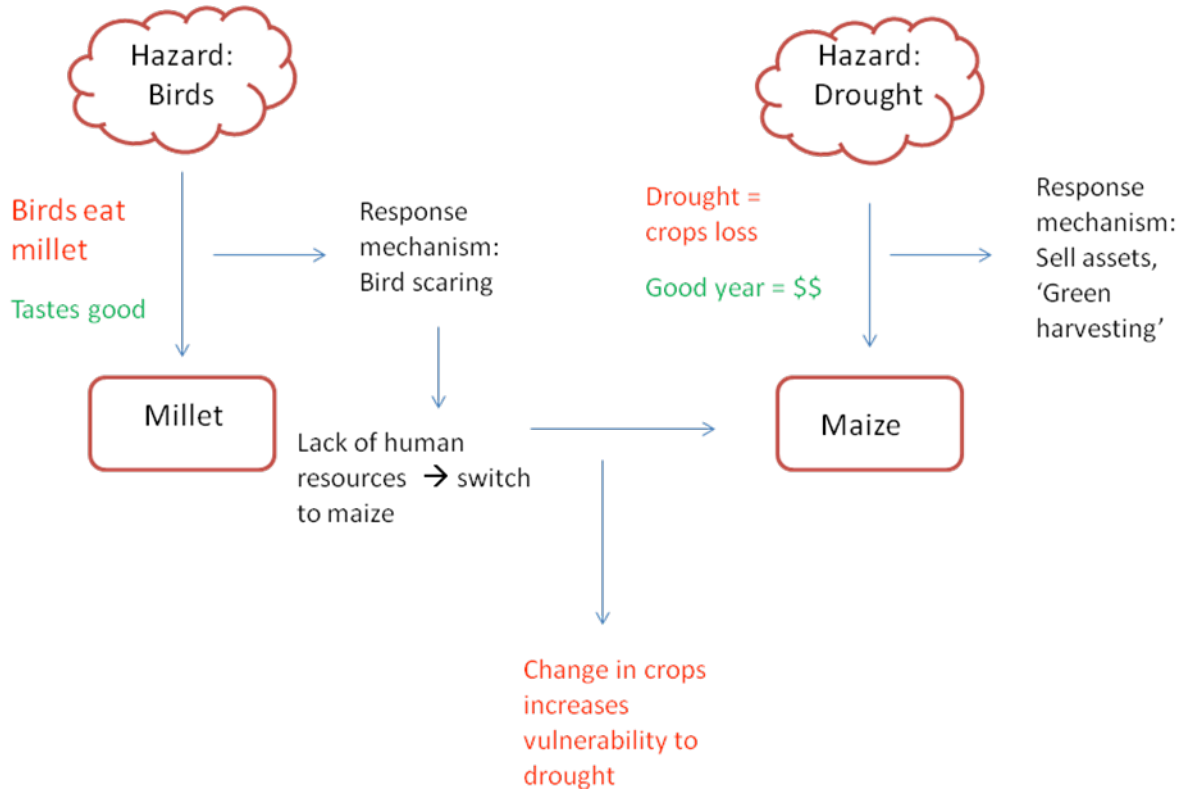


Figure 1 Causal flow diagram on risks and response mechanisms in Sokoine

5.2. Participatory methodology vs. a structured household survey

This understanding of the multiple factors underpinning and perpetuating vulnerability at the local level was facilitated by the DoV conceptual framework, as well as by choosing a participatory approach to the analysis. The pilot study was part of a project that had already implemented the CCAFS household baseline

survey in the Hombolo region (including Sokoine), which allowed to compare the findings from two very distinct methodological approaches.

