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The limits of climate services for food security in Guatemala: discourse, scales, and institutions

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The limits of climate services for food security in Guatemala: discourse, scales, and institutions

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Résumé

Les services climatiques (SC) sont un outil climatique moderne utilisé pour informer les usagers et aider à la prise de décision en fournissant des prévisions climatiques subsaisonnières et saisonnières. Au Guatemala, l'institution météorologique nationale et le ministère de l'agriculture, de l'élevage et de l'alimentation, avec l'aide internationale, mettent en œuvre les SC depuis 2017 par le biais de comités techniques agroclimatiques locaux visant à améliorer la sécurité alimentaire et l'adaptation au changement climatique. Ces comités sont des espaces de dialogue dans lesquels divers participants traduisent et transfèrent des connaissances climatiques modernes par le biais de la participation et de la collaboration. Bien que la plupart des efforts de mise en œuvre des SC visent à améliorer la communication et à les rendre localement pertinentes pour les petits agriculteurs et les paysans, cette thèse se concentre sur les intermédiaires et les institutions impliqués dans la production, la traduction et le transfert des SC. Grâce à une triangulation de méthodes comprenant des entretiens semi-structurés avec des acteurs clés, un travail d'archivage des politiques et des rapports gouvernementaux, et une approche d'observation participative dans les forums, les réunions et les comités techniques agroclimatiques locaux, cette recherche reflète les défis auxquels sont confrontés les défenseurs et les techniciens des SC pour donner un sens aux différences incommensurables de l'infrastructure climatique et du régime de la politique alimentaire. Cela signifie que les défenseurs des SC doivent naviguer entre deux régimes politiques différents, l'un concerné par le changement climatique et l'autre par l'insécurité alimentaire dans un système alimentaire guatémaltèque qui exclut la majeure partie de sa population. Les données empiriques montrent que sur le terrain, les attentes concernant l'utilisation des connaissances climatiques pour la sécurité alimentaire se heurtent à de nouveaux défis et limites (par exemple, les échelles et la temporalité, entre autres). Cependant, les initiatives des SC continuent à bénéficier d'un certain degré de confiance de la part d'institutions qui reproduisent et négligent les effets des problèmes structurels d'oppression tels que le colonialisme, le capitalisme et le patriarcat dans les SC. Dans l'ensemble, cette thèse réfléchit à la possibilité de réimaginer les SC comme un instrument capable d'intégrer la recherche alimentaire pour informer une politique alimentaire plus large et soulager les petits agriculteurs, les paysans et les intermédiaires de la responsabilité individuelle - le poids - de la lutte contre le changement climatique et l'insécurité alimentaire.

Mots clés : services climatiques, Guatemala, sécurité alimentaire, institutions, changements climatiques, discours, échelle

Abstract

Climate services (CS) are a modern climate tool used to inform users and decision-makers by providing sub seasonal and seasonal climate forecasts. In Guatemala, the National Meteorological Institution and the Ministry of Agriculture, Husbandry, and Food along with international assistance have been implementing the CS since 2017 through the implementation of the Local Technical Agroclimatic Committees that aim at improving food security and adaptation to climate change. These committees are spaces of dialogue in which various participants translate and transfer modern climate knowledge through participation and collaboration. Most efforts of implementing CS aim at improving communication between experts and users and producing locally relevant information to assist small farmers and peasants. In contrast, this dissertation focuses on the technicians, CS advocates, and the institutions involved in producing, translating, and transferring the CS. Through a triangulation of methods that include semi-structured interviews with key actors, archival work of governmental policies and reports, and participatory approach in forums, meetings and Local Technical Agroclimatic Committees, this research identifies and reflects the challenges that CS advocates and technicians undergo to make sense of the tensions between the future oriented climate data and everyday challenges of the food system. This means that CS advocates must navigate two different policy regimes, one concerned with climate change and the other with food insecurity in a Guatemalan food system that excludes most of its population. Empirical evidence shows that on the ground, expectations about the use of climate knowledge for food security are met with new challenges and limitations (e.g. scales and temporality, among others). However, the CS initiatives continue to enjoy a degree of trust from institutions that reproduce and neglect the effects that structural issues of oppression such as colonialism, capitalism and patriarchy have in the CS initiatives. Overall, this dissertation reflects on the possibility of reimagining the CS as an instrument capable of integrating food scholarship to inform wider food policy. It also suggests moving beyond its local relevancy to relieve small farmers, peasants, and the middlemen from the individual responsibility -weight- of tackling climate change and food insecurity on their own.

Keywords: climate services, Guatemala, food security, institutions, climate change, discourse, scales

Resumen

El servicio climático (SC) es una herramienta climática moderna utilizada para informar a los usuarios y asistirles en la toma de decisiones mediante el suministro de pronósticos climáticos subestacionales y estacionales orientados. En Guatemala, la Institución Meteorológica Nacional y el Ministerio de Agricultura, Ganadería y Alimentación junto con la asistencia internacional han estado implementando los SC desde 2017 a través de las Mesas Técnicas Agroclimáticas con el objetivo de mejorar la seguridad alimentaria y la adaptación al cambio climático. Estos comités son espacios de diálogo en los que varios participantes traducen y transfieren conocimientos climáticos modernos a través de la participación y la colaboración. Aunque la mayoría de los esfuerzos de implementación de los SC tienen como objetivo mejorar la comunicación y hacer que los SC sean localmente relevantes para los pequeños agricultores y campesinos, esta disertación se centra en los intermediarios e instituciones involucrados en la producción, traducción y transferencia de los SC. A través de una triangulación de métodos que incluyen entrevistas semiestructuradas con actores clave, trabajo de archivo de políticas e informes gubernamentales, y un enfoque participativo en foros, reuniones y Mesas Técnicas Agroclimáticas, esta investigación reflexiona sobre los retos a los que se enfrentan los defensores y técnicos de la SC para dar sentido a las inconmensurables diferencias de la infraestructura climática y el régimen de política alimentaria. Esto significa que los defensores de la SC deben navegar dos regímenes políticos diferentes, uno preocupado por el cambio climático y el otro por la inseguridad alimentaria en un sistema alimentario guatemalteco que excluye a la mayoría de su población. La evidencia empírica muestra que, sobre el terreno, las expectativas sobre el uso del conocimiento climático para la seguridad alimentaria se encuentran con nuevos retos y limitaciones (por ejemplo, las escalas y la temporalidad, entre otros). Actualmente, las iniciativas de los SC gozan de cierto grado de confianza por parte de instituciones que tienden a descuidar los efectos que los problemas estructurales como el colonialismo, el capitalismo y el patriarcado tienen en el programa. En general, esta disertación reflexiona sobre la posibilidad imaginar los SC como un instrumento capaz de integrar los estudios alimentarios para incidir con una política alimentaria más holística. La tesis sugiere que al reducir la importancia de generar SC que sean localmente relevantes puede aliviar la responsabilidad -peso- individual de pequeños agricultores y funcionarios públicos de abordar el cambio climático y la inseguridad alimentaria individualmente.

Palabras clave: servicios climáticos, Guatemala, seguridad alimentaria, instituciones, cambio climático, discurso, escala

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List of Acronyms

ANACAFE: Asociación Nacional del Café (National Coffee Association)

CS: Climate Services

CEPREDENAC: Centro de coordinación para la prevención de desastres en América Central y República Dominicana (Coordination Center of Central American and Dominican Republic for Disaster Prevention)

CIAT: *Centro de Investigación de Agricultura Tropical* (Tropical Agriculture Research Center)

FAO: Food and Agriculture Organization

FEWSNET: Famine Early Warning Systems Network

GFCS: Global Framework for Climate Services

ICC: *Instituto Privado de investigación de Cambio climático* (Climate Change Research Institute)

INSIVUMEH: Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología de Guatemala (National Institute of Seismology, Volcanology, Meteorology and Hydrology)

LTAC: Local Technical Agroclimatic Committee

SESAN: Secretaría de Seguridad Alimentaria y Nutricional de la Presidencia de la República (Presidential Secretary of Food Security and Nutrition)

SMC: Sistema de Monitoreo de Cultivo (Crop Monitoring System)

MAGA: *Ministerio de Agricultura, Ganadería y Alimentación* (Ministry of Agriculture, Husbandry and Food)

WMO: World Meteorological Organization

WFP: World Food Program

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For the Nicaraguan students whose dreams and lives were stolen by the regime,

For the exiles who suffer in silence.

1 Climate services: a response to climate change and food insecurity in Guatemala

1.1 Introduction

Since its first appearance in Guatemala in 2017, the modern climate instrument known as climate services (CS) has seen a growth in demand from several national and international institutions that operate in the country. CS can be described as a tool capable of providing sub seasonal (3-5 weeks in advance) and seasonal (up to 6-7 months ahead) climate forecast adapted to the needs of society. In Guatemala, CS are developed and implemented through collaboration between the National Meteorological Institution, the Ministry of Agriculture, and the Tropical Agriculture Research Center (referred to as CIAT for its initials in Spanish). Its appeal amongst the CS advocates and technicians comes from the premise that making modern climate knowledge available to small farmers and peasants will allow them to make informed and rational decisions on agricultural production to tackle climate change and widespread food insecurity. Recently, the inter-institutional report: *Capacidades de los servicios climáticos en Guatemala: Implementación del Marco Nacional para los Servicios Climáticos* suggests maintaining wide institutional collaboration, training all the population in the CS, and having the National Meteorological Institution as the leading institution (A. García et al., 2023).

The main product of the CS is the agroclimatic bulletin, which is a short report, tailored for groups of people like small farmers and peasants. Every three months, the CS advocates will gather participants in groups called Local Technical Agroclimatic Committees to coproduce the agroclimatic bulletins. These digitalized bulletins are later shared with the participants -and hopefully other people- through WhatsApp groups and institutional websites. CS advocates emphasize that each bulletin contains locally relevant meteorological data and agricultural advice. Although these committees are expected to include technicians, scientists, academics and small farmers from the locality of interest, their configuration mainly responds to the existing relations between the actors involved. Additionally, when defining the "local" in locally relevant CS, the Local Technical Agroclimatic Committees respond to the political jurisdictions and do not consider climatological conditions, watersheds or other social or natural criteria.

Regarding the content of the CS, the meteorological data comes in the form of meteorological charts, and thematic cartography like the one shown below in Figure 1. This image in particular shows the anomaly in the percentage of expected rainfall in the months to come. Despite the claim of local relevance, we can observe the quality of the image and the challenge that users will have to locate their municipalities, villages or farms. An extra challenge came from those municipalities located in between two or more isohyets. As chapter three further develops, these kinds of discussions were brought forward by the crop advisors in charge of transferring the agroclimatic bulletins and providing advice to small farmers.





Anomalía porcentual (%): Se muestra la desviación en porcentaje de la precipitación total estacional más probable con respecto a la climatología 1991-2021.

En el norte, este y oeste de la región, centro se esperan porcentajes mayores a 80%. En el centro y sur de la región se esperan porcentajes entre -20% y 40%.

Figure 1. Percentual abnormality in precipitation. Source, MTA Centro December 2022 to March 2023. p. 4

Although CS have gained popularity in Guatemala, they also enjoy global support. The rise of climate phenomena and environmental hazards around the world has triggered numerous projects of adaptation that make use of CS to tackle climate change in the global North and South. The World Meteorological Organization through the Global Framework for Climate Services has had an active role in raising awareness of the existence of CS and their potential to better inform decision makers on diverse sectors such as health, energy, water,

disaster risk reduction, and food (World Meteorological Organization, 1974, 1977, 2010, 2014d, 2014e). As a result, efforts of implementing CS in Latin America (Euroclima+, 2019), south-east Asia (Ewbank & Aid, 2016; Webber, 2015), and Africa (Andersson et al., 2019; van Huysen et al., 2018) have been made over the past decade.

However, despite having a straightforward goal of providing tailored information to better inform its users and improve livelihoods, the process of implementing CS comes with several challenges. CS advocates therefore have identified and worked on three instances of the CS cycle which include the *production* of climate data - both in quality and quantity -, the translation of climate data into information, and the capacity to transfer climate products to the users, which focuses on reaching potential users and increasing the demand for CS. Each of these sites of interest involve different challenges regarding the technical constraints in the generation and improvement of climate data (González, 2019; Navarro-Racines et al., 2020), issues with communication (Beveridge et al., 2018, 2019; Haines, 2019), coproduction of knowledge (Haile, 2005; Muller, 2014), scales (Vaughan et al., 2016, 2019), managing expectations (Lahsen, 2004; Semazzi, 2011), policies (Harjanne, 2017), building trust among users, or dealing with a heterogenous range of users and potential users who are involved in its development and implementation (Skelton et al., 2019). In other words, while climate knowledge and agriculture go hand in hand, implementing CS in food security programs has not been as straightforward as the CS advocates would wish.

In this manner, the vast majority of research and CS initiatives in the global South have focused on developing the users' capacity to learn about climate change and understand modern climate information to modify agricultural practices (Dayoub et al., 2018; Paparrizos et al., 2023). Therefore, improving communication between the scientific community and the users on the one hand, and evaluating the reach and effects that CS have on small farmers on the other, have become central to the pertinence of the CS products and CS advocates (Tall et al., 2018).

In contrast to the efforts that focus on reaching the users (A. García et al., 2023), this thesis aims at providing a new perspective by turning its gaze away. It offers an alternative

approach that focuses on the institutions and the technicians who reproduce and reinforce the CS discourse through their daily work of production, translation, and transfer of the CS in Guatemala. This research also offers an approach that aims at visualizing how the middlemen, as I refer to the governmental officials such as technicians and CS advocates, navigate between the expectations generated by the creation of future scenarios provided by the meteorological data, and the urgent need of food and generalized precarity. The middlemen are also characterized for having small aliquots of power as they put policies into action, yet also struggle with precarious jobs as I will discuss in chapter five.

In other words, this dissertation is not interested in evaluating the performance of the CS, or in understanding how and what CS users expect from such products – plenty of research has already been done on this in Guatemala and elsewhere- but on what the CS advocates understand about food insecurity and the food system, what they think about the CS initiative, how they measure its success, and about the role and capacity they have of addressing food insecurity and other structural issues. In other words, this research is interested in identifying the implications of implementing CS for food security. To do so, it reconciles the CS discourse that CS advocates vocalize and reproduce with wider food scholarship that is concerned with the food system. For the discussion of CS and food security, this is relevant because this exercise of conciliation has been absent from the CS research in general.

1.2 Research question

While this research is interested in food security and draws upon food scholarship, the main contribution is aimed towards the discussions that the CS community is having regarding the implementation of locally relevant CS. As the CS bring together scientists and technicians with users (e.g. small farmers and peasants), relations of power between the participants tend to draw attention from the CS community and social scientists. There are, however, other aspects left unquestioned such as the tensions created between the climate knowledge producers and the food system that this research explores.

In this context, the research question and secondary questions have been formulated and reformulated in a way that they involve the middlemen. This work therefore acknowledges that the role the CS advocates and technicians have in strengthening and disseminating the CS discourse is central to the development of the discussion. The question that guides this work is: what are the implications of implementing CS for food security in Guatemala? In other words, the question demands to inquire on the logistical and epistemological challenges the middlemen face and identify the side-effects their practices generate. Always in relation to the middlemen, other questions that guided this work included knowing where and how modern climate knowledge and food production for food security come together. Where do they meet? More explicitly, how do CS advocates understand the food system they are working on? To what extent does implementing CS respond to food security? How can general discussions on food scholarship inform future CS initiatives and research? And why does the CS have to be locally relevant to have any value?

1.3 Context

This research explores the implications of implementing CS in agriculture. To do so, it focuses on Guatemala for two reasons. First, in the Central American region, Guatemala has extensively implemented the Local Technical Agroclimatic Committees (LTACs) and produced the agroclimatic bulletins (see Figure 2) to cover 100% of the Guatemalan territory. One of the reasons that Guatemala is leading the CS initiative is due to the support that CS advocates receive from dozens of NGOs, researchers, and several national and international organizations working on food security over the years. Since 2017, the CS initiative has continued to grow despite COVID-19 restrictions, lack of personnel, and economic challenges. The agroclimatic bulletins are coordinated by the Ministry of Agriculture, Husbandry and Food (MAGA), but generated and communicated by the National Institute of Seismology, Volcanology, Meteorology and Hydrology (INSIVUMEH) and offer an important source of information. Having the possibility to observe the institutional process of implementing CS is both interesting and important because it allows me to examine how the institutions involved in the process agree on, or struggle and deal with their inherent differences and diverging goals.



Figure 2. Agroclimatic bulletin for Zacapa for the months of August and October 2021. Source: INSIVUMEH

Second, Guatemala also offers an exhaustive and fertile area of research related to food insecurity and hunger that allows further insight, perspectives, and different case studies (Conde-Caballero, Lorenzo, et al., 2021; J. L. García & Juárez, 2006). Research regarding food security in Guatemala can be traced back to the 1950s. By those years, the food geographer Josue de Castro (1952) claimed that food insecurity was in part produced by a monotonous diet, but he also argued that Spanish dominion and the *latifundio* had created unequal land distribution. The issue with land dispossession and unequal access to resources has also been acknowledged as one of the main factors contributing to food insecurity in other studies (Oficina de Derechos Humanos del Arzobispado, 2005). In contrast, most governmental efforts support the idea of modernizing rural Guatemala through development programs as a way of tackling food insecurity (Ministerio de Agricultura, 2016, 2021; Sistema Guatemalteco de Ciencias del Cambio Climático, 2019). In this manner, researchers have reflected and explored the mechanisms used by the government and NGOs that usually focus on the technification and modernization of the country side (Copeland, 2019b) to increase the yields of production. In this line of development, other scholars have evinced governmental efforts that have resulted in land dispossession and displacement by the military (Grandin, 2011; Shriar, 2002). Other

studies have identified lack of sanitization, access to water and protein ingestion (Cleaves & Tuy, 2015) resulting in the development of nutritional supplements for children (e.g. Incaparina¹ and recently the production of flour from Maya traditional seed of Ramon tree, *Brosimum alicastrum sp*²). In contrast, the Guatemalan social scientist of rural development José Pablo Prado (Prado-Córdova, 2011; Prado-Córdova & Bailey, 2021) stated that, to understand hunger in Guatemala, we have to look into Guatemala's history, the objectification of food, and the way Guatemala articulates with the capitalist world system. His Marxist approach allows further questioning and provides an entry point to tackle the country's national food system.

When it came to mapping the stakeholders involved in the CS cycle, the variety and number of participants also posed a challenge for this research. In Figure 3 below, I show some of the different institutions and actors that work either in the food system to improve food security or in the climate infrastructure to develop climate knowledge. The arrows in blue convey how different policies, ideas and discourses are usually directed and where they are originated. For instance, when it comes to the CS discourse, this can be traced back to the World Meteorological Organization and is directed to both, the Institute of Meteorology first and the Ministry of agriculture after (in other countries they include the energy, health and tourism sectors). As this dissertation will show, the influence that discourse has in the process tends to either overshadows national topics and challenges such as the economic constraints, discussions on food sovereignty or land dispossession, or can overlap with other institutional motives and goals that not always align with interests of small farmers and peasants. Although this figure is uncapble of reflecting the relations of power the different ministries have with the Guatemalan population it reflects a simplified version of where the CS are expected to work and enables us to identify the main institutions involled in the initiative and the relation they have with each other, to food security, climate science and climate services. It also identifies stakeholders that have a secondary role in the implementation of CS (more in chapter two). Secondary stakeholders might collaborate

¹ Incaparina is a food supplement created by a Guatemalan biochemist Ricardo Bressani in 1959. This nutritional powder contains the needed minerals and vitamins that lack in the diet.

² This is a new nutritional supplement, produced by women in Peten, Guatemala and winner of the *Premio Ecuatorial 2006* (United Nations Development Program, 2012)

with information -like FEWSNET or WFP- but they might also be only invovled in the difussion of the CS.



Figure 3. Stakeholders and governance

In this context, the implementation of CS in Guatemala also responds to a couple of challenges and characteristics worth mentioning. On the one hand, whereas Guatemala produces food surplus, meaning that it produces more food than the national caloric demand, it is a country with neoliberal policies characterized by having one of the highest levels of child malnutrition in the world and doubles the regional average of Latin-America and the Caribbean (see Figure 4). On the other hand, Guatemala has also become one of the most vulnerable countries to environmental hazards caused by climate change (Kreft et al., 2014). The natural cycles of floods and droughts are becoming more intense and severe. From this context, a battery of international actors ranging from non-governmental organizations to universities, and to the USAID, the United Nations Development Program, and the Food and Agriculture Organization (FAO), among others, have pushed forward programs of adaptation, resilience, and risk management to improve small-scale farmers and small coffee growers' food security and wellbeing. Among these efforts, the development of early warning systems for droughts is now being promoted by the Disaster Risk Reduction community which includes the Coordination Center of Central American and Dominican Republic for Disaster Prevention (known as CEPREDENAC) and INSIVUMEH. In recent years, Guatemala's meteorological institute has created the Climate Services and Research Department to develop daily reports, and three-month based bulletins on climate forecast and food production.



Figure 4. Malnutrition of children under 5 years of age. Guatemala (2008) and other regions (2000-2006). Source: Cleaves & Tuy. 2015:29

Throughout this thesis, I will show how most of the efforts that CS advocates undergo aim at improving the quality of the climate data, teaching about climate change and other meteorological concepts, raising awareness of the existence of CS, and promoting its use. As a result, logistical efforts of vulgarizing and co-producing knowledge have intrinsic value to the existence of CS and the relevance of the national meteorological institution. These efforts tend to overshadow the original goal of improving the livelihoods of peasants and small farmers as well as other challenges. Through this cycle, the importance of creating locally relevant climate information also becomes vital to draw attention and increase the demand.



Crop advisors

Figure 5) I present the CS cycle. In the inner circle in blue, I show the three main activities that CS advocates oversee. In the squares, I describe the mechanisms used behind said practices. These goals are important to address because they do not always align with food security or food policy. This diagram also responds to and reinforces the CS discourse regarding the use of climate science for food security. As CS advocates -in their own scientific community- claim that CS can improve food security in a growing context of weather variability and climate change they first focus on producing and improving climate data to provide a range of climate information for potential use. At this moment, the CSs advocates focus on contacting other institutions to generate collaboration and reach potential users. Then, on a second phase, CS advocates work with potential users and several organizations to translate the climatic data into useable and locally relevant information. This also means that CS advocates raise awareness over the existence of CS by implementing a top-down, bottom-up approach. They do so by deploying the LTACs to coproduce tailored information and produce agroclimatic bulletins for *departamentos* and municipalities. The third phase of the process refers to the communication and transfer of the CS to the end-user. They do so with the support of the crop advisors and the agroclimatic bulletins. Overall, this process creates collaboration and increases the number of users and participants with which CS advocates reinforce their CS discourse by increasing the demand of their products.

1.4 Research objectives:

In regards to the theoretical aim, this dissertation responds to a need of expanding the paradigm that allows new systems of knowledge, sharing understanding, and agreeing on polysemic concepts used in the programs of development (Beveridge et al., 2018). Drawing upon food scholarship debates can inform the CS discussions and provide better ways of addressing the CS initiatives on food security. As a geographical work, it also reflects on the scale of implementation by putting into question the efforts of delivering locally relevant CS and the process through which these scales are decided upon. What this means is that while producing locally relevant CS information is desired, integrating other scales into the analysis can provide new discussions, insights, and valuable knowledge. To

produce locally relevant CS also requires focusing on the middlemen, which includes researchers, technicians, and decision-makers at an institutional and national scale.

1.4.1 Objectives

1. Examine the process of implementation of CS for food security in Guatemala.

This objective explores the CS cycle and how CS advocates operate. Some of the questions include: Who participates in the CS implementation process? What are their beliefs? What do they consider and what do they neglect? How do CS advocates understand the Guatemalan food system? Is the Guatemalan food system taken into account in the process of developing the agroclimatic bulletins? If it is, how?

2. Explore the relations of power through knowledge that exist between Guatemalan institutions and the scientific communities that are involved in climate forecast and food security.

In the process of developing the agroclimatic bulletins, who decides about the content and information that is used? Who contributes to the discourse of CS? How are the discussions shaped and guided by CS advocates?

3. Examine the effects that the implementation of CS have in shaping the discourse of food security programs in Guatemala.

By exploring the implications of implementing CS for food security in Guatemala, these objectives aim to reflect on what it is to be expected from CS. What are the side-effects generated by the current ways in which CS are being deployed? Instead of evaluating if the CS are well communicated or if they are heeded by the farmers, the research reflects on wider unexpected effects.

1.5 Literature review: the development of climate services and its implementation for food security

The development of modern climate knowledge and its subsequent implementation in health, water, disaster risk reduction, agriculture and energy have a relatively short history. Although technological advance in the past decades have been undeniable and vital for its development and reach (Lynch, 2008), in the past century prominent climate scientists such as Bjerknes, Rossby and Wexler have created a strong institutional apparatus that facilitates communication and improves global climate knowledge (Edwards, 2010; Fleming, 2016). Reaching a global consensus on climate change and climate knowledge paved the way for a conference of 2009 in Geneva. At this conference, the World Meteorological Organization gathered various state ministries, research institutions and scientific communities to discuss the potential uses of CS (Hewitt et al., 2013). It also launched the Global Framework for Climate Services which would be implemented in several African and Latin American countries in an individual manner. Although the aim of implementing CS and improving the network between climate scientists and other disciplines throughout different states seemed to be a straightforward process, in practice it has presented several challenges (Webber, 2019).

The first struggle comes from the variety of ways in which the CS have been conceptualized within the interdisciplinary social science scholarship. For instance, CS are understood to be the expert's provision of forecasts and scenarios with economic analysis that have the capacity of positively affecting local communities (Nost, 2019), they are also understood as having the goal of "producing climate-related data, information, products, or knowledge that are "usable" for decision-making, planning, or policy" (Daly & Dilling, 2019, p. 62). Other scholars examine the use of CS in managing climate related risk (Vaughan & Dessai, 2014). Empirical studies in Africa have defined CS as tools for decision-making that involve the transformation of climate information into relevant advisory services capable of assisting individuals and organizations (Tall et al., 2018). However, when CS are implemented in programs of food security, scholarship has defined them through a process that includes the variety of actors involved so as to assure the

development of relationships between organizations and communities (Bouroncle et al., 2019; Hansen et al., 2014). That is to say that CS in agriculture become and are defined by what the communities and organizations involved agree on, the nature of the issues being addressed, their significance and how to address them.

Although these ways of defining CS share similarities and might seem clear, transferring its meaning to a wider audience is not. It is also worth noting that although these conceptualizations of CS convey the idea that they are a modern tool meant to aid and improve livelihoods and even be used for humanitarian action in Early Warning Systems, they also allow privatization and profitability through innovation and entrepreneurship. In these cases, researchers have pointed out how enterprises can provide specific products that accommodate to any specific client's needs (Keele, 2019; Nost, 2019) and increase CS offer and demand. In this sense, some CS research has also focused on a need to implement new business models that bring together the private sector with climate-related aspects for financial support while fomenting a subscription and 'online-based infrastructure' to enable CS to reach its users (Larosa & Mysiak, 2020). However, the variety of users tends to become problematic as this aspect will also change the nature of the CS. For instance, CS for peasants and humanitarian programs implies public CS information. On the contrary, CS for innovation, private monocultures, and conventional production systems aim at privatization and profit. This aspect raises questions of the nature of CS, whether they are to become a new input to the agriculture production process or a public service.

These discussions tend to neglect other social challenges. For instance, if CS are considered a public service, then how can natural resources like water and land be understood as private? If CS are privatized, the question is about knowing to whom will the cost of acquiring CS be transferred to: the food producers or the consumers? In Guatemala, the mixed implementation of CS that involves the public-private entities also generates unexpected and undesirable outcomes such as the erosion of the state's responsibility over its citizens or the disempowerment of peasants among other effects.

However, the discussions have mainly focused on the ways to raise user awareness and understanding about CS, even by relying on the private sector. Regarding user awareness, Lourenço, Swart, Goosen, and Street (2016) have stated that the CS, as a product, have no solid definition and that this ambiguity reflects on the variety of names that CS are given by its users. It is a product that is still in the making and relies not only on the climate community's understanding of the product, as also "providers, developers, users, potential users, and other stakeholders turn out to have different understandings or expectations of what is meant by 'climate services' and the 'market for climate services'" (Perrels et al., 2020, p. 3). The existing challenge of defining CS has further repercussions in making it accessible to users, mainly because of the range of actors involved in their production, provision, and use. In this case, the users and potential users become much more diverse than one might assume.

That being said, my aim is not to define what CS are, nor to question if they should be developed alongside communities or through private investment and innovation to raise awareness. What I am pointing out here is that regardless of the discussions presented above, CS are first and foremost a product developed in a "social-technical system that collects data, models physical processes, test theories, and ultimately generates a widely shared understanding of climate and climate change" (Edwards, 2010, p. 8) and that they are being introduced to other scientific communities and socialized by heterogeneous communities of potential users who operate at different scales. Therefore, CS studies require assessing how and which knowledge is being mobilized, even within the same epistemic community, and questioning the relations of power that are being exerted and negotiated. After considering where CS come from and what they are, we must examine who their users are. Then, we could potentially understand why CS users are ever changing even within the agricultural sector. As will be seen in the next sections, producing usable and accessible CS transcends questions related to the technical capacities and entails the collaboration and cooperation of different actors and epistemic communities.

1.5.1 Climate services for whom?

The current and potential users involved in several Global Framework for Climate Services meetings have included state ministers, research institutions, universities, and private enterprises (World Meteorological Organization, n.d., 2014a, 2014c). These meetings

provide a space for discussing the potential use that CS have for improving decisionmaking on food security, water, health, energy, and climate hazards. However, in practice, the implementation of CS often loses focus when the potential users become heterogenous and ambiguous. Skelton et al. (2019) state that there is a vague notion of who the users are, and although their typology includes a wide and diverse public, I will focus on agriculture alone. The CS and agriculture literature has focused on peasants (Madhuri, 2023; Bouroncle et al., 2019; Loboguerrero et al., 2018; Hansen et al., 2014), indigenous communities (Andersson et al., 2019; Ayanlade et al., 2017; Lemos et al., 2002), national meteorological ministries (Lahsen, 2004), policy-makers, humanitarian organizations (Andersson et al., 2019; Muller, 2014) and crop advisors working either with extensive monoculture in the USA (Haigh et al., 2015; Lemos et al., 2014) or with small farmers in tropical countries like Belize or Colombia (Haines, 2019).

Aware of the interest and potential use that the CS represent for all these actors, it is important to examine if the heterogeneous nature of the users in the agriculture sector has indeed posed a challenge for the CS community. Currently, research tends to focus on one user group or another without questioning the implications that this diversity could have on the implementation of CS, an aspect that I would argue gives rise to a second challenge. In short, this issue not only results in dispersed efforts of communicating CS to users, which I will develop below, but it also relies upon the use of malleable or polysemic concepts such as vulnerability, resilience and adaptation between different institutions and epistemic communities. At this moment, it is worth stressing that although food and climate does concern all these actors, and their involvement is important, delimiting their radius of action is difficult, more so when a modern tool such as CS are being incorporated into new areas and are meant to be 'taught' to others. In contrast, food studies have dealt longer with a wide array of actors and scales that include the producers, distributors, and consumers. In this sense, the food scholarship could potentially provide a new perspective to the CS community, as will be seen later in section 1.6. It suffices to say that sharing understandings between the CS community and food advocates could potentially help in identifying those users. Part of this research's interest is looking at how shared understanding is generated

and agreed upon by the institutions and international organizations and examining how the techno-scientific discourse permeates national discussions.

1.5.2 The challenges of communicating and transferring Climate Services to the users

Although CS users can be well defined by scholars or narrowed down by programs of development, the challenge of communication between epistemic communities or transferring climate information to these users has proven to be difficult. Lately, researchers who focus on peasants and small farmers have explored the implementation of the LTACs. After a successful experience in Senegal, the LTACs were implemented in Colombia (Loboguerrero et al., 2018). The premise under which LTACs work is that when farmers understand weather and climate forecasts and have the capacity to respond to aspects related to production, processing, and market given their local condition, then they can make better decisions regarding farm and business administration (Loboguerrero et al., 2018). The Colombian case illustrated the importance of combining and coordinating efforts between national institutions, technicians, NGOs that were already in place, and community actors. The synergy created by this wide range of actors has been supported elsewhere (Daly & Dilling, 2019; Haines, 2019). Overall, the Colombian case study emphasizes the importance of incorporating local organizations to better identify the communities' needs and demands. However, along with positive learning process, there have been other discussions around the CS and their effects in agriculture.

Alongside participatory methods, some researchers have also focused on the coproduction of knowledge as a way of improving communication and delivering better CS products. For example, indigenous methods of forecasting floods and droughts used by communities in the Limpopo Province of South Africa have been tested to evaluate how reliable their observations were. This would enable the incorporation of indigenous knowledge to the early warning system in development (Andersson et al., 2019), a practice similarly done with typhoons in the Philippines (Ewbank & Aid, 2016). In study cases from Belize and Brazil, local knowledge was not taken into account and information on lunar phases requested by farmers was taken out from CS products (Haines, 2019; Taddei, 2012). Haines concluded that the Belizean case "highlights specific issues relating to historic colonial and

postcolonial agricultural-industrial relations, land tenure, and the reliance on international networks and donors in the development, promotion, and delivery of user-oriented CS" (Haines, 2019, p. 56). Overall, regardless of the outcomes of coproduction of knowledge, a key component of building trust with the inhabitants was the inclusion of their local knowledge (Andersson et al., 2019). Other ways of improving trust among the communities was through the implementation of a two-way communication system that allowed constant communication (Knudson & Guido, 2019; Vincent et al., 2018). Although building up channels of communication and involving indigenous knowledge proved to be an important aspect in overcoming trust issues, these do not secure success from the development programs as the needed response from the population at risk was usually limited by their economic limitations (Andersson et al., 2019; Ayanlade et al., 2017).

