



Stakeholders' perceptions of factors influencing climate change risk in a Central America hotspot

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Abstract

To identify adaptation priorities, countries aim to systematically assess their climate change risks, consistent with international agreements. National-scale risk assessment usually follows an expert-led procedure that aims to establish traction with existing policy processes. This may underrepresent important local or regional contexts, including where there are divergent socio-cultural factors or value systems that influence risk perception. These differences in interpretation are explored in detail for Guatemala, located in a climate change risk “hotspot” region, based upon semi-structured interviews with a wide range of stakeholders. Perceptions of factors affecting climate change risk are assessed between different types of stakeholders. Adaptive capacity and risk governance are considered, including the role of international aid to reduce climate change risk in developing countries. Non-profit, inter-municipal organisations of two or more municipalities, named *mancomunidades*, are potentially a useful structure to build adaptive capacity through reflexive risk assessment.

Keywords Agriculture · Climate change risk · Vulnerability · Adaptive capacity · Stakeholders' perceptions

Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) invites all Parties to improve action on adaptation under the Cancun Adaptation Framework (Decision 1/CP.16), more specifically to enhance climate change-related disaster risk reduction strategies and to undertake risk assessment and management, taking into account countries common but differentiated responsibilities and respective capabilities (UNFCCC 2010). Methodologies for undertaking climate change risk and adaptation assessments are diverse and evolving due to the multi-faceted interaction of the factors that compose climate change risks. In 2012, the Intergovernmental Panel on Climate Change (IPCC) moved

from a vulnerability to a risk-based conception of climate change adaptation, where risk is composed of hazards, exposure and vulnerability, including adaptive capacity (Connelly et al. 2018; IPCC 2014). Risk and its dimensions are defined by the IPCC's Fifth Assessment Report (IPCC 2014, AR5, Working Group II): risk is the potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values; hazards are defined as the potential, future occurrences of natural or human-induced physical events that may have adverse effects on vulnerable and exposed elements; exposure refers to the degree to which a system is exposed to a given hazard (e.g. the presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social or cultural assets in places that could be adversely affected); vulnerability is the susceptibility to be adversely affected, including the capacity to cope and adapt (adaptive capacity), i.e. the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities or to cope with the consequences.

To achieve consistency, most risk assessments tend to be “top-down”, based upon a common assessment framework structured to deliver a national, or other large-scale, summary of adaptation priorities (Dessai and Hulme 2004).

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However, as adaptation is strongly influenced by local contexts, including diverse socio-ecological systems and legacy factors, the relevance of the “top-down” approach may be limited for making progress in some of these local contexts (Conway et al. 2019). Consequently, climate change risk assessments have been criticised for being too reductive and technical, regarding their interpretation of adaptation priorities, and for assuming that governments have all the capacity and means to manage risks through the implementation of national adaptation policies (Adger et al. 2018).

Several authors propose that climate change risk assessment requires a more inclusive and reflexive process to enable a wider pluralistic engagement on multiple dimensions of risk and how these relate to underlying values and norms, particularly regarding attitudes to the natural environment (Adger et al. 2018; Brown 2018; Ford et al. 2016). People’s values, beliefs and norms influence how they perceive, interpret and act with regard to climate change risk management (McDermott and Surminski 2018; Moser and Ekstrom 2010). Subjective risk is strongly related to context, including attitudes to, and tolerance for risk among different actors (Duckett et al. 2015; Patt and Schröter 2008; Shortall 2013; Weber and Hsee 1999; Wynne 1996). Recognising diverse socio-cultural contexts and the influence on risk perception is especially important in terms of indigenous or ethnic communities who can each have quite distinctive values, attitudes and norms resulting from their own traditions and heritage (Ahmed et al. 2019; UNDP 2000). Article 7.5 of the UNFCCC 2015 Paris Agreement calls for adaptation action to consider vulnerable groups and communities as well as traditional knowledge, indigenous peoples’ knowledge and local knowledge systems (UN 2015). For Anderson et al. (2019), the integration of traditional knowledge and informal observation of climate variability with high-resolution datasets is critical in addressing some of the uncertainties in data, trends and future impacts, and in developing relevant, equitable and evidence-based climate adaptation plans.

Risk perception therefore emerges as crucial for the formulation of adaptation priorities, and by defining individual or collective awareness of a need for action to manage the risk, it becomes an important determinant of adaptive capacity (Burton 1997; Paek and Hove 2017; Sjoberg 2000). There may be differences also in terms of whether the risk is defined and managed individually or collectively, or as a private or public decision, or even the extent to which it covers material or non-material values (Hinkel and Bisaro 2016). The multi-level nature of climate change requires governance systems able to manage and resolve conflicts of interest across multiple scales and among diverse policy actors (DiGregorio 2019) and this requires engagement with decision-makers, donors, international aid agencies and practitioners in order to map out the transmission of risk across sectors and scales (Adger et al. 2018; Brown 2018). It

is, thus, essential to understanding risk perception from the standpoint of the institutions, policy processes, cultures and economies where adaptation will occur (Brown et al. 2015; Eakin and Lemos 2010; Eriksen et al. 2015).

Even though most evidence suggests the burden of climate change is higher on the Global South (e.g. Munasinghe and Swart 2000; Afolayan 2001; Podesta and Ogden 2008) and that multi-level governance of climate change adaptation faces distinct challenges in these regions (DiGregorio 2019), there is limited scientific literature investigating factors affecting climate risk in Central American countries, a recognised global hotspot region for climate change (Donatti et al. 2019). Additionally, while the role of brokers as intermediaries to facilitate knowledge exchange is well established (e.g. Miller 2001), more evidence is required on how this brokerage can become more effective for complex issues such as climate risk management (Brown 2018). This study aims at better understanding stakeholders’ perceptions of the factors affecting climate change risk across multiple scales, in order to better understand how climate change risk could be reduced.

Methods and materials

Study country

Guatemala (Fig. 1), located in Latin America and the Caribbean (LAC), has high exposure to climate change hazards intersected with high socio-economic vulnerability (GFDRR 2011; De Souza et al. 2015; Kreft et al. 2017). The country ranks ninth in the world for the level of risk to the effects of climate change (World Bank 2021). Climate change risks include the reduction in water quality and quantity, higher incidence of pests and diseases, harvest losses and food insecurity, increase in forest fires and socio-ecological and economic impacts in the agricultural sector (MARN, 2009). According to the World Bank (2020), about 49% of the population are poor, or live below the upper-middle-income poverty line (defined as US\$5.5 per day in 2011 PPP), with poverty mostly affecting rural areas, where a very large share of the rural poor are engaged in farming activities (Janvry and Sadoulet 2010). The population in Guatemala is composed by *Ladinos* (mixed indigenous and of European heritage) and Indigenous people, who are also the poorest in the country (Cabrera et al. 2015; Noriega 2010). According to figures from the 2018 census, there are 14.9 million inhabitants in Guatemala, 6.5 million (43.75%) of which self-identify as Indigenous people, from the Maya, *Garífuna* and *Xinca* Indigenous Peoples, or Creole (Afrodescendants) (Instituto Nacional de Estadística de Guatemala 2019). The land-use sector is one of the most vulnerable sectors to climate change (CCAFS, CIAT and MAGA 2014; Hannah

Fig. 1 Location of The Republic of Guatemala, located in Central America (Source: Google maps)



et al. 2017). More than two-thirds of the population depends on agriculture, often closely entwined to semi-natural ecosystems, especially in diverse small-scale farming systems (Imbach et al. 2017).