The objective of the CCAFS baseline survey was to understand the links between genetic vulnerability of crops and resilience to climate change. The data obtained related to households' assets, landscape and crop diversity management, changes in crop framing practices (of the three selected crops sorghum, cow pea and pigeon pea) and perceptions of climate change and current adaptation strategies. In comparison to the PVA, the survey was designed on the basis of a predefined problem (i.e. loss of crop diversity reduces resilience to climate impacts) and a suggested solution (e.g. distribution of climate-resistant local seeds to increase food security). The objective was to obtain information on current crop farming practices, perceived climate risks and response mechanisms, to establish a baseline for measuring impact of the distribution of climate-resistant seeds. This consideration led the design of the survey, which follows a clear analytical path and gathers a wide range of comparable data across locations on the selected issues. However, it leaves relatively little scope for changing direction during the interview with households and incorporating unexpected findings (e.g. influence of non-climatic factors on crop changing practices). Its more extractive nature does not necessarily encourage the interviewee to be reflective about the answers provided, and might leave issues uncovered that the interviewee did not think about when asked on the spot.

The PVA on the other hand follows a very different approach, since it is (ideally) situated at an earlier stage of the analytical process, where the main problem and solution is yet to be defined - together with the local people and taking into account a wider variety of factors that go beyond the interaction of climate risks and crop farming practices. However, even with participatory approaches, a completely unbiased research process is hard to accomplish, since the position of the facilitator as project implementer, researcher or donor will, in most cases, bring with it power relations and biased views that can compromise the objectivity of the facilitation of participatory methodologies (Burns *et al*. 2012). Being aware and self-reflective of the project team's position in the process can help identify how potential biases and barriers could be overcome or critically reflect how they might have influenced the process (Chambers 1997).

In the case of Sokoine, the PVA was applied at a stage where the project interventions had already been defined, which gave it a limited scope of influence over redefining the problem. The project's focus on local seed varieties also led facilitators to steer the group discussion towards crops rather than livestock, for example. People in Sokoine belong to the Wagogo tribe, who have traditionally been pastoralists and only recently turned to agriculture. The fact that livestock was not mentioned during the discussions is noteworthy and demonstrates how influencing the group discussions as outsiders with a pre-set agenda can lead to different conclusions. The PVA did allow toidentify the above mentioned vulnerability dynamics related to different farming practices and also provided context-specific information, which helped to better adjust the project interventions to local needs. For the purpose of this study, it also allowed an interesting comparison between the survey and the PVA approach to understanding vulnerability.

The most interesting finding is that the survey did not reveal the bird problem, despite asking interviewees specifically about pests. One reason for this could be that the line of questioning in the survey followed a linear understanding of hazard --> impact --> response, which might have inhibited the analysis of less linear causal links, as illustrated in Figure 1. The DoV framework underpinning the PVA approach also puts local livelihoods at the centre of the analysis, and aims at understanding them as a strategy consisting of a diverse set of activities, which require access to a range of resources. Looking at the interaction between these livelihood activities and resources can help explain decisions on e.g. changing crop farming practices to less labour-intensive, but more climate-sensitive crops due to limited human resources needed for a range of non-agricultural activities.

Whilst the household survey generated a large data set on comparable indicators across localities (which is harder to do with a PVA), the PVA generated more detailed and contextualised information on specific issues. Participatory methodologies encourage the generation of information and analysis by the participants themselves, which opens up a space for reflection on how different factors and behaviours relate. Visualisations of causal relations, such as matrixes and causal flow diagrams aim to support this process of local analysis. The facilitator guides this process by asking questions that follow the trail of thought of participants, rather than a predetermined set of questions, which allows room to include factors that are difficult to predefine by outsiders.

Apart from generating a more complex and contextualised understanding of vulnerability at the local level, participatory approaches lay the foundations for building a relationship with the people by giving them a central role in defining the problem and setting the solution to issues directly affecting their realities. A first sign of this relationship of engagement being built between project implementers and locals was observed when the project team returned to Sokoine to distribute the seeds. In comparison to the other sub-villages, which had been part of the household survey but not of the PVA, people in Sokoine showed up in greater numbers to the meeting and demonstrated a stronger interest in the proposed project interventions. This show of interest can be the first sign in developing a lasting relationship with the local people through continuous engagement and local participation that can contribute to the sustainability and effectiveness of the project. The PVA also identified entry points for more local engagement, which could be harnessed for the implementation of adaptation projects, such as engaging with a group of local healers that were the custodians of indigenous climate knowledge, as well as existing plots in the sub-village which could be used for agricultural trials.