The capacity to transfer CS also demands institutional flexibility that eases the process of communication. In this regard, important experience from the International Research Institution for Climate and Society shows that an institutional role in the implementation of CS can actively change according to operational needs shaped by the local context and society (van Huysen et al., 2018). For instance, they had to adjust the name of their institution, its mission, and their institutional objectives to better adapt to the circumstances. At times, their planned activities would have to be postponed, cancelled, or changed as the International Research Institution would have to function in a background as an organization that allowed others to come in contact. The institution had to read the environment and the social dynamics, forcing itself to shift continuously from an active to a passive role. This kind of institutional flexibility is also evidenced in a case study in Jamaica, where information was better transmitted through sustained cellphone messages and calls and not in the conventional one-way radio broadcast or workshops as it was first conceived (Knudson & Guido, 2019). However, these processes of participation, and the necessity to work with heterogeneous actors, illustrate some of the challenges or barriers entailed by such work.

Another aspect of communicating CS to potential users involves improving the confidence and understanding of the quality of CS products. A case study in Brazil examined how the implementation of CS in agriculture suffered mistrust from possible users. CS were also
used as a political tool, understanding that "forecasting is a fundamentally political social action, despite the fact that the scientific disciplines most dependent on forecasting ... are those that systematically depoliticize it, focusing exclusively on its technical dimensions" (Taddei, 2012, p. 260). Frequently, discussions over the implementation of CS emphasize the importance of investing in meteorological stations. Thus, in a context of economic constraints that limit this investment, some researchers identified a need for reducing "public perception of uncertainty" (Taddei, 2012, p. 263) as CS products usually undergo most risk due to fragile reliability (Alexander & Dessai, 2019; Taddei, 2012). Exploring the challenge of transferring CS to the users, some researchers have turned towards crop advisors as potential agents of technological transfer.

However, the work that examines how crop advisors work and how they implement CS has been scattered and not analyzed through the policy regimes perspective proposed in this work. For instance, in the United States, researchers evaluated the factors that drove public and private crop advisors to use and disseminate CS among their clients located in the corn belt (Lemos et al., 2014). Interestingly, one important factor that influenced them in using CS was the feeling of being supported by their colleagues and institutions in which they worked, whether they were private or public. Furthermore, researchers agreed that crop advisors had gained trust from their clients and through constant and direct communication they had a crucial role in bridging the gap between CS and farmers (Haigh et al., 2015). In a different context, advisors in Belize would reflect "on the challenges of CS provision...[and] expressed apprehension about giving advice in the context of incomplete knowledge and high decision stakes" (Haines, 2019, p. 51). They would comprehend the limitations CS have in their country while also pondering the consequences that every farming decision had on peasants and smallholders' life. In this sense, the responsibilities were transferred to the producers.

An important aspect of crop advisors is that they are a component of the food system. They are impregnated with the dynamics and knowledge that involves producing food and profit for their clients. For them, CS are a new input that could potentially ease their work of providing relevant information to their clients. In this sense, they are actors with the capacity of becoming information brokers by actively navigating between the food production business and climate related knowledge. In other words, they act as individual actors "who foster knowledge exchange and help facilitate action" (Guido et al., 2016, p. 288) while also enjoying a degree of trust from the farmers. In contrast, gaining trust has been a challenge that some institutions have had to overcome and deal with by becoming flexible as previously mentioned. In this sense, crop advisors operate and are an important part of specific institutions.

Furthermore, communication and the role that institutions play is also worth analyzing. While there is a general agreement on the need to develop flexible institutions when addressing risk management or resilience (Grove, 2018), this aspect also demands further analysis that enables its implementation in *praxis*. However, it is important to acknowledge that these institutions not only respond to intellectual processes but also to the economic and political context which they are part of (Douglas, 1986). Additionally, the institution can be understood as a convention that minimizes uncertainty and provides order, their members are part of their societal pressures and realities that allow or opposes the desired flexibility. In this context there is a complex relation between the agency of the individual and the common agreements that take place in these institutions that shape the ways in which they function. When exploring the implementation of CS, it is useful to understand that institutions or International Organizations that Broome and Seabrooke (2012) analyze are created with specific capacities fit for particular aims and purposes. That is to say that the office responsible of implementing CS in Guatemala has been developed while considering the analytic capabilities that allow them -the middlemen and the institution- to make any State -or problem- in which they operate 'legible'. In this sense, INSIVUMEH and MAGA frame the issue of food insecurity in terms of what they can offer with climate information and technical advice. These institutions also make use of ambiguity to better work with diverse interests and goals they might have. Mary Douglas' (1986) and Broome's and Seabrooke's (2012) analysis of institutions is relevant and palpable when the middlemen and other technocrats discuss food insecurity across scales.

In practice, crop advisors also deal with a diverse group of users, with different backgrounds, contexts, and interests, whether they are extensive corn, sugarcane, palm oil or banana monocultures in the USA and Central American countries (González, 2019;

Haines, 2019; Lemos et al., 2014), or smallholders. In other words, the CSs are being inserted in different places regardless of the ecological particularities (e.g., micro-climates) and the historical and socio-political context while trying to adapt to a global food system that does not function as the CS advocates assume it does, nor does it share the principles of inclusion or the 'desire' of improving the livelihoods of the farmers.

Overall, communication and trust become a two-way path, on the one hand there is trust in CS product's quality from the users and providers, and on the other hand, there is trust given to the providers by the end-users. Regarding the former, some research focuses on managing expectations and improving the product's quality. The latter, focuses on the institutions' flexibility, a way of handling particularities whereby the organization can allow change instead of being rigid and overly hierarchical (Grove, 2018). Communication and trust with communities is one important and complex aspect of implementing CS, however, there are also differences between and within epistemic communities that are also worth acknowledging.

1.5.3 Critical approaches to Climate Services: from the global North to the global South

Researchers have examined how implementing CS usually results in maladaptive practices and a lack of critical reassessment that is incapable of challenging the existing assumptions (Webber, 2019). In this fashion, it is important to consider how epistemic communities operate. In doing so, this work understands an epistemic community as a network of experts and scholars with recognized and shared knowledge on a specific topic and the capacity to influence decision making (Haas, 2008). Epistemic communities become relevant as they are made up of actors who actively develop and circulate ideas that later become beliefs or state interest. This work thus demands looking at ways in which the CS and food scholarship is negotiated and agreed upon between epistemic communities and state officials. We must bear in mind that these epistemic communities also operate within fixed frameworks that allow them to investigate specific problems from fixed lenses and that they can neglect other explanations, understandings, and ways of approaching a common topic of interest. They do so to make a problem or state 'legible' (Broome & Seabrooke, 2012). We can observe these challenges when the climate community claims an understanding of the importance and preponderance that weather variability has in agriculture, while neglecting that rural hunger has many other factors that produce it (Taddei, 2012) and that other physical elements such as soil fertility and availability of vital nutrients are as important. Although this work warns of the limitations for technoscientific solutions, what Taddei (2012) observes is an overly specific view from the climate community of the important factors that influence food production.

Furthermore, differences between epistemic communities tend to grow when one considers the global North and global South. These differences and relations between the global North and South respond to ideological differences that materialize in several ways. They originate from the undeniable pursuit for development that is seen as a teleological path that ends in Western modernity with its ideals and principles. This idea of modernity shapes up and prioritizes certain ways of knowing and doing over others, creating numerous effects. For instance, countries from the global South tend to follow guidelines dictated elsewhere while dealing with economic constraint. In this fashion, Semazzi (2011) warns of 'warm beginnings' in the implementation of CS in countries in the global South and of the effects it has in eroding trust from the users, the researcher also risks neglecting not only economic constraints, but priorities set within national ministries as well as other ways of working. These priorities and constraints were evinced by the health ministry and medical personnel in Ecuador, where CS were to be implemented for dengue control. In this case, health practitioners would rather use old, but reliable and cheap methods (Lowe et al., 2017) to assess and manage peaks in *dengue* population than to incorporate CS in their analysis. In other words, climate is an important factor that affects daily life, but there are some cases where other needs are prioritized, or that the need for climate information is not as important as suggested.

Brazil offers another lesson related to the political conflict within 'epistemic communities' because researchers are not as homogenous as they would like to believe (Lahsen, 2004). Brazilian researchers made clear how they had to accommodate and learn how to 'sail' through politics, understanding that they lacked resources for their own research, publishing spaces, international recognition and national mistrust from their peers when working with foreign researchers (Lahsen, 2004). Unlike Ecuador's case that involved

meteorologists and health practitioners, the Brazilian case study examines differences within the same epistemic community. In other words, it is not only about 'teaching' users about climate knowledge and raising awareness, but also about managing the differences between the global North and global South. Whether there are economic constraints or political conflict within the same 'epistemic community', these challenges also call for attention.

Furthermore, it is important to acknowledge the internal colonial differences that are particular to each country. In this case, it is important to examine the Guatemalan context to better understand if and how the CS project reinforces ideas of modernizing rural Guatemala. It also demands assessing if these initiatives reject traditional practices that are usually considered by state actors to be backwards and inefficient. In Guatemala, Guzmán-Böckler (1969) also criticized liberal teaching in Guatemala's public university that promoted individual development over the society. Similarly, sociologist Jose Luis Rocha (2020) explored the role that Pentecostal churches and liberal ideologies have in shaping ideas of personal gain and development. In parallel, militaries were supported by evangelical groups during the rural development projects in the Civil war era. These projects of development from the second half of the 20th century were known as the poles of development have been well documented (Schirmer, 2010; Ybarra, 2018). In Guatemala, western techniques of resource management continue to force the relocation of Mayan descendants and to shape the ideas of development. This historical practice warns of the potential misuse of CS regarding community relocation through the use of techno-scientific discourse of development.

As seen in this section, the CSs scholarship has shown how CS initiatives have offered a range of discussions about the limitations and challenges of their implementation practices. However, they have also been conditioned by the belief and trust that CS advocates place on their products. This means that the empirical data and study cases mentioned above could also gain new insight from study cases on food security and broader critical food scholarship. In the following section I will provide a brief literature review of the food scholarship in general and Guatemala's food production system in particular.

1.6 Climate Services in a complex food system

Food unavailability, as Amartya Sen states, "is rarely a cause of food insecurity: 78 per cent of all malnourished children under five in developing countries live in countries with food surpluses" (in Ingram et al., 2012, p. 8), and Guatemala is not the exception (Cleaves & Tuy, 2015). A food system approach that focuses on "the linkages among the production, distribution, and consumption of food" (Ingram et al., 2012, p. 4) is helpful to understand hunger not only as a failure of the agricultural production component but by the complex relations between all the linkages. Resonating with the analysis of CS as a process of production, translation and transfer, the food system approach in this thesis provides an overview of Guatemala's socio-political context, its postcolonial legacies, and food scholarship on climate-smart agriculture, all of which have repercussion on food production, distribution, and consumption. For instance, in chapter one I briefly review the Guatemalan food production to provide a context in which CS advocates work. Later in chapter five and six, I draw upon climate-smart agriculture research and public policy to explore the latest approaches of agricultural and rural development around the world and shed light on the Guatemalan case.

At this moment, it is important to understand that some scholars have approached hunger through food scarcity at different scales, regional, household, and individual (Millman & Kates, 1990). In their work, Millman and Kates explore food shortage as the "insufficient availability of food within a bounded region" p. 11 and distinguish food poverty that focuses on a particular household (the smallest organizational unit in which individual share food), from food shortage that affects an individual. With their approach, they identify several causes for food shortage that include labor, appropriation, war, diseases, climate variation, but also mismanagement, greed, corruption, and ignorance. It is also important to mention that "food poverty may be seen at levels beyond the household, such as ethnic, caste, or social class groups, or in marginalized aggregations of households within an area." (Millman & Kates, 1990, p. 13). These households will not command food even when there is food within the area, similar to Dreze and Sen's work on entitlement (1991) which refers to the capacity of a community to command food.

Other researchers have recently focused on the food system and the effects it has on the climate change (Clapp & Cohen, 2009; Ingram et al., 2012). Some, like Ingram et al (2012) argue that one can look into the 'benefits' the green revolution has had on production and consumption by increasing yields and lowering food prices. However, they also raise concern over how these aspects can overshadow the impact that distribution of foodstuff and resources have on the environment. Following this concern, organizations such as the FAO and Guatemala's government have also pushed forward technological solutions that increase efficiency and production (e.g., improvement of systems of irrigation, access to hybrid seeds and genetic manipulation of livestock and crops).

In short, to work on food insecurity demands a wider view that is capable of observing a number of complex relations between things. That is to say that in order to explore and work with the food system it is important to have a better understanding of what a system is. In her work on systems, Donella H. Meadows develops a framework to work with and, more importantly, think about systems. She argues that thinking about systems provides an alternative approach to the deterministic rational that "trace direct paths from cause to effect, to look at things in small and understandable pieces" (Meadows, 2009, p. 3). Similar to Vandana Shiva's critique (2019), Meadows states that Western science prioritizes a reductionist approach that compartmentalizes knowledge. Although this approach of compartmentalizing knowledge has generated much benefit to society it has also produced the effect in which society seeks to control and 'technically fix' the problems. However, system thinking allows us to see the system as the "source of its own problems" allowing us to rethink and restructure them.

Her work and conceptualization of systems is thus useful before moving into and working with the food system. First, a system is a "set of things – people, cells, molecules, or whatever – interconnected in such a way that they produce their own pattern of behavior over time (Meadows, 2009, p. 2). A system can also be affected by restrictions or triggers caused by external forces. Second, systems "happen all at once" as they are interconnected. Thus, a system lens allows the researcher to see in a holistic way because it considers the elements and the interconnections that allow movements of such elements as well as the

purpose of the system. For the food system, its purpose has been to provide cheap food for urban dwellers.

For food scholarship, the system in food systems refers to "the set of activities involved in producing food, processing and packaging food, distributing and retailing food, and consuming food" (Ingram et al., 2012, p. 27) and includes the actors involved in such activities. For Christopher Yap (2023, p. 66), food systems are "complex, interconnected and multi-scalar, incorporating a diversity of material, social, economic and political processes".

Wider food scholarship provides a framework that also allows us to situate Guatemala in the global dynamics. As we will see throughout this dissertation, the CS are aimed at the production component of the food system, however its worth considering that malnutrition and food insecurity are a product of the wider logic of the food system whose main purpose has been to produce cheap food to sustain affordable living in urban centers (Foster, 2000; Yap, 2023) and not to provide food for everyone. This purpose can be traced down using the food regime theory (McMichael, 2009, 2013) which is characterized by "temporal intensification and spatial expansion of capitalist social relations" (Rioux, 2018, p. 717). These wider dynamics that food scholarship is concerned with allows us to gain perspective and question how the implementation of CS in agriculture is shaped by and adapted to a food regime and food system that has its own principles and purpose.

The food regime is "an organizing principle that expresses a form of rule or hegemony" were "the world food trade has, through a governing world price, encompassed an everwidening expanse of commodified agriculture and an associated deepening of the consumption relations." (McMichael, 2013, p. 21-22). The food regime also identifies the changes the food systems has experienced by correlating major events like the industrial and green revolution along with the political interests and trade policies set by the most influential nations of each epoch. By identifying three moments or shifts in the ways food and trade were managed and how these shifts ultimately altered the global food system, Phillip McMichael describes three food regimes. While the first food regime is arguably situated between 1870-1939, this research focuses on the second and third food regimes because they mark key events to comprehend Guatemala's food system. These two regimes were shaped and triggered by the "US/foreign aid, development and free enterprise, and WTO/free trade and market supremacy" (McMichael, 2009, 2013). Currently, the development of a fourth food regime driven by Chinese politics is being put into question however for this research it is not taken into account (McMichael, 2020).

Despite all the differences between Marx's Europe and Guatemala's current context, his view of the process by which capitalists accumulated land and capital through "force, fraud, predation and the looting of assets" (Harvey, 2006, p. xvii) resonates with Guatemala's history in two broad ways. First, Mayan communities have been continually displaced and dispossessed from their lands (Bockler & Bockler, 1969; Castro, 1952; Guzmán Böckler & Herbert, 1970; Martínez Peláez, 2009; Prado-Córdova, 2011). Second, for elites and Spanish colonizers, Guatemala's lack of minerals meant the land had no value except if it had indios³ to work the land (Prado-Córdova, 2011). The enclosure of the commons that Marx lived through and analyzed in Germany (Foster, 2000) and England would produce an army of labourers to be hired as wage workers on farms. When limits to the required labour were reached due to productivity rise, unemployment as concept came to exist which created an industrial reserve army that lowered the wages (L. F. Newman & Crossgrove, 1990). These general readings remind us how agrarian capitalism has been reproduced under similar dynamics throughout the world. For Guatemala's case, CSs advocates should not take for granted the effects that capitalism has on the food system they are trying to work with. Because the food regime has permeated most parts of the world, the next section offers a review of the contradictions the food system bears and are applicable to the Guatemalan food system. In this regard, it is therefore important for the CSs advocates and this dissertation to understand the State and its role in 'regulating, enabling, and reproducing global capitalist processes" and "contribute to more geographically sensitive approaches to food systems governance research" (Yap, 2023, p. 67). This resonates with Webber's concern with "understanding the climate services" and how this concern "requires attending to public sector austerity" (S. R. Webber, 2015, p. 144). Overall acknowledging the food scholarship that discusses policies, governance and

³ Maya communities have been called *indios*, colloquially used in a pejorative way. In this text I use the direct translation of words used by Severo Martínez Peláez and other Guatemalan scholars of the time.

system thinking is vital for CS advocates and the implementation of the agroclimatic bulletins when working for food security. In the next section I will provide a brief discussion on the food system's contradiction that have also been neglected in the CS literature.

1.6.1 Defining the food system's contradictions

As previously mentioned, CS advocates also operate in a capitalist agriculture whose efforts have been to develop and resist the natural limits to food production. That is to say that the current industrial food system that operates in Guatemala is the continuation and exacerbation of the limitations and contradictions observed in a capitalist agriculture since the first food regime. These differences include a process of commodifying nature (Castree, 2003), a need to accomplish a formal or real subsumption of nature (Boyd et al., 2001) and a struggle between working time and labour time that limit the capitalist expansion in agriculture (Singer et al., 1983). These internal conflicts are intertwined with cycles of regulation and deregulation of the market (Stoddard, 2015) which have incorporated fictitious commodities since its origin.

Industries have managed to come around some of these limitations. However, agriculture and food production must be distinguished from regular industries in the sense that agriculture deals with nature and natural processes. Boyd et al. (2001) detail the difference between the formal subsumption of nature which "confront nature as an exogenous set of material properties and bio/geophysical processes" (p. 557), and the real subsumption of nature which is limited by biological processes. Capitalism has compensated for the biological restraints (e.g., perishability, cattle growths, vegetable development and so on) through appropriationism and substituitionism. This aspect becomes much more relevant and palpable in CS products due to its absence. Although the introduction of agrochemicals and other mechanisms to control nature, along with the increase of the industrial reserve army (L. F. Newman & Crossgrove, 1990) works as a cover-up for the unsustainable production processes the food system has developed (Ingram et al., 2012; Weis, 2010), the CSs advocates become agents and active actors in this wider food system.

Despite the fact that extensive monoculture and agro-capitalist system still enjoy fame regarding its productivity (Gobierno de Guatemala, 2022), socializing the risks taken by the industries puts to doubt the efficiency that these industries claim to have (Weis, 2010). Tony Weis (2010) among others (Ingram et al., 2012) agree that the efficiency the industrial food system claims comes with undervalued costs. For Weis, the Transnational Corporations have increased the commodity's fetishism by transforming food in a way that it becomes a "de-spatialized commodity, ... severed from time, space and culture" (Weis, 2010, p. 318). Regarding the production and distribution activities, there are biophysical overrides from the energy consumption and land degradation. Energy for transportation is harder to replace and biofuels have been argued to be replacing edible grain production (Clapp & Cohen, 2009; Weis, 2010). These discussions not only shed light on one incommensurable difference in which CSs advocates operate, they also put into question the impact that the commodification of food has in the livelihoods of people. In upcoming chapters, these differences generate practical challenges in which crop advisors and CS advocates are constantly struggling to conciliate.

Finally, the industrial food system has incorporated the flex crops mainly to deal with price volatility. These new commodities are supported by several claims of food and energy security, green energy generation and climate change mitigation (Alonso-Fradejas, 2015) but they have also been studied as causes of land grabbing in Latin America and the Caribbean (Borras Jr, Franco, Gómez, Kay, & Spoor, 2012). Amid discussions of food productivity and lack of production, it important to know that in general, 48% of grain production is consumed by humans and the other half is fed to animals and used for biofuels (Weis, 2010, p. 327). Amidst these discussions, the question is who are the communities and people who are taking the risks and suffering the effects of the conventional and dominant food system? In the next section I provide a context of Guatemala's food production system.

1.6.2 Guatemala, the food system, and the food producers

Independence from Spanish dominion did not translate into improvements of indigenous rights and livelihoods. In his book, *La patria del Criollo*, the Guatemalan Marxist-historian Severo Martínez Peláez questions if "Independence [was] truly a revolutionary event or

simply a means of implanting the "*patria del Criollo*" (Martínez Peláez, 2009, p. 74) This *Criollo*'s homeland refers to the Guatemala made by and for the Criollo Elites whose only interest was to profit from the advantages that colonialism gave them with no intervention from the Crown. In this regard, Martínez Peláez demonstrates that Independence did not change the colonial system but built upon it. For instance, whereas independent Guatemala no longer had to pay any tribute to the Crown in Spain, compulsory labor for "Indians", previously known as *mandamientos*, remained. The violent cycles of Conservative and Liberals that followed were ignited by "class struggles between *criollos* and the middle strata" (Ibid., p. 275).

Martínez Peláez later emphasizes that Liberals' goal was to level themselves with criollos. In doing so, they set in place violent mechanisms of control, oppression and dispossession. First, with the abolition of Indigenous communal holdings the *criollo* elites created a mass of displaced and unemployed people. Second, Liberal reforms would foment a path of growth through the creation of *minifundios*, or smaller farms. Severe laws like the *reglamento de Jornaleros* and the *Ley de Vagancia* (Vagrancy Law) would benefit the new groups of small landowners and help them expand their control and profit by granting them access to slave-like labor. Vagrancy Law forced Maya people to work for low wages or be sent for unpaid labor to develop infrastructure for the government of Jorge Ubico (Martínez Peláez, 2009). The growing number of unemployed and landless Indigenous people would result in them having to accept any wage to avoid forced labor. This Liberal era would be known as the coffee dictatorships period in which, according to Martínez Peláez, *Criollos* would finally have what they had fought for, their own *Patria del Criollo*.

In other words, monoculture farms continue to rely on low-wage labour, land distribution continues to be highly unequal, and the majority of the arable land belongs to a minority who produces crops for exportation in conventional monoculture farms. Aside from one interrupted agrarian reform in the 1950s, most of the arable lands are owned by a minority. However, agriculture continues to be one of the most important sources of income for the

Guatemalan State despite late processes of commercialization⁴ of peasants and overall depeasantization.

By 2016, agriculture produced 13,6% of national GDP and accounted for 31,2% of formal employment (Ministerio de Agricultura, 2016). According to the National Institute of Statistics, in 2018 there were 14,901,286 million people in Guatemala from which 46,15% lived in the rural areas (Instituto Nacional de Estadística Guatemala, 2020). Although small farmers and peasants are key providers of crops and food for national consumption, 89,5% of the arable lands are destined to other crops. In contrast, the graph in Figure 4 shows how the staple crops that include beans, rice and corn only represent 1,6%, 0,2% and 8,7% of the agricultural lands.

⁴ Jose Luis Rocha focuses on the effects of migration in the countryside whereby *remesas* -remittances- sent by immigrants has an effect of rising the prices of rural land despite a depeasantization process. Additionally, the relation between peasants and their lands is transformed when land ownership is used as mortgage to pay *coyotes* -smugglers-.



Figure 6. Use of agricultural field: Corn (dark blue), Beans (orange), Rice (yellow), and other uses (light blue) Source INE, 2020, p. 58

However, the actors involved in the food production are highly heterogenous. The figures used by the government are not always easy to follow because they often change from one document to another. For instance, the diversity of the categories in which food production actors are sorted responds to the producers' access to the market and land. In this sense, according to a conversation I had with a SESAN official, the Guatemalan government has divided the producers into four groups, infra subsistence, subsistence, surplus and commercial producers. However, as Table 1 shows, in the 2000s, infra subsistence and subsistence farmers were considered as one category and represented 53,3% of the registered population. The commercial producers were also divided into small and big commercial producers. This re-categorization gives the illusion that land inequality is not so severe. If one takes into account the landless, the infra subsistence, and the subsistence producers of Figure 7, they account for more than 770,000 households or nearly one and a

half million people (Ministerio de Agricultura, 2016). Land census therefore continues to be controversial because it is embedded with a history of land dispossession, a neoliberal food regime and racism (Alonso-Fradejas, 2012; Grandia, 2014; Pietilainen & Otero, 2018). As we can see in table 1 and figures 7 and 8 is that these figures vary.

Table 1. Typology of distribution of agrarian household, 2000, 2006, and 2011. Source: National Institute of Statistics2019-2020. p. 78

	2000		2006		2011	
Tipología	N° hogares	Porcentaje	N° hogares	Porcentaje	N° hogares	Porcentaje
Sin tierra	190.388	15.40%	68.988	6.10%	164.097	12.60%
Infrasubsistencia	650 000*	53.30%	69.077	6.10%	105.856	8.20%
Subsistencia	009.922		486.307	43.20%	513.395	39.50%
Excendentarios	295.854	23.90%	210.559	18.70%	171.42	13.20%
Pequeños comerciales	66.752	5.40%	236.904	21.10%	228.621	17.60%
Grandes comerciales	26.129	2.10%	53.075	4.70%	115.988	8.90%
Total	1.239.045	100.00%	1.124.909	100.00%	1.299.377	100.00%

Fuente: Elaboracion propia sobre la base de BID (2006) e INE (2006 y 2011)

*La tipología realizada en el estudio de Taylor et al. (2006) considera a los hogares agropecuarios de subsistencia, mas no distingue entre el nivel de infrasubsistencia y el de subsistencia, como lo hace el estudio de la FAO (2010).



Figure 7. Configuration of Guatemala's food production according to the Ministry of Agriculture, Livestock and Food (2016).

In Figure 7 I represent the data provided by MAGA's 2016 report to contrasts it with Table 1, which is retrieved from the National Institute of Statistics where infra subsistence and

subsistence farmer represent up to 84%. Although this information is retrieved in MAGAs 2016 report, the data comes from a census in 2003. This difference between the data in the same institutions is not due to an improvement in land acquisition, but it corresponds to categorizations and recategorization processes as mentioned above.

Finally, from Figure 8, I emphasize that although commercial producers which represent 3% of all producers, they own 65% of the arable land, while 97% of the small farmers – 45,2% subsistence and 46,8% infra subsistence and 3,2% surplus producers – occupy the remaining 35% or arable lands. The disparity of this data, coming from the same ministry responds to a process of recategorization that governmental officials use according to their needs. The images also convey institutionalized ideas whereby commercial agricultural is linked with the use of modern infrastructure. Furthermore, the images chosen for the governmental report shows the difference between the surplus farmers who have the capacity to hire men in contrast with subsistence agriculture in which the work relies on unpaid women, that implement traditional methods in smaller plots to produce food for self-consumption. As Chapter 4 also points out, the categorization of the agricultural producers also happens with the CS initiatives and CS advocates which tend to produce undesired effects. Understandably this recategorization also responds to the heterogenous nature of the food producing sector in Guatemala's food system.



Figure 8. Typology of types of farmers. Source: Censo Agropecuario 2003, INE, in Política Agropecuaria 2016-2020, p. 37

Despite the Peace Treaty of 1996⁵ and the consecutive creation of FONTIERRAS⁶ that aims to promote land distribution, in 2016 Guatemala still held one of the highest coefficients of land inequality of 0,84 in the GINI scale used to measure land inequality (Ministerio de Agricultura, 2016). The disparities that small farmers face regarding access to land in quantity and quality, MAGA's latest review of Guatemala's agricultural production points out how the subsistence and infra subsistence producers struggle with one of the lowest yields in corn and beans -18 out of 23 – worldwide. The report mentions that banana farms have the highest yields in Central America, sugar cane occupies the 3rd

⁵ The Peace Treaty: Signed in 1996, it put an end to 36 years of war. The conflict left more than "200 000 people dead, 626 massacres, 430 villages wiped out... 1.5 million internally displaced, and 150 000 refugees in Mexico (of a population of 8 million)" (Nelson, 2010, p. 88). The peace process began 1986 during the presidency of Vinicio Cerezo in the first democratic elections since 1950. The truth commission later stated that 93% of the victims were at the hand of the state (Joras, 2007).

⁶ FONTIERRA or Fondo de Tierras is an institution that works under the Peace Treaty and focuses on four aspects: Access to land for integral development, legal processes to provide land, sustainable community development and strengthening of governmental institutions. From: fontierras.gob.gt March 2023, to access website, write the address as is.

place worldwide and palm for oil also has one of the highest yields in the world. This measurable and arguably 'objective' data is mobilized to convey that these farming systems are modern and highly productive.

The short overview of Guatemala's rural land and food production system cannot be complete without acknowledging the effects that colonialism and the ideas of development and modernity have had in rural Guatemala. That is to say, modernity is deeply embedded in politics regarding food production. Chapter five expands on how modernity and development have been a tool of control used by the government and military powers (Copeland, 2012, 2019b) and for this dissertation's interest, how it all fits with the CS initiative in Guatemala. I also mention some of the initiatives and programs of development held in Guatemala in the past century to provide a wider context of the current food system. Overall, these figures show different representations of the composition of the countryside. I will not linger on the methods used by the institutions to retrieve this information, rather it is better to examine the difficulty of agreeing upon the composition of the farmers. The data becomes unreliable and can be used by each institution for different purposes. It is with this data, and in this context that in Guatemala the advocates are working to improve food production, food security and farmers' livelihood.

1.7 Dissertation outline

This thesis has been divided into six chapters. In chapter two, entitled: "Rendering the collision of the climate infrastructure and the food system observable", I present and discuss my research approach and methods. This chapter will first provide the methodological considerations which include the research methods and personal reflection of the influence that my professional development and lived experience had in this research. The methods selected can only make sense if they are organized and analyzed through a theoretical framework. In this manner, section 2.4 develops the theoretical framework used to make sense of this research. For instance, it defines concepts like policy regimes, collisions, and the middlemen. Finally, it develops a section on power to better examine the relations between farmers and the scientific community and between technicians and experts of the two policy regimes.

Chapter three, entitled: "Implementing the Climate services in Guatemala, expectations vs reality", focuses on one of the main objectives; it explores the process of producing, translating and transferring the agroclimatic bulletins in Guatemala. It examines the mechanisms and techniques used by the CS advocates to raise awareness, vulgarize climate knowledge and co-produce agroclimatic bulletins. However, it also pays attention to the diversity of participants, the discourse that CS advocates carry and the way in which they evaluate their efforts and outcomes. This chapter does the exercise of comparing the expectations that CS advocates have of the CS with the grounded experience or reality. With discourse analysis of grey literature of both, international institutions and Guatemalan institutional reports, chapter three reflects on those topics, discussions, and issues that have been neglected by CS advocates and CS community in general. It is also a chapter developed with the purpose of providing a solid contextualization of how the CS have developed in Guatemala since 2017.

"The promise of climate services at different scales" is the title of chapter four where I raise questions regarding how CS advocates overlook the issues with scales of operations and the tensions that arise when transitioning from macro to micro scales. As the title conveys, the promise of CS is a belief that CS can function despite the different challenges that occur across scales of operation. This chapter also encourages the CS community to consider other questions: What if local scales are not the best approach for CS advocates to focus on? Can a global desire -and discourse of adaptation- of improving food security by informing the most vulnerable sectors of society about climate change really translate to practices that respond to local needs? What are the practical implications of implementing modern climate knowledge to municipal needs? The chapter identifies several challenges – regarding conceptual mutability and conceptual dilution to name couple - and reflects on how and where the CS advocates meet when implementing CS for food security across different scales. Overall, this chapter shows that talking about CS for food security and adaptation becomes more challenging at micro-scale than it does at a macro-scale.

Chapter five or "Climate coloniality, an exploration of the institutional dynamics in a colonial and neoliberal government" reflects on how, despite the challenges of making CS

locally relevant, CS advocates continue to trust and implement new CS initiatives. They have expanded their number of LTACs and increased the number of participants every year since they first arrived in Guatemala. This chapter draws on Farhana Sultana's concept of climate coloniality to dissect the side-effects that are not taken to account in CS research in general, and in Guatemala in particular. It develops on climate coloniality to evince how CS, as part of the climate-smart agriculture trend, creates synergy with capitalism and colonialism to the detriment of the majority. Furthermore, current CS initiative reinforces colonial legacies and the neoliberal Guatemalan state that claims to assist farmers and Maya communities. The capacity that a technological apparatus has of erasing historical and present-day social issues are also examined throughout this chapter that tries to understand why CS advocates continue to believe that producing locally relevant information provides a solution to food insecurity.

Finally, chapter six or "Rethinking the climate services" provides an overview of the main findings of the thesis. These findings are organized according to the three instances of the CS cycle of production, translation, and transfer of climate information. However, the goal of this chapter is to provoke questions among the CS advocates and future researchers of the subject regarding new ways of thinking about and implementing CS. To do so, this chapter engages with recent food scholarship that draws on Foucault's biopolitics and the concept of agrobiopolitics to manage societies. Finally, it reviews and reimagines a new definition for what the CS could be, what the LTACs are and what to expect from them.

2 Rendering the collision of the climate infrastructure and the food system observable

2.1 Introduction

CS advocates navigate between two global issues. On the one hand they are concerned with weather variability and climate change, and, on the other hand, with food production and food insecurity. Guided by their knowledge in climatology and meteorology, CS advocates have poured their efforts into improving the livelihoods of the food insecure and vulnerable populations in the global South by implementing several initiatives that focus on producing, translating, and transferring modern climate knowledge to small farmers and peasants. In other words, these initiatives have mainly focused on the practice of making CS available to the wider public and locally relevant to small farmers and peasants. They have done so by implementing the Local Technical Agroclimatic Committees (LTACs) in which they gather various participants and organizations to discuss climate and agriculture to produce the agroclimatic bulletins that contain agricultural advice based on climate scenarios.