The National Policy of Climate Change aims at reducing vulnerability and improving climate change adaptation capacity at the national and local levels through the close engagement of the Central Government with the municipalities and the civil society (MARN 2009). In 2013, Congress approved the Climate Change Framework Law (*Ley Marco de Cambio Climático Decreto 7–2013*) with the objective of preventing, planning and responding to the impacts of climate change (MARN 2013). The framework law created a National System of Information about Climate Change and expects the wider participation of stakeholders in the development of climate change-related plans, programmes and actions. In 2016, a National Action Plan for Climate Change was adopted by the government in the application of the 2013 framework law, listing the mitigation and adaptation priorities to be dealt with by public and private institutions (Segeplán, 2016).

Data collection and analysis

Data collection was undertaken in May 2016, during a drought. It focused on the social-ecological systems consisting of the “bio-geo-physical” units and their associated social actors and institutions. Semi-structured interviews with key experts and local level stakeholders were undertaken both at community centres and schools, and at the farm holdings. Semi-structured interviews are characterised by topic guides which lead to major open-ended questions used in every interview, but not always in the same sequence. These interviews develop in a conversational and reasonably informal manner offering participants the chance

to explore issues they feel important (Clifford and Valentine 2003). Information was also opportunistically collected during a workshop with local-level stakeholders piggybacked on the climate change and gender council meeting hosted by the *Mancomunidad Nororiente* in Zacapa city. Engaging with a wide range of stakeholders, allowed the development of a comprehensive understanding of phenomena and tested the validity of the information collected through the convergence of information from different sources (Hay 2016).

Notes were taken during fieldwork and developed into a more complete account of what people said soon after. Qualitative data was organised manually in emergent themes, namely perceptions of changes in weather patterns and impacts, underlying causes of vulnerability and adaptive capacity, and sub-themes under these themes. Following the principle of “informed consent”, all participants in the study were informed that data would not be associated with any names for confidentiality reasons and would be securely stored.

Semi-structured interviews with experts in land use, climate change and indigenous communities, in Guatemala City

Data collection included semi-structured interviews with 10 people who have an expert role in the investigated setting, namely climate change science, land use (agriculture, forestry), natural resources management and biodiversity and one former Guatemala environment minister, who is knowledgeable about both the environment and climate change, and also on indigenous communities’ worldviews. As no indigenous people took part of the study, one Maya priest who studies the Maya culture and indigenous worldviews was also interviewed in order to explain indigenous people perceptions on the factors affecting climate change

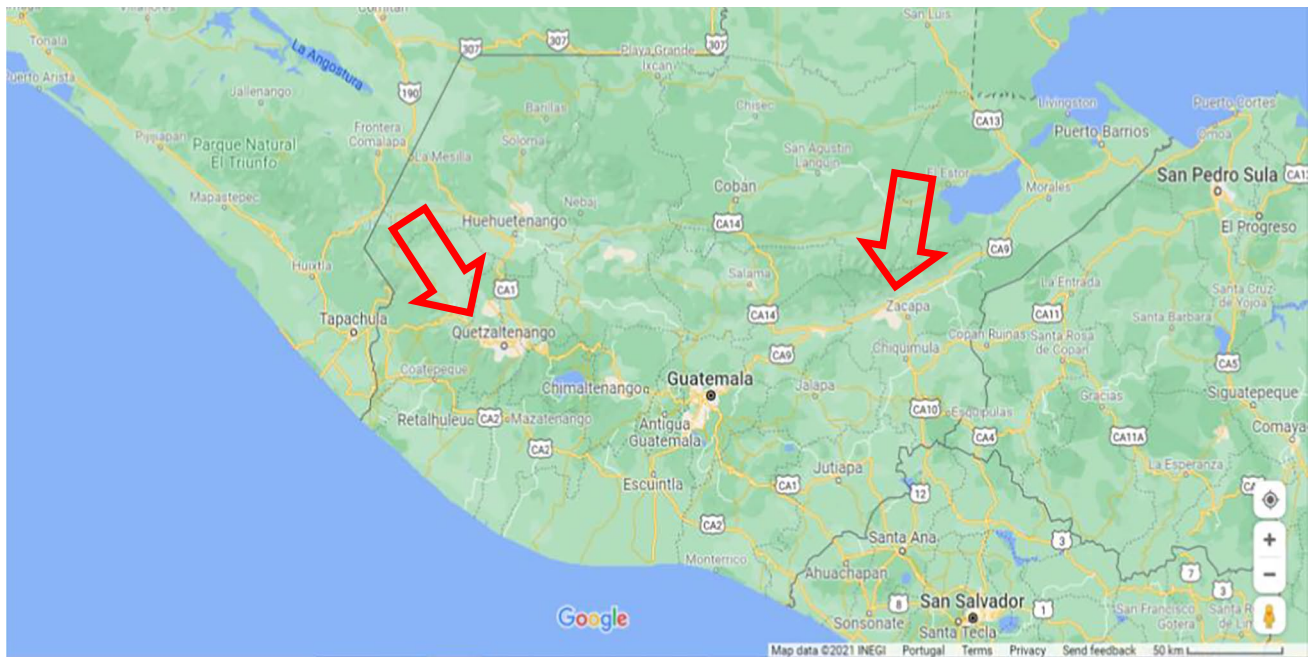


Fig. 2 Arrows showing the location of Quetzaltenango and Zacapa cities in Guatemala, where *Mancomunidad Metrópoli de los Altos* and *Mancomunidad Nororiente* are located, respectively (source: Google maps)

risk. Experts articulated their own views rather than institutional views. Purposive sampling was the method chosen by the IDEADS, a national non-governmental organisation (NGO) on Environmental Law and Sustainable Development in Guatemala, to identify experts. Informal, semi-structured interviews lasted between 60 and 90 min and the list of questions discussed is presented in annex A.

Semi-structured interviews and field visits with local-level stakeholders in two sites in Guatemala

The IDEADS contacted two *mancomunidades* in Guatemala, namely *Nororiente* and *Metrópolis de los Altos* (Fig. 2), which in turn contacted local stakeholders (e.g. members of rural communities, farmers, extension services, technicians, local politicians) in their regions of influence by snowball sampling. These identified villages to visit and small-scale farmers and members of rural communities to interact with. The *mancomunidades* are non-profit, inter-municipal organisations of two or more municipalities with a juridical person status, which were established in 2002 after the reform of the decentralisation laws, with rights and duties according to the legislation applied to the municipalities (article 49 of the Municipal Code, reformed by the article 10 of the Decree 22–100) (Gutiérrez 2006; Alvarez 2012).

The objective of the *mancomunidades* is to provide the common good and to implement public policies at the local level, mostly on transboundary issues such as climate change risk and resilience management. The *Mancomunidad*

Nororiente convenes also a climate change and gender council (*Mesa de Cambio Climático y Género* in Spanish), which is a meeting that congregates a wide range of stakeholders to discuss climate change and gender-related problems with the participating municipalities.

Five villages were visited in the territory covered by the *Mancomunidad Nororiente* and 4 villages were visited in the territory covered by the *Mancomunidad Metrópoli de los Altos*. In these visits, the research team had the opportunity to interact with the community members, extension service workers municipality staff, small-scale farmers, mayors (*alcalde*) and leaders of the community development councils, called *Cocodes*, both in schools and/or community centres, and in farm holdings. The *Cocodes* are the community-level system of rural and urban development and integrate part of the national system of development councils. They have the objective of promoting economic, social and cultural development of their communities as well as to promote the participation of the population in the identification and prioritisation of projects, plans and programmes that benefit the community (Lopez et al. 2006) and they cooperate with the *mancomunidades* in the identification of solutions to the needs of the population (Alvarez 2012). The disaggregation of local-level stakeholders per type and per village is presented in Table 1. They were all *Ladinos*.