Compared to the household survey, the PVA provided a wide range of information in a relatively short time period and allowed the household survey data to be put into context (as well as highlight contradictions between the two). The household survey provided more information on specific issues (e.g. types of crops), whilst the participatory assessment allowed to contextualise these and include subjective perspectives (e.g. local characteristics for choosing certain crops). It is thus not necessarily a question of which of the two methods is better, but how they can complement each other if implemented in parallel. Having the preliminary findings from the survey available facilitated the implementation of a 'rapid version' of the PVA and allowed us to be more specific in framing the questions asked during the exercises. However, undertaking the PVA after the survey and at a stage when the project interventions had already been designed, might have reinforced the bias of project implementers to obtain information that proved their hypothesis of problem-solution and influenced the responses received. Undertaking the PVA prior to the household survey is also an option and would help to improve the questionnaire or design of the household interviews. If structured surveys are carried out as part of the project, this makes the process more complicated, so there needs to be a careful assessment of the value of the different types of interventions, their sequencing, and how the outside agency portrays itself and is perceived by the local people in using the different methods.

The PVA can also work on its own, when implemented over a longer time period, which allows a more in-depth understanding of vulnerability. Similar studies in Mexico and Colombia, where a longer five-day PVA was implemented, show a much more detailed and robust data set than the one obtained in 2.5 days in Sokoine.

5.3. Process - Timing and scale for the PVA

The toolkit recommends selecting different tools depending on the existing information base and relationship with the local people, since the time dedicated to the participatory vulnerability assessment will affect the quality and quantity of information obtained. In the case of Sokoine a rapid assessment of 2.5 days was

implemented to test whether valuable data can be obtained in a short time frame. Although the data provided was valuable and helped to improve the selection of seeds for the project, the time limitations made it difficult to collect all the required information for a comprehensive vulnerability assessment. The short time frame did not allow us to verify and triangulate data with different people and groups within the sub-village. A rapid assessment also restricts the time needed to build a relationship of trust between actors who had not previously worked together - in this case local farmers and researchers of the project. This can translate into a reluctance to share information with outsiders, which was observed amongst the female participants in Sokoine. It therefore proved difficult to get a clear assessment of the patterns of access and control over livelihood assets across social groups and gender, which would have been necessary to obtain a more differentiated understanding of vulnerability at the local level. That being said, a short assessment could still be useful in cases where the project implementer or researcher already has a good relationship with the local people and extensive knowledge of the community and only needs to fill in some information gaps.

Another lesson learned is the importance of carefully planning the timing of the participatory vulnerability assessment, which can affect how the information is being used and how inclusive the planning processes are. The earlier in the process it is undertaken, the more it can feed into the planning processes. Yet, it can also be useful as a 'reality check' if implemented in the later stages of the project. As mentioned previously, the methodology is designed to identify current risks to livelihood strategies and food system characteristics as perceived by the local people, rather than making predefined assumptions about how climate risks are affecting the local reality. This can then form the basis for discussion with the stakeholders/communities about potential solutions to identified problems and be the first step of a participatory planning process to design and implement adaptation measures at the local level. In our case, the rapid vulnerability assessment was tested in the context of an ongoing project at a stage where the project activities had already been decided. The scope to change the type of interventions was thus limited. Nevertheless, findings from the participatory methodology were used to modify the interventions and incorporate the local perspectives. For example, following the focus group discussions the choice of seeds for distribution was changed and a locally preferred crop was added. Project implementers also took into account the different types of soil and their compatibility with different crops when distributing the seeds.

The scale of implementation is another important issue to be considered. The toolkit is designed to be used in a specific locality, yet many project implementers have limited resources and time and cannot implement a participatory vulnerability assessment in every locality they work in. In some cases it might work better to reach out to different communities at the same time. In the case of Sokoine it turned out that the sub-village level was too small a unit to understand the local food system, since the market and different exchange mechanisms cross the sub-village borders. In retrospect it might have been more appropriate to use the market place as the unit of analysis and implement the vulnerability assessment with the different groups of people that this market supplies. However, broadening the scale of analysis by adding more localities/actors applies a trade-off of losing specificity of findings and potential exclusion of vulnerable groups. These trade-offs need to be carefully considered and managed by the project team.