This chapter focuses on detailing the methods used to inquire and navigate through the fieldwork. It also provides a theoretical framework and methodology used to make sense of the data and to justify the methods. It is important to state that this research does not intend to provide a recipe to improve the delivery of CS. In this sense, the research gains a degree of liberty to examine the process of implementation with no promises or compromises. This means that I am a researcher who is free to reorient the analytical focus away from the peasants and small farmers and into those key actors who are in charge of processing, translating and transferring the climate information into the agroclimatic bulletins and CS users. However, this does not mean that I neglect the small farmers and peasants, nor do I undermine the importance of their inclusion and participation in the process. On the contrary, setting the gaze away from the CS users offers new sites of examination and new participants to engage with. As the analysis and empirical material will show in the following chapters, the middlemen have impact in CS initiatives and in

the livelihoods of peasants without always having direct contact with them. As a result, some of the effects generated by this initiative are not those the CS advocates would expect.

Overall, this chapter aims to provide a theoretical lens capable of exploring, identifying, and observing how CS advocates go about implementing climate knowledge for food security. As mentioned in the beginning of this introduction, the work that CS advocates do and how they navigate between climate science and food production means there are several implications taken for granted in numerous sites, actors, discourses, and other components involved in the process. These components provoke frictions (Tsing, 2005), tensions (McCann & Ward, 2012; Temenos & McCann, 2012, 2013), or collision as I have called them and are assembled in a web that is conditioned by the food and climate policy regimes that influence the outcome of the process.

Divided into four sections, section 2.2 provides the methodological considerations that situates me as researcher in Guatemala. In this section I discuss the research process in relation to my professional development as an environmental engineer. I also reflect on my professional and life experience which allowed me to understand my prejudice towards governmental entities in Central America as well as the limitations and opportunities that environmental engineering had in the process to do research. This section also presents the methods from which I gather and organize data. Each method has its own strengths and weaknesses; therefore, section 2.3 reflects on the limitations met throughout the research and defines the scope of the research. Section 2.4 provides the theoretical framework I used to make sense of the archival work, semi-structured interviews, and the observations I had of the meetings and forums I participated in. This section mainly focuses on defining concepts of policy regimes, collision and abyssal line as well as the middlemen and institutions.

2.2 Methodological considerations

As an environmental engineer, I was trained in physical sciences to quantify and produce specific results on water and waste management, or to run environmental impact assessment studies among other things. My interest in food security later drove me to study plant health and production. In this sense, my academic work has focused on food production: first I focused on resource and waste management practices in banana farms, then, through soil analysis, I would evaluate the salinization process and other mineral parameters of agricultural soil under arid conditions in Spain. This positivist approach in which I have felt comfortable working with also left me with several other questions unanswered.

The qualitative research that geographical studies implement provided me with instruments capable of "absorbing, sifting through, and interpreting the world through observation, participation, and interviewing" (Tracy, 2020, p. 3) which were otherwise not available or relevant in past research experience. Qualitative studies also included short-term or long-term immersion, similar to my experience living in a banana farm in Guatemala. I recall my experience as an environmental engineer in Guatemala because, despite being concerned with environmental quality performance, I could not avoid looking at the working environment, labor conditions, governmental relations with private companies, the impact that international consumers had in monoculture production and green label certifications among other aspects that left me with more questions than answers. These topics, and the contrast between the economic and natural richness with the endemic food insecurity and malnutrition would bring me back to Guatemala 10 years later to research CS and food insecurity.

Guatemala would also become a more accessible site to do research in comparison to Nicaragua⁷ and the dictatorship that censors and forbids any kind of social research or anything that might resemble journalism. In this context, I began my research on food security in Guatemala with a new paradigmatic reflection. One that would be capable of identifying multiple points of view to challenge the positivist idea of the "one true reality". As a result, an interpretative paradigm or constructivism drove my first steps of this research as I could empathized with every participant I encountered while trying to "see the world as others see it" (Tracy, 2020, p. 51) without being judgmental. This holistic

⁷ I am a Nicaraguan born in Honduras. Under different circumstances and other social-political conditions I would have done my research in Nicaragua.

understanding would have me moving between CS advocates, CS participants, and other actors who are critical of the process.

In this context I would also consider myself an outsider to the CS initiative. This means that I am not a CS advocate who is trying to push forward the CS initiatives. However, as a fellow Central American I have deep and personal interest in the processes that CS advocates undergo to produce CS and in uncovering the potential results and effects that they have in food security in general. This interest comes from my experience working in agriculture along with my concern with the effects that climate change and food insecurity have in the Central American region. Personal interest in these topics and the institutions involved in the process is not free from a negative perception I have of the Central American governmental institutions regarding reliability, governance, and their efficiency.

The distrust I have towards the institutions and the CS in general does not mean my research was a process about proving that CS do not work, nor about making them function. On the contrary, I did my research thinking that the current CS initiatives that aim to improve the livelihoods of vulnerable people are important, but that they would also benefit from further reflection, a wider perspective of an outsider and a degree of skepticism towards the CS discourse. For instance, the result of questioning the CS advocates' efforts to focus on the delivery of locally relevant CS enables me to set out on a different path, one that tries to identify and explore the implications that are otherwise left unquestioned.

The combination of lived experience -as a Central American- and newly acquired insight from interviewees and other conversations would become a part of me as a researcher that is both a foreigner and an outsider. This baggage or wisdom (Tracy, 2020), has not left me indifferent regarding the State, their officials, social justice, and food insecurity in general. It also means I should be "thoughtful about this background and its influence" over my research and thinking process. This "baggage" also provides me with a degree of knowledge about Guatemalan's social conventions and social cues which in turn enables me to be better prepared to analyze "particular circumstances present in [a] ... scene, and only then move toward grander statements and theories" (Tracy, 2020, p. 3-4). Without the baggage, I would not be able to identify these circumstances or their value to inform. In the next subsection, I will discuss my process and experience of doing research in food security in Guatemala. I reflect on my position as an external observer, one that does not belong to any organization, and tries to "get in" the different sites of discussion. Efforts to join these discussions and participate in the LTACs and other meetings or get hold of CS advocates and other participants without losing track of my objectives were at times overwhelming. The idea of "studying through" and following policy as McCann & Ward (2012) calls it, evokes these efforts of navigating around and through the policy regimes I will discuss in section 2,4. To systematize the data gathered from these experiences I triangulated archival analysis, semi-structured interviews and participatory observation methods described in the following subsections. Along with the methods I mention below I also made use of a personal agenda to keep track of my thoughts, feelings, and impressions as my research process happened.

2.2.1 Studying through

"Studying through" for this research meant that my fieldwork transcended the controlled space created by the CS advocates that had "merged" the climate knowledge with agricultural practices. "Studying through" will become more evident once I have discussed the methods. In section 2.4, I revisit the idea of "studying through" and its capacity to adapt to the particularities of the fieldwork. For instance, on the one hand, the LTACs are ephemeral sites that last only half a day and occur once every three months. On the other hand, the agroclimatic bulletins become the final product of these LTACs, however they are a mere glimpse of what has been done for the LTAC to function. These bulletins do not reflect everything that has been talked about in the meetings, and despite sometimes showing a picture of the participants, these images do not say much about the individuals who attended, their thoughts or engagement in the process.

It also meant that the food system was everywhere despite efforts to confine it to the 7-to-12-page long agroclimatic bulletins and the LTACs. Creating these controlled spaces resonated more with the idea of confined climate models that the climate infrastructure had with their weather stations, computer program, and offices. In contrast, the malfunctioning food system could not be contained in similar ways. In this manner, as researcher I was following actors and policies instead of focusing solely on the elites or the vulnerable people (McCann & Ward, 2012) mainly because the field "where actors, things, spaces, text in which the phenomenon of study may be found" (Tracy, 2020, p. 11) could not be contained nor refrained.

Having set the gaze further away from the CS products themselves and into the food system in general brought important impressions and feelings when I "entered" the field. I could say that, once I arrived in Guatemala, to talk about hunger felt like joining late in a conversation that had already taken place. I thought of myself as "yet another one" of the bunch of organizations and technicians working on the issue. Although the climate factor and CS were indeed the new additions, they were incredibly smaller in proportion to the amount of work already done on food insecurity. This feeling was reinforced throughout the fieldwork by continually running into food related newspaper articles (a couple of articles per month in just one newspaper, El Periódico was later censored and his chief editor sent to prison by former Guatemalan government), or evidence of numerous meetings and workshops that were held and manifested in banners and post-it notes left behind on the walls (like the one in Figure 9), social events (see picture of Figure 10), or the paperwork archived in boxes that SESAN offices had in their hallways. These pieces of information were important images that stacked up to the already robust number of academic publications, the numerous international and governmental reports that analyze and propose new ways of tackling hunger.

Concretely, the post-it note of the picture in Figure 9, was a paper left by someone else and reminded me that several meetings regarding food security were occurring at many times, inside and out of governmental institutions. As a researcher or even any governmental official that works on the subject, it would be rather difficult if not impossible to attend to every food related meeting happening in Guatemala. The advertising of Figure 10 (frequently reproduced in the newspaper) also reproduced the discourse that food insecurity had surpassed governmental capacity and had to rely on civil society. In this sense, as Rose (2001) contends, images provide information if one understands the value of knowing the sites of production, circulation and audience. For instance, *El Periódico,* is a daily newspaper mostly read by middle-class Guatemalans who generally agree with the idea

that the government is incapable of ameliorating or improving food security. The advert called for donations by promoting the high-performance athlete Daniela Andrade who would run 5,300 Km from North to South of Chile. In the message, people are called to give out donations for the food insecure in Guatemala. Similar to CS advocates' efforts to raise awareness, hunger also had other actors doing their part and participating in different ways.



Figure 9. The MAGA offices in Escuintla. The picture shows a post-it that was left out from another workshop, it reads: "Purpose: Contribute with the national efforts to eradicate hunger and malnutrition" Escuintla, 2022



Figure 10. Advertising in Guatemala's newspaper. It reads: Calories for Life. 1 calory equals 1 Quetzal. Source: El Periódico

Overall, in a context of urgency, my constructivist approach and aim at developing a critical view to generate a new perspective for CS and food insecurity felt troublesome. I had the impression that my lack of promises and results (as a non-result-driven participant) was unappealing to most of the CS advocates and selfish on my part. A way of tackling

this sensation was by using the methods I had to my disposition in the best possible way. In the following section I will talk about the three methods implemented for this research.

2.2.2 The research methods

This research has been designed to better examine the process that CS advocates undergo to produce, translate, and transfer the CS through the agroclimatic bulletins. These methods had to have the flexibility of adapting to the CS advocates' availability and on their willingness to participate in the interviews and share information. This research implements a qualitative method that enables me to engage with those who work on CS, understand how the agroclimatic bulletins are done and where these processes take place. In other words, I follow the traces that build upon the idea that climate change and food insecurity require a technological fix, and that CS are capable of providing such. This research process of following policy resembles what McCann & Ward (2012) says is to "study through". Doing so demands the triangulation of archival work, semi-structured interviews, and participatory observation to provide different perspectives on the subject, as a way of achieving results that can complement each other and not to validate a single point (Woolley, 2009).

The institutions selected for this research were categorized into two types of sources, primary due to their direct implication in the LTAC and agroclimatic bulletins, and secondary ones that included other participants of the LTACs who would provide insight or participate in these meetings but were not directly in charge of producing the agroclimatic bulletins. In other words, the primary sources oversee the whole cycle of the CS and are vital for the existence of the LTACs, whereas the secondary sources contribute to the process but are not actively advocating for the CS. Regarding the primary sources, these are not homogenous. For instance, INSIVUMEH is in charge of supervising Guatemala's meteorological conditions and providing weather forecast, and MAGA oversees food production. CIAT, which was also a primary source, has the role -as an international research center-, of providing experience, supervising the creations of the LTACs and evaluating their performance for improvement.

The secondary sources that participate in the LTACs and contribute in the agroclimatic bulletins are much more diverse than the primary sources. This category includes academia, NGOs, international organizations, and crop advisors who despite being part of the Guatemalan state are not CS advocates. On the table below, I show the methods implemented for this research in correspondence with the source of information. On the one hand, primary sources provide direct experience of CS. These sources have been essential to my research because they have experience of the implementation process since the first LTAC in Chiquimula in 2017. The secondary sources were also important because they complemented the research by providing other perspectives and ideas that were usually left aside in the LTAC or in the wider CS discourse.

Table 2. Methods implemented in the research and the sources of information. Primary Sources refers to the institutions that are actively pushing forward the climate services. Secondary sources are collaborators and contributors but do not oversee the process of implementation. The list of participants includes: MAGA: Ministry of Agriculture, Husbandry and Food; CIAT: Centro de Investigación de Agricultura Tropical; INSIVUMEH: National Institute of Seismology, Volcanology, Meteorology and Hydrology; SESAN: Secretary of Food Security and nutritional

Methods	Primary Source	Secondary source	
Discourse analysis of	Institutions:	Institutions	
grey literature	• MAGA	• SESAN	
	• CIAT	 Each and Approximation (EAC) 	
	• CIAI	• Food and Agriculture Organization (FAO)	
		Acción Contra el Hambre	
		World Food Program	
		• Agroclimatic bulletins, reports, governmental policies, and mandates	
Semi-structured	Officials and state	Officials and state bureaucrats from:	
interviews	bureaucrats from:		
		• SESAN	
	• MAGA	World Food Program	
	• CIAT	• FEWSNET	
	• INSIVUMEH	• Universities	

Participatory	• LTAC	Forums, meetings and workshops:
observation	Escuintla Centro-Sur	 Central American Forums on climate change and food security among others The Crop Monitoring System

While the archival work is done to gather data for image and discourse analysis, the semistructured interviews aim at examining how the technicians make decisions and operate. Although a wide variety and range of institutions are involved in CS and food security, this research gathered most of the information - through interviews or reports- from INSIVUMEH, MAGA, SESAN and CIAT. Unfortunately, apart from regular conversations with MAGA officials involved in the process of writing the agroclimatic bulletins, they did not grant me the opportunity to interview them despite agreeing to do so.

Foreseeing difficult access to institutions and government officials, the research demanded a dynamic and flexible qualitative method capable of adjusting and allowing a dialogue between disciplines and theories. With a goal of providing a wider perspective that manages to evince the collision between the two policy regimes, the triangulation of methods allowed certain flexibility for the research to adapt to the way the actors and institutions work and provide a robust source of information to analyze. It also prevented the results obtained from being overly specific or shallow and adjusting to multi-scale policy regimes. Admittedly, I went into the research recognizing the challenge and potential failure of not being able to access and/or assess the incommensurable data and observations between what the different actors of each policy regime could provide. However, I also thought that the empirical data could pinpoint areas of interest for further questioning and reflection. The methods I will discuss below are organized on how this research has been developed. I first began with archival work -which was the method I implemented from beginning to end –. The participatory observation began once I arrived in Guatemala and in the governmental facilities or zoom meetings I was invited to. Finally, the semi-structured interviews relied on the participants and were mostly done in person.

2.2.2.1 Archival work

The archival work involves reports and research done by different institutions involved in food security and/or CS that shape the discourse. I examined reports done by the WMO since 2009 with the creation of the Global Framework for Climate Service (Hewitt et al., 2012; World Meteorological Organization, 2014c, 2014b, 2020), the subsequent National

Framework for Climate Services (Davies, 1990; World Meteorological Organization, 1974, 2010, 2011), to the Latin American region that focused on the Caribbean countries (World Meteorological Organization, 2013a, 2014e), the Central American region (Buontempo et al., 2020; Euroclima+, 2019; World Meteorological Organization, 2013b, 2014g, 2014a, 2016), and finally the Guatemalan scope (Hansen et al., 2014). These documents provided valuable data regarding the discourse, objectives and other characteristics that pertain to the deployment of CS. Equally, if not more valuable were the reports recommended by CS advocates and some secondary sources in the interviews. These documents mostly focused on the process and challenges of implementing CS and the LTACs (Bouroncle et al., 2017; Navarro-Racines et al., 2020), or evaluating the impact that the CS have in Guatemala (Giraldo et al., 2019; Hernández-Quevedo et al., 2022), other sources were reports that focused on food security (Cleaves & Tuy, 2015; FAO, 2016; FAO, OPS, et al., 2018). All these reports were available online on different websites.

In this dissertation I have also read several reports done by international organizations and analyzed their relation to Guatemalan governmental reports to better understand how the CS discourse is produced and reinforced. Therefore, I decided to examine Guatemala's National Development Plan (Gobierno de Guatemala, 2014) and MAGA's two most recent Institutional Plans as sources that complement the data. These documents matter because they serve as political guidelines used by the state functionaries to implement the policies (Ministerio de Agricultura, 2016, 2021). In addition, the agroclimatic bulletins were also considered part of the grey literature. Although the agroclimatic bulletins are the material representation of the CS, they are shaped by a wider discourse that can be traced back in the documents mentioned above. The way in which these bulletins are written and presented responds to the demands and conversations held in the LTAC, however, these discussions are also conditioned by the participants and the organization's limitations (see chapter 5). Overall, the agroclimatic bulletins contain general advice on agricultural practice that take into account the climate. For this research, I have read most of the agroclimatic bulletins created in Guatemala since 2017. In general, image and discourse analysis in text prove valuable to analyze the four sites of visual methodology that involve the production or origin of the image, the image itself, where it is distributed and to whom (Rose, 2001). Furthermore, Fairclough argues that critical discourse analysis is also capable of looking into language and "its involvement [with] the workings of contemporary capitalist societies" (p. 1). He calls for a critical discourse analysis that is aware of the capitalist and neoliberal era of free market and reduced welfare.

2.2.2.2 Participatory observation

Participant observation is one of the main components of this research's methodology. It provides what an interview is not capable of showing. To be precise, participatory observation provided the possibility of experiencing or identifying everyday processes that challenge structural dynamics which cannot be observable through texts or interviews in general. For instance, in chapter four I discussed how international organizations learn how to navigate politics to have legal authorization to operate in the country. This meant that while international organizations collaborate with national ministries, their research methodologies, and efforts to attend the issue of interest needs to be framed and aligned to the ways in which the Guatemalan state operates.

Participant observation thus demands close "attention and that you observe carefully and patiently" (Laurier, 2010, p. 117) so that one notices things that cannot be otherwise observed. In other words, the success of this method relied on my perceptiveness, focus, and personal experience of having lived in and worked in Guatemala. It is also a method I would improve as my fieldwork progressed because I could take better and faster notes. Participant observation also improved as I progressed in fieldwork because it demanded getting acquainted with the processes, the participants, and the dynamics. This would also allow me to notice the messages communicated by the participants in subtle ways that could easily go under the 'radar'.

In this sense, participating in meetings and forums on CS and food security not only provided direct information about the thesis' subject, but it also gave me the opportunity to be a part of other discussions regarding bureaucracy, interests, and agendas that limit and shape decision and action. In other words, participant observation manages to grasp how the macro and micro scales intertwine through language, body expressions, and behavior (Herbert, 2000). This method thus demands a balance between emotional investment, as a researcher and the theoretically informed analysis required in academia.

In the LTACs, I would introduce myself as a researcher that was trying to understand how CS worked and the impact they had on food security. I also spoke about the interest I had in understanding the challenges of implementing CS and that I would take notes during the meeting to learn from the experience in general. I always said I was studying geography but also mentioned that I was an environmental engineer. I was aware - and experience would also confirm - that introducing myself as an engineer made them feel more at ease because it meant that conversation would be kept between technicians. Since these meetings involved low-tier officials, I did not take any pictures, nor did I record the meetings and names of any of the participants. However, I did follow an oral consent protocol before interviewing anyone after the meetings. In Table 3 below, I detail the variety of meetings and forums I participated on and in which I implemented the method of participant observation. These meetings are divided into categories according to the scale of operation they focus on. The column labeled as "topic" shows what the meetings were about and whether the CS or food security was prioritized. The fourth column provides a list of the organizations that participated in each meeting. Unlike the LTACs meetings which were held in person, most of these meetings were online via Zoom. Regarding the LTAC WhatsApp group, I was made part of it once I arrived and introduced myself as a researcher. In this group the CS advocates would share different types of weather and climate reports. Some participants would share information or videos about food insecurity or related to emergencies - during the rainy season or related to volcanic eruptions -. This group was also used to inform and invite participants to future LTACs, various kinds of workshops on climate change and adaptation or job openings. Rarely was the group used for political comments.
Table 3. Meetings and participant observation. The column "Meeting" refers to the name of the meetings I participated in. The Forum meetings are uploaded on the Facebook page of the Comité Regional de Recursos Hidráulicos. In this table CEPREDENAC stands for Coordination Center of Central American and Dominican Republic for Disaster Prevention. INSIVUMEH: National Institute of Seismology, Volcanology, Meteorology and Hydrology; MAGA: Ministry of Agriculture, Husbandry and Food; WFP: World Food Program; FEWSNET; Famine Early Warning System Network; SESAN: Secretary of Food Security and Nutrition; FAO: Food and Agriculture Organization

Meeting	Scale	Торіс	Participants	
Forum	Macro – Central	CS for climate change and food	CEPREDENAC	
	American Region	security, disaster risk reduction	SICA (Central American System of Integration)	
			INSIVUMEH	
			MAGA	
			National Meteorological Institutions	
			National Agriculture Ministries	
Mesa de agricultura	Macro – Central	CS for agriculture and food	INSIVUMEH	
y café	American Region	security	MAGA	
			National Meteorological Institution	
			National Agriculture Ministries	
Sistema Nacional de	Meso – Guatemala	Food security and CS	WFP	
monitoreo de cultivo			FEWSNET	
			MAGA officials	

			SESAN	
			INSIVUMEH's CS advocates	
LTAC (Escuintla)	Micro – Municipal	CS and food security	Crop advisors	
			CSs advocates	
			Meteorologists	
LTAC (Centro)	Micro – Municipal	CS and food security	CSs advocates	
			MAGA technicians on plant health	
			MAGA technicians on production	
			MAGA soil technicians	
			ANACAFE coffee technicians and promoters	
LTAC (Centro)	Micro – Municipal	CS, food security and climate	CS advocates	
WhatsApp group		change	Crop advisors	
			Numerous institutions such as FEWSNET, WFP,	
			MercyCrops, CIAT, Bioversity, FAO and SESAN among	
			others	

2.2.2.3 Semi-structured interviews

The semi-structured interview is a method that has the capacity to "collect data on [...] diverse range of subjects" (Longhurst, 2010, p. 104). Its informal tone allows interviewees to give open responses. Most importantly, semi-structured interviews can be used with other methods. Despite their advantages, semi-structured interviews are subjected to the interviewees' availability and the human connection developed between the participant and the researcher. This would produce a snowball effect in which two key actors of the process would put me in contact with others. In this sense, relatability and friendliness would vary from one interviewee to another thus altering the conversations and the overall quality of the interview. From my research experience in Guatemala, I noticed that implementing this method was much more challenging with young adult officials in their 30s than with recent graduates in their 20s or seniors -between 50 and 60 years of age-. For instance, recent graduates were open to talking about the role the government had during the Civil war or their experience navigating the organization's hierarchical chart and the different existing offices. The seniors that had been working with their institutions for over 20 years were also accessible as they felt their job experience and stability allowed them to speak freely. They had already kept their jobs throughout several different presidential mandates. In contrast, adults in their 30s and 40s would not grant me interviews despite having previously agreed to talk and holding a degree of power within the institution. Accessibility was also conditioned by the degree of implication the state official had with the CS initiative. In other words, those whose work mainly involved the development of CS were more reticent than those who had several other projects going on. In these cases, I decided not to push myself into interviewing some of these CS advocates and respected their discretion, mainly because they would also allow me to join the meetings and LTACs.

Before my first interviews I also prepared a guide of questions and observations to share with the different interviewees regardless of their role and institution. The guide shared some questions regarding the use, promise, and challenges of implementing CS in Guatemala but also had the flexibility of taking different paths if the interview required to do so. This allowed the participants to express their personal thoughts on a similar topic and thus set a departing point for the rest of the interview. I pay close attention to the interventions that would divert from the reports and archives I had previously read and continued to read during the fieldwork. My personal interests or critique about the effects of land inequality, governmental capabilities and limitations were only brought when the conversation had created a better environment, as suggested by Longhurst (2010). I also left tougher questions for later in the conversation when I saw an opportunity to intervene. These opportunities were sometimes brought up by the interviewers, in other moments they hinted at an opening or provided insight into a topic I had not considered before or that I considered too sensitive to start with. For instance, it was surprising to hear complaints of corruption and governmental inefficiency by some officials. I was particularly surprised by a young agronomist who told me that it was natural to expect that rural Guatemala could not trust them because the government had been murdering them just a couple of decades ago (in reference to the Civil war and the massacres).

Semi-structured interviews proved to be a great method to uncover missing pieces from the archives. Its richness came from those observations and comments that the participants brought up to the conversation which were not always related to the question I had posed. This allowed me to consider things or certain aspects of the CS and Guatemala that I had not thought of before. Overall, I had the opportunity to interview governmental officials of several institutions, national academics, and several researchers or technicians from international organizations (see Table 4 below). The informal interviews refer to those that were not recorded or that lasted less than an hour. Informal interviews also include regular conversations I had with low tier officials; therefore, discretion and anonymity were important for protection.

As a researcher I also made it clear that I did not have economic or technical resources to improve the process of implementation of CS. My focus of understanding the process of CS was only to provide a new perspective to challenge what was being done. In this sense, some of the CS advocates lost interest in me, but others did connect in a better and more honest way.

Table 4. Semi-structured interviews	(informal interviews marked with *	^k)
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Institution	Туре	Official	Encounters
INSIVUMEH	National	Meteorologist	3
		CS advocate	3*
SESAN	National	Official of food security	2
CIAT	International	CS advocate	1 and 1 informal
Universidad Rafael	National	Academic	1
Landívar			
FEWSNET	International	Food security early	1
		warning	
WFP	International	Food security	1
ASOPUENTE	National	NGO food security	1
MAGA*	National	CS advocate	1*
		Crop advisors	5 *
		Technicians	4 *

The method of semi-structured interviews was challenging as an outsider because it meant that the CS advocates were naturally reticent to share information or grant interviews about the challenges of the CS initiative. However, participants and other governmental officials who were not CS advocates would speak freely about the challenges of tackling food insecurity in Guatemala. Being a foreigner and fellow Central American also gave me the opportunity to share other topics of discussions on history, corruption and poverty or even small talk about sports and food. All these topics of conversation also generated a degree of trust in which the participant and I could share our personal interests outside their work and my research. These conversations also encouraged me to reflect further on the individual struggles that each technician or state official endured, their wishes and their ideals. This made me realize that, similar to the CS user's heterogeneity, bureaucrats were not a homogenous group either. Overall, semi-structured interviews were vital for this research despite the general challenge I had of taking notes and keeping up with some of the information. Permission to record the interviews usually coincides with the job stability of the interviewee. I also noticed that recording interviewees also made them feel less comfortable. In this sense, I sometimes had to decide between taking notes as fast as possible, risking losing information or recording the interview and losing information because of the interviewee's decision to withhold information. Finally, I would finish this section by saying that despite most interviewees not demanding anonymity, I have decided not to use any of their names. This decision comes from my personal concern with job instability in Guatemala's government. Aside from naming the institutions involved in the CS initiative and those who participated in my research, I do not use any names or concrete working position.

2.3 Scope and limitations

Some strengths of the qualitative research method are that it allows me to "enter" areas where otherwise I could not. However, "good qualitative research" demands the combination of conscious notetaking and structured methods which in turn can only improve with practice and organization. While these aspects can be improved over time, the challenge with qualitative methods also manifested in the difficulty to grasp the limits of the so called 'object of study'. After all, the CS are an idea, a bulletin, a meeting and even a promise whose origin in the WMO downscales to the crop advisors, peasants, and small farmers. As I talked with academics, technicians, NGOs representatives and CS advocates I realized I would not be capable of talking to everyone involved in the process and forcibly miss out on insight and experiences.

Aside from a couple of CS advocates who refused to be interviewed, I understood that participation and academia were welcomed, but only under the condition that they would serve their goals of communicating CS or developing mechanisms for users to appropriate and use CS for agricultural practices. In this sense, if my research had focused on a small village in the Dry Corridor or the highlands in the *departamentos* of Huehuetenango or Quiché the experience with these government officials would have been different, but so would have been this whole dissertation because it would demand other methods to

measure yields, decision-making and income and longer periods of time to work alongside communities. This in turn would have turned my research topic into something different, much alike to what CS advocates are doing.

I am aware that the limited access I had to interview some government officials is a limiting factor to my research process because it prevented me from having other valuable thoughts and insights on the ongoing process of CS. In other ways, it also proved that the aim of this research had hit something worth reflecting upon. As a response to this challenge, the secondary sources mentioned in this chapter contributed with new perspectives or at times would also resonate with ideas and concerns I had and would push me further in these directions. Overall, throughout my research process I have not lost sight of the small farmers, peasants, and Maya communities. They have been the reason for me to tackle the issue of food insecurity and the food system in the first place. Identifying and reflecting on the implications of implementing CS for food security is a way of thinking about them from other instances. The next section I will discuss mobilize the theory used to make sense of the results of the methods I have discussed so far.

2.4 CS, the hinge between climate forecast and food insecurity: exploring the interactions between the policy regimes through policy mobility

The LTACs can be defined as "ephemeral spaces of knowledge production and circulation" (Temenos & McCann, 2013, p. 346) where participants are first taught about modern climate science through the *Educlima* component of the meetings. In the same meetings, the participants are later provided with the climate forecast of the region so that they can discuss and elaborate agricultural advice to small farmers and improve food security. According to CS advocates, this process is framed as purely objective and technical. It is a place where technicians and experts use their experience, knowledge in agriculture and their newly acquired knowledge of climate to provide advice on agriculture and assist the small farmers and peasants. However, the claim of objectivity is not accurate because the discussions and topics are conditioned by social dynamics, history, colonial legacies, and power relations. In this regard, McCann and Ward (2012) offer an interesting approach to policy implementation that focuses on how policy actors construct, mobilize and mutate

policies. They offer a methodological approach that can adapt to the non-static and mobile nature of policy making because policy construction "move[s] from one place to another" and are constantly "being assembled, disassembled, and reassembled along the way" (p. 43).

McCann & Ward (2012) and later Temenos & McCann (2012) also developed the idea of "studying through" instead of studying up and focusing on the colonizer or elites or studying down and focusing on the vulnerable. For this thesis, 'studying through' means being capable of following stories, objects, people, and discourses through different sites, at various moments of the day and throughout the year. In this ensemble of knowledge, ideals, and intentions that make up the CS, I follow actors and study through by having previously developed an awareness that CS are not only a product of climate knowledge but the result of complex relations between actors and institutions. In other words, despite being a product that is pushed forward by the World Meteorological Organization, CS are the result of friction or collision between two separate policy regimes, the climate infrastructure and food system policy regimes. As a result, I identify and locate multiple and heterogenous institutions and bureaucrats who are working on, moving, participating, or observing the implementation of CS on the ground. These "middling" technocrats (Temenos & McCann, 2012, 2013), street level bureaucrats (Lipsky, 1980) or as I call them the middlemen -because middlemen include technocrats, governmental bureaucrats, and international experts-, are responsible of teaching, spreading, and implementing policies. They are in between the Elites and/or high-tier officials that research that "studies up" focuses on, and the vulnerable communities that the CS community has mostly focused on by "studying down" (McCann & Ward, 2012).

In this light, some new questions begin to manifest. For instance, what does it mean, logistically and epistemologically, for CS advocates to make the LTACs function? What are the techniques that they use to make CS usable? How do they talk about food security? What are their thoughts, goals, experiences, and challenges? Lastly, what are the topics, challenges, and questions they are not engaging with and why? For this research, omissions and silences are also valuable sources of information. "Studying through" allowed me to move between temporally constrained sites, or ephemeral spaces (e.g., the LTACs, regional

and national CS forums, the LTACs, the WhatsApp group) that do not have a particular building or office to go to, or a legal frame that can support and/or regulate them.

As mentioned in the introduction, participants and CS advocates discuss weather patterns, climate scenarios, food prices, plant requirements and other immaterial and material, human and nonhuman components that are taken into account in the agroclimatic bulletin to provide personalized advice to the farmers. They juggle with numerous variables of the two different policy regimes, the climate infrastructure, and the food system. These policy regimes are the *mélange* of things that include different groups of actors, objects, and literature that share distinct characteristics and topics of interest, one being food and the other climate. Each policy regime also has its own epistemic community which here is understood as the group of scientists and professionals who "are responsible for developing and circulating causal ideas and associated normative beliefs and, thus, help to identify state interests and preferences as well as to identify legitimate participants in the policy process" (Haas, 2007, p. 3). For instance, while CS advocates generate climate scenarios, the FAO, FEWSNET and SESAN -among others- put together the Integrated Food Security Phase Classification (more in chapter four) to project the number of people who will become food insecure. Overall, CS advocates, technicians and state bureaucrats are all "solution-starved' actors, often under pressure to 'deliver'" (McCann & Ward, 2012, p. 45) outcomes of pretested models.

A policy regime therefore refers to the combination of the material, that includes human actors, crops, weather stations, computers, cars, cellphones, road infrastructure, and the immaterial involving a set of principles, epistemologies, new knowledge production, socializations, governmental reports, the market, and institutions. One can say that observing the transgressions in the CS production process is what Anna Tsing's (2005) brought forward in her work on friction which I will review and use to develop further in the section on friction and collision in section 2.4.2. However, I will first turn to the role that institutions and CS advocates have in this initiative. The next section provides a framework I used to address them.

2.4.1 Exploring institutions and middlemen delivering climate services

In his work about turning climate sciences into a service, Atte Harjanne (2017) points out that CS advocates and the WMO have clearly developed strong arguments on the pertinence of using CS for current world challenges. Harjanne argues that the process of deploying CS is based on "narrow assumptions on human and organizational behavior" (2017, p. 1) largely left unquestioned. I would add that human behavior and food production are not predictable, nor can they be easily modelled as weather and climate can. Work done on the act of decision making offers the complex view of how people make decisions not only based knowledge but "finite moment of urgency and precipitation" (Mccormack & Schwanen, 2011, p. 2814). However, other scholars argue that decisionmaking is inevitably limited and conditioned. Kevin Grove (2018) describes bounded rationality as the limits to knowledge in which a person cannot fully grasp and comprehend a phenomenon. Going further, Grove cites the work of Hebert Simon that argues "that decision taken in the absence of total knowledge are not irrational but are rather rational within contextual limitations" this applies to "decision-makers who are embedded in complex environments that human rationality cannot fully understand or process" (Grove, 2018, p. 14).