Topics discussed are presented in annex B. During the interactions, the academic term “climate change” was replaced by “the weather” (*el tiempo*) in line with Hulme (2009), de Vet (2013) and Metcalfe et al. (2020). The

Table 1 Local level stakeholders contacted during the study

	Village*	Members of rural communities (N)	Small-scale farmers (N)	Other local-level stakeholders			
				Extension service workers (N)	Local politicians (e.g. Mayors)	Technicians from municipality	Technicians from the <i>Mancomunidad</i>
Territory covered by <i>Mancomunidad Nororiente</i>	Village C	20	2**	2	0	0	3
	Village B	16	0	0	0	4	3
	Village J	31	0	0	0	4	3
	Village SC	0	3	2	2	1	3
	Village P	0	10	0	1	0	2
Territory covered by <i>Mancomunidad Metrópoli de los Altos</i>	Village Q	0	3	1	0	0	2
	Village S	0	0	2	1	5	2
	Village S2	5	0	0	1	2	3
	Village O	3	0	0	1	0	2

*Village names were changed into codes.

**Included in the number of community members in this village.

N, number.

interaction with the communities occurred mostly at school buildings and other public buildings, and with small-scale farmers at their farm holdings. The field work allowed the observation of socio-ecological systems in situ. Interactions with community members and small-scale farmers lasted between 45 and 60 min.

Workshop embedded in the Climate Change and Gender Council hosted by the Mancomunidad Nororiente

In May 2016, the *Mancomunidad Nororiente* hosted a Climate Change and Gender Council with 24 attendants. These 24 people were representatives of international NGOs, local development agencies, women's associations, farmer's associations, international aid agencies, municipalities, adjacent *mancomunidades*, the Government Secretary for Planning (SEGEPLAN), the National Subsystem for Research, Innovation and Livestock Transfer (SNITA). Within the Council meeting, a specific workshop designed by the research team was held taking advantage of the presence of a wide range of local stakeholders to discuss the role and effectiveness of the *mancomunidades* in tackling transboundary problems such as climate change risk and vulnerability reduction. The technique used to engage participants with the research topics was a carousel activity. This provided a communicative and interactive opportunity for participants to move around the meeting room in a circular manner (like a carousel), stopping intermittently for periods of 10, 20 and 30 min to comment, discuss and respond, verbally and in writing, to probing questions posted by the researcher. These questions are presented in annex C. Each group identified a rapporteur to present to the whole audience the answers to the questions

and to discuss them widely for 30 min more. The workshop lasted a total of 90 min.

Results

Stakeholder perceptions focused on the factors contributing to climate change risk in Guatemala, especially weather changes and impacts, factors contributing to rural communities and small-scale farmers' vulnerability to climate change and adaptive capacity. Some factors affecting vulnerability were interrelated. Regarding adaptive capacity, apart from climate change adaptation practices at the farm level one unexpected theme emerged, the role of the *mancomunidades* and their Climate Change Gender Council in climate change risk management. Figure 3 presents the perceptions of factors affecting risk and the interconnections between them. These factors are presented in more detail in the following sections: The "Results" section presents the perceptions of weather changes and impacts in Guatemala; the "Perceptions of factors contributing to agricultural vulnerability to climate

change" section presents the factors perceived to affect climate change risk and the "Adaptive capacity" section presents the factors affecting adaptive capacity.

Perceptions of changes in weather patterns and the impacts

Experts on land use and climate change Weather changes noticed were warmer nights in May and hot waves in February, false starts of the rainy season and heavy rain falling in a very short period. It was said: "in the past, there

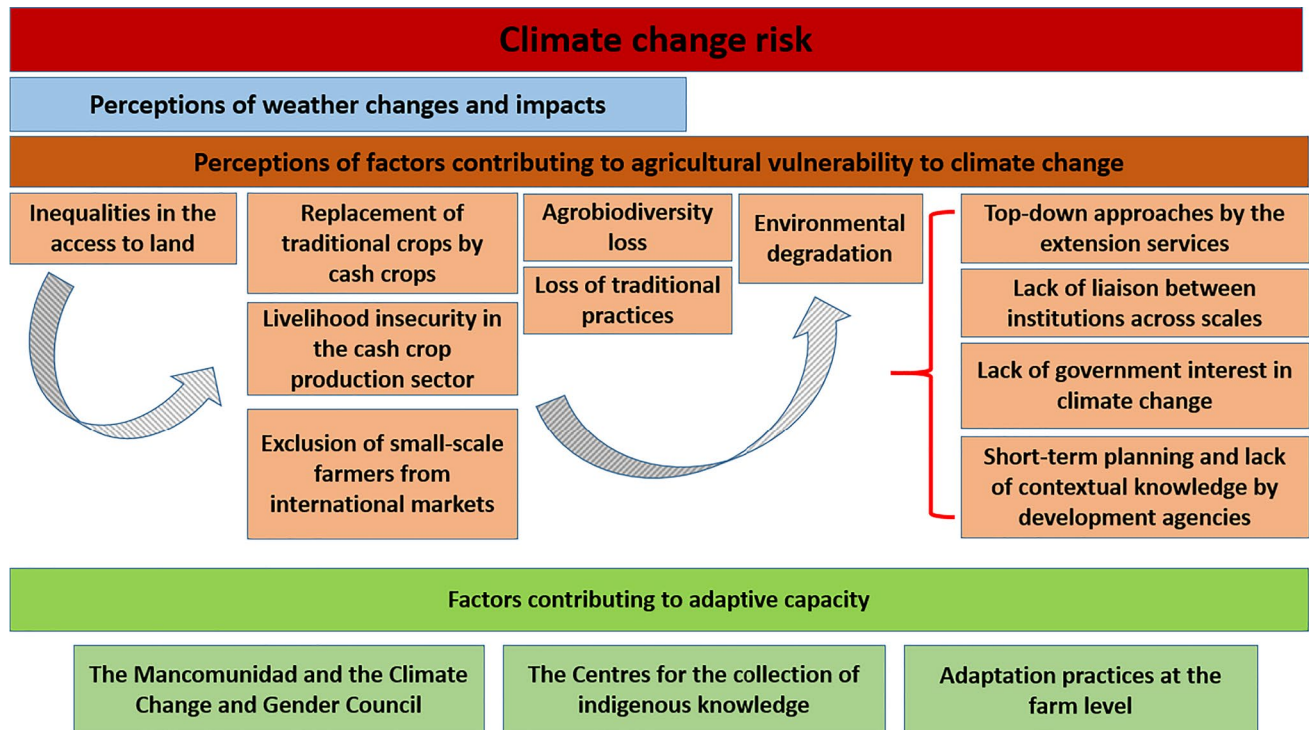


Fig. 3 Stakeholders' perceptions of factors affecting climate change risk in Guatemala

was usually one extreme event every seven years, but more recently, about 17 extreme events (droughts and flooding) every 2–3 years, with this trend increasing”. The mid-summer drought with low rainfall known as *la canícula*¹ has been extended from 15 to 40 days and the extended *canícula* conjugated with soil degradation is not bearable for farmers: “With good agricultural conservation practices, maybe farmers could cope for 30 days, but with soil degradation, they cannot cope for more than 15 days”. The lack of water and rain was perceived to negatively impact the yields of subsistence crops such as maize and beans: “These crops were produced twice a year before but now the risk this does not happens anymore is high”.

In the Dry corridor of Guatemala “the rain will not be enough” to the increasing production of highly water-intensive vegetables for the export markets (melons, avocados and grapes) as the region is expected to have more pronounced droughts in the future. The coffee leaf rust (*la roya*) (*Hemileia vastatrix*) is becoming more dangerous with climate change, mainly in plantations at higher altitudes, which were resistant to the disease before: “La roya has been always present but it is much more dangerous now

with climate change, mainly with the coffee plantations that have not been affected before. The development of the disease depends on temperature and rainfall. La roya now affects at a higher altitude”. And “This is making farmers to sell their coffee farms to bigger producers or for housing development”. The negative impacts of climate change on the coffee production were considered to affect negatively rural workers working in the sectors because “the harvests are lost so jobs are also lost because the big producers do not contract the workers anymore”. Forest fire risk is expected to increase. The increase in the incidence of tree diseases such as the pine bark beetle (*gorgojo del pino*² in Spanish) was reported for pine stands.