The incentives for participation of the local people are also important and highly context-specific. In the case of Sokoine the project team had decided to provide food for the participants as a thank you for their participation. However, participants wanted to receive monetary compensation for their time, which was ultimately granted in the form of food vouchers. This issue was highly contentious, since the project team did not want to create perverse incentives for participation and also didn't want to jeopardize inclusiveness by selecting a few who would receive vouchers and participate. On the other hand, it had to be recognized that we were outsiders and participants were dedicating a substantial amount of their work day to attend a workshop, without knowing whether this would have any beneficial outcome for them. Requests for

compensation can depend heavily on the cultural context, as well as on the track record of the organization. In this case, an alternative to money could have been the distribution of seeds, as compensation for participation. It is crucial to manage expectations of participants and be realistic about what the organization can offer in the short and long term. A good balance has to be drawn between compensating people for their time, and simultaneously trying to create a space for collective exchange, learning and action (which has to be maintained throughout the project cycle and beyond). Empowerment through inclusive participation and decision making will in itself create ownership over the process and incentivize people to participate; this needs to be built over time and cannot be expected in the short term.

These are just a few examples to highlight that users of the toolkit need to make several decisions, which are very context-specific and cannot be prescribed. Hence, the toolkit needs to be used in a critical, reflective and flexible way in order to adapt it to a particular project context and locality, and manage people's expectations responsibly.

6. Conclusion

The methodology provides local planners and researchers with the tools to understand the multiple dimensions of vulnerability in relation to climate and other risks from a local perspective. It provides an entry point to analyzing how local livelihood strategies are affected by climate impacts and how this in return affects the availability, access to and use of food through the local food system. These interrelations are multifaceted and the methodology does not enable complete understanding of these. Yet, in comparison to more linear and top-down approaches, it manages to reveal some of the complex relationships between different political, social and climate-related factors that explain local-level vulnerability. Combination and triangulation with other sources of information, derived from different methodological approaches, is key to increase the robustness of the analysis and feed into adaptation planning by taking a more holistic approach that includes local perceptions of vulnerability.

However, in order to effectively implement the toolkit, decisions have to be made, which involve trade-offs in terms of affordability and quality of the participatory vulnerability assessment (PVA). The first one relates to choosing the appropriate time and scale for the PVA. Implementing it at a high scale sacrifices specificity of the analysis to the extent that the findings become useless when trying to interpret them at the local scale. On the other hand, undertaking the vulnerability analysis at the smallest possible scale (village level) is time-consuming and the findings are not necessarily comparable across sites. In addition, this makes the methodology hard to upscale beyond the project dimension. Project implementers (and arguably researchers) would need to evaluate these trade-offs carefully, and seek complementarity between methods rather than taking a strict 'either-or' approach. Implementing a PVA in every village might seem costly at first, but understanding local preferences and perceptions of risks allows addressing potential barriers to local uptake of adaptation measures from the start, which can make or break the project in the long-term. Being reflective throughout the process and willing to adapt to local realities will help design interventions that are more likely to be accepted by local communities, since they are based on their needs and tailored to their particular context.

This leads to the second set of considerations, which refers to the amount of time spent on the PVA and whether this allows for inclusive participation at the local level. Weighing the pros and cons of methods for a vulnerability assessment requires to look beyond the type of data generated, and evaluating the costs and benefits of choosing different types of processes (e.g. participatory vs. extractive). If local participation is actively encouraged throughout the project cycle (beyond the assessment stage), it is likely to create a sense of ownership over the process and long-term adoption of the adaptation measures. Hence, a short assessment

not only compromises the quality of data obtained, but also the opportunity to build long-term relationships with the people which can contribute to the sustainability of the project.

Users of the methodology therefore need to be critical of how to apply the PVA in their particular context and take account of the implications of when the vulnerability assessment will take place, how much time will be dedicated to implementing it, the extent to which findings will feed into the planning processes and how these decisions affect the relationships with the local people. Ultimately, if implemented well, the PVA will save costs in the long term, by avoiding project failures and will help to ensure successful piloting with good local uptake.

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