In this sense, assumptions about human behavior are examined in this thesis to evince the challenges of merging the policy regimes on an individual and institutional scale, but it also allows reflection on the influence and impact that CS has on food policy. Currently, CS advocates seem to be unaware of the effects they have on public policy about food security; they also lack reflection about this topic (Hernández-Quevedo et al., 2022). CS advocates manifest, both in their reports and in interviews, that their initiative is focused on logistics, outcomes, and future goals (Giraldo et al., 2019; Hernández-Quevedo et al., 2022). This left other topics and challenges neglected (e.g., the functioning of Guatemala's food system or the mechanisms that the Guatemalan State had to address food insecurity with the use of CS to name a few). This lack of vision, so to speak, is due to the general interest and urgency of reaching peasants and other actors of the food production component. As chapter three will show, these efforts are conditioned by principles of inclusion and vulgarization of knowledge.

Their focus on outcomes and the continuous efforts to reach new goals is expected. Broome & Seabrooke (2012) and Mary Douglas (1986) provide insight on how institutions are conditioned into being outcome-oriented, subjected to scrutiny and delivering results. This means they must be able to prove their capacity to deliver what they say they are made for. Additionally, Mary Douglas and her approach to radiation and health also proved valuable. She focuses on the "disagreements between the scientists practicing nuclear medicine on the one hand and a section of the general public on the other" (p. 3), in this fashion, this dissertation also lingers in the gap existing between academics, engineers, agronomists and meteorologists. Douglas goes on to portray the "selective deafness in which neither of two parties to a debate can hear what the other is saying." (Douglas, 1986, p. 3). Therefore, identifying this deafness as a mechanism used to build collaboration between institutions has been one of the implications I sought in the fieldwork. Whereas Temenos & McCann (2013) referred to mutated policies as the "gatherings of 'parts' of elsewhere into one assemblage" (p. 347), this research has identified deafness and mutating concepts as a mechanism used to maintain collaboration at different scales of operation despite existing tensions between policy regimes (in chapter four, I develop this discussion on what I identified as conceptual mutability).

Maintaining a certain policy responds to the nature that climate service for food security has of being a program of development that carries ideas, beliefs, and a powerful discourse. In this sense, I also engaged with and draw from the research that focuses on development, specifically agricultural rural development (Escobar, 2012; Ferguson, 1993; Li, 2007). These scholars' work provided valuable experience on how institutions make use of categories and produce a "human subject" who responds to the solutions that organizations and governments are tasked with and capable of providing. This classification of the "human subject" allows institutions to organize a rather chaotic environment (Douglas, 1986), however, it also results in the oversimplification of the rather heterogenous environment they work on (more in chapter three). Additionally, Ferguson (1993) and Li (2007) portray how this process of providing solution demands from technicians the capacity to frame the issues as technical and apolitical. Overall, they evince how programs of development can produce side-effects that transcend the 'success or fail' dichotomy.

Finally, it is worth stating that this thesis acknowledges that institutions rely on the government officials to enforce their policies in their day-to-day work with citizens (Lipsky, 1980). State functionaries or street bureaucrats, as Michael Lipsky calls them, are in direct contact with citizens, farmers, and peasants in contrast to managers whose goal is to provide measurable data and results. As mentioned above, the meetings that CS advocates and other participants hold in the LTACSs are the sites in which these street bureaucrats merge climate and food security. Contrary to what seems to be a natural process of incorporating climate knowledge into food production, this research evinces that the LTAC engages with a variety of actors from different backgrounds and organizations. On the following section, I will discuss how the CS, by materializing into the agroclimatic bulletins, produces "tension-filled relationship between territorial fixity and place specificity and global flows, relations, and interconnections" (Temenos & McCann, 2013, p. 348). These tensions are thought of as collisions between the policy regimes that take place in the LTAC, the agroclimatic bulletins, the forums CS for food security and even the WhatsApp chat group that shares the CS. In practice, the advice on food production that is given at a municipal scale collides with the global food system dynamics.

2.4.2 On Frictions and collisions

The tensions produced by the exercise of abstraction that technicians undergo to merge climate knowledge with ideas of food security are here referred to as collisions. Collision produces an image of a rather violent encounter which, at this moment, is not yet so evident or clear. Tsing, in a different, yet pertinent manner, talks about friction to refer to those spaces in between where things happen. Her work manifests how these spaces, if well examined, can reveal how globalism and localism are translated. She argues that instead of continuing the debate "over whether science is a privileged form of truth or political impositions" it is more important to "learn about collaborations through which knowledge is made and maintained" (Tsing, 2005, p. 13). Friction therefore evokes a site in which things happen and epistemological differences manifest.

Over and above Tsing's conceptualization of friction as the space where things happen, collision, for this thesis, also refers to the space where violent side-effects are engendered

as we will see in chapters three, four and five. Although she does not label them as such, some examples of these effects are clearly discussed by Tsing. First, she mentions the introduction of techno-politics as a mechanism in which tradition is modernized. To a certain extent, co-producing knowledge in the LTACs is also a way of reaching, absorbing, challenging, and changing traditional knowledge. The LTAC became a place where one proves the quality of each participant's knowledge and tries to incorporate western climate knowledge to respond to climate change problems. Second, she argues that the differences between scales matter in the sense that: "projects that make us imagine locality... in order to see their success, are also scale-making project" (Tsing, 2005, p. 57). The scale-making project in this thesis will be discussed in chapter three and four, where I talk about how institutions shape problems into manageable smaller ones through the conception of measurable parameters to foment collaboration and relevance. Scales are also important because they validate State intervention at local level (Ferguson, 1993), especially in a weaken neoliberal Guatemalan State. A side-effect is that, instead of auditing politicians and high-tier decision-makers over food security and climate change policy, most of the research and discussions have focused solely on micro-scales and on vulnerable populations. As a result, these studies have undermined the role that politicians and decision-makers have regarding the CS, to focus on the disempowered and vulnerable citizens. This means that building upon the idea that CS can produce locally relevant climate information to improve livelihoods produces manageable and convenient projects for the elites in which the *status quo* is left unquestioned.

Where does this collision happen? And how does universal understanding of climate knowledge influence the national arena of food security? In what way does the creation of a future through climate scenarios produce things? What kinds of things? To narrow my search for collisions I have represented the policy regimes with two separate circles and with a line that represents Boaventura De Sousa Santos's concept of abyssal line. The abyssal line is an imaginary line that creates a division between what counts as knowledge and what does not. It also reflects capitalist interest because it divides those research questions worth asking from those that are aligned with the *status quo* and that offer conventional solutions. For this thesis and Guatemala in particular, collisions occur in the

LTACs when tensions between global discourse and local demands along with the differences between policy regimes result in unwanted effects that are detrimental to the vulnerable people the CS are aiming to assist. It is where the CS and climate change discourse becomes a form of discipline through the configuration of "a group of statements that structure the way a thing is thought, and the way we act on the basis of that thinking" (Rose, 2001, p. 187). Collisions, contrary to the idea of frictions, are not so innocent because they are programs of development that continue to impose practices and ways of thinking. Chapter five will further explore this concern through the concept of climate coloniality.

Having identified the primary sources of information - above in section 2.2 –, I have also situated them in the policy regimes they belong to. Although the abyssal line in the figures below (see Figure 11-12) seems rather clear, the fieldwork experience showed that some things did not fall on one side or the other, but were rather occurring, leaning out in some conversations, curbed, made absent or omitted. What I mean to say is that on a macro scale, the abyssal line helped me in the process of shaping my thought on how the climate infrastructure policy regime guided but also limited the discussion between the CS advocates and technocrats when implementing CS. However, at a micro-scale, Tsing's idea of frictions is more helpful to illustrate the messiness of the process and the blurriness of the abyssal line.

In Figure 11, I have chronologically situated myself in the Guatemala of 2017 prior to the time when the first LTAC was implemented. We can see two different 'worlds', each with its own discussions but also with different challenges regarding the global and the Guatemalan context. Although the figure is an oversimplification of a complex assemblage of actors and institutions in which policies are mobilized, it serves as a basic guideline to show a non-exhaustive list of institutions and topics of discussions to start with in the research process. In this sense, the figure shows a list of institutions followed by the topics they generally discuss and are interested in. Divided by an abyssal line, the policy regimes in Figure 11 then shows how the institutions and topic change between the global North and global South accordingly.

In more detail, the circle to the left (also Figure 11) shows how some meteorologists in the global North have resources and access to supercomputers to produce global climate scenarios. These scientists use thousands of weather stations distributed around the world and are thus concerned with understanding global climate behavior and producing climate scenarios. In contrast, Guatemala's national meteorological institution is dedicated to the national scale of operation and relies on private weather stations and external provision of data (the National Oceanic and Atmospheric Administration in the United States or Copernicus in Europe) to produce their climate forecasts. They also have the challenge of managing an institution with a lack of weather stations, resources, and personnel. INSIVUMEH officials, which according to their website are not all meteorologists, also must navigate around political constraint due to corruption and a lack of trust from the Guatemalan citizens. Regarding knowledge, the climate infrastructure also displays a global consensus on climate knowledge that excludes other ways of knowing the climate like traditional methods that use animals and insect behavior or the *cabañuelas* at the beginning of the year to forecast weather (Ewbank & Aid, 2016).



Figure 11. Guatemala prior to the implementation of the first LTAC.

In the same figure on the right, food security discussions in the global North englobe wider issues with food availability, input prices and food price speculation among others. The FAO, the Consultative Group for International Agricultural Research now known as

CGIAR, and other global actors push forward climate-smart agriculture to tackle climate change and build resilience. In Guatemala, below the abyssal line, there are other discussions that are less 'popular' among the local elites and difficult to address and discuss for the majority of the state officials. Some of these topics involve food sovereignty that has been championed by Maya communities (Declaración de Atitlán Consulta de Los Pueblos Indígenas Sobre El Derecho a La Alimentación: Una Consulta Global, 2002), land dispossession, and the various effects that cash crops have on the environment and society. Regarding the technicians and other actors involved in the food production system, we can see that the food policy regime has agronomists within the global North whereas the global South has peasants and other many other Maya communities. In other words, Guatemala's food production landscape is much more heterogenous and complex as peasants and numerous Maya people are forced to cohabit and rely on labor offered by monoculture landlords caused by land dispossession. Although there are agronomists within the global South, these technicians can also be part of the Imperial South⁸ which stands for a group of people within the global South who promote ideas of modernization and food security in detriment to traditional knowledge. In a similar manner, discussions on food price speculation, climate change, environmental certifications and food security are raised by global institutions, such as the FAO, while the social context in the South demands discussion on land dispossession, hunger and other barriers related to environmental laws, tariffs, and competition against subsidized grains. Overall, the two policy regimes can and have been operating separately, they are self-sustained systems with their own components, logics, principles, and missions.

Once the CS arrived in Guatemala in 2017 through the creation of the first LTAC in Chiquimula, these two policy regimes were merged. This initiative responded to concerns with food insecurity on the one hand, and climate change on the other. It is worth mentioning that Chiquimula is one of the *departamentos* that was hit hard by a famine of 2001 (FAO, 2016). Figure 12 tries to represent this collision. Although the two regimes will now share the specific goal of improving yields, livelihoods, and well-being through the provision of tailored climate information, general characteristics and the principles that

⁸ Below I use the term intellectual vassalage which comes from the Guatemalan sociologist Guzmán Böckler.

each policy regime has will remain unchanged. That is to say that one policy regime does not question or challenge the other. In this light, two aspects are worth mentioning. First, both policy regimes will carry their own abyssal lines with the differences mentioned above. Second, for the collision to happen, people and institutions must create a favorable space for dialogue and meetings to be held. If it was not for the CS advocates and other participants climate scientists and humanitarian and food security organizations would each remain in their own corner. From the literature review I covered in chapter one, I have not found any that has framed or approached the CS initiatives considering the LTACs and the abyssal line, or the merging of the policy regimes, nor have any examined the implications of this collision.



Figure 12. The arrival of CS in Guatemala and the subsequent collision of two policy regimes

It is also expected that within each policy regime, local practices could resist and challenge global ideas and institutions. As mentioned above, acknowledging the abyssal line and the imperial South also elucidates internal struggles and contradictions that this research tries to evince. Overall, each policy regime has its own ideology and ways of operating. They carry a set of values and policies supported by different jargon, terms, and concepts (e.g., certainty, vulnerability, risk, resilience). Whether current academic discussions revolve around food sovereignty or food security (Gürcan, 2018; Holt-Giménez, 2011; Wittman, 2009), adaptation (Pelling, 2011), or resilience (Bourbeau, 2018; Grove, 2018), in practice,

we see that in Guatemala both policy regimes are put to work together bringing along their own abyssal lines and inconsistencies. In the figure above, the question mark in the middle represents the unknown implications and the issues taken for granted of implementing process of the CS for food security in Guatemala.

However, the expected interaction between regimes and the collisions that I have hoped to encounter and render visible are likely to be produced by governmental officials and other CS advocates either in academia or international organizations. As I will detail in the upcoming chapters, the empirical work done can show some of the discussions -in interviews or meetings-. In Figure 13, I represent how the policy regimes meet, unnaturally, by the work done by the CS advocates in the LTACs. In these meetings the abyssal line becomes blurry. CS advocates (as chapter four and five will show) navigate between the ideals of inclusion and vulgarization of knowledge and the social struggles and complaints from crop advisors. In this manner, the figure shows some of the topics that arose from discussions I witnessed in the LTAC, or conversations I held in private with crop advisors. The topics I present in the figure below were not part of the traditional discourse or in the literature review I covered. These discussions are thus situated below the line and hint on the particularities that the Guatemalan context has and the capacity to shape the process of implementation of CS. The discussion below the abyssal line are those topics that have been brough up by crop advisors in the meetings, while others were discussed in semistructured interviews with actors involved in food security that are not the CS advocates.

Although national ministries and institutions are the ones the guide the discussions, their mechanisms of implementation and the reports in which they base their work are heavily influenced by FAO, CIAT or the World Meteorological Organization. Reproducing ideas of modernization and technification of the countryside do contrast with the lack of economic and human resources to reach the furthest areas of the country but also limit discussions of local needs (more of this subject in chapters four and five).



Figure 13. Policy regimes figure showing the participants and the topics of discussions above and below the abyssal line.

On the left, discussions within the climate infrastructure involved deciding on how to move around the country the few weather stations that INSIVUMEH possesses. There were a limited number of weather stations as well as human resource to operate them (González, 2019). Therefore, the meteorologist moved them around depending on his technical criteria but also on available and trustable citizens who are willing to collaborate and take data to send it to INSIVUMEH via cellphone. Additionally, creating the LTAC responded to a couple of interests. First, CIAT officials and CS advocates saw the growing number of LTAC as a success in their operations. It also meant that the CS had reached more people as each LTAC included other boundary organizations, NGOs, students, and interested participants in general. Second, on the ground, the LTAC responded to the politicoadministrative divisions in Guatemala that was conditioned by the existing good or bad relations between city mayors and governors. Excluded from these conversations about the location and reach of the LTAC were other participants and experts who would rather use watershed, microclimates, and other environmental criteria to create the LTAC.

In the same figure, in the circle to right, below the abyssal line, the food system also brought concealed topics of discussions. When climate knowledge was taught in the Educlima sections of the LTAC and MAGA officials received training about meteorology and climatology, other challenges were left out. These included the lack of agricultural insurance, water management law, seed banks, or any kind of rural agricultural development plan that SESAN was pushing forward⁹. However, the discussions never considered complex and profound topics such as food sovereignty or land reform. Overall, this figure shows how CS is an example of the compartmentalization of knowledge, and when it tries to intervene in other issues as food insecurity it becomes violent against western science itself because it produces overgeneralizations through limited scopes of analysis (Shiva, 2019). Going further, Vandana Shiva (2019) criticized the idea that gathering data -climate data in this case- is a form of producing knowledge. This thought becomes pertinent when climate science begins to dictate what counts as knowledge and becomes entitled to value other practices or research questions. In other words, although climate information and climate services are the integration and analysis of data, it is a knowledge that still finds it difficult to be integrated into other epistemic communities. In Guatemala these 'strong' questions that have the capacity of shaking and defying the system's status quo (de Sousa Santos, 2015, 2018) are left unmentioned and whenever one drives the conversation towards them the conversation topic is changed or stopped. This challenge was also manifested by the crop advisor's manager who openly welcomed academia, not those "social scientist, but the engineers and technicians". ¹⁰ Finally, the participants in both policy regimes agree on the challenge of changing the traditional, in their words, "cultural" practices. This issue is understood as a threat to the program and is explained as the "unwillingness to become modern" (more in chapter five). Elucidating the implications, or those topics and issues that have been taken for granted demands a framework that allows power to be seen not only as oppressive but also as a source of creation of opportunities. Quoting Shore and Wrigth, McCann and Ward (2012) agree that

⁹ These topics of discussion came up in personal interviews I held with some officials as well as other meetings I participated in. Some topics were brought up by the interviewees and others by me, however everyone agreed on the importance of keeping seed banks, developing a law on access and protection of water and on land distribution.

¹⁰ Some seminars in which MAGA officials participate, and I was part of, had presenters with claims about using 'real science' to assess and tackle climate change.

"power creates webs and relations between actors, institutions and discourses across time and space" p. 46. Therefore, I now turn to power in the next section.

2.4.3 Seeing power as an agent that creates, conceals, shapes, and banishes

How are the collisions over the topics of discussions between the global North and global South resolved? How do I identify and examine these collisions that do not have a particular object -other than the agroclimatic bulletins-, an office -other than the temporal meetings of the LTAC-, or a particular state official -this includes CS advocates in INSIVUMEH, MAGA, and CIAT- to talk to. I have tackled this challenge by addressing power. Power manifests in the relation between experts and citizens, between groups of technicians, and also between the elites and the rest of the Guatemalans by deciding over the topics and discussions that are worth having. Power is also a producer of opportunities and ideologies.

In this research, power is examined through texts and speech because state officials and institutions become "among other things an apparatus of verbal interactions, or an 'order of discourse'... a speech community" (Fairclough, 2013, p. 40). The speech community can not only encourage social and verbal interactions between different actors but can also limit and restrain them according to any institution's interest. Attending different types of meetings allowed me to track down who were the organizers and how discussion was guided accordingly¹¹. The type of language used, and the actors involved were also of interest in the research process.

Therefore, to examine power also allows the research to differentiate ideology from knowledge. Power creates a discourse that shapes how things are thought and acted upon, and it is not only exerted through force with policemen and prisons, but through claims of absolute truth as well. By articulating images, practices, and language, "the construction of claims of truth lies at the heart of the intersection of power/knowledge" (Rose, 2001, p. 190). In this fashion Norman Fairclough states that "unless s/he [the researcher] is aware

¹¹ As chapter three and four show, I not only attended the LTACs but also National and Central American forum in which CS were part of the discussions. This gave depth to the analysis because the fieldwork was not limited by the LTAC experience, but it also experienced how the CS were discussed at other scales.

of the ideological dimensions of discourse, the chances are that s/he will be unconsciously implicated in the reproduction of ideologies, much as a lay subject is" (Fairclough, 2013, p. 46-47). The effects of power and ideology produce several effects in the dynamics of relations between state officials and the citizens first, and amongst experts of different institutions second.

As I mentioned before, the institutions and the government officials in charge of implementing the CS are the middlemen who produce and reproduce the discourse and ideology about CS. In their meetings and through their reports, practices, and language the CS advocates recall Foucault's notion of "conduct of conduct" by which they define habits and aspirations to shape citizen behavior (T. Campbell & Sitze, 2013; Foucault, 2013). Instead of exerting disciplining power, the government now educates and persuades to gain consent (Li, 2007). CS programs are therefore entangled with other technical initiatives like soil management practices by which citizens are meant to implement certain agricultural practices to receive stipends, support, and recognition. This concern is further explored in chapter five.

Second, power also has effect on the institutions that work in Guatemala -the same institutions that exert power over others-. Regarding the effect that ideology and power has on the institutions, it translates into the use and overuse of techno-scientific approach that prevents further reflections. For instance, state officials argued that 'hard' science provides 'objectivity' to address the issues at hand, it also allowed them to create and categorize the 'food insecure' population. The solutions thus become non-political and tend to "focus more on the capacities of the poor than on the practices through which one social group impoverishes another" (Li, 2007, p. 7). These practices need the approval of the central government (Ferguson, 1993) and resonates with what one of the CS advocates told me about working with governmental constraints and having to "work with what we have [to our disposition]", otherwise they would not be allowed to work in the country. Chapter four explores how institutions collaborate and generate agreements over ideas and objectives despite difficulties concerning scales and concepts.

Overall, the theoretical framework I drew upon has prepared me for the fieldwork and methods I decided to implement. It provided a sense of elasticity to my thought process in

which I could "study through", find, and make sense of those implications left aside. It also conditioned and limited my thought process in other ways because the policy regimes are but limited and simplified versions of the 'real' world in which technicians meet, discuss, work, and make a living. Despite their limited reach or capacity to grasp the real world, they have already provided a foundation to work with in this thesis.

2.5 Conclusions

The CS community and researchers have focused on delivering CS that respond to local needs and demands of small farmers in a timely manner. This focus has drawn attention away from other aspects that this research examines. By looking at the institutions and the middlemen that include the CS advocates, state officials and other participants involved in the process of implementing and delivering CS, this chapter draws attention on other aspects that affect the implementation process of CS.

Doing research on governmental institutions demanded self-reflection and the capacity to curb my negative perception of Central American national institutions to allow other perspectives to thrive. Previous research experience I had that involved an inaccessible and autocratic Nicaraguan government would also prepare me to manage around potential distrust from Guatemalan officials and the capacity to take cues when needed. Despite having understood the challenge of accessing these spaces, I also considered the need to dive into these institutions to progress the discussion on CS.

For this research, a "combination of inductive and deductive reasoning" became iterative and abductive because it became a "back and forth process of constructing a hypothesis, carrying that hypothesis into the field of investigation, and revising it" (Tracy, 2020, p. 27-28). Without losing track of the main research question, I have focused my interest on the institutions and the middlemen because they are responsible of implementing CS and because they exert power that can change, shape, silence, and guide civil society towards a desired outcome.

Overall, doing research that focuses on the middlemen who oversee the processes of production, translation, and transfer of CS through mechanisms of inclusion, co-production

of knowledge, participation, and communication implicitly carries a degree of complicity with the belief that CS can improve livelihoods and food insecurity. This does not mean that one should not continue to research the communicational aspects of CS, or to implement initiatives with such principles. However, changing perspectives or paradigms as Beveridge et al. (2019) champion in their work, can also provide new insights and refreshing questions to the process.

In the following chapters I will show how the idea of inclusion and citizen participation does not translate into palpable actions, nor does it generate structural changes. Citizens are encouraged to participate and change superficial things like the content of the agroclimatic bulletins, but nothing else. To my view, this makes participation a sort of spectacle because it has no social or political implications (more in chapter five). This chapter provides a framework to grasp how institutions work, how discourses are shaped, and how actors navigate these assemblages. Doing so, it pushes forward the multi-disciplinary approach that CSs advocates have done in Guatemala in the hopes to reassess their efforts and current objectives.

3 Implementing Climate Services in Guatemala, expectation vs reality

3.1 Introduction

CS are relatively new in Guatemala; however, the CS initiatives can be traced back to the World Climate Conference-3 of 2009 when the World Meteorological Organization (WMO) announced the development of the Global Framework for Climate Services (GFCS) (World Meteorological Organization, 2012). As a result, in the upcoming years the High-level Taskforce, established by the GFCS, produced several reports, and developed an Implementation Plan that would later be used for future CS initiatives. Since then, CS advocates have organized several conferences around the world to raise awareness about the existence and value that climate information holds when used to inform decision makers and policymakers on various issues regarding water, agriculture, health, disaster risk reduction, and energy. Some of these conferences include the 2016 *Foro Iberoamericano* (World Meteorological Organization, 2016) that involved several Latin American countries, the Latin American workshop for CS in San José, Costa Rica (World Meteorological Organization, 2014g) and a forum for the Caribbean countries (World Meteorological Organization, 2013a).

As we can see above, the WMO focused on the global South, mainly because the "poorest countries are especially at risk of climate variability and climate change" (World Meteorological Organization, n.d. p. 1). Officials at the WMO argued that, in order to have a beneficial impact on people, climate information has to be produced, improved and made available to everyone. With this in mind, new initiatives in the global South used the GFCS to develop the National Framework for Climate Services (NFCS) (World Meteorological Organization, 2014b) to work directly with each country at a time. In the years that followed, several NFCS meetings were held in countries of Africa (World Meteorological Organization, 2014f, 2018, 2019), the Caribbean (World Meteorological Organization, 2014b). Although this range of initiatives demonstrates that there have been wide interests and no lack of efforts to implement the CS, it has also made the efforts of tracing them much harder because the

CS have taken different paths around the world. In other words, it becomes difficult to track which countries and institutions continue working on them and how. For instance, Europe developed the Copernicus program that is now working with universities in Central America to innovate on the use of CS in the region. There is also Euroclima+ that focuses on supporting projects that target climate change and adaptation in Latin America. To do so, Euroclima+ promotes the development of the national meteorological institutions and the use of CS in the Latin American region (Euroclima+, 2019). To date, Euroclima+ has already held several workshops in Central America and Ecuador with the collaboration of Spain's meteorological institution. For this thesis and chapter, I focus on Guatemala's National Meteorological Institution – INSIVUMEH - and CIAT which are leading the initiative to implement the CS in Guatemala.

Amidst this range of initiatives, the principles of inclusion and vulgarization of knowledge as well as the goal of improving the livelihoods of people who are the most vulnerable to climate change remain unaltered. This aspect matters because the principles, established under the WMO's world vision, influence and define meso and micro scales of operations while diminishing the colonial legacies and the diverse socio-political contexts. What this means is that, despite designing a method that invites everyone to participate and to appropriate modern climate knowledge, the expectations that CS advocates have of the CS show important differences with the grounded experience. In this sense, this chapter reflects on the differences between the expectation and desires with the grounded experience mainly by looking at the collaborators of the CS, the process, its users, and the CS products or outcomes, all developed under the banner of inclusion and collaboration.

This chapter has two objectives, on the one hand, it presents an overview of how the CS are operating in Guatemala so that later chapters are easier to navigate. On the other hand, it follows the discourse regarding the expectations of using CS for food security. To do so, the chapter traces and organizes the argument around the principles of inclusion and vulgarization of knowledge which are embedded in the discourse and practice. The general idea of this chapter is also to contrast the expectation with the grounded reality of the implementation process of the CS. It does so by dividing each of the following sections

into two parts, the first addresses the expectations that CS advocates have on the CS by drawing on reports, and discourse. The second draws from the empirical experience.

The sections explore how the CS advocates engage -or not- with the food system and what they think -or not- about when they talk about food security. The omitted discussions and topics about the food system or Guatemala's colonial legacies also provide an important source of information to reflect upon. As a way of systematizing the data, I have selected four aspects of comparison between the imagined process and the grounded experience, these include observations and analysis about i) the collaborators (section 3.3), which refers to the institutions and organizations that support and push forward the CS, ii) the users (section 3.4) or those who are meant to be benefited by CS, iii) the process of implementing the CS along with the participants of the LTACs (section 3.5), and, iv) the outcome of the process which refers to the agroclimatic bulletins (section 3.6).

3.2 Reviewing the CS implementation process through the eyes of the CS advocates

In Latin America, the Local Technical Agroclimatic Committees (LTACs) were first implemented in Colombia. Now they have been introduced in Guatemala, Honduras, and Nicaragua as well as other South American countries. The LTACs are important because they are the sites in which CS take shape and materialize. Following the cycle of the CS (see Figure 5 of page 10), the LTACs are vital for the translation of the climate information and in some cases their direct transfer to end users. According to the LTAC handbook used in Guatemala, they are defined as:

Spaces open for dialogue among actors who represent different public and private institutions, associations, academia, cooperatives and NGOs and international cooperation, among others, along with local food producers of each region, with the goal of providing knowledge of the behavior of the climate in a locality (Hernández-Quevedo et al., 2022, p. 13; my translation).

The CS advocates use these LTACs to improve their capacities to communicate with the users through a sustained dialogue between parties. The definition establishes the clear goal

of providing climate data to different groups of people. To achieve such a goal, CS advocates are required to teach about climate knowledge to everyone willing to learn about it and to work on providing advice with local precision in a timely manner. This vision resonates with the Guatemalan government's goal of teaching modern knowledge and modernizing the countryside (as discussed in chapter five). Research done by CIAT also shows that NGOs and other organizations also share this desire. By 2022, the LTACs had gathered more than 100 organizations to become part of the committees and through them, distribute the agroclimatic information to their members (Hernández-Quevedo et al., 2022). However, for this research I have focused on the three key organizations (the primary sources of information mentioned in chapter two) that oversee the production and transfer of the CS by generating synergy between organizations or directly pushing forward and organizing the meetings. CIAT which functions as a boundary organization and provides expertise and technical supervision, INSIVUMEH which is the national meteorological institution that has access to meteorological data and is the only institution legally allowed to communicate climate data, it is also responsible for teaching and training participants and users on meteorology and climatology, and finally, MAGA is the institution which provides most of the facilities where the LTACs take place. MAGA is also in charge of the crop advisors who are in direct contact with the small farmers and peasants and therefore are encouraged to disseminate the agroclimatic bulletins and reaching the countryside. Although La Universidad Rafael Landívar also works with CS, I have focused on the three organizations mentioned above because they are involved in most of the existing LTACs of the country. In the map of Figure 14, CIAT details the number of existing LTACs along with the primary institutions involved in their functioning. The figure also shows that the LTACs share other development programs pushed forward by the Consultative Group for International Agricultural Research (CGIAR).



Figure 14. Leading organizations of the LTAC in Guatemala and CGIAR initiatives in color. We see the logos of MAGA, University Rafael Landivar, ANACAFE, CDRO, GREPALMA, WFP, and CUNORI Source: https://insivumeh.gob.gt/?page_id=16372

Similar to CIAT, CGIAR also focuses on developing the 'digital component' (more about digitalization in chapter five and six) to provide personalized information through the programs called Climate Resilience, AgriLAC *Resiliente* and Livestock and Climate. This hints on how LTACs are also spaces to generate collaboration between institutions that have different objectives. Tracing where CS initiatives begin and where they end makes the research complicated because some CS advocates from CIAT are also involved and interested in side-projects that overlap with CS but are not always the same. In the subsections below, the chapter expands upon the variety of actors involved and the degree of engagement they have with the CS. As we will see, food security is conditioned by the CS advocates' positivist approach of providing one reality regarding climate behavior and weather patterns in which decision-making and every aspect of the food system can be calculated, understood, and rationally acted upon.

To make LTACs function the WMO and the GFCS suggest that institutions and organizations get in contact with each other (see Figure 15 below). Therefore, the process of producing and using CS involves communication, as conveyed by the two-directional arrows, between different categories of institutions that include academia, enablers,

boundary organizations, the national meteorological institutions, and the CS users. Each category not only has a different role when it comes to the implementation of CS, but they represent diverse groups of institutions with heterogenous goals, capacities, scopes, and limitations. For instance, academia not only includes public and private universities but also private research institutions (in Guatemala we find the Instituto Privado de Investigación Sobre Cambio Climático which in chapter five is discussed how their participation becomes problematic) and the inclusion of indigenous knowledge which in practice is easier said than done. The enablers include international organizations like the FAO or the World Food Program among others. Enablers improve the CS by sharing their information on food insecurity and agricultural production. They provide expertise, workshops, and resources. Boundary organizations are those in charge of generating synergy or links between potential users, enablers, and governmental institutions. These are more diverse because they include NGOs which are not always working on food insecurity and less so on climate. Finally, according to the WMO, the user category includes farmers, pastoralists, fishers, individual citizens, businesses, and policymakers. The following subsections will expand upon these categories by focusing on how the CS advocates view each participant.



Figure 15. The participants of the CS according to the WMO Source: WMO (2018) Step-by-step Guidelines for Establishing a National Framework for Climate Services. p 8

3.2.1 The LTAC in practice

Drawing from empirical work done in Guatemala, this section will delve into the conception of the LTACs, not to redefine what they are, but to brand the concept with precision. Beside being a place to teach and discuss climate knowledge, it is important to state that the LTACs are also ephemeral spaces (as previously said in chapter two) in the sense that they are transient. Aside from the three key-organizations that oversee the LTAC, the rest of the participants can vary from one meeting to the other. These groups of people and organizations do not have a CS division or office therefore the existence of the LTAC is limited to a specific time and place.

Additionally, the LTACs are formal meetings that are not legally constituted spaces and in which participation is voluntary. In this sense, the responsibility of individuals to change their habits contrasts with the lack of responsibilities that the LTAC convey due to their nonexistent legal frame. In other words, while governmental officials are encouraged to participate in these meetings, they are not required to use this information, nor do they have mechanisms to support the farmers if the climate forecast goes wrong. In contrast, the small

farmers who do not heed these recommendations are seen as stubborn (more in chapter five).

Overall, the LTACs are created to include "everyone who wants to use and talk about climate knowledge" as I was told by a CS advocate in one of the LTACs. Much like the liberal democracy that Nicolas Copeland (2019) well described in his work on NGOs and Guatemala, the LTACs encourage everyone to change their habits and practices to adapt to climate change. The final goal is to make peasants modify their behavior and agricultural practices according to the climate information they receive. Finally, empirical work also showed that the LTACs are embedded with modern values that include the participation of the citizens, inclusion of women, and the vulgarization of knowledge to encourage communities to appropriate the modern climate knowledge. Therefore, the meetings are also meant to encourage communication in a top-down and bottom-up approach to enable trust and increase a demand from the users (Giraldo-Mendez et al., 2018).