Experts on indigenous community worldviews According to the Maya priest, indigenous people acknowledge climate change and report changes in flowering timings, insect tiredness, especially pollinators and ants and bird behaviour. He said: “The ancianos (the elders of the community) do not sleep because they are worried thinking the rain will not come.” The Maya priest also said that “In every community there is knowledge about how nature works. (...) There are birds that predict the rain. But the animals are now very disturbed and confused. The farmers wait for the birds that

¹ Period of reduction or absence of rainfall and temperature increase in the middle of the rainy season usually occurring in July or August (Magaña et al. 1999).

² *Dendroctonus adjunctus* Blandford.

predict the rain to seed.” Another expert also mentioned that indigenous people notice a change in animal numbers and behaviour: “there are many ants now, and many more bats, there are many more hummingbirds drinking sugary waters [artificial feeding] in the garden because flowering has not started yet”.

Local-level stakeholders In one village, the mayor was accompanying the extension service workers at checking the impacts of the pine bark beetle, which they said were increasing in the area. Small-scale farmers reported the decrease in rainfall and observed the increasing unpredictability of the rainy season, which used to dictate the start of their sowing season. The mayor of another village noticed: “There have been good times before. For example, during Hurricane Mitch it rained a lot and farmers harvested a lot, but after there has been less and less rain”. Small-scale farmers in the regions covered by the *Mancomunidades Nororiente* and *Metropoli de los Altos* mostly reported harvest losses in maize, which is the base of their subsistence and culture. One farmer in *Nororiente* region said “We were able to produce 15 quintals per family before but in the last years the rain has been less and less and the production as well”. Another farmer said: “Before we would produce 3 times more than this but because of the lack of rain in the last 3 years, the production levels are lower”.

Perceptions of factors contributing to agricultural vulnerability to climate change

Inequalities in the access of land

Experts on land use and climate change Large-scale farmers (*latifundistas*) and agribusinesses own or manage almost all productive land in Guatemala where they produce most of the export crops, namely sugar cane, plantain, banana, palm tree, gumtree and cocoa. In the case of the sugar cane, the land is managed by the industry, which rents it from large landowners and undertakes all management decisions. Small-scale farmers occupying the marginal land they have got through the land reform report more drought-related stress than those farmers who own land holdings in the productive lowlands and closer to water streams and are therefore more vulnerable to climate change.

Experts on indigenous communities’ worldviews According to the Maya priest, indigenous people hold the right to use communal land, which is managed by the natives. However, he reiterates that “there is only a few of these left”. He mentioned indigenous people are vulnerable to land grabs because they ignore the land management agreements between institutions and municipalities and are alienated

from the decision-making processes. He said that “each family (commoner) must have their title and they have the right to decide about what is going on in their land”.

Local-level stakeholders In the territory covered by the *Mancomunidad Metrópoli de los Altos* farmers in upland areas are small-scale and own small plots of land (1 *cuerda* = 0.393 ha per farmer) resulting from multiple land divisions during inheritance processes and this also constrains crop production. Many farmers do not have access to water streams for irrigation nor to fertile land, which is mainly a privilege of Spanish descendants. In territory covered by the *Mancomunidad Nororiente* members of rural communities mentioned they have difficulty in accessing land and pointed out that the very small-scale characteristic of farm plots (0.6972 ha/farmer = 1 manzana/farmer) constrains crop production. In the highlands, the land is mainly private and used for coffee production, but some municipalities also own land. In some villages, the municipality land is not enough for all villagers. Some small-scale farmers inherited the “right to use” the municipality land from their Spanish colonial ancestors and other villagers (e.g. health guardians, former extension workers) are sometimes offered the “right to use” the land. The more fertile lowland area is occupied by melon producers who rent that land from *latifundistas*. In the region covered by the *Mancomunidad Nororiente*, the demand for land by landless communities has already led to invasions of private land.

Replacement of traditional crops by cash crops

Experts on land use and climate change Experts highlighted the replacement of traditional crops by cash crops³: “The country is now importing its food. We are eating wheat bread instead of maize, sweet potato⁴ or yucca⁵ bread. So now we depend on international markets to eat and we produce (coffee, sugar, chocolate) and rubber (hule in Spanish) for the international markets. We are not producing structural foods for nutrition. The farmers have been obliged to go to the highlands and to produce maize and beans, and eatable plants, vegetables, potatoes for the Guatemala people. This does not bring wealth to the country but undernourished people, analphabetic, with learning problems, kids who do not go to the school, cheap labour and this all will cause immigration, delinquency”.

³ An agricultural crop is grown to sell for profit. The term can be used to differentiate marketed crops from subsistence crops, which are those fed to the producer’s own livestock or grown as food for the producer’s family.

⁴ *Camote*.

⁵ *Cassava*.

Local-level stakeholders In the region covered by the *Mancomunidad Metropoli de los Altos*, technicians from one municipality believed that intensive production of cash crops for the export markets increases the risk of food insecurity and contributes to environmental degradation. They perceived that the malnutrition rate among children does not correlate positively with the increase in fruit and vegetable production in the region. They observed the increasing trends in potato production to export to neighbouring countries (e.g. Honduras and El Salvador) and were concerned that potato production was replacing maize production, which is important both in terms of culture and food security.

Livelihood insecurity in the cash crop production sector

Experts on land-use change and climate change One expert claimed that melon, avocado and passion fruit produced for the export markets do not provide reliable employment and as these fruits are not processed in the country there is no added value to the product. He considered this agribusiness model obliges people to migrate and sends the money back as remittances whose total amount, he said: “is higher than the country’s Gross Domestic Product”. This, in turn, was believed to make the country very dependent on these remittances and therefore vulnerable to what happens in the countries of origin of these remittances. Another expert, however, believed that “poverty indicators are better in the south coast where sugar cane, banana and palm oil is produced because there is more health centres and more formal work and in this region workers get more than the minimum wage, so this attracts many people”.

Local-level stakeholders One technician from the *Mancomunidad* considered the melon producers do not ensure workers annual jobs “The melon producers employ people during 9 months (...) The 3 months from May to September they do not employ anyone”.

Exclusion of small-scale farmers from international markets

Experts on land-use change and climate change One expert pointed out there are no certified seed nurseries in Guatemala, so the seeds and plants of the fruit varieties required by the global markets are not easily available, which makes it almost impossible for small farmers to buy them. Another expert reported that many small-scale farmers who tried to produce sugar cane had to give up and rent their land to larger-scale producers because they could not compete with the big sugar producers. However, by renting their land they become more food insecure: “When they rent the land they have to buy food (maize and beans), which is the base of

their diet and culture, and are therefore more vulnerable to food price fluctuations”.

Local-level stakeholders Small-scale farmers said they were excluded from producing fruits and vegetables for the international markets as the seeds and plants (e.g. melons, avocados and grapes) have to be imported and because of that are very expensive. Farmers in the regions covered by the two *mancomunidades* reported their lack of economic capacity to purchase improved seeds (e.g. hybrids, modern varieties) and the difficulties to access credit at low interest rates. Technicians from the *Mancomunidad Metropoli de los Altos* also mentioned that the Ministry of Agriculture and Livestock and Food (MAGA is the Spanish acronym) used to build water reservoirs in marginal land for the benefit of small-scale farmers but has stopped building them.