3.3 The collaborators and the Climate Service advocates

The CS advocates promote collaboration between experts, civil society, and various public and private institutions as a way of vulgarizing modern climate knowledge but also of reaching a wider public and creating new CS users. Aware of the institutional limitations and weaknesses that the National Meteorological Institutions have, collaboration also aims at producing new agreements, projects and working with organizations with whom otherwise CS advocates would not. I place emphasis on this aspect because it informs us about the assemblages in which CS move. This complex array of organization would include feminist, youth, and humanitarian organizations among others.

Overall, this mélange of institutions operates in different policy regimes. They have different goals and orientations that are not always aligned with one another. These institutions also vary according to the country in which CS are being implemented. Therefore, what might have worked in Colombia or elsewhere, might not be the same for Guatemala. I am aware that the diagram above in Figure 15 has the goal of providing a general idea of who can participate in the LTACs to improve the CS and to consider every

potential actor available. It is, however, important to reflect on the differences and limitations that each institution carries, their goals, principles, their ways of operating and how they influence the implementation processes to understand how these factors condition the implementation of CS on food security.

3.3.1 The collaborators in practice

On the ground, collaborators have diverse origins and interests. In the image of Figure 16 we can identify the strategic allies who collaborate -with various degrees of involvementin the LTACs. We can identify the leading role that INSIVUMEH, MAGA and CIAT have in this initiative. They are followed by Columbia University and CGIAR, both of which are involved with other projects. During my fieldwork I only met one of their representatives, but they did not agree to meet with me. NGOs and humanitarian organizations are also involved as well as two Guatemalan Universities. Although INSIVUMEH, MAGA and CIAT are the organizations in charge of implementing the CS, Figure 16 hints of the involvement of bigger organizations and academia that provide funding, research, and experts. Aside from the number and variety of institutions involved, this image also implies that there are many approaches, interests, and degrees of engagement.

From a food scholarship perspective, these organizations also represent diverting approaches to food insecurity. For instance, the FAO and CGIAR tend to support reformist trends that push forward food security in contrast to radicals who champion food sovereignty (Holt-Giménez, 2011). Mainly because the LTACs focus on climate projections, food system discussions are left aside either because CS advocates are incapable or unwilling to address them. However, the incommensurabilities between the two policy regimes are worth addressing to better understand how the CS initiatives are being assimilated by century-old food system practices. In other words, what the CS do is perpetuate reformist food system tendencies of neoliberal approach with a strong market-led economy rather than allowing alternative views that acknowledge progressive initiatives of citizen and food justice (Bebbington, 1993; Copeland, 2019a; Holt-Giménez, 2011; Snipstal, 2015) or those akin to food sovereignty like the one mention in Atitlán

meeting (Declaración de Atitlán Consulta de Los Pueblos Indígenas Sobre El Derecho a La Alimentación: Una Consulta Global, 2002).



Figure 16. Strategic allies. Source: https://insivumeh.gob.gt/?page_id=16372

Overall, aside from food security related discussions, some allies focus on academic research while others are humanitarian organizations like Mercy Corps or the FEWSNET. There are also civil organizations such as the *Asociación* CDRO which is a cooperative that involves leaders from Totonicapán who are interested in developing, managing, and executing holistic projects of development. On the other spectrum GREPALMA represents the guild of palm oil producers of Guatemala, one of the most aggressive extensive monocultures of the country. I would add ICC as a private research institution that works closely with the palm oil industry and other private monoculture farms. As previously mentioned, the collaboration between these organizations does not mean that they discuss or agree on structural issues regarding food production, land distribution, access to the market among, access to water, among other challenges. They can only agree to inform and be informed on climate and food production related issues. As a researcher of CS and food security, to identify the mechanisms and reasons by which the CS advocates and the LTACs neglect the complex politics of Guatemala's food system is to observe the tensions generated between the policy regimes (more in chapter four and five).

3.4 The expected user

The user is the term used by the CS advocates to refer to those individuals, corporations or organizations who should benefit from tailored climate information to make better decisions. Scientific literature and reports alike have already mentioned the heterogeneity of users. For Guatemala, both in regional and national meetings the CS advocates talk about the users to refer to the farmers and food insecure. On a local scale, this category becomes problematic because farmers, as concept, evoke a variety of kinds of food producers but it can also disregard this variety depending on the grasp that the CS advocate and other participants have on the food system. In other words, if the CS advocates and state officials are unaware of the food system particularities, it becomes an additional challenge for the initiative to have the desired impact. For instance, for Guatemala, farmer is a complex category which according to state reports varies according to land tenure, the individual's capacity to generate labor or their capacity to access the market. This category also refers to groups of people who suffer from food insecurity and, for the Guatemalan context are recategorized into ethnic groups (as we saw in chapter one).

For this thesis, I will use the CS advocates' concept of user provided in an introductory video clip used to inform the wider public about the CS. The video I will analyze can be found on INISVUMEH's website and explains what CS are and why they matter for food security. The video starts by portraying the farmers as being confused with climate behavior and meteorology (see image in Figure 17). On the background, a narrator argues that with the current climate change context, the farmers are no longer capable of knowing weather patterns. In the image we can also see a dry and worn-down environment in the background. The image also shows an extensive monoculture farm located in what seems to be a valley. In Central America, valleys are owned -or have been taken- by the rice, banana, or sugarcane industry because of their high soil quality and the flatness that enables the use of machinery to facilitate irrigation.



Figure 17. LTAC in Latin America. Source: https://insivumeh.gob.gt/?page_id=16372

The image above also hints at the mechanisms used by institutions to reinforce certain ideologies that are taken for granted. These images produce a 'regime of truth' (Rose, 2001) in which small farmers and peasants are unconsciously homogenized despite their diversity. A reason for this simplification can be that institutions are built to regulate and organize chaos; therefore, the complex landscape of the food production sector needs to be simplified for the CS to be imagined.

3.4.1 The users in practice

For the CS advocates, the user represents those who are meant to use and benefit from the CS. In practice, empirical evidence shows that the conception of a "user" englobes a rather complex idea that is worth addressing. Whereas all collaborators and participants agree that the CS are meant to assist food insecurity, in Guatemala, the climate variability is one of many factors that afflict and affect agricultural practices. Small farmers, as chapter one evinced, are also a heterogenous category that englobes thousands of people who cannot always participate in the LTACs as the video clip of section one shows. This means that the CS advocates need to rely on others to reach the small farmers and peasants. In Guatemala, CS advocates rely on MAGA and its acquired nature of a workshop ministry (I elaborate about this on chapter five) to reach the users and their objectives.
Overall, the term, user, is an all-encompassing concept that blurs the heterogeneity of the food producers. This blurriness explains how the limitations and challenge that CS advocates have of reaching them is handled through unclarity. In other words, users are everyone and no one at the same time. A side effect is that, to compensate for the lack of access to the small farmers, CS advocates try to address issues with sexism and patriarchy by encouraging women participation in the meetings and feminist organizations as well. These new participants and crop advisors also become users. In this aspect, chapter five reflects on how the involvement of feminist organizations could give an illusion of change, but it does not mean that these organizations can modify the meetings or generate structural changes -like access to land or decision-making- to modify practices (more in chapter five). Although some researchers have evinced how women are vital for small farmer in Guatemala (Calderón et al., 2018), the CS advocates with whom I spoke with could not tell the degree of influence that women from the LTACs had on agricultural decisions. However, the participation of women and feminist groups for the CSs advocates means raising the number of users and practicing inclusion.

Overall, according to the CS advocates' estimation, the CS in Guatemala have reached a total of 6650 farmers directly through the LTACs or indirectly through a third person by either crop advisors or the organizations involved (Giraldo et al., 2019). In comparison, chapter one drew on MAGA reports to state that there at least 190 000 households categorized as infra subsistence and subsistence farmers. Taking this number into account, the LTACs in Guatemala currently reach 3,5% of the potential users who are food insecure. This puts into question the capacity of the Guatemalan institutions to reach those farmers they claim to assist and of the CS initiative in general.

3.5 The participants and the process

As the sequence progresses, the farmers join a panel of experts that visibly includes two scientists in their white robes and two policymakers in their formal clothes. These meetings discuss "science-based information" -as the narrator says- about crop phenology and climate (see Figure 18). "This information is not at a national scale", the narrator adds, but "it is now delivered at a local scale for farmers to use". The meeting also conveys an idea

of equality between participants to share, discuss, and put together the agroclimatic bulletin.



Figure 18. LTAC Source: Source: https://insivumeh.gob.gt/?page_id=16372

From this segment we receive a couple of important messages, on the one hand, the video says that CS can provide reliable data for micro-scales that surpass the national scope. This means that for CS to be locally relevant, they must respond to individual farmers' demands. On the other hand, the image also conveys the idea that farmers can engage with policymakers and scientists on equal terms and in direct conversation.

3.5.1 The participants and the process in practice

To analyze the participants grounded to the empirical evidence, this subsection is divided into three parts. First, I will define the participants of the LTACs which at times take the place of the users in the LTACs and are responsible for creating and disseminating climate information. Second, I will detail and analyze the process through which the participants create agroclimatic bulletins. The second part also shows how the implementation of the CS advocates and INSIVUMEH demand collaboration from citizens and other institutions to operate stations. On part three, I briefly discuss how and with what mechanisms the participants of the LTACs work on to elaborate the agroclimatic bulletins. These bulletins are then presented in section 3.6.1.

3.5.1.1 The participants

The LTAC meetings are scheduled by the CS advocates, and the invitations are sent to everyone who is interested through WhatsApp or email. If anyone, not invited, wants to join the group, the person can also contact the people in charge and ask to be invited. The contact information is given at the end of every agroclimatic bulletin. Although MAGA has played a major part in expanding the reach, other relevant actors include ANACAFE¹², La Universidad Rafael Landívar and the private research institute ICC. Regarding MAGA and ANACAFE, these institutions are participants, but they also have the task of providing the physical space, inviting new potential participants, and coordinating the meetings. ICC and ANACAFE also share climate data because they own a considerable amount of weather stations. The lack of weather stations that the public sector has is thus alleviated by the private sector. Additionally, other actors from civil society, national and international organizations, and foreign aid that have their own programs of development are also a source of information¹³.

When participants are MAGA's crop advisors, invitations are also semi-compulsory as it happened in MAGA-Escuintla where the participants were the available crop advisor summoned by their regional manager. Although these meetings are planned ahead of time, the meeting was delayed because the manager had to contact each advisor personally for the meeting the same morning. This gave the impression that the meeting was not taken as a serious subject by the MAGA delegation. In general, this *departemento* has 14 municipalities and a total of 42 crop advisors, however in the meeting only 15 crop advisors were able to assist because most of them were not available.

¹² According to their website, ANACAFE is the National Association of Coffee. Founded in 1960 by the coffee Law. They define themselves as a private institute with public service.

¹³ For instance, FEWSNET shares data on food prices and WFP monitors crop phenology. Together, they all contribute to knowing how many people are suffering food insecurity and how many will be in the upcoming months.

More importantly for these meetings is the participation of INSIVUMEH's meteorologist, the Climate and Research Department engineer, who is also one of the CS advocates, and MAGA's engineer from the Office of Strategical Geographical Information and Risk Assessment. The engineer also signs as professional support for the Strategical Agroclimatic Information. In Guatemala, the participation of the meteorologist is vital due to the credibility and trust he enjoys among technicians, therefore, the weeks in which the agroclimatic bulletins are to be developed, this CS team has to travel throughout the country to deliver the climate information and create the agroclimatic bulletin in each of the 19 LTACs.

Overall, the majority of the LTACs participants are government officials. Peasants and small farmers are not only a minority but at times they are completely absent from these meetings. Contrasting with the video clip in section one, the LTACs I participated in also conveyed the sentiment of a distant relationship between the government officials from the Capital city with those of the *departamentos*. During the LTAC pause, the government officials did not mingle with the crop advisors, in other words collaboration and team work often began and ended in these meetings in which participants did not know each other and CS advocates could not intervene or provide further support to the crop advisors' needs, aside from the agroclimatic bulletins.

The picture of Figure 19 was taken from the LTAC-*Centro* and it shows the participants of the process. This meeting, despite being in the Capital city had fewer participants than the one in Escuintla and fewer crop advisors. It also involved ANACAFE which represents thousands of coffee growers. Similar to Escuintla's LTAC and contrasting with the video clip, there were no farmers in the meetings. Most of the participants were MAGA officials from different offices (e.g., technicians dedicated on managing pests, forestry production, cartography, and soil management among others). The majority were young, and newcomers to the ministry and the initiative.



Fotografía de MTA Centro

Figure 19. Participants of the LTAC-Centro in Guatemala City, 2021. Source: LTAC-Centro 2021.

The LTACs analyzed here were not abnormal cases, according to CIAT's evaluation of the LTACs in Guatemala only two LTACs (Izabal and Zacapa) have wider participation of farmers between 5% and 8% respectively (see Figure 20 below). These graphs also show that CS heavily relies on state officials, most of whom are crop advisors and other "street level-bureaucrats". However, it also shows contradiction with the government's reports I analyze in chapter five and with MAGA's Institutional Plan that labels Maya people as being "individualistic" and having "no capacity to collaborate". For instance, some *departamentos* like Totonicapán, Izabal and Chiquimula show that *Asociaciones de agricultures* are an important and considerable component of their LTACs. These associations are organized and led by Maya communities who collaborate and oversee projects and programs of development in their regions. For instance, *Asociación CDRO*, as mentioned before, looks after holistic development programs that respond to the interests of their communities.

Overall, representation in the LTACs is uneven. While CS advocates can claim that each LTACs are produced or confectioned in an organic manner, it is necessary to evaluate each site individually to understand why there is an absence of farmers or who are the government officials who participate in these processes? What are their capabilities,

challenges, and everyday tasks? Currently, CS advocates are not able to dissect each experience and can only provide wider analysis of their efforts by measuring quantities and providing percentages. Furthermore, the graph (Figure 20) below from the report used by the CS advocates to evaluate their progress also demands further questions. For instance, what information can these percentages hide? Specifically, how numerous were these meetings? These percentages are not accompanied by the number of participants. Do these percentages include one-time participants, or only those who are fully engaged in the process? How does the capacity to move between towns (or the lack of public transportation) restrain participation? Interestingly, the graphs also show that academia is mostly focused on the LTACs located in the Dry Corridor (e.g., El Progreso, Chiquimula, Jutiapa, Chiquimula and Zacapa) despite the fact that food insecurity is widespread. Additionally, due to poor road infrastructure, less accessible departamentos like Totonicapán and Huehuetenango show a contrasting participation in which the former is only implemented by government officials and the later, shows the absence of governmental representation. These two departamentos have historically been intervened on by the State, and they share a lack of communication -or trust- between the population and the government. This resonates with the observation made by some government officials telling me that Mayan communities reasonably had no trust in them because they represented repression. While CS advocates view their work as purely technical, crop advisors and other technicians involved with small farmers had other experiences. Amidst these particularities and considerations, the abyssal line manifests when institutions share goals and determine what matters and what counts as knowledge without reflecting on the socio-political context of the locality. Setting goals of improving livelihoods manages to overshadow sensitivities that small farmers and peasants could have about the state and the institutions involved in the projects.



Figure 20. Typology of participants. In light green farmers, green agriculture associations, in blue members of the public sector, in yellow are the local government officials, orange represents international cooperation 2022 Source: Monitoreo y Evaluación de las Mesas Técnicas Agroclimáticas (MTA) en Guatemala (2022) p. 26

3.5.1.2 The process of running a LTAC

In this chapter, I have first detailed how the expectations raised by the CS advocates and the climate infrastructure showed that meteorologists had the capacity to gather policymakers and small farmers in an office to discuss climate and agriculture in a scientifically manner. In this subsection, I will examine the process by which the CS advocate create the agroclimatic bulletins. However, the process is not straightforward. As CS advocates make efforts to have their information be incorporated into food production decision, they neglect the wider food system they are being incorporated into.

Meetings always begin with an opening speech given by the host, which as mentioned before, can be given by MAGA's regional director or the person in charge of the LTAC from ANACAFE. The CS advocate then gives another speech in which he talks about the importance of knowing and understanding modern climate knowledge. In this section of the meeting, the CS advocates emphasize the importance of becoming modern and resilient to climate change. The opening words are also used to repeat the message from the videoclip discussed in the section above about how the LTACs believe in the importance of inclusion, communication, and vulgarization of knowledge.

After the introductory words, the CS advocate reviewed some of the topics discussed on previous LTACs meetings and asked questions to the participants to see if they remember what they had learn before. This also served to transition the meeting into the *Educlima* section in which the meteorologist takes the word to give a presentation about a meteorological concept of interest. During my field work, he explained what convectional rainfall was, its importance, and how to identify the natural phenomenon. Forest fires were also discussed because they were a major threat at the moment -it was dry season. Although food security is the issue that concerns and gathers the participants, *Educlima* becomes an additional component of the CS initiative. It not only vulgarizes knowledge but also grants relevance to an otherwise neglected institution that has insufficient weather stations to cover the national territory. When *Educlima* is given online, the CS advocates also focused on the user's knowledge regarding the variety of bulletins and meteorological reports that they share in WhatsApp. If users and participants do not learn about modern

climate knowledge, they will not be able to use it, therefore, *Educlima* is a vital prerequisite for the CS to reach the users.

Beside the production of the agroclimatic bulletins, INSIVUMEH also gains relevance and generates expectation among the participants by producing a range of reports and short bulletins that are emitted several times a day. These reports include daily satellite image analysis, natural disaster forecasts, daily accumulated rainfall, daily weather forecast, daily maximum and minimum temperature report, early warning for electric storms, weekly agroclimatic bulletin and the three-month agroclimatic report. On regular days, the WhatsApp group receives three meteorological reports and during hurricane season, the group is much more active, and CS advocates share reports and weather surveillance every hour. In this sense, WhatsApp becomes a vital tool for sharing this information even though Guatemala is the Central American country with the lowest access to internet only reaching 36% of its population (Rocha, 2023).

With this overload of information, CS advocates consider and argue that this information allows crop advisors to monitor the rainfall projections on a weekly basis. The CS advocate explained that the way to read the data is by looking at the projected rainfall with three days in advance of the day of particular interest (in case a farmer wants to plant, harvest or fertilize a crop in such particular day). If the rainfall projection remains unchanged then, one could expect that the projection is reliable. They then argued that with the provision of all these climate and weather information, the user could make their own conjectures, along with their local knowledge and expertise about what to do regarding food production.

The LTACs are also much more than just a space to share and talk about climate knowledge. It also serves as a platform used to develop collaboration to compensate for INSIVUMEH's economic and human constraints. For instance, the meteorologist would also use these meetings to engage citizens with the collection and sharing of meteorological data for INSIVUMEH. This is also considered in the LTAC handbook in which, as part of the climatology and meteorological alphabetization process, farmers learn how to use the weather stations (Giraldo-Mendez et al., 2018). In the image below, Figure 21 shows the technical card of one of ANACAFE's weather stations. The card includes information

about the person in charge of operating the weather station, the location, and date when operations begin. Some of the measured variables are temperature, precipitation, relative humidity, wind speed, wind direction, solar radiation, and soil temperature. This figure also raises questions regarding the goal of co-producing and vulgarizing knowledge. Although I agree of the importance of these processes, as I discuss in chapter five, it also raises concern about how the neoliberal Guatemalan State manages to transfer responsibilities to its citizens over certain aspects that should rather be handled by state officials.



Ficha Técnica de Estaciones Meteorológicas

Figure 21. Technical card for a weather station in Esquipulas, Chiquimula, Guatemala. Source: MTA: Una guía detallada sobre la implementación de las MTA, paso a paso. 2018, p. 20

By the end of the meeting, crop advisors are expected to be better trained in meteorology and climatology. With their input and advice, CS advocates and agronomists from central MAGA proceed to write the agroclimatic bulletins to be shared in the *departamento* and municipalities in the upcoming days. An important observation raised by the meteorologist was about the ministerial mandate he had of training future meteorologist through shortintense courses or workshops. This also hinted on the misconception about meteorological sciences and short-sightedness of the high-tier officials have. Directing the meteorologist to train other state functionaries on meteorology through these crash courses undermined his experience and knowledge.

In the next section, I will show and comment on how CS are distributed, the information they contain and what is expected from them. At this moment, it is also important to remember that the CS have been mostly produced by technicians, meteorologists, and CS advocates and not by small farmers as it is intended. Omission regarding other topics of discussion such as the food system in general, INSIVUMEH's limitations, MAGA's policies of development and modernization which I will develop in chapter five speak of the collision between the two policy regimes.

3.5.1.3 Agroclimatic advice and the bulletins

The agroclimatic bulletins are developed during the second half of the LTAC meeting. First, the meteorologist talks about the climate scenarios at national scale followed by the micro- municipal scale¹⁴. To do so, CS advocates would zoom in the Guatemalan map with the climate projection to the area the crop advisors worked in (as reflected in Figure 22). The crop advisors were then asked to locate the *municipios* in which they worked to provide agricultural advice based on the information previously given. In this sense, crop advisors are supposed to merge meteorology with their local knowledge and expertise of the communities and crops to come up with advice. As evidenced later in chapter four of this

¹⁴ The meteorologist has to communicate the climate scenarios over 20 times during the LTAC season, once per LTAC in addition to the Central American Forum and in the *Sistema Nacional de Monitoreo de Cultivos*. Although proud of the trust people had on him, he would also tell me that fewer LTAC were needed to cover the country and that other technicians from INSIVUMEH should also take part of this process. However, he also admitted he was the only meteorologist in the institution.

thesis, municipalities that were located in between quadrants or pixels generated confusion and became new challenges to the CS initiative. Some of these municipalities would also have several micro-climates within one mountain in which specific communities lived on. For instance, crop advisors would argue that the mountain had a rainy side and a drier one, making the projection unviable. As a response, CS advocates would say that their experience was useful, and they could give advice while considering these challenges.



Figure 22. Precipitation forecast and a comparison with the former year for Zacapa department. Source: Agroclimatic bulletin Zacapa 2021. p 4

Once the climate projections were discussed, the LTAC organized the workshop into five groups according to five crop categories which generally includes perennials, fruits, vegetable, forest, and coffee. Once the groups were conformed, the participants had to discuss the advice they could give for each crop in relation to the weather projection such as that seen in Figure 22. Most technicians had to agree that the aim of the LTAC and the CS was to reach the municipal scale therefore, discussion about using other scalar projections was left out of question. Overall, the LTACs and MAGA always tried to have crop advisors from each municipality. In this sense, they could argue that CS was capable of reaching 100% of the territory.

3.6 The expected results

According to the videoclip of INSIVUMEH's website, once the LTAC was held the agroclimatic bulletin was supposed to reach the farmers. By the end, the videoclip showed the same farmer with the agroclimatic bulletin printed in his hands. Behind him is a much greener field which still looks like a conventional extensive monoculture farm of corn (see Figure 23). The soil seems to have more humidity, and the plants are greener as well. Although the video suggests that the green fields are a product of the agroclimatic bulletins, it does not reflect on how the farmer might have used more fertilizer, or that the rainy season could have alleviated his costs of irrigation, nor it shows how the behavior of the crop price could have an impact on his profit once the harvest season is over.

Despite the fact that in Guatemala, most of the farmers are small farmers or peasants usually displaced to the mountains, the video above is better aligned with the government's rhetoric on rural development. Although chapter 5 will expand on this topic, it suffices to say that the Ministry of Agriculture and the government in general have favored conventional monocultural production as displayed in the video. On the contrary, traditional knowledge and traditional agricultural practices, despite being promoted throughout the reports, have been left aside in a clip made to raise awareness of CS. The Figure 23 also raises questions regarding the CS' users or target population. As this chapter will later show, the majority of Guatemala's small farmers are infra subsistence and subsistence producers -the food insecure- who are characterized by being either landless or having small parcels of land usually located on the mountains.



Figure 23. LTAC Source: https://insivumeh.gob.gt/?page_id=16372

Overall, the expectations and desires that CS advocates elaborate in their reports, meetings and videos provide an idea over how CS are supposed to work. However, it is incapable of considering and preparing itself for the complexity and challenges that the conventional food system offers (as discussed in the literature review in section 1.6).

3.6.1 The results in practice

In the previous sections, I presented a video clip in which the CS advocates argued that the agroclimatic bulletins hold nature-based and scientific advice that, if heeded, could improve the livelihoods of peasants and farmers. However, these bulletins are conditioned by two broad aspects, on the one hand, they depend on the engagement and experience of the participants. This means that technicians, CS advocates and other participants involved in the LTACs have different degrees of knowledge and need to learn how to navigate economic dearth and other challenges (more in chapter four and five) to create a CS product of value. On the other hand, the LTACs are also conditioned by the inherent epistemological limitations that climatologists, meteorologists, and CS advocates in general have of the food system. For Guatemala, this means that even the most successful LTAC (those that have wider participation) are limited by if not conditioned by a positivist

approach that understands food production as a combination of quantifiable variables. Furthermore, the thought of measuring meteorological parameters and forecasting weather is thought of as the means to make rational decision-making while neglecting the social, historical, and political conditions in which peasants and farmers live. In short, the agroclimatic bulletins present a partial and limited reality that is a product of the violent collision between the two policy regimes. They become a technical *dispotif* that is the culmination of a discourse that favors modern knowledge above other ways of knowing and even above social issues which I will discuss in the following chapters.

As this chapter has shown, each LTAC is different, not because of the *departamento's* climate particularities or the crops that it produces (which already are important differences), but because of the participants involved in the process. Below (from Figure 24 to Figure 27), I show four agroclimatic bulletins done by different LTACs for the period of December 2022 to March 2023. While I have reviewed most of the bulletins produced in Guatemala, I chose some of the latest editions available and not the ones I attended to back in 2021 because the content and presentation have changed over the past months. Although every LTAC is different from one another, the CS advocates have homogenized the content making it easier to compare them.

The bulletins I will present here come from the *departamentos* of Quiché, Escuintla, *Centro* (LTAC-*centro* includes the *departamentos* of Guatemala, Chimaltenango y Sacatepéquez), and Chiquimula which is the oldest and most experienced LTAC. Chiquimula is also where part of the Dry Corridor is located and where the communities of Jocotán and Camotán were struck by famine in 2001. The reason I chose these LTACs was to have a sample of very diverse *departamentos*. For instance, Quiché is located in the western highlands and most of its population are Ixil Maya communities. Accessing Quiché is also challenging due to the poor condition of the roads. In Quiché there are also *La Vega I & II*, which are hydroelectric projects located in *Nebaj*. According to the Environmental Justice Atlas website, these projects have generated conflict with the population because they were developed without consulting local communities. These projects have also affected more than ten communities' access to resources. Human rights in Quiche have been violated since the Civil War, where Ixil communities were massacred during the 1980s.

Regarding Escuintla, Chimaltenango, and Sacatepéquez, these are all located closer to the Capital city, and they produce coffee, banana, sugar cane and palm oil. Due to the distance between Guatemala City where the CS advocates are located, and the rest of the *departamentos* the meetings were held at different moments. These meetings range from November 28th, 2022, to December 8th, 2022. Aside from the distance and accessibility to some of these places, the CS advocates are also a small group of people and cannot delegate responsibilities or take turns.

The images of the agroclimatic bulletins change after each edition, however they always hold certain characteristics. As we can see, the images below (Figures 23, 24 and 26) show productive small farms with healthy crops. Unlike Figure 24, most of these images do not provide a context of the place or farm where the image was taken. This erases local differences and, similar to Figure 27, show monoculture farms and commodity crops for exportation and not family farms for subsistence¹⁵. Overall, these images tend to reproduce MAGA's goal of technify and producing crops for the international market.

¹⁵ To see more images and agroclimatic bulletins, visit INSIVUMEH website: https://insivumeh.gob.gt/?page_id=16372.



Foto: Recolección de cosecha de maiz, y frijol aldea Poza De la Pila, Ipala Chiquimula, Fotografia Melvin Heredia. Foto: Protección de bosques, municipio de Concepción Las Minas, Fotografia: Cesar Sanchinelli.

Época de Cosecha y Postcosecha. Pronóstico diciembre 2022, enero a marzo 2023.



Figure 24. LTAC Chiquimula Dec 2022- March 2023



BOLETÍN AGRO CLIMÁTICO

DICIEMBRE 2022 - MARZO 2023



Figure 25. LTAC Quiché Dec 2022 - March 2023



Figure 26. LTAC Escuintla Dec 2022 - March 2023



Figure 27. LTAC-Centro Dec 2022 - March 2023

Moving forward, on the bottom section of the images above (Figures. 23-26), we can see the diversity of participants who were involved in the process. In practice, this aspect is important because it translates into the number of weather stations available for the LTAC to work with. For more clarity, Table 5 shows the number of stations available for each LTAC as well as the territory they cover. Although each *departamento* has a diversity of micro-climates, communities, and crops, we can observe that access to weather stations is unequal and usually, the "more productive" *departamentos* where the extensive monocultures are located, have access to more climate data per Km².

I would also stress how celebrating collaboration in the CS reports conceals the need that the public sector has to access weather stations to improve the quality of the data. As I explain in chapter four, the meteorologist had to "juggle" with the stations he had, moving them from one place to another where he judged they would provide better data. Another aspect is that collaboration does not mean better quality of information, neither does collaboration translate to equality. For instance, the LTAC of Quiché has organized civil participation as mentioned in Figure 20 (page 96). However, this does not translate to improving data quality nor does it have a similar effect to that of ANACAFE and its 15 weather stations. In other words, diverse representation did not reflect on the quality of the agroclimatic bulletins or on developing alternative bulletins. On the contrary, one bigger, homogenous, and powerful organization like ANACAFE (which also represents bigger coffee farmers) provided weather stations, and a laboratory to measure water and soil quality which in turn improved the agroclimatic bulletin's content.

LTAC	Departamento	INSIVUMEH	Private weather	Territorial
		weather	stations	extension
		stations		
Chiquimula	Chiquimula	2	0	368 Km ²
Quiché	Quiché	4	0	8378 Km ²
Escuintla	Escuintla	8	0	545 Km ²
Centro	Guatemala	6	15 (belong to	2253 Km ²
	Sacatepéquez		ANACAFE)	465 Km ²
	Chimaltenango			85.47 Km ²

Table 5. LTAC, their weather stations and the extension the LTAC covers.

Regarding the content of the bulletins, they all share the same organization. They are composed of two broad sections, the first part focuses on providing climate data on precipitation (accumulated and expected rainfall) heatwaves, and cold fronts among other climate phenomena of the season. The second part usually begins with an agricultural calendar (except LTAC-Centro). In Figure 28, I present the calendar which is the same for the three LTACs. It is important to comment on some aspects. First, this calendar is provided by FEWSNET, and it is used for Guatemala as a whole and not the *departamento*, this means that the calendar is not adapted to the LTAC - nor that it is 'locally' but nationally relevant-. Second, the bulletins advise farmers to choose between two varieties of beans, and three varieties of corn, to be planted either on the Pacific coast or on the highlands or the dry corridor. According to the Institute of Agricultural Science and Technology (ICTA in Spanish) the corn variety ICTA HB-83 we see on top of the chart of Figure 28 is adapted to all the climates of Guatemala from 0 m.a.s.l. to 1400 m.a.s.l. ICTA also claims that this variety is also available on the market and has wide acceptance by the consumers. Although it does not talk about the resistance to pests, it says it is capable of resisting wind currents (Cardona, 2014). On ICTA's website we can also find other varieties recommended specifically for Chiquimula (like the ICTA B-1, ICTA Maya and ICTA HB-83) or the highlands (e.g., ICTA B-7 which is in the figure below, and ICTA B-1) or the Chimaltenango area for the LTAC-Centro (e.g., ICTA Don Marshall and ICTA V-301) (ICTA, 2013, 2015a, 2015b). These varieties of corn are not mentioned in this

agricultural calendar despite being produced for different regions. In other words, FEWSNET and the agroclimatic bulletins have prioritized three varieties of corn and two of beans over the others that are place specific.

Calendarios agrícolas

· Calendario agrícola (maíz), condiciones trópico humedad favorecida y limitada



Figure 28. Agricultural Calendar for Chiquimula. Source: LTAC Chiquimula 2022

After the agricultural calendar has been provided, the bulletin has a section in which they give advice on different crops. This section is what usually differentiates one bulletin from the other. The main difference can be seen in its content and the degree of specificity or generality of the advice provided. In Figure 29 and Figure 30 below I contrast the advice given for corn production in Quiché, with the one provided in Chiquimula respectively (English will follow).

We can see in Figure 30 from Chiquimula that the LTAC considers grain humidity and advice the farmers to take the seed out to dry. They add that it is important to move the grains every 45 minutes for ventilation and to improve the drying process. Below, in Figure

29, the LTAC of Quiché is more general and does not provide anything new that a farmer would not already know.

Pag.5

BOLETÍN AGROCLIMÁTICO NO. 8 - MTA - QUICHÉ, GUATEMALA



Figure 29. Advice on corn and beans for LTAC Quiché in 2022. Translation follows below.

Basic grains			
Use varieties that are resilient to frostbite,	Soil conservation, proper harvest and post-		
identify the areas that are less affected (it	harvest techniques.		
refers to general affectations), prevent			
excess of water, use barrels as torches (to			
prevent forest fires, avoid bonfires.			
Schedule planting and harvest.	Select and store seeds that will be used in		
Implement la dobla once the corn is fully	the next cycle.		
developed (dobla means to bend the branch	Take care of water sources and make		
so the corn dries faster).	proper use of water.		
	Use organic and chemical products against		
	fungus and pests.		

BOLETÍN AGROCLIMÁTICO NO. 14 - MTA - CHIQUIMULA, GUATEMALA

Acciones Preventivas Sugeridas 1. Postcosecha frijol y Maíz

La postcosecha de maíz de segunda y frijol de relevo o de asocio del año 2022, es una de las actividades que las familias campesinas que deben de llevarse a cabo con mayor cuidado posible, más cuando se da en un año con mucha lluvia como fue marcada en el 2022.

Durante la etapa de poscosecha, sin un manejo adecuado, las pérdidas de granos básicos pueden llegar entre un 10 a 20 por ciento por mal manejo de la misma.

El grano de maíz y de frijol es resultado del esfuerzo y planificación del productor; cualquier pérdida durante el período de almacenamiento se considera como absoluta (García–Lara et al., 2003).

Después de salir de un año muy lluvioso, se considera que ambos cultivos podrían estar en un rango alto de humedad para su almacenamiento.