Environmental degradation

Experts on land use and climate change Palm oil and livestock production were considered the main causes of high deforestation rates: “the forest area has reduced to 34% in the past 25 years and there was a large forest area before. (...) There has been an expansion of palm oil in the area of Petén. This has been a cause for deforestation in the area”. Banana production was also perceived as a cause of deforestation: “the State has given banana producers land (...) and this caused even more deforestation as this land was covered by forests”. Another cause of deforestation mentioned was drug trafficking: “drug traffickers convince community leaders to invade forest land and settle there, then they deforest the land, then they leave and sell the land to the palm producers” and that people in protected areas lose control of land as “they are obliged to sell the land because they are surrounded by palm. They are then employed to work in the palm areas”. Several impacts of deforestation were identified, namely soil erosion, degradation of water quality, increase in the average temperature in forests and climatic variability in spring over the past 40 years (shorter and more intensive rainfall periods).

Sugar cane production also impacts negatively many ecosystem services, namely the water quality “it has been responsible for the destruction of the riparian woods”, freshwater provision “sugar cane producers have irrigation infrastructure and divert the rivers for their use and benefit”, soil quality “the soils under this crop are usually deep and heavy soils but are weakly aggregated. With heavy mechanisation, the soils break and are converted in soil dust. It is very difficult to restore these soils once they have been destroyed” and air quality “with tornados this soil dust is lifted and pollutes the air of the surrounding places so air quality is degraded causing health problems. (...) The residues of the sugar cane

are also burned. This is forbidden but the producers still do it. This means that the quality of the air is also degraded”.

Experts on indigenous communities’ worldviews The Maya priest mentioned that in the past him and “his brothers and father used to wash in the river but now the river does not exist anymore. It disappeared because of deforestation”.

Local-level stakeholders Extension workers in the *Mancomunidad Nororiente* explained they were working on a management plan to avoid more deforestation and to reforest with several tree species in land belonging to the municipalities. They said there had been many deforestation in the area and they wanted to stop it. One farmer from one village said “farmers there are blocking the road up to the top of the mountain because there has been too much deforestation and this is the cause of the lack of water downstream. The forest is needed for the water”.

Agrobiodiversity loss

Experts on land use and climate change Native wheat and yellow maize production decreased sharply because of subsidised North American wheat and maize enter Guatemala at lower prices, competing with local varieties. One expert considered the imports of yellow maize from the USA to Guatemala cause food insecurity in the country: “The yellow maize was also produced in Guatemala before. This is the maize to feed animals. However, the USA subsidises this maize and it enters the country at a much lower price than it is produced here. So, the farmers are not producing this maize anymore and the Guatemala variety was lost because the seeds were not maintained as the farmers did not get profit by planting this crop”. The area of rice production expanded five times but with foreign varieties while native rice varieties are disappearing. One expert said: “Rice is an important crop for Guatemala. There were rice varieties from Guatemala but there is no Guatemalan rice anymore. The variety is lost and there is no bank of seeds that can produce the Guatemalan variety”. Agrobiodiversity loss decreases food security and increases the vulnerability of small-scale farmers to climate change because local varieties (e.g. native maize) are better adapted to the climate than hybrid and foreign varieties: “This maize is very resistant to the harsh conditions (drought and pests) in Guatemala but the yield is low”.

Experts on indigenous communities’ worldviews The Maya priest revealed that crop diversification was more common in the past: “Before there were more diversification of crops and farmers would not depend on inorganic fertilisation. The priests and people linked to the Catholic Church encouraged

the introduction of inorganic fertilisation among the farmers and this has killed diversity”.

Local-level stakeholders In the territory covered by the *Mancomunidad Metropoli de los Altos*, farmers mentioned that they hardly grew white wheat, which is culturally important, because it has a low price in the market. Members of rural communities in the territory covered by the *Mancomunidad Nororiente* admitted that their ancestors grew many more varieties of fruits and vegetables than they do now.

Loss of traditional practices

Experts on land use and climate change Traditional practices such as terraces, incorporation of soil residues, use of inorganic fertiliser (e.g. manure) and multi-storey systems in terraces, which are beneficial for soil conservation, have been discontinued. There is an increasing number of farmers raising cattle on slopes and implementing conventional tillage with consequences in soil degradation, increase in food dependence from international markets and consequently food insecurity. Multi-storage systems are not promoted nor supported by the Ministry of Agriculture, Livestock and Food (MAGA is the Spanish acronym): “I found some multi-storey systems in some farms left from the past and saw these systems provided a range of products and protected the soil from rainfall and erosion. These traditional systems were abandoned.” People’s capacity to adapt is lost: “we are copying the USA in terms of their agricultural practices and forgetting the capacity of adaptation the people had before, which also adapted to the conquest, because there has been always droughts and people survived”.

Experts on indigenous communities’ worldviews The Maya priest believed that traditional practices such as soil conservation practices and irrigation could increase crop yields, essential to guarantee food security.

Local-level stakeholders In the territory covered by the *Mancomunidad Metrópoli de los Altos*: “farmers sow according to the moon cycles but do not revolve the soil or return farm residues to the soil as they did before”. A decrease in the implementation of soil conservation practices is perceived, with consequences in soil erosion and decrease in potato yields. One female farmer in the territory covered by the *Mancomunidad Nororiente*, however, said she “learned how to farm from her father who told her about comestible plants and about the medicinal plants” and she uses “madre de cacao” (*Gliricidia sepium*) to fertilise the soil as her father taught her.

Top-down approaches by the extension services

Experts on indigenous communities' worldviews The Maya priest thought the extension service workers have a top-down approach towards indigenous people and suggested older indigenous farmers should teach younger farmers about the old farming practices. He recognises, though, that the civil war generated distrust among people and that it was difficult to re-establish communication and a knowledge sharing in the communities in the post-war.

Local-level stakeholders In one village near the city of Zacapa, in the region covered by the *Mancomunidad Nororiental*, the mayor revealed her good connections with the extension services from the national forest institute (INAB) and actively promoted their interaction with small-scale farmers for advice on good soil practices, fruit tree varieties, and forest conservation. Small-scale farmers used to get advice from government extension services before these were discontinued. Farmers in the region covered by the *Mancomunidad Metropoli de los Altos* explained these services used to offer reliable advice and were very knowledgeable of the different socio-economic and environmental contexts but that the recently revived services have a top-down approach and did not understand their local context. Farmers from remote communities reported they did not have access to knowledge networks nor agricultural technical assistance, only to extension workers sharing information on fertilisers and on available subsidies for woodland planting.

Lack of liaison between institutions across scales

Experts on land use and climate change One expert considered that people working at the ministries and municipalities do not use the data and information produced by the national meteorological institute (*Insivumeh*) to design local risk management strategies.

Experts on indigenous communities' worldviews The Maya priest believed that a high percentage of the country's money was managed by the *Cocodes* and said these local institutions are not well accepted by the communities because they are imposed by mayors (and associated political parties) and thus not democratically elected. He denounced the existence of conflicts with the communities due to the corruption of the *Cocodes*.

Local-level stakeholders Technicians at the *Mancomunidades* criticised the constant staff rotation in the municipalities, which are intermediate-level institutions. They consider this staff instability constrains the capacity building and learning by doing required to implement climate change-related plans and actions. Members of rural communities

considered that the *Cocodes* are not interested in climate change and agriculture-related problems, but in lobbying for the construction of bridges, roads, health centres and criticised the poor communication existing between these local organisations and the communities.