Es recomendable hacer un buen manejo del grano para reducir su humedad a un 12 a 14 por ciento.

Las actividades recomendadas son:

- Secado al sol en forma artesanal, y natural, moviendo el grano cada 45 minutos, para un secado uniforme del mismo.
- Los horarios recomendados son de 9:00 de la mañana a 4:00 de la tarde en días soleados. Después de secarlos aproximadamente por 7 horas al aire libre para su secado, debe de enfriarse por aproximadamente 2 horas. Para que no se produzcan exudaciones por precalentamiento excesivo y provoque la proliferación de hongos y toxinas.

1.1 Cultivo de maíz, (postcosecha)

El exceso de humedad en el cultivo de maíz es perjudicial para el almacenamiento después de la postcosecha, ya que las altas humedades en el grano provocan proliferación de aflatoxinas.

Se considera que aproximadamente un 30% del total de los granos básicos es de mala calidad, debido a todo el proceso de postcosecha, afectando así la salud de las personas adultas y especialmente a la niñez, donde se cree que se derivan problemas serios de desnutrición. (Memorias de la Cuarta Mesa Redonda Latinoamericana Sobre Prevención de Pérdidas pos Cosecha de Granos, 1989).

Se recomienda que la humedad de los granos para almacenarlo en sacos, graneros o silos sea de 12% a 14%; y minimizar los riesgos a pérdidas y granos contaminados con aflatoxinas que son perjudiciales para la salud.

RECOMENDACIÓN GENERAL: Para llevar a cabo una buena poscosecha, se debe de considerar las siguientes actividades:

Revisar los silos o graneros metálicos a tras luz, para verificar si estos tienen agujeros donde se escapa los gases de las pastillas utilizadas para curar los granos.

Figure 30. Advice for corn and beans LTAC Chiquimula 2022. Translation follows below.



Fotografía Hugo Rodriguez 2014: Secado del frijol por alta humedad en parios de cemento.

Fotografía Hugo Rodriguez 2014: Secado del

MAIZ por alta humedad, en patios de

cemento



àg.

Agroclimatic Bulletin No. 14 - LTAC - Chiquimula, Guatemala

Suggested Preventive Actions

1. Post-harvest of beans and corn

Harvest of the second corn (in Central America there are two harvest seasons *primera* and *Segunda or postrera*), beans or an association of both is a practice that peasant families have to do with extreme caution in 2022 because it is a year with high precipitation.

During post-harvest season, without proper management, you can expect losing between 10 to 20 percent due to poor management.

The corn and bean grain are the result of work and planification of the producer; any loss during storage is considered as absolute (Garcia- Lara et al., 2003).

After a rainy year, it is considered that both crops could have high levels of humidity from 12 to 14 percent.

Recommended activities are:

- Artisanal drying method using the sun. Move the grains every 45 minutes to guarantee uniformization.
- Recommended time to dry grains is from 9:00 am to 4:00 pm on sunny days. After 7-hour long sessions, have the seeds cool down for 2 hours to avoid sweat and prevent fungus and toxins from proliferating.
- 1.1. Corn (post-harvest)

Excess humidity in corn affects storage because high levels of humidity produce the proliferation of aflatoxins.

It is considered that 30% of the total of staples of bad quality, is due to the post-harvest practice, affecting the health of adults and minors from where malnutrition generates (Memoirs of the Fourth Round Table of Latin America for Prevention of Lost of Post-harvest Crops, 1989).

It is recommended that grains with a humidity of 12% to 14% to be stored in sacks or silos, minimize risks of loss and contamination with aflatoxins.

General recommendations: To guarantee a good post-harvest practice consider the following:

Check the quality of your silos and metallic grain holders and verify they have no holes.

3.7 Conclusions

In this chapter, I first focused on showing how the CS advocates develop a discourse that promotes the use of modern climate knowledge under the claim that farmers and peasants can no longer decipher the weather, suggesting that they are unable to make informed decisions due to climate variability and climate change. In this fashion, CS advocates can frame a problem to which they can provide solution based on scientific information of seasonal and sub-seasonal climate forecast that is locally relevant for the users. They can also generate collaboration behind a humanistic goal. From this founding premise, the climate service advocates can develop programs and practices to implement the use and demand of their CS products. However, as the climate service initiative takes shape in practice, incommensurable differences between policy regimes generate collisions between a simplified food system conceived by the CS advocates and the grounded reality. As a result, the modelled idea of how climate services are expected to operate is imposed by the CS advocates without much reflection.

Although the CS have been an initiative first developed by the WMO, in Guatemala CS are organized and pushed forward by CIAT, INSIVUMEH and MAGA. In this manner, the chapter showed how the efforts of implementing CS take shape and materialize through a series of guided meetings called LTAC (Bouroncle et al., 2017; Hernández-Quevedo et al., 2022). It also shows how agronomists, meteorologists and other technicians engage with CS at various degrees of commitment and how they create consensus about the type of information that is required.

However, the most important aspect of this chapter has been the exercise of contrasting the expectations that CS advocates have of their product with the grounded experience in which they work. I have argued that these inconsistencies between the expectation and reality can be understood as collisions occurring between the policy regimes. As I

organized this chapter, collisions arise from the differences generated at different sites. These sites included the collaborators, the users, the participants, the process and the agroclimatic bulletins. Overall, this chapter identifies a number of important issues related to the implementation of CS in Guatemala.

First, the CS advocates claim that they need collaboration from other institutions to raise awareness, vulgarize climate knowledge and have access to potential users. In practice, CS advocates need these institutions to have access to private weather stations and citizens to operate their weather stations. Additionally, INSIVUMEH needs other public and private institutions to access buildings in which they can have the LTACs meetings.

Second, the CS advocate promulgate important and desirable global values like inclusion and vulgarization of knowledge in their CS initiatives. However, in practice it means that the diversity of participants in the LTAC translates into a variety of goals, dynamics, approaches on food security -or food sovereignty- and other topics of interests that are left unquestioned (more in chapter four). Although inclusion is one of the principles, these different topics or challenges cannot be incorporated into the LTAC meetings due to their format and focus on climate.

Third, regarding the importance of vulgarizing knowledge and teaching people about modern climate science, the LTACs seem detached from reality. While CS advocates aspire to have direct communication with small farmers and peasants, for Guatemala, these users are usually landless, unable to read or write in Spanish, some might not speak Spanish and at times are located in distant and inaccessible places. Although I do not oppose inclusion or vulgarization of knowledge, my concern is that the CS discourse also gives an illusion that education and knowledge matters to the government, but this contrasts with the deficient public education system. For instance, while the LTACs continued to operate throughout the COVID-19 pandemic, schools were suspended throughout the two-year period. In other words, this chapter has shown the value that high-tier officials give to the meteorological sciences and workshops contrasts with the lack of support the public schools had through pandemic.

Fourth, non-legal commitment to participation in the LTAC made the information less 'official'. This suggests that no one is responsible for the production, quality, or utilization of the CS information. In other words, the CS initiatives risk becoming unsustainable or destined to failure because they are currently incapable of reflecting about hunger and food insecurity. This trait translates into wider institutional participation. In turn, CS advocates can argue that the variety of actors and institutions involved becomes a strength of the LTACs and proof of its demand and recognition. However, it can also be argued that these institutions gather around palpable ideas and measurable goals (Broome & Seabrooke, 2012) that overshadow their main goals or other complex discussions that would surpass their capabilities (Douglas, 1986). Although I do not oppose collaboration, the characteristic heterogeneity of the LTACs does not mean engagement and it also translates to other side-effects like conceptual mutability and conceptual dilution which I will discuss in chapter four. More importantly for this chapter is how collaboration is needed to piece out the agroclimatic bulletins in which the agroclimatic calendar is produced by FEWSNET, which in turn uses ICTA's information, along with the advice given by the crop advisors. It also shows the differences in the content existing between those LTAC with private participation and those that do not have access to a private institution like ANACAFE in which someone is hired to oversee the process. In other words, the participatory approach resembles an incomplete jigsaw puzzle made from pieces of different puzzles to describe a bigger scenario.

Finally, the agroclimatic bulletins show that the CS and the LTACs do not consider other types of cultivation methods. Similar to the video clip, the CS also focus on monoculture and conventional agriculture which in Guatemala is a capitalist food system. Usually, the CS advocates have incorporated surveys and demographics to allow the LTAC's participants to give out their opinions are a way of integrating social studies into their processes, yet there is more to do if CS advocates desire a better social scientific component in their processes of implementation. Some of these aspects will be analyzed in the following chapters. Suffice it to say that CS advocates need to think that CS for food security has more implications than those currently given. In other words, I cannot agree with their claim that it is a holistic approach to pair CS with climate resilient initiatives

when CS advocates do not engage with food police regime and Guatemala's food system. Currently, CS advocates are not willing or capable of tapping into this policy regime and, above all, policy makers are left unquestioned.

Some ending thoughts invite reflection of how the LTACs and the agroclimatic bulletin create and deliver partial realities. They conceal issues regarding the lack of access to education and the landless aspects of the pretended users. However, CS advocates and their collaborators manage to fabricate a potential future (more on future geographies in chapter four), one in which participants can believe that knowledge of climate scenarios will prevent crops from suffering from climate variability and that people can improve their yields and livelihoods. CS advocates also describe a partial reality that undermines a food system analysis. This means, it avoids thinking about who the farmers are in each municipality, what their needs and demands are. It also neglects issues with food transportation and the consumers' role in supporting local producers.

Chapter four and five will evince how taking for granted the collision between the policy regimes means that scales are not taken into account (chapter four). It also means that participants do not engage with or take into consideration public policy and the colonial legacies of Guatemalan institutions (chapter five).

4 The promise of Climate Services at different scales

4.1 Introduction

At the start of this research, I was interested on examining the climate infrastructure and the food policy regimes as a way of providing a new perspective to the implementation of CS in agriculture. Only as I progressed on my empirical work, mainly through participatory observation and various conversations with key participants and the meteorologist, was my attention drawn towards the politics of scales which I decided to develop more in this chapter. Along with this new interest in scales, I also place close attention to the incommensurable differences between the policy regimes of the climate infrastructure and the food system to explore if there was any relation between them. In this sense, an awareness of existing disparities generated by scales and the policy regimes are explored throughout this chapter to provide a new approach and reflection to the implementation of CS in Guatemala.

As Brown & Purcell (2005) claim, scales should be an object of inquiry because "humanenvironment dynamics in development" have "scalar configuration" (p. 607). Furthermore, these configurations undergo political struggle that is worth understanding. For the CS in Guatemala and this research, this means looking at the sites in which CS advocates participate and produce the CS. These are sites of convergence between organizations that focus on climate and food production, and they operate at three different scales namely the Central American region or macro, the national or meso, and the municipal or micro. These sites include the Central American Forum for Climate Forecast for Food and Nutritional Security, the National meetings of crop monitoring and the LTACs -macro, meso and micro respectively-. Only with empirical work through participant observation could I show that the ways in which CS are discussed in these sites vary according to each scale. For instance, the topics of discussion and the vocabulary used are altered or modified due to scalar constraints that are left unquestioned in the CS process of implementation. However, the CS discourse is also reinforced in these scales -macro and micro specifically- making them sites of interest that need to be re-examine. Before moving forward, I recognize that dealing with scales have been problematic and challenging for geographical research in general. In order to engage in such matters, I will briefly review the theoretical discussions on scale that human geographers have had on the past decades and understand why it is an important aspect to keep in mind for this research in particular.

The main concern with implementing CS for food security has been the way to downscale and transfer the climate information to farmers in a timely and locally relevant manner so that they can have time to prepare for droughts, heatwaves, or heavy rainfall (Bruun Jensen et al., 2016; Hewitt et al., 2012, 2013). As mentioned throughout chapter two and three, the challenge of translating and transferring climate information has already been acknowledge and it has been tackled by employing a top-down and bottom-up approach that includes and encourages citizen participation (van Huysen et al., 2018) and the coproduction of knowledge (Vincent et al., 2018). Researchers and institutions have developed simple but detailed guidebooks and manuals that follow these methods such as those that have been implemented in Guatemala (examined in chapter three). As a result, these methods have generated interest, expectation, and discussion from the CS community and social scientists. However, this dissertation argues that there is a tendency to focus on the communicational aspect of implementing CS at the cost of neglecting other aspects. CS literature and empirical data from Guatemala thus shows a tendency in which CS advocates tend to believe that the inclusion of qualitative data (e.g. variety of participants, and documenting citizen participation) is synonymous with the inclusion of social science and place-based CS research. In other words, CS advocates and the CS community in general have fallen into a 'local scalar trap' "whereby researchers assume that organizations, policies, and actions at a particular scale [micro scale for the CS] are inherently more likely to have desired social and ecological effects than arrangements at other scales." (Brown & Purcell, 2005 p. 608).

As a result, overemphasizing the importance of locally relevant CS has limited the CS advocates' capacity to reflect, rethink and question the possibility of alternative practices. Instead of focusing on micro scales that works with communities and small farmers, this chapter will examine the institutions, and the CS advocates involved in the process as a

way to avoid the local trap of the micro-scale approach or the macro-scale limitations of taking away agency from the individual. For this research, individual agency is explored in the middlemen who produces, translates, and transfers the CS.

By focusing on the institutions and not on the local-communal practices it is possible to generate valuable reflections. On the one hand, we can raise further question about the politics of scales that are usually taken for granted by the CS community. For instance, why do CS advocates prioritize communities and farmers over municipalities, state officials, international institutions, and governmental policies? In practice, when CS advocates develop the agroclimatic bulletins, politics of scale that limit self-reflection regain relevance thus a re-evaluation of the scales of operation is required. On the other hand, the disparities between the policy regimes have several effects on the implementation of CS in agriculture, most of which have been neglected. These disparities need to be examined so the CS advocates can evaluate the potential effects that they have in CS implementation and food security in general. That is to say that, if CS advocates are eager to 'teach' about modern climate knowledge, how willing are they to learn about food scholarship and rural Guatemala?

Divided into three sections, chapter four first focuses on the wider theoretical discussions of scales in human geography. Then it reviews literature on how scales are understood and reflects on why they matter for this thesis' analysis and the deployment of CS in food security in general. Section two then provides a general overview of how CS are implemented in Guatemala considering the different scales of operation followed by a more detailed reflection at a macro, meso, and micro scales. It focuses on how these scale making projects intervene with the CS discourse and practices. Section three then identifies and analyzes the challenges of implementing CS based on the differences between policy regimes and the challenges that come with each scale as they intertwine without much consideration. In order to widen our perspective on the various ways in which power relations have effects on the ground it is important to acknowledge and identify these differences.

4.2 Scales in theory, and their effects in practice

Political ecologists in geography have widely discussed the ways in which research can engage with scales. One can find opposing views, from Marston et al. (2005) who analyze the possibility of a human geography without scales in an effort to alleviate the 'army of affiliated binaries' to Jonas' (2006) response against such idea. Clear enough is the fact that research that exclusively analyzes micro or macro scales suffer from several limitations mainly caused by the hierarchical characteristic which can only be overcome if the research does not rely on scales (Jonas, 2006; Watson, 1978). Additionally, integrating macro and micro scales in research comes with important challenges in which managing and systematizing enormous quantities of data produces different challenges (Watson, 1978) all while dealing with intellectual traditions that restrict the research and researchers.

For this work, scales are important for the analysis because CS and food security involve downscaling global and Central American regional climate projections to a municipal and communal level (Bruun Jensen et al., 2016). However, downscaling becomes a seemingly natural decision that goes without questions because CS, in discourse, are produced for and with small farmers. Before moving forward, I should clarify that I am aware that my scalar approach is a product of what Neumann (2009) calls a scalar epistemological decision. This decision does not have to, nor will it overlap or coincide with that of the institutions that this research is focusing on. Otherwise, I would have focused on a particular community or a group of small farmers because scales also respond to 'particular agendas' that belong to the actors involved in the process (Brown & Purcell, 2005). Neumann (2009), states that within these agendas, NGOs, research institutions and international organizations in general, tend to redefine scales even in contradictory ways. They use, reconfigure, and construct new scales according to their needs. In retrospect, the challenge of being an outsider and gaining access to these meetings also meant that I did not work for any of these organizations, nor had I to define my research according to their interests. On the contrary, and much to my relief, I was given the liberty of examining the CS advocate's work with no promise of delivering practical results.

Scales are thus, socially constructed, fluid and fixed alike, but also a relational idea (Brown & Purcell, 2005). In this sense, scales are complex and can become a direct object of inquiry. For this work, I draw on Taylor's paper of 1982 of the use of micro, meso and macro scales (see, Marston et al., 2017). Although Taylor's conception of scales has been progressed by some fundamental critical geographers that include David Harvey, Erik Swyngedouw and Doreen Massey among others, mainly to alleviate the global-local binary, or reduce its hierarchical nature criticized by Marston et al. (2017), it remains relevant as it is the most practical approach used by the institutions. In other words, like Taylor, these scales guide the national meteorological institution's practice of implementing CS. This work does not pretend to rethink the concept of scales but draws on this literature to review CS implementation in Guatemala and generate further insight. Scalar discussion in this thesis is not about technical capacity of the climate projection but the social and political decisions along with their implications.

Therefore, the analysis and data presented below was collected from the meetings I participated in. At each meeting I would focus on the participants and their interventions as well as the main objective of the meeting which was always well defined in the opening words. I would rely on taking notes to track down the time given and/or used by each individual to intervene in the discussion. This information hinted about the types of messages or topics that were prioritized, who were the leading participants, what kind of vocabulary they used, how they talked to each other and who they acknowledged the most. As a result, I could better understand how the challenges of food security varied at each meeting, and how certain topics and concepts disappeared while others emerged and gained relevance. More importantly, reviewing the CS at different scales will shed light on implications of the process of implementation that would otherwise be left unquestioned. The following subsections provides the data and analysis gained from this process.

4.2.1 Climate Services and scales

At a regional scale, the Central American countries are gathered to participate in the *Foro de Aplicaciones de los pronósticos climáticos a la seguridad alimentaria y nutricional* (*Foro* from short). In parallel, national, and local meetings are also held to disseminate and

implement modern climate knowledge in the form of CS to inform decision-makers on food production and food security. The national - the National Crop Monitoring Systemand local meetings – LTAC - are two political platforms that involve different scales of operation and key actors that include the Central American national meteorological institutions and their respective ministries of agriculture. For the Guatemalan case these are INSIVUMEH and the Ministry of Agriculture, Livestock and Food (MAGA), two key institutions involved in the creation of the LTAC and the delivery of the CS at a micro scale.

Reviewing scales is vital when discussing CS for several reasons. In the first place, both the *Foro* and the LTAC involved geographical areas that are much smaller than the meteorologist's global view of nature. The CS stem from global climate projections that are meant to inform actors with a local and relevant scale view of things. The work done in chapter three shows how the CS are created, what they look like, how they are expected to operate and how they function in reality. It also discusses some of the main challenges of producing and deploying locally relevant climate information (Beveridge et al., 2018).

Drawing from the grey literature and the empirical work done, it can be stated that the CS discourse is being created and mobilized from a national scale by the national meteorological institutions towards two scalar directions, regional (macro) and local (micro). Whereas efforts at a regional scale involves developing international cooperation to reinforce the discourse, local efforts draw from regional experience to meet logistical challenges of improving food security. This means that, what CS advocates claim of being capable of doing at a regional scale, contrasts with the challenges met at a micro scale. At each scale of operation, a discourse is reinforced in different, yet specific ways which are to be detailed on the following sections.

With the goal of representing and organising my argument, Table 6 defines and describes these three scales. As a general overview, Table 6 shows the spaces in which the CS are pushed forward and how the discourse of CS for food security being reinforced. The table also shows the different organizations that participate in the meetings. These institutions are divided into two kinds of participants: leading and secondary organizations. For
instance, at a regional scale where Dominican Republic and Central American countries meet, we find that the organizer is the Central American Integration System in collaboration with the National Meteorological Institutions. In this sense, the ministries of agriculture and other participants are secondary participants. In contrast, at a meso-scale, the Guatemalan *Sistema de Monitoreo de Cultivos* sees a change in the configuration of these participants. Guatemala's national meteorological institutions become one of many other organizations, most of which are international. At this scale, the Secretary of Food and Nutritional Security or SESAN becomes one of the leading organizations that is also in charge of generating and approving the report on food security for politicians and decision-makers. Finally, at a municipal or micro scale, the national and international organizations are relegated to a secondary position in regard to INSIVUMEH, MAGA and CIAT who are the CS advocates and main organizers of the LTACs. In LTACs we find more individuals representing themselves in the sense that low-tier officials like crop advisors participate to gain training and new expertise to maintain their jobs.

With the above details in mind, Table 6 also shows how the participants involved in the meeting generate effects that become characteristic of each scale. These include the 'subject of discussion', the 'target users' and the 'temporality' of the practices that are promoted. Although the climate information remains consistent throughout scales, for the LTACs, the meteorologists will focus on the climate information tailored to the *departamento* and several *municipios* while the national climate scenario becomes secondary subject and is briefly covered in the meeting.

In this sense, regarding the 'subject of discussion' the climate services sound promising at a regional scale and are mostly framed as a vital scientific tool for decision-making and policy. Although small farmers and peasants are mentioned to be the target group, it is also commented that technicians and professionals are responsible for generating the information in a scientific and objective manner. On a meso-scale the organizations involved begin to take the CS with certain caution and try to provide a better context of the food production challenges that small farmers face. At this level, most institutions tend to discuss current demands and struggles that are related to food production, crop phenology, market, and weather. Finally, on a micro scale, in the LTAC, climate information becomes the center of the discussion and is forced into the participants to elaborate agroclimatic bulletins and provide advice. In other words, there are no LTACs without climate data and the production of CS.

In regard to the 'target users' there is also a difference worth considering. The literature review in chapter one already explored this issue. Here I show how this challenge materializes in every meeting. For instance, whereas the Central American System of Integration and the Institutions participating in the *Sistema de Monitoreo de Cultivo* prioritize high-tier government officials, experts, technicians, and decision-makers with a certain degree of power, the LTAC focus on small farmers and crop advisors. For the 'user' category the difference is seen between the micro scale and the other two bigger scales.

In the last column to the right, Table 6 focuses on 'future temporalities'. For the CS initiative, temporality can be viewed as Lefebvre's (2004) work on rhythmanalysis which reminds us that it is useful to examine time as repetitions and cycles. In other words, there are long-term climate cycles which include El Niño and La Niña Southern Oscillation that meteorologist measure and with what they work to provide advice. However, humanitarian organisations that deal with body cycles of food consumption have shorter timeframes. In this case, CS and agriculture becomes a space that intertwines longer climatic cycles with the yearly agricultural cycles and human cycles. To conciliate these differences, work on future geographies offer important insight on how actors "define a range of plausible futures", this case being a food secure future (Kurniawan & Kundurpi, 2018). Actions are oriented towards these timespans through programs of adaptation to climate change (e.g., soil management technique) and tend to overlook at hunger as an everyday struggle. An important aspect regarding temporality is that only at a meso-scale with no participation of farmers is the crop's natural cycle considered. Although climate projection is treated as a reliable source of information, the crop's phenological development and food demand is not always taken into account in the discussions.

A way around this temporal disparity is to project future goals into present day behaviours under the promise of a food secured future. For instance, the separation of events like Guatemala's famine from 2001 from historical and social context continues to engender conventional ideas of rural development mainly by the Guatemalan government. In his work, Reinhart Koselleck (2004) discusses how the future came to be monopolized by the State. He describes how individuals and their context become a historicized time. In a similar manner, Jude Kurniawan and Aravind Kundurpi (2018) underscore that, who wields power defines such futures. For instance, in Guatemala, INSIVUMEH is the only institution that can legally provide the climate projections. The national meteorological institutions that can determine future events thus becomes the institutional representation of modernity. They are authorized to shape and imagine the future but also can assist other institutions with scientific evidence to make a point or an argument to support specific initiatives. For instance, MAGA uses the FAO's research on desertification to argue for a modernized agriculture that diminishes its impact on climate change.

Along with the concerns with power, research on future geographies provides insight on other kinds of challenges. For instance, these programs of development that build future scenarios usually conceive the future as something determined and scientifically calculated. However, future is not exact, nor can it be conceived as a "deterministic destination", because it holds multiple possibilities. Regarding the future created by CS initiatives, it is characterized as an epistemic future because it is represented as stable and, to an extent, it has involved causalities that have been scientifically established (Kurniawan & Kundurpi, 2018) through climatological calculations. To imagine futures, Kurniawan & Kundurpi (2018) argue for the need to envision society and space together. A deterministic future in which food insecurity is simplified means that CS advocates ignore other factors or thought processes for decision-making that users might undergo as mentioned in chapter two, page 63.

Table 6. Scales of intervention and their characteristics.

Scale	Area	Meeting	Leading Participants	Secondary Participants	Subject of discussion	Target user	Future temporalities
Macro Regional	Central America	Foro	Central American Integration System National Meteorological Institutions	Ministries of Agriculture	CS for food security CS for water management CS for disaster risk reduction	The Central American National ministries of agriculture	Future climate scenarios and future response
Meso National	Guatemala	SMC	INSIVUMEH MAGA SESAN International Organizations (FAO, WFP, FEWSNET)	Not determined	Wider food security discussions with CS components	Ministries, international organizations, decision makers, not farmers. The goal is to elaborate reports for high tier decision makers.	Future climate scenario. Crop phenology and food production challenges. Demand immediate response to alleviate hunger and resist the rise of food prices and inputs.

Micro	Departamento	LTAC	INSIVUMEH	Other	CS for food	Decision-	Future climate
Local	and		CIAT	organizations	security and	makers	scenarios.
	municipios		MAGA		food production	(includes crop	
			Crop Advisors			advisors,	Provides advice on
			ANACAFE			peasants,	present and future
						producers,	agricultural
						infra-	practices
						subsistence	
						farmers and	
						subsistence	
						farmers)	

Table 6 also hints at how the scales in which the implementation of the CS is meant to occur respond to particular political agendas set by the actors who preside each space. Arguably, politics of scales may respond to organisational limitations or interests. However, they are also determined by different epistemes, on the one hand, meteorologists gather global data for processing, elaborating projections and then they scale down to a Central American scale, followed by a national and the local scale. In this manner, the way in which the national meteorological institutions of the Central American region view climate allows, foments, and provides a space to think about Central America as a unity. They are actors with the broader interest to reconnect and generate collaboration between the fragmented Central American countries. On the other hand, in these workshops, meteorologist must engage with agronomists, farmers, and other technicians (or not) and organizations who work within the food systems. The meteorological institutions follow the WMO's and LTAC principles of sharing and coproducing knowledge. Both, in the regional and most local scale practices, knowledge is subjugated or adapted to the climate infrastructure despite the principle of coproducing knowledge.

I was intrigued to look into the ways the climate infrastructure managed to merge with the food policy regime. However, as I attended the meetings at regional, national, and municipal scales, I took notice of the ways in which discussions were taking shape and the tensions between discourse and practice emerged. At one level the overarching goal of the meetings was clearly communicated by digital brochures, and the opening speech given regarding the use of climate knowledge for food security. On another level there were the actual discussions and PowerPoint presentations given by the participants. This means that, in order for downscaling to occur, the participants had to implement techniques like making use of unclear and flexible concepts to generate agreements between the wide range of institutions involved (Broome & Seabrooke, 2012). In this particular case, I have called conceptual mutability to refer to the way in which the meteorological institutions, agricultural ministries and international organizations focused their work on peasants, producers, farmers, subsistence farmers or infra-subsistence farmers. Although the institutions seem to agree on whom they are working for, the effects that ambiguity or conceptual mutability has is yet to be evaluated. This confusion did not occur at a regional

scale, however at the national and local scale it did become problematic because on the ground, all of these actors (peasants, small farmers and so on) are different at many levels and they are all involved in food production. This chapter will develop more of this topic in section three.

In Guatemala, downscaling also comes with a kind of conceptual dilution. What I mean to say is that as organizations work out at different spaces and narrow down their scales of operation, the concept of food security tends to be removed from conversations while other concepts and discussions related with food production emerge and gain relevance. Other issues like land distribution or access to the communities are never discussed yet were commented by interviewees outside these meetings. As one academic told me, for small famers in the highlands to the west, the poor road development impedes the access to the market. In other words, in order to improve food security, beside having a better comprehension of climate change and weather variability it is important to acknowledge other issues that usually tend to be prioritized due to their immediate effects.

I found that, one way for CS advocates to work around these tensions is with the conceptual mutability and conceptual dilution mentioned above. Although CS advocates have been vocal about their principle of inclusion and about working with various potential users, in practice, this aspect becomes challenging. A reason is because CS advocates face the threat of losing relevance against other issues such as price speculation, access to a market, and input prices among other issues, therefore they rely on the number of users that request their services. However, at local scales, new and more urgent needs tend to displace the interest that crop advisors might have on the climate services. As a result, (as mentioned in chapter five), the CS advocates will tend to count any participant of the LTAC as an engaged collaborator.

In practices, it is important to identify the range of heterogeneous users and to examine how the climate service advocates mobilize their goals to identify the differences that emerge between the actors of the policy regimes. It is not the same to talk about food insecure -landless infra subsistence farmers- at a national scale and later consider only commercial farmers with the capacity to hire labor. Research done in South Africa regarding the use of genetically modified seed to improve yields evinced how the heterogeneity among small famers proved to be challenging for international organisations to deliver positive effects in their programs of food security (Fischer & Hajdu, 2015) and Guatemala is not the exception.

Overall, scales become problematic in two ways, for researchers it means reflecting on the process of examination that transcends the desire of producing overarching theories or romanticising local experience. For the practitioners, the CS advocates in this case, it shows that the technological fix is not simple nor reproducible as a recipe. Providing climate data with hybrid seeds that follow the climate scenario should not be expected to provide fast solution. As Klara Fischer (2016) argues technology is not scale neutral. Fischer examines how programs to introduce genetically modified seeds and technological fixes are always conditioned by social drivers.

The following section will focus exclusively on how the concept of food security is mobilised at every scale namely the Central American region, the national, and the local or in other words macro-meso-micro. As the reader will notice, the meso-scale of operation where the *Sistema de Monitoreo de Cultivo* (SMC) takes place offers a different experience from the regional and local scales which were mostly led by the meteorological institutions. It could be argued that it is a result of the variety of actors involved and a kind of balance in power, but I argue that it also responds to the perspectives that a national scale of analysis provides which escapes the other two.

4.2.2 Macro-scale: Discussing food security in *El Foro Centroamericano de Aplicaciones de los pronósticos climáticos a la seguridad alimentaria y nutricional*

The CS discourse is reinforced by the Program of Information Systems for Resilience and Food Security and Nutrition for the Region - Central American Integration System's (PROGRESAN-SICA) and Regional Committee for Hydraulic Resource's regional scope in Central America. These organisations champion CS in a top-down, bottom-up manner through the LTAC meetings and the Central American forum. The three-month climate scenario presented at this forum is directly aimed at users and decision-makers. However, the users are not clearly defined and throughout the conversation it is assumed that they are the most vulnerable population. The ambiguity of the targeted population is evidenced when most of the government officials of agriculture focus their presentation and advice on the economically important crops (e.g., banana, coffee, pineapple) of their country rather than emphasizing crops for self-consumption. A lack of time to prepare the presentations is also evident by the type of agricultural advice given which tends to be general.

The time for preparation also varies within each country. For instance, the Panamanian agriculture representative would acknowledge he had only a couple of hours to prepare his presentation because the National Meteorological Institutions did not provide the information with more time. Another important aspect of this forum was that whenever a geographical area of any country showed normal rainfall projections, no advice or recommendations were given. This allowed the meeting to move faster but it also exhibited a contrasting difference between the regional scale view of the national meteorological institutions against the national scale that the ministries of agriculture care for. In Figure 31 (top) we can see how INSIVUMEH divides Guatemala into nine climatic regions to provide general information on the expected accumulative rainfall. Guatemalan officials proudly said they were the leading country when it came to disseminating their information. In the same Figure 31 (below) it is shown how INSIVUMEH has the capacity to inform the whole country through the implementation of 19 LTACs and covering 100% of the national territory.

Perspectiva climática para Guatemala mayo-julio 2022 Según el análisis de años análogos y pronóstico estacional de modelos se elabora el mapa de categorías de precipitación. Belic Categoria Región Franja Transversal del Norte, Arriba de lo Bocacosta normal Caribe Sur de Petén Este de Zacapa y Chiquimula Occidente Norte, Oeste y Este de Petén Valles de Oriente Normal Altiplano Central Pacifico Categorias ias ma de América Ca AN 🤇 N (INSIVUMEN ò **ESTRATEGIA DE** and a **DIVULGACIÓN DE LA** PERSPECTIVA Mesas Técnicas Agroclimáticas (MTA) - Actualmente existen 19, cubriendo el 100% del país Previamente se organizaron dos eventos regionales orientadas a las regiones de Bocacosta y Pacífico. Y se tiene planificado el acompañamiento a las sedes departamentales para cubrir el total del país. Mesas Técnicas (MTA)

PRONÓSTICO DE PRECIPITACIÓN ACUMULADA M.I.J 2022

Figure 31. INSIVUMEH's climate regions and Guatemala's LTAC. Source: INSIVUMEH's presentation at the Foro de Aplicaciones de los pronósticos climáticos a la seguridad alimentaria y nutricional (Centroamerican Forum for applications of climate forecast on food security and nutrition). CRRH's Facebook page

Although the regional scale of analysis involves the coordination of all the Central American countries, there are some parameters that are not homogenized. For instance, while most countries provide information regarding temperature, the start of the rainy season and the *canícula*, Honduras only provides information regarding the *canícula*, and Nicaragua does not provide information on the temperature. The *canícula* is important for crops as it tells when the rainy season is expected to stop (historically around August). This

period gives the farmers and peasants the opportunity to harvest and dry their crops and prepare for the second season. At a regional scale, the Regional Committee for Hydraulic Resources also monitored watersheds of which Guatemala monitors only two of its 38 watersheds. There was no clear reason why some watersheds were prioritized over others. Overall, the inconsistencies evidence a lack of coordination among the Central American national meteorological institutions, but it also showed that they have unequal relevance within their countries of operation.