Lack of government interest in climate change

Experts on land use and climate change One expert considered that there has been some remarkable efforts to take the Climate Change Framework Law forward but “the lack of enforcement, lack of genuine interest from the current government, lack of financial resources and the lack of knowledge and dissemination about the [Climate Change Framework] law at the regional and local levels have hindered the implementation of the law”. This is tied to the lack of funding for data collection, which has impacts on the production of country-specific data: “the main problem is the lack of data for everything related to agriculture, household surveys, soils, geology, and climate. Degraded meteorological stations have been replaced by automatic ones that do not last because of thunderstorms and are difficult to maintain [these are provided by the cooperation and are very expensive]”. The meteorological stations are not maintained and data is not collected because there has been a disinvestment in data collection: “data collected in the country is not enough to conclude the climate is changing in Guatemala”. Weather and climate data are collected by a range of entities including the national meteorological institute (*Insivumeh*), research institutes and development agencies but these are not standardised nor ready to use and the lack of funding was delaying the *Insivumeh* plans to collate and homogenise multisource data into a single database. The Institute for Agricultural Science and Technology (ICTA in Spanish), which is in charge of generating and promoting research on agricultural sciences and sustainable agriculture is also underfunded and public seed banks are not well maintained. This leads to consequences such as increasing homogenisation of fruits, vegetables and cereal varieties (maize, wheat), and to agrobiodiversity loss. One expert explained that MAGA also used to fund extension services to give advice to farmers but this was discontinued for a relevant period of time before being reinstated again in a different format.

Experts in indigenous communities' worldviews The Maya priest considered that the government, as well as NGOs and international aid agencies, are not interested in recovering and protecting indigenous knowledge and reported the lack of action to rescue this knowledge: “There are almost no projects about rescuing traditional knowledge and if there is

any it is in urban areas". He requests: "the knowledge from the (old and wise) has to be rescued because otherwise it will be lost they are old and dying now".

Local-level stakeholders Technicians working at the municipalities highlighted problems with the intermittent nature of national weather information sharing by the national weather institute, which hindered their ability to design risk management strategies. Members of rural communities in the region covered by the *Mancomunidad Metropoli de los Altos* were concerned about the lack of a national programme for grain storage considering this "leaves the country dependent on other countries for cereals".

Short-term planning by international development agencies

Experts in land use and climate change According to experts, there are several climate change-related actions implemented by development agencies in the country. For example, the United States Agency for International Development (USAID) hosts an online platform to disseminate climate information to policy makers, municipalities and farmers and the German Aid Agency (GIZ) collaborates with some *mancomunidades*, are members of their Climate Change and Gender Councils, and supports community adaptation practices such as water collection and storage, and compilation of traditional agricultural practices. However, some experts considered that most aid agencies do not fully understand the country socio-economic and environmental context. They thought that aid officers were more knowledgeable in the past than nowadays. They believed that most agencies work without a common agenda, establish their plans without considering the interested parts, do not monitor the impact of their actions on the ground, and the funding they provide is dependent on their governments' agendas and politics, and not on Guatemala's interests. They consider that aid agencies provide funding for climate change adaptation programmes but fail to understand traditional and local knowledge and do not promote it, thus constraining the success of their own programmes. One expert gave the example of one aid agency that supported the implementation of automatic meteorological stations but ignored the recurrent thunderstorms that break them down and the higher costs needed to fix them. Another aid agency provided funding to build water reservoirs but not to maintain them so they broke down and became useless. Other expert said that one aid agency supported financially a reforestation and management programme for forest protection and production but the latter aspect has been stigmatised

because the communities think their woods will be destroyed and they attack the forest service workers.

Experts in indigenous communities' worldviews The Maya priest considered "there has been little effort in understanding people and sometimes cooperation spend millions without any impact because they are not able to understand people." He judges "the cooperation can throw as many money into adaptation as they want but it will not be successful without understanding these [Guatemalan] issues". He considers that aid agencies, government agencies and NGO's do not articulate their plans and actions between themselves and points out the lack of participation of indigenous people in the design of national and regional programmes and strategies, and the little effort made by the agencies to include them, thus condemning the adaptation plans to failure.

Local-level stakeholders One technician from the *Mancomunidad* pointed out the short-term vision of aid agencies and considered the pressure they have to obtain immediate results is not compatible with the long-term vision needed at the regional and local levels. He stated "the work done by the cooperation agencies is not continued, not maintained and not monitored. It depends on the countries to fund it and one year it can happen but the next year it does not happen anymore." He thinks that aid agencies are contributing to small-scale farmers' inability to adapt: "too much cooperation has made the poor communities (campesinos) very dependent and not knowing how to walk by themselves as they have lost the capacity to adapt because they only wait for help." One technician from one municipality reflected "Sometimes I ask myself why the communities who receive more funds from cooperation are still so poor and have not developed". The case of one communitarian oven built with aid funding for people to make bread and which became idle after a while because there was no money to keep buying the ingredients was reported.

Small-scale farmers in the territories covered by the *Mancomunidades Nororient* and *Metropoli de los Altos* pointed out the failure of a national programme supported by an aid agency to promote the implementation of soil conservation practices and irrigation ditches in exchange for food. Farmers in the territory covered by the *Mancomunidad Metropoli de los Altos* also revealed they did not trust hybrid maize seeds provided by development agencies via local extension services because they did not know how these would perform in the field, they thought hybrid potato seeds did not produce resistant potatoes that would resist all year around, and they considered that hybrid wheat varieties were not adapted to climate change because yields they had got were low. Farmers would rather have native seeds easily available as they perceive these were less prone to pests and diseases than hybrid seeds.

Adaptive capacity

The Mancomunidad and the Climate Change and Gender Council

Local-level stakeholders attending the workshop embedded in the Climate Change and Gender Council hosted by the *Mancomunidad Nororiente* considered that the *Mancomunidad* and its Council offers a place for “learning about the actions implemented in the region by the different member organisations” and for “exchanging knowledge on project management at regional level”. They also mentioned the Council facilitated cooperation between regional stakeholders as it was a “good opportunity to share solutions to the problems faced by rural communities” and to “improving the relation with other member organisations working in the same territory”. Stakeholders also considered the Council “supported personal development and capacity building”.

Stakeholders also acknowledged the barriers constraining the implementation of the actions on the ground. One problem is the “intermittent municipality participation and limited budget to implement climate change actions” due to recurrent staff rotation in the municipalities. They also pointed out the “weak link between the actions strategically planned by the Mancomunidad and the required interventions at the local level”, the “lack of knowledge exchange about climate adaptation practices” and “cultural blockages” to implement the actions required.

Centres for the collection of indigenous knowledge

Experts on indigenous community worldviews The Maya priest considered the recent implementation of centres of knowledge to collect indigenous knowledge as a way of improving the communities’ adaptive capacity.

Adaptation practices at the farm level

Experts on land use and climate change. In terms of local-level adaptation measures, experts observed that large-scale sugar cane, banana and melon producers were now including crop residues in the soil and this was perceived as a good adaptation practice by improving soil fertility and water holding capacity. A small percentage of the sugar cane area was said to be converted to biodiesel and ethanol production in order to replace hydrocarbons by sugar cane by-products, responding to the country mitigation objectives. Banana producers were investing in efficient irrigation methods and building canals in concrete to save water. Large-scale farmers who occupied the fertile lowland areas are building new boreholes and deepening the existing wells to extract more water for irrigation in order to avoid harvest losses from drought.

Local-level stakeholders Members from rural communities did not think adaptation practices were widely implemented. One farmer in the region covered by *Mancomunidad Nororiente* mentioned he was replacing maize by lemon trees as a response to the harvest losses caused by the drought but several others said they were not changing their crops. In the region covered by *Mancomunidad Metropoli de los Altos*, farmers said that maize crops now require more irrigation to be viable and were contemplated replacing maize by other crops.