Although the National Meteorological Institutions do coordinate to put together the information, when shared with the wider public it does feel disjointed. Regarding the distribution of time used for the presentations, every country has 15 minutes to communicate their climate scenarios. This 15-minute timespan is shared between the meteorologist and agronomist, and there are various degrees of preparations as the Panamanian remarked. Overall, each country had a different priority, while Honduran agriculture officials discussed the importance of adapting the vocabulary to the farmer's demands, other countries prioritize the use of CS for the private sector, and Belize did not participate in the meeting.

Overall, institutional agendas are important because they shape discussions and also influence how challenges are framed despite claiming that they (institutions) have a shared and specific goal of improving food security. In this sense, the CS advocates' beliefs on inclusion, vulgarization of knowledge and coproduction of knowledge (see chapter three) are challenged by logistics, disparate goals, and unstandardized practices between Central American national meteorological institutions and the national agricultural ministries.

4.2.3 Meso-scale: Discussing food security in: *Sistema de Monitoreo de Cultivos* (Crop Monitoring System)

At a national scale the discussion was strikingly different. Although this space was integrated by INSIVUMEH's CS advocate, it was mainly led by other actors that include the FAO, FEWSNET, WFP, MAGA and especially SESAN. This became noticeable as the time given to the topics regarding food insecurity was prioritized while climate

information was less discussed. I could believe that climate information was relegated in part due to the fact that regular precipitation was expected in the climate outlook for 2022. However, I argue that displacing CS was the result of the types of actors involved in the meeting. These actors are more embedded with the food system, albeit their conventional approach on food security.

The first hint of the disparity between regime was that, as the international organisations became key participants at delivering specific information, the way they communicated their data provided a fixed and palpable idea of who the users were supposed to be. To begin with, their crop advisors and employees from these organisations had direct contact with rural Guatemala and several minor cities to gain access to information concerning food and fertilizers prices among others. The communication between these participants and small farmers in rural Guatemala also gave a sense that the message had a degree of urgency that was palpable in their demands and questions but was absent in the Central American forum.

In Figure 32 (first image above) we can see how black beans, and white and yellow corn prices are monitored in specific communities, those being the *municipios* and rural communities. The international organizations also interview their collaborators to know when people are expecting to plant beans and corn. They also inform the participants that some farmers will plant sooner due to the rainy season. In the same figure (below), the crop advisor offers information regarding the number of Hectares of corn and beans that are being affected either by pest or weather. They estimated the number of families and the economic loss. These tables are generated in April thus allowing a fast reading of the national situation. SESAN and other institutions can then elaborate the report on the seasonal hungry people¹⁶.

¹⁶ From seasonal hunger: Guatemala identifies seasonal hunger as a period in the year where several families become food insecure due to external factors. Although they might bounce back and forth from this state, they are continually monitored.

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Pronóstico de siembra

Maíz - Mayo, Frijol - Septiembre

Debido a las lluvias, algunos agricultores están próximos a realizar la siembra de maíz.



TABLA DE DAÑOS A CULTIVOS DE MAÍZ Y FRIJOL

Departamento con Reporte de Daños agrícolas	Familias afectadas (Total)	Estimación de área dañada (Hectáreas)	Área perdida totalmente (Hectáreas)	Estimación de Pérdida en Quetzales		
Izabal	29	39	39	Q109,500.00		
Puerto Barrios	29	39	39	Q109,500.00		
Maiz Blanco	29	39	39	Q109,500.00		
Total general	29	39	39	Q109,500.00		

Fuente: DICORFR-MAGA 2022

Figure 32. World Food Program corn and bean price monitoring system. Source: Mesa de Monitoreo de Cultivos (Food price monitoring workshop)

Whenever there were hydrological deficiencies in areas with low precipitation forecast, participants raised questions regarding the types of mechanisms that the government had available for implementing and preventing water-shortage crisis. For the Guatemalan case, the only mechanism available beside handing out food in dire situations was paying stipends at the end of the agricultural cycle (October-November). The stipend was given only to those farmers who had implemented and completed soil management practices that

include windbreaks and buffer strips among others. They were also given after the crop advisors had visited each farmer and decided who had fully completed all soil conservation practices.

However, discussion would focus on monitoring beans and corn yields and prices. With such information they could project the people who would become food insecure in the following season. In this meeting there was also a wider consensus on who were the public they attended, those being the subsistence and infra-subsistence farmers as SESAN's official repeated or the vulnerable population which the WFP representative mentioned in our conversation.

This workshop also included other technical information such as the phenological stages of corn and bean. Technicians from MAGA would monitor how these subsistence crops were developing, almost in real time and would later correlate the information with the climate information to locate areas that could pose threat on the crops. The Normalized Difference Vegetation Index¹⁷ was also used to cross reference with other data and to monitor Guatemala's water demands. The resulting product from these meetings was the elaboration of a bulletin with advice on fertilizer subsidies, production of organic fertilizers by the subsistence and infra-subsistence farmers (by the CS advocate), and the use of compost. Overall, there was a sense that SMC did manage to integrate technical information with more traceable market data to elaborate a practical, trustable, and useable product. For the SMC the report generated was not targeted to the population in general but to decision-makers in the government and other international organizations that shared their goal. Although some of the advice, like producing organic fertilizer was common to all scales, the correlation of data gathered from across the country and through satellite images like the Normalized Difference Vegetation Index provided open discussions on the government's responsibilities and role of developing mechanisms to attend the current and future demands (as I will later develop on the discussion regarding stipends), but also projects regarding water availability. National scale not only transcended local administrative problems, but it also managed to integrate food and agricultural input prices

¹⁷ This index measure or quantifies greenness in plant leaves to give an idea of the plant's health and changes.

along with the climate information, phenological stages of plants and the Vegetation Index for international organizations and SESAN to plan ahead regarding the number of families expected to become food insecure. This data mattered most for these organizations as their area of influence and their work is in direct contact with farmers.

Some of the key factors associated to food insecurity for the year 2021 are shown in the Integrated Classification of food security phases (CIF) document and include the COVID-19 pandemic, rise of food prices, depletion in the grain reserves and job loss. The level of detail regarding the food insecure in Guatemala is surprising, in Figure 33 we can see that institutions working for food security use categories to define the degree of affection and the number of people who are expected to be food insecure over a period of time. In the same document, exhaustive level of information is shown regarding the number of people who are food insecure per *departamento* (see Figure 34). Institutions working for food security have their own mechanisms to project and measure the people who will suffer from food insecurity. They also have technicians and various sources of information available to provide valuable data on what to expect regarding future food crisis.

Clasificació intormación y Norma	n Integrada Is que parantition Me	de la Seguridad Alimentaria en Fases aves Decisiones relativas o Seguridad Alimentario y Autorstana	COBIERNO de ALIMENTARIA Y NU GUATEMALA DE LA PRESIDENCI DE LA REPÚBLICA	GURIDAD TRICIONAL A						
GUATEMAI 3.5 MILLONES DE DE CRISIS O EMER	PERSO	NAS EN SITUACIÓN A DE INSEGURIDAD ALIMEN	ANÁLISIS DE INSEGURIE ALIMENTARIA AGUDA DE LA (MAYO 2021 - ENERO 20 NTARIA PUBLICADO EN JUNIO 2							
SITUACION	ACTUALE	N MAYO - AGOSTO 2021 0	SITUACION PROYE	TADA A SEPTIEMBRE 2021 - ENERO 202						
	Fase 5	Personas en Catástrofe		Fase 5	Personas en Catástrofe					
3.5 MILLONES	Fase 4	174,000 Personas en Emergencia	2.5 MILLONES	Fase 4	58,000 Personas en Emergencia					
20% de la población analizada (17.1 millones).	Fase 3	3,285,000 Personas en Crisis	14% de la población. analizada (17.1 millones)	Fase 3	2,454,000 Personas en Crisis					
Personas en crisis o emergencia de inseguridad alimentaria	Fase 2	7,776,000 Personas en Fase Acentuada	Personas en crisis o emergencia de inseguridad alimentaria	Fase 2	7,988,000 Personas en Fase Acentuada					
aguda (Fase 3 o peor de la CIF) REQUIEREN ACCIÓN URGENTE	Fase 1	5,876,000 Personas con Inseguridad Alimentaria Mínima	aguda (Fase 3 o peor de la CIF) REQUIEREN ACCIÓN URGENTE	Fase 1	6,609,000 Personas con Inseguridad Alimentaria Mínima					

Figure 33. The Integrated Classification of food insecurity phases for Guatemala May 2021 to January 2022. Dark red stance for catastrophe/famine, red stands for emergency, orange for crisis, yellow for stressed and green for minimal or none. For May-August 2021 there were 173000 people in emergency. Source. SESAN, 2021

	Fase	Población	Fase 1		Fase 2		Fase 3		Fase 4	ļ	Fase 5		Fase 3+	
Departamento	de área	Total	#	%	#	%	#	%	#	%	#	%	#	%
Alta Verapaz	3	1,355,134	352,335	26	704,670	52	271,027	20	27,103	2	0	0	298,130	22
Baja Verapaz	2	333,537	116,738	35	166,769	50	50,031	15	0	0	0	0	50,031	15
Chimaltenango	2	746,366	261,228	35	410,501	55	74,637	10	0	0	0	0	74,637	10
Chiquimula	3	447,544	179,018	40	156,640	35	102,935	23	8,951	2	0	0	111,886	25
El Progreso	2	194,388	87,475	45	71,924	37	33,046	17	1,944	1	0	0	34,990	18
Escuintla	2	802,479	401,240	50	337,041	42	64,198	8	0	0	0	0	64,198	8
Guatemala	2	3,557,909	1,565,480	44	1,601,059	45	391,370	11	0	0	0	0	391,370	11
Huehuetenango	3	1,399,367	377,829	27	741,665	53	279,873	20	0	0	0	0	279,873	20
Izabal	2	446,461	156,261	35	245,554	55	44,646	10	0	0	0	0	44,646	10
Jalapa	2	400,905	196,443	49	140,317	35	60,136	15	4,009	1	0	0	64,145	16
Jutiapa	2	552,114	138,029	25	358,874	65	55,211	10	0	0	0	0	55,211	10
Petén	2	622,409	329,877	53	238,964	40	43,569	7	0	0	0	0	43,569	7
Quetzaltenango	2	909,879	363,952	40	409,446	45	127,383	14	9,009	1	0	0	136,482	15
Quiché	3	1,081,964	281,311	26	584,261	54	216,393	20	0	0	0	0	216,393	20
Retalhuleu	2	376,398	188,199	50	154,323	41	33,876	9	0	0	0	0	33,876	9
Sacatepéquez	2	396,167	174,313	44	178,275	45	39,617	10	3,962	1	0	0	43,579	11
San Marcos	2	1,189,274	535,173	45	475,710	40	178,391	15	0	0	0	0	178,391	15
Santa Rosa	2	446,436	200,896	45	165,181	37	80,358	18	0	0	0	0	80,358	18
Sololá	2	474,240	213,408	45	189,696	40	71,136	15	0	0	0	0	71,136	15
Suchitepéquez	2	612,438	244,975	40	275,597	45	91,866	15	0	0	0	0	91,866	15
Totonicapán	3	493,864	123,466	25	271,625	55	98,773	20	0	0	0	0	98,773	20
Zacapa	2	270,473	121,713	45	100,075	37	45,980	17	2,705	1	0	0	48,685	18
Gran Total		17,109,746	6,609,358	39	7,988,165	47	2,454,452	14	57,772	0	0	0	2,512,223	14

GUATEMALA | ANÁLISIS CIF DE INSEGURIDAD ALIMENTARIA AGUDA

Figure 34. The Integrated Classification of food insecurity for each departamento in Guatemala May 2021 to January 2022. Source. SESAN, 2021

4.2.4 Micro-scale: Discussing food security in the LTACs

Although food security is one of the key concepts mentioned at the *Foro*, we could not see how the topic was further developed by the national agriculture ministries because they lacked time to prepare. At a micro-scale, the Guatemalan ministry of agriculture that is one of the participants of the regional *Foro*, becomes a key participant in the LTAC not only because of the existing governmental mandate to support food security initiatives, but also because they are the ones that provide the facilities for the LTAC and the technicians to produce and transfer the agroclimatic bulletins. As it was seen in the LTAC's description in chapter three, not all information discussed by the international organizations at the SMC was transferred to the LTAC neither does this information seemed to be internalized by the participants in any practical way. At every LTAC, the meetings are treated as separate from the other forums or meetings in the sense that climate projections from the *Foro* and SMC were repeated (for a third time, and many more times for other LTACs) to the new actors, generally crop advisors. While INSIVIMEH gave more attention to the local area, MAGA's presentations were not aligned with the local needs, nor did they brought any information of what was discussed at the SMC. MAGA would usually give a presentation regarding their ongoing projects on soil classification or pest management.

Additionally, the conversation would differ depending on the institutions that was hosting the LTAC. For LTAC Centro-sur it was ANACAFE, and they would prioritize discussion related to coffee production. In this LTAC, MAGA's presentation was oriented towards the elaboration of a national soil taxonomy cartography. In fact, the discussion at LTAC Centro-sur was more technical and felt unattached to food security issues because most of the technicians and government officials involved were not in direct contact with farmers nor did they have direct experience on food production. Overall, the meeting held at ANACAFE's facilities in the Capital city of Guatemala contrasted those held in MAGA's facilities. Locate in one of the most exclusive zones of the Capital city, ANACAFE's central building was characterized by the beautiful architecture with internal hanging vegetations, natural sunlight and the provision of high-quality coffee given out in the meeting. Outside the city, MAGA's facility was completely different (as seen on the previous chapter), and they would provide water bottles to the technicians and plastic water bags to the crop advisors. These rather cosmetic differences were acknowledged by a young MAGA official when she said she liked it when ANACAFE hosted because they provided cookies and coffee. On the practical side, MAGA's presentations and crop advice for the agroclimatic bulletin of the region were targeted to the coffee growers. This meeting also had fewer crop advisors since it was expected that the role of transmitting this information would lie with ANACAFE's advisors. Overall, the discussion in the LTAC varies according to the participants and although crop advisors were not the expected endusers, they became one of the most important nodes for decision-making and knowledge transfer.

At this space, crop advisors know the farmer's needs and advice is given according to categories of crops selected (perennial, vegetable, forest) yet because the discussion is regarded as technical, only certain types of discussions and advice are taken into account. For instance, the rise of fertilizer price is tackled by advising the production of organic fertilizer. Most of the time, this recommendation was given by the CS advocate in what felt like scripted advice. When I asked a crop advisor the reasons why people did not take advice on soil management practice or producing organic fertilizer, he replied that most of these people only have two or three *cuerdas*¹⁸, they do not have the option of losing one of their *cuerdas* in soil conservation when they are expecting to eat everything they can possibly grow throughout the year and that they plant everywhere they can. This reminded me that in fact, the bulletins are targeted to the small producers regardless their landless condition as usually happens with infra-subsistence farmers.

Advice at local scale also becomes harder because crop advisors are not willing to risk a farmer's living by giving erroneous information. This reticence was already stated by the researcher Sophie Haines (2019) in Belize. In Guatemala, delivering erroneous information was experienced by a former LTAC participant from the Dry Corridor region who told me they once gave advice, and the weather turned out different from what was expected. The fellow farmers complained, and they no longer participated on the LTAC. However, at the current stage, CS advocates measure their success by calculating the number of people their product reaches. In this sense, at every meeting they would urge crop advisors to transfer the knowledge and give advice. In this sense, the LTAC-Escuintla provided valuable information on how these issues are handled. After a moment of discussing how trustworthy was the climate information, a crop advisor agreed to give advice only if they were to transfer the responsibility, they said: "I could say that according to INSIVUMEH technicians [they placed strong emphasis on who was giving out advice], you [referring to the farmers] can plant in this or that day." Overall, the message was that these crop advisors

¹⁸ One *cuerda* equals 400m² or 4% of a Hectare.

would not give advice on a personal level, they could agree to become a channel of communication but not advisors. Overall, frictions generated between global/modern climate knowledge and local realities become violent. These collisions between global knowledge and local realities occur because the global CS claims are translated into life changing decisions for many families in the countryside and for the CS employees who deliver the climate information in rural areas.

Conversation diverted and technicians and advisors commented that in Guatemala, the variability in rainfall and climatic conditions are not homogenous within the same *municipio*. Some *departamentos* might even include four climatic regions therefore, scaling down climate projections is not as trustworthy as meteorologists want to believe. One of the participants went further and said farmers were better off by not planting anything at all because either by droughts or floods, they would not gain anything but debts and throw away their work. However, others argue that meteorology is not an exact science:

"So, how can one have the capacity to get ahead of this and inform people when to do their agricultural practices, for example, when to plant, fertilize, apply fertilizers. This is complicated and meteorology is not an exact science. So it is difficult to tell people: today is not going to rain and it might not rain but the general idea is to calibrate these systems and help them (the farmers)". Academic. Guatemala City, 2022. My own translation).

Overall, it became harder for participants to provide advice on food production as the scale of implementation got localized. In parallel, other subjects or struggles emerged making the discussion complex and charged with social, economic, political, and environmental layers. Using *departamentos* and *municipios* as scales of interventions responded to political and administrative factors that were not well received by the technicians. According to CS advocates, this allows collaboration to grow, however, in practice, it also limited other participants' experience when their interventions diverted from the LTAC's agroclimatic bulletin or the elaboration of agricultural national plan as it happened with the SMC. As the scales of operation scaled down, so did the responsibilities and the sense that each individual has the power to decide and

responsibility over his own wellbeing. Correspondingly, as I will reflect in chapter five, neoliberal policies embedded in institutions seek the citizen's individual improvements through merit and work. These efforts maintain the illusion that decision and opportunities are given to subsistence and infra subsistence farmers.

In the next section, I address the way in which the differences between the policy regimes manifest in the LTACs and CS products. Although the participants of the meetings held at a macro scale with other Central American countries manage to handle some of the disparities, I will now turn to the middlemen such as the crop advisors. I will detail how the governmental officials, CS advocates and other participants handle the incommensurable differences.

4.3 Examining the tensions generated by scales and the policy regimes

The difficulties of producing locally relevant CS information increases as the scales become localized. However, the challenge between scales remains the same overall, and it is in part produced not only by the deficient climate information and lack of weather stations, but because there are also two major different topics of discussions that are forcefully paired, that of climate knowledge and the food security. Both, the *Foro* and the LTAC emphasize that the CS's main topic of interest is the provision of agricultural advice based on climate information. In this sense, the meetings destined some time to educate the wider audience on climate related terms and climate change through *Educlima*, other parts of the meeting focused on presenting weather and climate projection. However, on the SMC meetings, the CS are used as a departure point for their discussions on food insecurity. After evaluating the effects that projected rainfall would have on Guatemala, climate information was later relegated as other topics start to emerge. This clash is seen in several ways which will be explained in the following subsections.

Overall, the pursuit of generating locally relevant climate information and its subsequent success comes from methods of self-evaluation that are measured by the CS advocates (Giraldo et al., 2019; Navarro-Racines et al., 2020). However, these methods are impinged and impregnated with a wider discourse around CS and food security that can knowingly

or not neglect certain aspects. One of those parameters measured by the CS advocates are: the reach their climate products have, the participations within the LTAC, and the institutional agreements between INSIVUMEH and MAGA that forces the government officials to participate in such meetings. These parameters of self-evaluation (Giraldo et al., 2019; Navarro-Racines et al., 2020), believe that scaling down is done through participation. However, they will not consider how the climate infrastructure in which they are part of, is working with the incommensurable differences they have with the food system. In other words, CS advocates and meteorologists value the importance of sharing their knowledge on modern climate science, yet they are unbothered to understand how Guatemala's food system is working. On the following subsection I discuss how these differences manifest.

4.3.1 Users and decision-makers

From the first chapters in this thesis, particularly in chapter two and three, the users and decision-makers have been a slippery subject. Although users are different, they also appear at times to become one undifferentiated subject. For instance, INSIVUMEH and MAGA both think about the users as the farmers. However, as seen before, farmers are a non-homogenous actor. They risk being confused or neglected as the governmental official pointed out when referring to MAGA's representatives:

"They [MAGA officials] ask me, who is my targeted population? We are updating the Food Security and Nutrition policies with its... everywhere the problem with food insecurity and nutrition, but who is our targeted population? I'm startled that you are asking this, you are supposed to tell me who is our targeted population. He/she could not answer. I'll tell you, based on my experience, you need to focus, you do not have abundant resources, so you need to prioritize the most vulnerable, those who are most vulnerable, the small farmers." (SESAN's official, Guatemala City, 2022. My own translation)

This aspect is equally troublesome at an institutional level. In MAGA's report (Gobierno de Guatemala, 2022) the ambiguous description of subsistence and infra-subsistence farmers leaves out important details regarding land tenure (as detailed in chapter one). Additionally, throughout the interviews and meetings, the farmers were described as

peasants, farmers, and producers which would evidence a lack of agreement between government officials. All of these concepts convey different ideas as to who are CS advocates, and their CS products are working for. The users thus, can be anyone, even peasants who do not own land, those who are illiterate or Mayan communities who might not speak Spanish. As introduced before in chapter three (I develop further in chapter five), the idea MAGA has of dealing with poverty and small farmers has been through the implementation of initiatives that aim at modernizing the countryside. One of these concerns has been the incorporation of small farmers into the market (international market as well), all while neglecting centuries of oppression and land distribution inequality. In this manner, MAGA continues to be a governmental apparatus that seeks to modernize the countryside. The pursuit of modernity in Guatemala has a history of its own as seen in chapter one (Grandia, 2014; Schirmer, 2010).

These users are not only the vulnerable population, but they can also become decisionmakers. As the meteorologist said, "everyone has a degree of responsibility and decisionmaking regarding their jobs". Meteorologist decides which climate scenario and projection will be distributed to the public, afterwards, the crop advisors decide if and how they transfer the information given to them. Finally, farmers, peasants, subsistence, or infrasubsistence farmers have agency of their own when it comes to deciding what to do with information given. They are responsible of their precarious condition and most importantly of their improvement because they can now learn about climate variability and modify their agricultural practices.

During my fieldwork it was evident that decision-makers were meant to operate in a topdown manner. However, this decision-making began at an intermediate and low-level of operation within the Guatemalan institution (e.g., Meteorologists, technicians) and climbed down to the crop advisors and the end-users. Every time I asked about the responsibilities of the Minister of agriculture or other high-ranking officials, the responses became unclear. Aside from an academic who continuously stated that the combination of corruption and the lack of weather stations were strong reasons to have a failed program, most of the interviewees were not precise and would easily divert away from the question. As I was later told by an academic, the "former INSIVUMEH's director is a fugitive of justice... they proved he bought overpriced weather station" and now he is on the run from the authority. Overall, high ranked officials were not regarded as decision-makers due to a lack of trust placed on them and because they seem to have a lack of interest in solving the issue as the interviewee continued explaining his personal experience with politicians:

"[when we were finally heard] the vice minister says, it's a good study, you should ask for international funding so you can do it. Hm, they seemed to have washed their hands of us, when we were the ones who were presenting the study so they could invest on infrastructure and roads. But they said we should look for funding and build the roads. We are an academic institution, the only thing we can do is to propose and provide the government with information, but we tried [pushed forward the development of the highlands] with three different government officials and it was not possible." (Academic, Guatemala City, 2023. My own translation).

These types of discussions, those that diverted away from the implementation of CS in food security, happened more often than expected. I had thought I would have to dig further with questions, but interviewees would naturally hint at what were the issues that concerned them the most. These problems were a product of the ways in which the two policy regimes merged in unnatural and forced ways. I will not linger much on Guatemala's current endemic corruption, but it is worth mentioning it. Corruption however was a point of shared frustration, whenever the participant found out that I came from Nicaragua, they would acknowledge that such problem was something we all struggle with in the Central American region.

Working with government officials and governmental institutions always had a component of corruption which I tried to navigate around. I did so, not because of willing ignorance, since this is a subject of everyday news, but because I considered it could limit my analysis and even my accessibility to the people I wanted to talk to. Despite my caution about the corruption and 'culture' issue (more in chapter five) these topics did affect the implementation of CS. My approach proved useful in other ways as it made some challenges visible without me having the need to bring them into discussion. Now I will turn to the moments when the policy regimes worked together -or not- mostly by drawing on fieldwork and participatory approach I implemented. This section further demonstrates how the policy regimes are forced together.

4.3.2 When climate takes the back seat.

The complex food system has already produced several food crises as the one in 2008 (Clapp & Cohen, 2009). However, the Guatemalan agricultural system as seen in chapter one has internalized the modern agrarian food system relying on inputs and international food prices for exportation. When the international organizations and SESAN address food insecurity and acknowledge the weather and climate change they also try to relate the climate data with the data they produce.

In this sense, the SMC and some LTACs detected threats that were going to affect the current planting season. This was mainly the increase in the fertilizing prices that went from Q250,00 to Q450,00¹⁹ per *quintal*²⁰, a 180% within the span of one year. Some of alternatives that farmers would use to tackle this issue include applying 100% of the solution of fertilizer until they run out of fertilizer, leaving a considerable portion of the plot unfertilized²¹. Others have planned on diluting the fertilizer and apply the full extent of their plot, this second action meant having poorly fertilized crops and the risk of producing poorer yields.

This problem monopolized the discussion as SESAN, and the other institutions knew that this would result in an increase in the number of families becoming food insecure in the upcoming months. This increase was corroborated months later in the newspaper that I read every day throughout my fieldwork. Figure 35 points out that 4,6 million Guatemalans are at risk of becoming food insecure. The article claims that the combination of factors like COVID-19, the invasion of Ukraine and the labor market has a direct effect in Guatemala's food security.

¹⁹ On average throughout 2022, 1 US\$ equals 7,74Q. The fertilizer price was raised from 32,33 US\$ to 58,19 US\$

²⁰ 1 *quintal* equals 100Lbs.

²¹ This is one mechanism for coping with input prices. In other circumstances people will skip meals to save money for fertilizers (see, Beveridge et al., 2019)



Figure 35. The title read: Study alerts that 4,6 million Guatemalans are in risk of food insecurity. Source: El Periódico, July 2022

Crop yields in this year are threatened despite the fact that INSIVUMEH had projected a regular rainfall throughout the year in most of the country. The international organizations would also avoid falling into political discussions because, as SESAN's official later told me that, this organization in particular needed the minister's approval to work in Guatemala. I was lucky to witness how the international organization's employees had to navigate and respectfully ask for the permit to be updated. At that moment, I had not understood what was happening in the meeting, but later it was cleared by SESAN's official. In this case, since MAGA officials were new in their jobs, they did not know the bureaucratic process. The explanation went like this:

"If you noticed, there was a kind of discomfort there, because FEWSNET works with projects and the validity of their project had finished so there is an interruption [of projects]. There is an agreement letter that regulates the functioning of the technical workshop. So, they [FEWSNET] are requesting an addendum to be reincorporated to the workshop, but this has come out late due to the changes [in MAGA], so the people do not know the process and are asking what is expected to be done, it is an administrative issue..." (SESAN's official, Guatemala City, 2022. My own translation)

Social and political discussions were manifested at a local level in the LTAC or through private interviews. Although some of the issues related with agriculture input prices had already been hinted out at a national scale in the SMC, the LTAC did provide several other points of discussion. The local scale and discussions with crop advisors materialize the disparities of the policy regimes and the struggles with scales. Regarding scales, the challenge was mostly tackled by a forced discourse and consensus whereby all the participants produced technical advice with applicable activities. The final bulletin product had anonymity, and photographs of the participants of the meetings were shared internally.

However, besides scales, the policy regimes merged through force. In what one would believe was to be purely technical, the LTAC had crop advisors complaining from structural and profound problems. Vital to this analysis were the LTAC I was part of. During the elaboration of the agroclimatic bulletins, the conversation took unexpected paths that did shed light on the incommensurabilities between policy regimes. For instance, the crop advisors asked the CS advocate to invite the renown and private research institution ICC for future meetings. This institution is well regarded by INSIVUMEH because they share their meteorological data with them and have become an important collaborator. Yet they are also known for providing their service to the sugar cane companies. As the crop advisors complained, *cañeros* (sugarcane farmers) do not follow the few existing laws that regulate their practice. They burn their crops without considering wind direction thus affecting the communities nearby. The airplanes used to apply pesticides do not fly at the agreed altitude and now beekeepers are struggling with the production of honey as bees are continually dying, additionally, family gardens no longer produce food for self-consumption. Finally, monoculture farms are the ones that alter the flow or dam the rivers with no consideration for the communities downstream. Amidst jokes and criticism, the CS advocates had to guide the conversation and laugh away the complaints. To put an end to this discussion, one crop advisor advised his colleague to lay low because raising his voice could get him into trouble – which was another way of saying he could get hurt or killed-. In turn, the crop advisor agreed and said he would like more support from Central MAGA, in front of MAGA's representative. This closing complaint resonated with the janitor's comment I mention in chapter five. This discussion was not violent in any way. Humor in the form of sarcasm and irony was much used by crop advisors to alleviate the harsh criticism their messages carried.

Other discussion involved the provision of agricultural stipends. Handing out stipends has become a form of economic relief that is given to families that have been affected by climate hazards. Due to previous corruption scandals, they are not well regarded by some and have now become a long and strenuous administrative process. As a newly hired MAGA official said, Hurricane Eta and Iota stipends were given two years later when people no longer needed them. In the case of the SMC discussion on stipends, the organizations and SESAN asked MAGA to explain how and when the economic alleviation would take place. Although everyone agreed that the increase of fertilizer and the food prices in April would have direct effect on the upcoming months, MAGA's stipends were to be given in September or October.

The feeling of constraints and impotency were felt not only with international organizations and SESAN's officials but also with CS advocates. However, one way or the other, structural issues such as unequal access to land, lack of a national water law, or mechanisms for fast response were entirely outside CS realm of control and therefore negligible. In other words, the goal of generating locally relevant climate information can not allow 'strong questions' that challenge structural issues to progress the discussion towards an alternative food system (de Sousa Santos, 2015, 2018). These topics would challenge the *status quo* and most definitely relegate the relevance of the CS's information. In this sense, CS falls into a kind of development program that chases after the improvement of wellbeing but, as Tania Li (2007) states, tend to conceive the solutions as technical. This involves a series of practices that narrows down the problems to scales that are governable, with specific limits and visible boundaries. Li (2007) sees the practices of rendering technical, as a way of setting boundaries between the expert who is capable of analyzing the problem and providing answers and the those subjected to guidance. In this matter, whenever I posed a question regarding land tenure I was always diverted back to technical discussion:

"That [access to land] has nothing to do with the rich and poor gap because it is a structural situation that is not going to change, in Guatemala that [land distribution] is already settled and it is taboo, otherwise they would have approved the water law and the integrated rural development law." SESAN's official, Guatemala City 2023. My own translation.

The governmental official would avoid saying unequal land distribution, he advised me not to continue that path saying that "your hypothesis is not valid, [CS] do work, but we have to work on closing the gap regarding planification, mainly by strengthening the crop advisors" (SESAN's official, my translation), in other words, he insisted that I should hold my analysis on the practical level. Asking other types of questions would get me nowhere. In a way, he hinted that he chose the fights worth fighting for, mostly those that sought to improve rural development with reliable crop advisors.

4.3.3 Future needs vs current demands

Drawing from the scalar and policy regimes disparities, this section develops on the timescale differences that also emerge in practice. The premise of adapting CS to agricultural practices to guide decision-makers on food security also begins with time-related differences. For instance, CS are meant to answer specific agricultural questions that include:

- 1) When are the farmers expecting to prepare the soil?
- 2) When are the farmers expecting to harvest?
- 3) When are the farmers expecting the *canícula*?
- 4) When should the farmers apply fertilizers to improve our yields?

5) When can the farmers expect pests?

These questions are asked before any agricultural practice is done. In this sense, meteorologists are always running against time to provide information in a timely manner. However, SESAN and the international organizations are dealing with hunger throughout the year regardless of the season. They have set, as mentioned before, the seasonal hunger period to recognize people who will become temporarily hungry during the year and thus increase Guatemala's vulnerable population.

In other words, while CS focuses on future needs regarding potential droughts, floods, harvest season and so on, the others like SESAN and international organizations are discussing current demands of subsidy to prevent hunger from rising. Attending such demands, relies on governmental responsiveness, as well as consensus and comprehension of the Guatemalan context regarding food policies to tackle price input and agriculture risk among other factors. The nonexistent food security policies do not allow the governmental officials to have mechanisms to react and prevent the 'state of calamity' but only to measure and respond as 'firefighters' as a couple of governmental officials felt their work was.

This research in general argues that the disparities regarding time are inherent to the policy regimes and their epistemic differences. Furthermore, these differences do not prevent the CS to be deployed but generate uncalculated side-effects (Ferguson, 1993). However, it is observable, as Timothy Mitchell's (2002) work previously did, that conversation around food insecurity and CS maintains a certain type of discussion in which public health, malnutrition, and hunger, caused by poverty and landlessness were translated to be solved technically and become measurable as well.

4.4 Conclusion

Before setting out to do the fieldwork and even now, I continue to ask the question of why must CS become locally relevant? Why do the international organizations and the national meteorological institutions keep pushing forward the use of CS in local communities? As the title for this chapter hints, the discussion around CS' local relevance comes along with

politics of scale and disparities between policy regimes that overlap in indistinguishable ways. The implementation of CS at a local scale responds to political agendas that are reinforced by either a need to maintain institutional relevance or the limitations that the scientific community and policy regime carries. This chapter examined these disparities by evaluating how the CS for agriculture is deployed at every scale. Additionally, it has placed attention on the leading key actors of the discourse. The decision to limit the actors was to maintain a manageable size of information but also to prevent myself from losing focus. In this manner, these are the concluding remarks that can be drawn from fieldwork and participatory observation on scales and the policy regimes.

To begin with, it is important to understand that for institutions, the CS created in the LTACs 'are' locally relevant because micro-scale is used to frame issues, render the problems solvable, to generate collaboration, and to modify individual agricultural practices. As seen throughout this chapter, this results in an analysis that lacks depth because it does not consider potential disparities between the policy regimes at a micro-scale. Experience from the fieldwork in Guatemala showed that scales of operation are usually determined by logistical and political-administrative factors. These factors contrast with the technical discourse that meteorologist claim to have but was not always considered. For instance, the meteorologist insisted that there were too many LTAC in the country (a total of 19), while the CS advocate considered the increasing number of LTAC as a positive indicator of success because it generates collaboration. The increasing number of LTAC meant more institutions involved and therefore access to a wider population.