Discussion

Guatemala struggles with high exposure to natural hazards and high rates of poverty, malnutrition and maternal-child mortality, and it also has one of the highest rates of violent crime and of inequality in Latin America (USAID 2017). Climate change can amplify these risks, posing even greater challenges to long-term development goals in Guatemala (USAID 2017). In order to assess and effectively manage climate change risk, it is crucial to analyse how hazards, exposure, vulnerability and adaptive capacity interact, under societal constraints (Adger et al. 2018; IPCC 2014). For Brown (2018), a key step towards a better understanding of these interactions is to use system thinking to identify key linkages and the potential for critical transitions, including the role of people as modifying agents of ecosystems. This study aimed at unveiling the intricate nature of vulnerability to climate change and adaptive capacity in the agricultural sector in Guatemala through the collection of narrative information, including personal stories and testimonies, from a group of key experts, practitioners and farmers. By engaging with a wide range of stakeholders, risk assessment can include their valuable specialist knowledge, but also map out the transmission of risk across sectors and scales (Brown 2018). This study collected perceptions of changes in weather and its impacts, perceptions of factors affecting vulnerability in the agricultural sector and potential activities that might contribute to adaptive capacity.

Perceptions of changes in weather patterns and impacts

Most stakeholders in the study considered that weather patterns were changing. This was somehow expected as the fieldwork period coincided with the 2015/2016 drought, caused by the El Niño phenomenon, which was classified as one of the worst droughts in 35 years in Central America, with the Dry corridor region especially affected by widespread crop failure and food insecurity (USAID 2017). The extended *canícula* period, the reduced and more intensive rainfall periods and the unpredictability of the rainy season

were perceived by both experts and farmers around Quetzaltenango and Zacapa as unusual weather changes. Farmers in the Western Highlands of Guatemala also reported that *la canícula* has been more prolonged than in previous years and less predictable in its timing, resulting in pronounced crop losses (Hellin et al. 2017). Metcalfe et al. (2020) also found similar farmers' perceptions of weather changes in Mexico, concerning the timing of precipitation and its impacts on farmers' agricultural activities. Anderson et al. (2019) found statistically significant changes in *la canícula* start date and statistically significant increasing trends in *la canícula* end date (indicating a later end date and a delayed return of wetter conditions) throughout the Dry Corridor regions of Nicaragua and Honduras, as well as along sections of the Pacific coast in Guatemala.

Experts mentioned that indigenous people were reporting changes in rainfall as well as changes in animal behaviour, especially the behaviour of birds that predict the rain. Indigenous people are often very astute observers of changes in the natural environment (García-del-Amo et al. 2020; Ford et al. 2016; Johnson et al. 2016). Ford and Smit (2004) consider that increased unpredictability in animal behaviour prevents the elder and skilled in the community to be able to predict the weather as they did in the past.

Historical climate data for Guatemala confirms that the number of consecutive dry days has increased and the dry season is warmer and more prolonged, and precipitation has exhibited a decrease in monthly values, with the greatest reduction seen in June and August. However, average annual precipitation and the number of consecutive wet days do not show significant changes (World Bank 2021).

Experts and farmers noticed different impacts of climate change. Experts mentioned an increase in the incidence of coffee leaf rust, causing greater harvest losses and leading to rural unemployment and migration. Avelino et al. (2015) considered climate change as the main cause of the past coffee rust crisis in Central America, however, even though a direct link between climate change, rural unemployment and migration, has already been established in grey literature (e.g. Wernick 2019; Lakhani 2019). People are dying: how the climate crisis has sparked an exodus to the USA (The Guardian, 21 July 2019. <https://www.theguardian.com/global-development/2019/jul/29/guatemala-climate-crisis-migration-drought-famine> 2019) Some authors (e.g. Conway et al. 2019; Eakin et al. 2006) consider that migration is a complex phenomenon that cannot be attributed to individual factors. Farmers mainly reported harvest losses in maize production. Crop losses, including maize and beans, by subsistence farmers in the Dry Corridor of Central America, were widely reported by the FAO (2016, 2017, 2019a, 2019b).

Vargas et al. (2018) simulated the effects of drought in Guatemala and found the most negative effects would be concentrated in agriculture, given its intensive use of water,

with considerable risks to food security. The USAID (2017) informed that higher temperatures and more variable rainfall will hamper agricultural productivity, increasing the risk of food and water insecurity among the most vulnerable, particularly indigenous groups, who are mainly subsistence farmers in remote geographic areas and represent at least 40% of the population.

Perceptions of factors affecting agricultural vulnerability to climate change

In this study, land distribution was mentioned by experts as a factor contributing to rural communities and farmers' vulnerability to climate change. Land tenure might be considered central to vulnerability and resilience research but it is often overlooked (Chagutah 2013). Experts linked inequalities in the distribution of fertile land to social problems such as land invasions and land grabs of indigenous communal land and also to rural communities' and farmers' low capacity to adapt to extreme weather events (e.g. droughts). In Central America, small-scale farmers cultivate mainly marginal and steep areas from which they depend for both food security and income generation (Hellin and Schrader 2003). According to experts, while large-scale farmers were investing in irrigation and soil conservation practices and were adapting their production to the demands of the national and global markets, small-scale farmers were only able to change their crops. Insecure land and water rights may, in fact, be limiting farmers' capacity to adapt as these are an obstacle to the conversion of land to alternative uses (Feliciano 2019; Tucker et al. 2010). Experts highlighted that the insecurity in land rights especially affects indigenous communities who are excluded from land management agreements and official land decision-making processes.

Another source of vulnerability to climate change pointed out by experts is related to cash crop production for the international markets. According to most experts, this activity is replacing the production of traditional crops, only provide seasonal jobs, it excludes small-scale farmers from international markets, and it causes environmental degradation. The latter, can in turn partly determine the intensity or recurrence of hazard events (Cardona et al. 2012), and consequently, aggravate the risk posed by climate change to rural communities and farmers (Brown 2018). Experts also pointed out potential cascading effects to rural communities and small-scale farmers resulting from the increasing production of cash crops in Guatemala, namely food insecurity, difficulties in access to land and water resources and unreliable jobs with consequent migration and dependence of community members from family remittances. One expert, however, believed that cash crops such as sugar, banana and palm oil could provide formal jobs and access to health care. Achterbosch et al. (2014), for example, consider that farmers

and/or workers can earn an income by growing cash crops with which they may purchase a wide variety of food, thus improving the food access dimension of food security. It may be that cash crop production is especially adverse for small-scale farmers and rural communities when it is linked to large-scale land acquisition and/or land grabbing, and consequently to the relegation of small-scale farmers to marginal lands and marginal positions, limiting their capacity to adapt to climate change and exacerbating food insecurity. Isakson et al. (2014) also established a correlation between the production of cash crops and the loss of native maize production in Guatemala and Hervas (2020) observed that oil palm production, another cash crop, has compromised native maize farming by pushing up labour costs, heightening social tensions and taking over scarce land resources. The loss of native maize varieties was, in fact, a source of concern for many experts in this study, who considered this was limiting farmers' coping capacity to deal with adverse weather conditions as these varieties were more resistant to harsher climate.

Institutions such as extension services, governmental environmental and agricultural agencies, and international development agencies, who could strongly contribute to reducing vulnerability and improving the adaptive capacity of rural communities and small-scale farmers were, however, believed to have marginal or even no role in this. According to experts consulted in this study, the government underfunds data collection, agricultural research, seed banks and grain storage programmes, and neglects traditional and indigenous knowledge. In fact, public institutional capacity did severely deteriorate as a consequence of the structural adjustment measures introduced during the 1980–1990 decade, ignoring severe inequality problems that significantly reduce or close the already limited institutional capacity to attend to such problems instead of transforming and tackling them.

Many aid agencies working in the country try to cover for these deficiencies and their staff undertake data collection and agricultural research, and provide advice to small-scale farmers and communities, and help them implement their programmes on the ground. However, these were considered by many stakeholders to have deficient knowledge about the local context, to have a short-term rather than long-term planning approach, to fail in maintaining the projects and to fail in including indigenous communities in their decision-making processes. Ley (2017) also found deficiencies in the approaches taken by development agencies in Guatemala. This author investigated aid-funded decentralised renewable energy projects and found that poor technical design and lack of appropriate operation and maintenance protocols have prevented these projects from meeting their sustainable development goals. Arndt and Tarp (2017) consider that aid architecture was primarily designed to assist poor

people in poor countries without considering global environmental issues and therefore was not currently suitable to address climate change-related issues. Eriksen et al. (2021) highlight that internationally-funded interventions aimed at climate change adaptation and vulnerability reduction inadvertently reinforce, redistribute or create new sources of vulnerability due to shallow understanding of the vulnerability context, inequitable stakeholder participation in both design and implementation, a retrofitting of adaptation into existing development agendas, and a lack of critical engagement with how "adaptation success" is defined. A review on foreign aid and poverty reduction undertaken by Mahembe and Odhiambo (2019) have found, however, that foreign aid has a positive impact on poverty, especially when aid is targeted at pro-poor public expenditures such as agriculture, education, health and other social services, and when it is spent in production sectors, infrastructure and economic development. This review, however, does not consider the contribution of aid agencies to the adaptive capacity of rural communities or small-scale farmers, even though it can be expected that by having a positive impact in reducing poverty, foreign aid can increase peoples' capacity to cope with climate change.

Extension services, which could have, on its turn, a continuous role on knowledge sharing and exchange about climate change risk (Ali and Erenstein 2017), were halted during a relevant period of time by the government. And even though, these have been re-established more recently in Guatemala, their new approach was considered "top-down" by most stakeholders consulted in the study, and therefore, the advice provided was hardly taken up on the ground. "Top-down" approaches, which include external people coming and telling communities what to do, have already been discouraged by Raymond et al. (2010) who, instead suggest social learning and the development of a dialogue between local communities, including indigenous people, government representatives and researchers. Lawrence et al. (2020) recommend persuasion rather than enforced compliance in extension, advice and knowledge systems.

Local-level government interventions could also decrease the vulnerability of people directly affected by climate-related events by providing better infrastructure and easy access to inputs, markets and information services (Abid et al. 2016). However, this study found that at the municipalities, constant staff rotation constrained the institution's capacity to implement climate change-related plans and actions and that, at the community level, the *Cocodes* were considered ineffective to address climate change risk reduction as they were more focused on lobbying for grey infrastructure. The International Union for Conservation of Nature already noticed a lack of coordination between the local authorities and the national government in Guatemala, which results in weak governmental presence, uncoordinated policies, inadequate environmental laws and regulations,

complex land rights system, budget restrictions, low stakeholder participation, little or no community organisation and limited transparency (Nehren et al. 2014). Metcalfe et al. (2020) also verified that recurring changes in administrations at the municipal level led to the absence of monitoring and evaluation of climate change actions and programmes in Mexico. DiGregorio et al. (2019) found institutional and political barriers to multi-level governance of climate change adaptation in the land-use sectors of Brazil and Indonesia.

The role of mancomunidades and the climate change and gender council in promoting adaptive capacity

The establishment of watershed committees, the strengthening of farmers' and women's associations, the promotion of the land organisation and the improvement of the administration and coordination capacity at the local level has long been recommended by the United Nations Development Programme to reduce the vulnerability of small-scale farmers (UNDP 2000). The *mancomunidades*, and their climate change and gender council, could, in Guatemala, play a key role in mediating the transformation of coping capacity into adaptive capacity. In this study, different stakeholders attending the workshop held at the climate change and gender council organised by the *Mancomunidad Noriente*, in Zacapa, considered the Council an important platform for knowledge exchange and to promote collaboration with other organisations in the assessment of risk and vulnerability, and in the design of risk reduction strategies, such as sharing information about effective farm adaptation practices. The *mancomunidades* could, therefore, be important at integrating multi-level adaptation since they connect multi-stakeholders and are more independent from political parties than individual municipalities and act across multiple scales through their network of stakeholders. These institutions could bridge "high level" (e.g. World Bank, USAID, Government) and "lower level" (e.g. communities, *Cocodes*) risk assessment by facilitating interaction with people or groups operating within different institutional and professional cultures, and by creating opportunities for the discussion of different perspectives (Guido et al. 2016). DiGregorio et al. (2019) consider that such innovative institutions should be strongly encouraged to integrate weaker local level interests, especially of indigenous people and small-scale farmers, in centrally dominated policy processes. Ley (2017) defends that communities with a governance structure, or some form of community participation, will be better able to cope with a natural disaster than others where no governance structure or participation exists. Andersson et al. (2005) claim that if local politicians see potential financial or political benefits associated with environmental governance, they are more likely to be active in such activities.

Conclusions

Detailed vulnerability assessments are required to better improve risk identification, to implement risk management strategies and to monitor climate change risk reduction. This research interacted with a limited number of stakeholders, including key experts, local politicians, technicians, members of rural communities and small-scale farmers, in Guatemala, in order to better understand which factors are perceived to affect climate change risk. Perceptions of climate change-related hazards and its impacts, of factors contributing to the vulnerability of rural communities and small-scale farmers, and the elements that may contribute to their adaptive capacity, were assessed.

The failure by the government, extension services, development agencies and local level organisations in reducing vulnerability to climate change and in increasing adaptive capacity, was greatly pointed out by most stakeholder types. The government was perceived to have low or no interest in climate change at the same time that it was perceived to be underfunding data collection and failing to protect, promote and support traditional and indigenous knowledge. The Climate Change Framework Law was perceived to have been poorly disseminated at the regional and local levels, this constraining the implementation of the framework law on the ground. Local-level organisations such as the *Cocodes* were also perceived to have no interest in climate change risk reduction, neither in the improvement of the adaptive capacity of rural communities and of small-scale farmers, who represent most of the population in Guatemala. The extension services were perceived to have a top-down approach by small-scale farmers and indigenous communities. Aid agencies were perceived to have a lack of knowledge about the local context, and short, rather than long-term vision. These factors, combined with the high exposure of rural communities and small-scale farmers, were perceived to be contributing to their difficulty in anticipating, coping with, and recovering from the impacts of climate change, and therefore limiting their capacity to adapt and to mitigate climate change risk.

The *mancomunidades* and their climate change and gender councils could support governmental and non-governmental institutions to reduce climate change risk of rural communities and small-scale farmers as their main objective are to promote the common good, their focus is on transboundary issues, for which actions need to be coordinated at the inter-municipal level, they are especially aware of the challenges posed by climate change, they are not as dependent on

political parties as to the municipalities and they are able to congregate a wide range of regional stakeholders to discuss common and complex problems. They can play an important role in promoting cross-scale interaction at the national, regional and local levels in the territory they cover, and are probably well placed to reconcile “top-down” with “bottom-up” climate risk assessments. Additionally, they could coordinate the implementation of climate change risk reduction strategies among aid agencies, NGO’s, municipalities, farmers’ and women’s associations, researchers and other interested parties. The role of the *mancomunidades* in climate change risk reduction in Guatemala deserves, however, further research.

One major concern of this research is the lack interaction with indigenous communities, as the only contact with indigenous worldviews was through a Maya priest. This coincides with their lack of participation in most decision-making processes in the country and their lack of capacity to access resources and to escape poverty. The interaction between indigenous knowledge centres and the climate change and gender councils could be an effective way to promote and increase indigenous people participation, and as required by the National Climate Change Policy (MARN 2009), and later the Climate Change Framework Law, which states: “Create conditions to favour, promote and strengthen the participation of indigenous people in the implementation of the climate change policy and its strategies”. Indigenous people constitute about 44% of the population in Guatemala, so it is crucial that adaptation plans take into account their specific context and culture, and especially, that traditional knowledge is recognised as a valuable resource in complementing gaps in climate data, trends and impacts. It seems also essential to improve land access for the poor. The landless are often considered more vulnerable to climate change because their livelihoods, including access to food, are less secure. This problem should be addressed at the national level if climate change risk reduction is to be properly tackled in Guatemala.

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