However, other actors like the experts who work in international organization said that on a personal level, they would rather use water sheds as criteria for informing, planning, and decision-making. Regardless of the desires and diverse opinions, the number of LTACs meant an extra workload for the meteorologist that had to travel throughout the country to personally deliver the information. When asked about the increasing workload, the meteorologist clearly stated that it was not only well received, but it also reinforced trust from the technicians and other actors involved in the LTACs. In other words, CS advocates talked about this experience with a degree of pride over what they had accomplished even during COVID-19 times.²²

Examining the scales at which CS are being deployed and discussed has mainly provided information to understand how CS are championed and discussed. What I mean to say is that depending on the scale of operation, CS allow certain debates to flourish at the expense of overshading others. The question is, do different scales of operation allow or deny certain discussions? If so, in what ways? As was seen throughout this chapter, at a regional scale, the forum's goal of providing a regional climate scenario for food security and water management through the Regional Committee for Hydrological Resources generated a series of commitments from the meteorological institutions and the ministries of agriculture. However, the response from these ministries of agriculture was uneven and did not always align with the forum's goal as some of them would provide advice for the main exportation crops. The three-hour long meeting did not allow the ministries of agriculture to provide in-depth information.

Scales also had certain effects on the participants. In an indirect way scales do affect and modify the participants' idea of whom the information was to be directed at. It also conditioned the ways and the thought process of coming up with new and different mechanisms to tackle the issues. For instance, the national scale allows a view of Guatemala's climate in a way that avoided local context limitations. In this manner, climate information was contextualized with other social data to generate wider and concrete action (e.g., agricultural insurance, stipends). These actions were meant to be operationalized by the minister and mid-level governmental officials. In other words, the decision-makers or users of the report generated on the national scale had a different intent and target population. On the contrary, on a local scale, the LTAC had crop advisors commenting on fertilizer prices, and the impact that monoculture activities had on the communities and

²²Two things to comment here. First, the Guatemalan State has a small state apparatus where the majority of its employees have temporal jobs. This forces the state officials to prove their worth to renew their temporal working contracts (more in chapter five). Second, as mentioned in chapter two, COVID-19 brought much disruption to Guatemala. The pandemic affected every sector of the population and although most governmental ministries slowed down their workloads, CS advocates did not. For instance, the public education was interrupted for almost two years as mentioned in El Periódico article entitled: *El anhelado retorno a las aulas* issued May 22nd, 2022. During this period, students did not have any access to education.

food security. These discussions, despite being of utmost importance, produced no results mainly because they did not reach top officials.

As scales zoomed in, food security as concept became blurred and displaced by a range of emerging concepts and issues. This phenomenon I have called conceptual dilution as I have used an analogy to the chemical solute that is absorbed by a larger solution until it becomes unrecognizable. In other words, the effects that CS were meant to have on food security along with the wider discourse lost traction as scales were localized.

On a regional scale, economic disparities among the national meteorological institutions were also evidenced by missing climate data among countries. Despite the difficulties of having well operated and maintained weather stations throughout Guatemala's country (due to the lack of personnel at INSIVUMEH) there was no discussion of the ways in which they could better distribute the weather stations throughout Central America to provide better information and tackle these economic constraints. Although climate data was integrated into the region, the decisions made by each meteorological institution remained independent.

Agreements regarding the concept of users among the advisors were unclear throughout scales and organizations. In this work, I have described this confusion or lack of agreement as a conceptual mutability. I argue that the conceptual mutability that includes producers, farmers, and peasants have uncalculated effects on the applicability and transferability of information, not only because they mean different things but because it intertwines with local and place-specific social injustice.

The main limitations for the CS applicability came from the disparities and incommensurability between the climate infrastructure and the food system. Climate remains important at each scale of analysis; however, each scale provided different perspectives that, if well managed, overlapped with data that each international organization provided to come up with better information and advice. Whether there exist poor climate data or not, the national scale did allow further data to be overlapped such as the The Normalized Difference Vegetation Index, the University Rafael Landívar's micro-

climate cartography or the soil taxonomy map. At a technical level, the climate information for local users, those located in specific *departamentos* and *municipios*, also suffered from a lack of trust and reliability as advisors also had to deal with a range of micro-climates, a variety of types of soil, and topography. Technical difficulties that CS advocates face at different scales also intertwine with the heterogeneity of actors involved in food security. In parallel to the technical and economic limitations, a lack of comprehension of the food system seemed noticeable. Mainly when CS advocates would champion organic fertilizers and soil management techniques without considering particular factors such as the lack of space or organic material to produce the amount of organic fertilizer required by the plot.

As I close this chapter, I am aware there are systems of oppression that I have not yet expanded upon. Capitalism and colonialisms are indeed embedded in these spaces, and they will be examined on chapter five. However, most of what has been discussed throughout this chapter has been done to challenge the way in which Guatemala is implementing the CSs for food security. It has done so by re-examining scales of operation and by taking into account the policy regimes of the food system and the climate infrastructure. Without these aspects, CS advocates and other actors cannot identify the subtle nuances of their practices. Chapter five will provide a different lens to analyze the same institutional level. As we will see, governmental officials learn to navigate in a capitalist and colonial system in which they are both victims, and replicators.

5 Climate coloniality, an exploration of the institutional dynamics in a colonial and neoliberal government

5.1 Introduction

The promise of delivering locally relevant CS to enable decision-making and improve farmers and peasants' livelihoods becomes trickier as scales shifts from macro -the Central American region- to micro scale - the municipal level-. Chapter four identified and explored some of the challenges met by CS advocates and other key participants at these mentioned scales. These challenges are relevant because they have usually been overshadowed by research that has focused on communicating CS (see chapter three) and examining the relations of power between modern climate knowledge and traditional knowledge. Although the analysis of chapter four identified new challenges regarding the ways in which scales affect CS implementation, there are some questions that are still worth asking. As I first explored the mechanisms and ways in which the CS discourse is produced, I was also curious to understand why CS advocates continue to build on the CS promise of improving small farmers and peasants' livelihoods. How and why are CS advocates drawn towards this belief? Who decides and builds upon this idea to continue the efforts of reaching small farmers and peasants?

Similar to previous chapters, the analysis done in chapter five draws from the empirical data gathered from the interviews with key actors and the meetings I participated in such as the National Crop Monitoring System and the LTACs. However, different from previous analysis, chapter five traces the discourse used by technicians, CS advocates, and government officials regarding the trust they have in the CS. This means identifying the arguments used by them, most of whom are technocrats, to push forward the CS. Equally important is to provide depth and context to this data. In this manner I had to situate these experts and their responses in a Guatemalan context and the food system. In other words, I had to have notions of Guatemala's socio-political context and be acquainted with its history, with the postcolonial studies, and food scholarship on climate-smart agriculture.

To address the questions above, this chapter explores how the implementation of CS in Guatemala aligns with global dynamics of climate coloniality. Climate coloniality was vital for this analysis as it refers to those projects of development conceived in the global North that are meant to generate adaptation to climate change yet become detrimental to minorities in the global North or wider communities in the global South. In other words, global concerns regarding climate change, agriculture and food insecurity create an environment of consensus between expert individuals and institutions that allows collaboration around the improvement of livelihoods, ideas of inclusion, vulgarization of knowledge and co-production of knowledge to reach users at community level. However, this consensus also conditions or neglects alternative views or discussions as well as the participants who might not share their views. It becomes a kind of ideology in which researchers and technocrats reproduce the discourse through their research practice (Fairclough, 2013).

In this chapter, climate coloniality is explored through notions of power/knowledge. I interpret this power as a hegemonic power that guides the discourse and shapes national decision-making. For instance, some Guatemalan government reports like the National Development Plan *Nuestra Guatemala* 2030 (Gobierno de Guatemala, 2014), or the ministerial strategic plans (Ministerio de Agricultura, 2016, 2021) are influenced by global trends of climate change mitigation and adaptation through techno-scientific solutions. These documents provide a guiding path for state officials to look after technical and modern alternatives of development. Furthermore, power can also manifest between individuals, as CS advocates come to teach about weather and inclusion, or between organizations, whereby leading institutions define a framework for the others to work with. In this case, power is exerted through the use of knowledge and creates an illusion of being a source of 'opportunities' for peasants and small farmers to improve their livelihoods.

Overall, climate coloniality provides a theoretical framework to organize thoughts as well as this chapter's content in general. It does so by examining the capitalist, colonial and patriarchal legacies that permeate the Guatemalan institutions involved in CS implementation. After providing a concrete definition of climate coloniality in the subsection below, this chapter is divided into three sections. Section one argues that CS is

an add-on of the green revolution. This means that implementing CS perpetuates the new green revolution by allowing and pushing forward conventional food security and technological agricultural practices. Therefore, establishing a link between CS and the green revolution enables a better understanding of the implication that CS has on food security. Section two follows the concept of climate coloniality by exploring how neoliberalism is embedded in the process of implementation of the CS in Guatemala, namely by exploring how neoliberalism makes possible the articulation between austerity, market-led solutions, and liberal ideal of individual improvement as a desired path of development. Finally, section three expands on the colonial legacies that the Guatemalan government carries. Doing research on development in Guatemala without taking into account colonialism risks reproducing certain colonial practices. In this case, the chapter examines how colonialism and institutional racism shapes local discourse regarding the creation of the 'other'. Drawing from participant observation, semi-structured interviews, grey literature, and other scholars' experiences in Guatemala, we can identify new challenges and understand how the CS advocates and other participants reinforce their trust in the CS as a tool capable of alleviating food insecurity, regardless of the effect that it could generate.

5.1.1 Climate coloniality

Drawing from Farhana Sultana's (2022) concept of climate coloniality, this research reflects on how the CS become an important tool to support ideas of climate change adaptation strategies through modernization. Although CS are deployed with the idea of ameliorating food insecurity in the countryside, the desire that the Guatemalan state has of becoming modern quickly overtakes the process. Modernity in Guatemala is achieved by promoting ideas of "market development", "technification", "innovation" and "individual improvement" (Ministerio de Agricultura, 2016, 2021). In this sense, Sultana mobilizes the concept of climate coloniality to criticize how the technocratic discourse -which echoes with the implementation of CS- coexists with capitalist and colonial practices. Aligned with her critique on COP 26, I will try to illustrate how the CS also generate "spaces [that] become spectacles, one of performance, that erases historical and spatial geopolitics and power relations" (Sultana, 2022, p. 2). In other words, the aim of improving the user's
livelihoods through communication, participation and women inclusion can have opposing effects that reduce the desired impacts and can generate unwanted outcomes.

In this sense, climate coloniality brings forward a framework to explain the role and effects that climate knowledge or CS programs within colonial, patriarchal, and capitalist systems have in rural development. As Sultana states, climate coloniality

is experienced through continued ecological degradations that are both overt and covert, episodic and creeping – e.g. pollution, toxic waste, mining, disasters, desertification, deforestation, land erosion, etc. – whereby global capitalism articulates with development and economic growth ideologies to reproduce various forms of colonial racial harms to entire countries in the Global South and communities of color in the Global North. Climate coloniality is perpetuated through global land and water grabs, REDD+ programs, neoliberal conservations projects, rare earth mineral mining, deforestation for growth, fossil fuel warfare, and new green revolutions for agriculture – which benefit a few while dispossessing larger numbers of historically- impoverished communities, often elsewhere. (Sultana, 2022, p. 4)

Implementing CS in rural Guatemala resonates with Sultana's concept of climate coloniality in various ways. However, this chapter also develops the concept of climate coloniality. Through a post-structural analysis, it shows how government officials and other key participants negotiate and navigate through numerous challenges met on the ground. Much like Lipsky's (1980) interest in how street level bureaucrats implement policies, in this chapter I demonstrate that government officials are subjected to, but also enablers of the structural systems of oppression, namely capitalism, patriarchy, and colonialism. This question matters because, to examine the middlemen involved in the collisions between the policy regimes and in the reproduction of climate coloniality, means that one must ask "In which building? In which bureau? Through which corridor is it accessible?" (Latour, 2005). With these questions, Bruno Latour challenges wider claims of systems, structures, and in this case, regimes. In other words, climate coloniality is helpful to explore these wider structural systems but could also gain from the exercise of asking where, how and who makes climate coloniality happen.

In the following sections I will show how CS reproduces climate coloniality. Questioning why CS advocates believe and push forward locally relevant CS matter for two reasons. First, it allows us to identify how the ideas of self-improvement and individual freedom for decision-making are an illusion considering covert and coercive power dynamics that manifest in the practice of deploying CS. Second, by identifying this illusion, we can challenge the ideas that modernist and development programs carry to further reflection and self-critique that CS advocates lack.

5.2 CS, an 'anticipated' add-on to the new green revolution for agriculture

In Guatemala, the conventional programs of development that contain ideas of modernizing its countryside persist. They have not left; they only changed or adapted to current times in which global concerns have focused on climate change and weather variability. In this fashion, CS have arrived in Guatemala with good timing because it is capable of pairing together wider issues with climate change with national and local challenges of food insecurity. As a result, the CS initiatives draw interest from several fronts and organizations because it is capable of engaging with these issues. What this means is that focusing on the implementation of CS offers technicians and state officials practical and short-term objectives (e.g., raise awareness, run workshops, teach about modern climate knowledge) that give them relevance and measurable success. Below, I will show how CS and climate change are paired with climate-smart agriculture to provide ostensibly new solutions and generate working opportunities.

In this sense, much like conservations projects, mining for alternative energies and REDD programs, CS respond to global concerns over the effects that climate change has over the world. In Guatemala, the impact that climate change and weather variability have had in the past years is also raising concern and demanding further action (Kreft et al., 2014). As a result, in 2019 the *Sistema Guatemalteco de Ciencias del Cambio Climático*²³ produced its first report on Guatemala's future climate scenario and the effects that climate change will have in many sectors including agriculture and food security. Elaborated by a multi-

²³ The Guatemalan Scientific System for Climate Change involved several researchers from Guatemalan Universities, technicians from Guatemalan Ministries, private NGO researchers and civil society.

disciplinary and inter-institutional committee the document emphasizes on the need to adapt to and mitigate climate change (Sistema Guatemalteco de Ciencias del Cambio Climático, 2019). In chapter six the document focuses on agriculture and food security and mentions that climate change offers an opportunity to develop alternative models for food production. One of the key ideas the chapter brings forth includes the expansion of agricultural insurance as a key component to protect farmers from the effects that climate variability has on their crops. However, it also identifies the economic constraints farmers face that even forces some families to interrupt their children's education, diminish the quality and quantity of food intake and migrate nationally or internationally in search of labor and income to compensate for the loss of their crops. In contrast to chapter six, the document's executive summary for decision-makers prioritizes technical solutions. The document's executive summary also mentions the need of supporting "climate-smart agriculture, organic agriculture, access to market, diversify crops, pest management, water and soil management and innovation" as key components to tackle climate change by adapting the agricultural practices (Sistema Guatemalteco de Ciencias del Cambio Climático, 2019, p. 9).

Climate-smart agriculture resembles conventional agricultural practices because it usually involves modernizing the countryside through specific agricultural practices (Sain et al., 2017). This approach usually neglects alternative agriculture practices. The idea that lingers from this document is that Guatemalan academia and the private research institutions should provide their expertise and align with the Guatemalan State's ideas of development and modernity. Accordingly, MAGA's Institutional Strategic Plan of 2021 mission is to:

...foment an integral rural development through transformation and modernization of the agricultural, forest and hydrobiological sector, developing productive, organizational, and commercial capacities to achieve food security and food sovereignty, and competitiveness with clear norms and regulations for product management in the national and international market, all in guarantee of natural resource sustainability²⁴ (Ministerio de Agricultura, 2016, p. 59. My translation)

As the reader can see, the priority for MAGA is not only to allow or facilitate, but to actively push forward any change that can substitute any form of non-modern agricultural practice. This first statement sets the pace for the institution's interest and programs they support which, in broad terms, includes anything that is considered modern. The statement is followed by a couple of contradictions. On the one hand, it mobilizes the concepts of food security and food sovereignty into seemingly one category, an idea with which both academia and activists would disagree with (Boyer, 2010; Clapp, 2014; Declaración de Atitlán Consulta de Los Pueblos Indígenas Sobre El Derecho a La Alimentación: Una Consulta Global, 2002; Holt-Giménez, 2011; Wittman, 2009). On the other hand, words like "commercial capacities", "competitiveness", and "market" are all better aligned with the conventional Guatemalan food system than with any idea of food sovereignty and arguably with food security. Finally, MAGA's mission closes its statement with its compromise to pursue environmental sustainability. This statement is also aligned with Guatemala's National Development Plan K'atun 2032 (Gobierno de Guatemala, 2014) which has direct influence from the UN's sustainable development goals.

Reading through Guatemala's institutional reports it is visible that there is a compromise with building resilience and adaptation to climate change, something that is difficult to criticize. Therefore, it becomes difficult to criticize such initiatives without proposing any viable alternative mainly because it would be regarded as 'unproductive' critique to the good cause of protecting the most vulnerable. However, projects that aim at improving livelihoods and vulnerability are not absent of critique. In her work in Canada, Emilie Cameron (2011) raises awareness of projects that focus on vulnerability by either 1) incorporating traditional knowledge with Western knowledge, or 2) those projects that engage indigenous communities in the process of understanding climate change, vulnerability, and adaptation. In common, these projects do not take into account

²⁴ Misión: Somos una Institución del Estado, que fomenta el desarrollo rural integral a través de la transformación y modernización del sector agropecuario, forestal e hidrobiológico, desarrollando capacidades productivas, organizativas y comerciales para lograr la seguridad y soberanía alimentaria y competitividad con normas y regulaciones claras para el manejo de productos en el mercado nacional e internacional, garantizando la sostenibilidad de los recursos naturales.

colonialism as a "historical and contemporary process" that can deliver "profound consequences" (Cameron, 2011, p. 104). As this chapter has developed, CS initiatives mostly resonate with the second approach in which vulnerable communities are educated on certain subjects while neglecting wider colonial processes. Furthermore, similar to the CS initiatives, literature and reports sustain a discourse in which indigenous knowledge remains traditional and 'local'.

Cameron warns of the importance of active reflection on colonial and political context that shape projects of adaptation and resilience. In this sense, it is worth considering how CS advocates fall into these dynamics that allow well intentioned initiatives to reproduce unwanted colonial discourse. For instance, when CS advocates argue that the use of CS is beneficial to the most vulnerable communities because CS initiatives in Guatemala intertwines with climate-smart agriculture that is tailored to local practices. Climate-smart agriculture is already problematic because it can potentially depoliticized and dehumanize the issue and, as any green revolution demands a generous economic support from the government to back the programs (Fischer, 2016; Fischer & Hajdu, 2015). As an interview with a CS advocate shows, the search for potential solutions in the technical realm tends to neglect wider social issues as well as immediate food demand. In this sense, in parallel to the goal of providing climate scenarios for decision making, boundary organizations like CIAT also have other long-term goals. When I asked about the technical challenges of delivering CS to the users, CIAT's technician, acknowledged in spite of a "lack of digital integration for this to happen [in reference to CS implementation], we manage to make local information get centralized" they later added:

so I think that digital integration is something we need to work on, and its something we have pushed forward from CIAT to make it come true at least in some pilot tests and then extend it. It is something we will continue to work on, we have the initiative for the upcoming three years and we are going to begin with institutions that have better quality of data and then we will move on towards the ministry of agriculture to see how they can provide data that can help us improve the agroclimatic advice in the LTAC, those are some aspects we look forward into the future. (CIAT employee, Guatemala City, 2022. My own translation) In this sense, under the CS initiative, CIAT also has long-term objectives in which climatesmart agriculture becomes the means to improve resilience and food security. The lack of digital integration sets new paths and opportunities for services to be provided. It also shows temporal disparities between longer term goals that contrast with immediate necessities of lack of economic resources to buy inputs, access to water and land. However, this discourse is reinforced by MAGA's Institutional Strategic Plan 2021-2026 because it supports their goal of

providing information on the market to the producers through the creation, implementation and maintenance of an informatic platform that allows to know the situation of the national, regional and international market with the goal of helping the producer to make better decisions and plan their agricultural production (My translation, Ministerio de Agricultura, 2016, p. 123).

Whether it is CS, climate-smart agriculture or digital integration for small farmers and peasants, these initiatives aim at modernizing the countryside. They are initiatives deployed by international organizations, governmental Ministries, and some branches in academia. Overall, the ideal of modernizing the countryside serves as an umbrella of possibilities in which power also creates opportunities (Crampton & Elden, 2007). In this sense, national academia collaborates with international organizations to develop numerous projects.

On other scales, the UN's sustainable development goals are taken into account by the Government's National Plan. In this sense the Central American National universities and academia also work with the European Copernicus²⁵ program. Pushing forward innovation, technical solutions are pursued through scientific contests like the one The Universidad Rafael Landívar had in 2022. This Central American University contest called HACKATON Copernicus Central America 2022 focused in using climate information and satellite data for students to innovate new uses. In parallel, new courses

²⁵ Copernicus is the European program coordinated by the European Commission. The program uses global data from satellites and weather stations to provide information for service providers. The services are open access and free.

like the diploma on climate science and climate services²⁶ are being offered by the Universidad Rafael Landívar in coordination with the private research institution ICC (Figure 36). In the affiche below, the course offers future students basic training in climate and climate services to be used for disaster risk reduction and crop advisory. As mentioned in chapter two, all of these side-programs are CS-related and make the process of researching CS complex as it inundates the environment whether that is in academia, humanitarian, or governmental planning.



Figure 36. Private course of CS. Source ICC at: https://icc.org.gt/es/diplomado-en-ciencias-del-clima-y-serviciosclimaticos/

Sultana's work on climate coloniality warns that if these initiatives neglect the social structural inequalities, they risk reinforcing ongoing and highly exploitative colonial and capitalist relations. Arguably, global concerns of climate change carry a Gramscian kind of hegemony which combines "coercion and active consent, to bring others into line with [particular] objectives" (Agnew, 2005. p. 446). In other words, the repetition of an idea

²⁶ The diplomat includes three modules: 1. Basis of climate and climate services, 2. Climate risk management in crop advising, and 3. Agroclimatic early warning system.

that seems to benefit everyone, is but beneficial to the Elites because it hides structural issues by guiding the conversation away from them.

Overall, we can observe the coordination and consensus that government, academia, and international organizations have around the need to modernize agricultural practices and teach Guatemalan society about climate change. Going against these initiatives or questioning their reach means closing away opportunities to collaborate with others. What the following sections will show is that the mechanisms of implementing CS carry mechanisms of coercion by separating those who use CS and become modern from those who resist it. In other words, resisting modernity has two effects, first, it reinforces prejudice -e.g., the idea that farmers have a stubborn culture- and second, it becomes coercive by denying farmers and peasants from acquiring governmental stipends when they do not follow certain farming practices.

5.3 Neoliberalism, from material dearth and the individual 'will to improve'

Climate coloniality also considers how "capitalism articulates with development and economic growth ideologies" (Sultana, 2022. p. 4). CS in Guatemala need to be situated in the legacy of a 36-year long conflict that only ended with the Peace Accord in 1996. However, the Peace Accord also left most of Guatemala's population neglected. Linda Green (2011) states that the Peace Accord was "an arrangement between the business elite, the military, and the leaders of the guerrilla group" p. 371²⁷. As a result, peace brought together two new instruments of violence against the poor -a majority of whom are Mayan communities-, impunity and free-market capitalism through neoliberal policies that favors the transnational elite (Green, 2011; Velásquez Nimatuj, 2016). The counterinsurgency tactics from the Civil war that actively aimed at undermining trust and creating divisions also left the rural Guatemala divided and in cases complicit in human rights violation.

²⁷ Furthermore, Joras (2007) discusses how the economic costs that private companies had during the Civil War is a reflection of the alliance between the private sector and the military and of the private sector's opposition to the peace process. Overall, the private sector was not harshly affected by the Civil War, "the cumulative loss as to GDP in Guatemala for the period from 1965 to 1990 was only 9.9 percent. In El Salvador and Nicaragua, in comparison, losses accumulated to 38.1 percent and 113.4 percent, respectively" (Joras, 2007).

During the post-War period, the elite and the government collaborate and coincide in their aim to achieve modernity. In this fashion, the country implemented a neoliberal approach that brought: "new forms of political-economic governance premised on the extension of market relationships" (Larner, 2000, p. 5). In his work in Guatemala, Charles Hale defines neoliberalism more precisely as:

a cluster of policies driven by the logic of transnational capitalism: unfettered world markets for goods and capital; pared down state responsibilities for social welfare of its citizens; opposition to conflictive and inefficient collective entitlement, epitomized by labour rights; resolution of social problems through the application of quasi-market principles revolving around the primacy of the individual, such as assessment based on individual merit, emphasis on individual responsibility and the exercise of individual choice (Hale, 2002, p. 486)

Considering Hale's definition of neoliberalism, three aspects are important to highlight in this work, austerity, the primacy of the individual, and the market-oriented solutions. Neoliberalism is a key characteristic that fits into the process of implementing CS. Regarding the efforts to produce locally relevant CS, we can argue that it aligns with the idea that change, and improvement can only come from individual efforts. In other words, CS initiatives coincide with Hale's neoliberalism in the sense that CS cannot be understood as a solution for communities nor can it focus on developing communal solutions. Therefore, national-scale solutions are not explored by CS advocates. In the following subsections and drawing from Hale's notion of neoliberalism and Sultana's climate coloniality, we will see how caring for oneself amidst austerity and material dearth is possible under the promise of improving our livelihoods through individual merit.

5.3.1 Climate Services and austerity

The "pared down state responsibilities" that Hale mentions began in Guatemala in the 1990s and it is visible in the economic constraints that MAGA and INSIVUMEH deal with. Economic limitations are acknowledged in MAGA's last two Institutional Strategic Plans. Material dearth affects MAGA's access to vehicles, computers, physical space to store archives, and documents, all of which are identified as institutional weaknesses that undermine their ministerial mission (Ministerio de Agricultura, 2016, 2021). In a day-to-

day practice, this translated to collaboration by carpooling between INSIVUMEH's and MAGA's officials -with whom I shared vehicles to go to the LTACs-. In other words, carpooling responds to the lack of vehicles and need of transportation and not to environmental consciousness.

In addition to material dearth, more personnel are also needed for the institutions to provide their expected services. In this sense, as mentioned in chapter three, the LTACs also offered the possibility of reaching potential citizens interested in providing support for INSIVUMEH's weather stations as there is a lack of personnel.

Regarding the access to budget and austerity, some interviewees from either other governmental institutions or academia were more critical towards MAGA's organizational capacities. They would argue that there was no lack of resources but corruption and lack of political will from high officials and ministers. However, from within MAGA, crop advisors did complain that they needed proper computers to work with and that they had to use their personal phones to access and share the CS. For instance, in Escuintla, the regional manager of Escuintla's crop advisor complaint that his team had no functioning computers and asked the delegates from the Capital city about the administrative process to ask for IT support. Whether if funding is a limiting factor or not, Figure 37 below shows how the budget destined for MAGA has remained unchanged despite general growth of the National budget. By 2021, MAGA's budget represented 1,74% of Guatemala's national budget. Despite major compromises, mounting demands, and new promises found in MAGA's strategic plans or the National Development Plan K'atun 2032, the allocated budget for the Ministry has remained unchanged. This figure is striking when one considers that nearly half of Guatemala's population live in the rural areas and that 4,8 million people rely on agriculture for subsistence.



Figure 37. In blue: Guatemala's national budget, the red line refers to the budged assigned to MAGA. Source: MAGA's Institutional Strategic Plan 2016-2021 p. 27

Furthermore, Figure 38 also shows that the budget is never fully utilized. For instance, in 2020, only 70,72% of the budget was used. Although this was the first year of the pandemic, it is also true that corruption scandals have also created a culture in which spending State money is not well regarded. There are several mechanisms created to audit and track spendings which makes the process less efficient. As a result, one of MAGA's officials told me that providing supplies to victims of Hurricanes Eto and Iota of 2020 took from several months to a year to arrive. Despite these controls, the former president Otto Perez Molina -and former military of the Civil war during the 1980, who was also in charge of violent military operations- was sent to prison not for human rights abuse but for corruption. In this same manner, INSIVUMEH's director became a fugitive after being investigated about buying overpriced equipment.

In this regard, the state of continued economic auditing generates a culture in which low tier officials need to "tighten their belts" and deliver results as a way of showing commitment and compromise. A different example was given by one MAGA official who explained that the aid relief (e.g., foodstuff, medicine, or money) destined to the families affected by the Hurricanes Eta and Iota in 2020 did not reach them until a couple of years later, the reason being an inefficient system made to prevent theft. Therefore, the already meagre budget that MAGA receives has never been fully used in the past five years.

Ejercición Fiscal	Presupuesto General de Ingresos y Egresos del Estado	Presupuesto del Ministerio de Agricultura, Ganaderia y Alimentación			% de Participación en el Presupuesto General de
	Vigente	Vigente	Ejecutado	% de Ejecución	Ingresos y Egresos del Estado
2016	Q 71,347,027,013.00	Q 1,251,888,172.00	Q 1,036,077,574.60	82.76%	1.75%
2017	Q 77,622,573,371.88	Q 1,594,801,224.00	Q 1,478,498,080.82	92.71%	2.05%
2018	Q 78,391,493,135.44	Q 1,482,765,022.00	Q 1,404,713,629.77	94.74%	1.89%
2019	Q 88,327,546,213.00	Q 1,470,374,785.00	Q 1,308,309,352.24	88.98%	1.66%
2020	Q 107,760,721,039.00	Q 1,587,098,204.00	Q 1,122,415,902.14	70.72%	1.47%
TOTAL	Q 423,449,360,772.32	Q 7,386,927,407.00	Q 6,350,014,539.57	85.96%	1.74%

Fuente: Elaboración Propia con Información del Sistema de Contabilidad Integrada -SICOIN-

Figure 38. Budget assignation and spendings for MAGA between 2016 and 2020. On top we can read: the year, the national budget, MAGA's assigned budget, the amount used from the assigned budget, the % used according to the assigned budget, and the % used according to the national budget. Source: MAGA, 2021. p. 145

As I did research on how CS was being implemented in the countryside, I felt a harsh contrast between our conversations with CS advocates regarding digital integration for climate-smart agriculture and the use of modern CS with the facilities from where these ideas were being pushed forward. Despite general arguments that CS are for anyone who is interested in climate knowledge outside the Capital city, the facilities made evident the lack of resources and state of abandonment in which they are. The experience of travelling to the MAGA offices in Escuintla that is located 61km away from the Capital city to participate in the LTAC shows evidence of this. Once there, the janitor who had worked for years in central MAGA and had to travel on a daily basis from the *departamento*, mentioned how grateful and happy she was to see us (central MAGA delegates) come from the Capital city to visit and "not forget about us".

We can see what the janitor meant in the following images taken in MAGA-Escuintla where we held the LTAC meetings. Escuintla is a coastal city on the Pacific coast; therefore, its tropical climate has an average temperature of 30°C. In the month of June when I visited, the average high reaches 33°C. Although the meeting began early in the

morning, by 10am the heat had already risen. Some participants became sleepy due to this heat and lack of A/C or fans (see images of Figure 39 and Figure 40). The CS advocates used PowerPoint presentation however the room was not well prepared and the curtainless windows allowed too much sunlight to come in. As a result, the crop advisors had to make an extra effort to see the presentation as the brightness of the projector was insufficient. The image in Figure 41 shows a wet floor that had recently been washed and an improvised electric extension cord. The power cord ended in a metal disc which I thought was dangerous to operate.



Figure 39. MAGA's facility for the LTAC meeting in Escuintla Source: Bellanger, H., 2022



Figure 40. MAGA's facility for the LTAC meeting in Escuintla Source: Bellanger, H., 2022



Figure 41. Modern climate knowledge for MAGA. Source: Bellanger, H., 2022

Amidst the modernist talks of digital integration and modern climate knowledge with key actors in Guatemala City, the lack of economic resources that MAGA faces is striking. Whether there is corruption, lack of organizational capacities or material dearth, the austerity of neoliberalism manages to undermine these constraints with the idea of individual improvement. With this in mind, the next section will discuss how the CS initiative does benefit from the neoliberal idea of individual improvement to gain supporters while ignoring the economic constraints.

5.3.2 The individual improvement and transfer of responsibilities

As mentioned above, material dearth is not the only issue of concern. Decision-making and individual responsibility, as neoliberal traits, are also embedded in CS. For instance, the meteorologist was aware of his share of responsibility when deciding which climate model was best fitted to Guatemala. Decisions to move around the few weather stations INSIVUMEH to improve the data is also part of his job. After making his decision on which climate model he would use to produce the climate scenarios and communicate to the wider community, the meteorologist had to participate in almost every meeting (those mentioned in the previous chapters) to present the results to the agronomists and agricultural technicians for them to produce agroclimatic advice tailored for the region. Crop advisors were also pressed to give advice based on the agroclimatic bulletins. In this sense, the thread of responsibilities climbed down through various levels of government official until finally and ultimately reaching peasants and farmers at the bottom. Under this logic, the small farmers and peasants were then made responsible for either making use of this information to improve their livelihoods or choosing to disregard it. This logic of transferring responsibilities becomes problematic as it reinforces the idea that peasants can overcome structural issues, infrastructural deficiencies, and social inequalities only with a bit of 'modern' knowledge. Furthermore, the CS initiatives do not contemplate any response to potential mistakes their CS advice could have. Similar to what Sophie Haines (2019) documented in Belize, some crop advisors were reticent to provide advice based on the CS because they did not want to give erroneous information and carry the responsibility of affecting families that already lived in vulnerable conditions.

While participating in the LTACs, I kept asking myself how the CS advocates managed to believe that the CS and modern climate knowledge could compensate for social inequality. Whereas one state official would directly tell me that the agroclimatic bulletins do work, a private conversation I had during lunchtime became an eye opener. This happened after the heated discussion of the meeting we had in Escuintla. In this conversation, the CS advocates would acknowledge that social inequality would prove to be too challenging for their capabilities. After manifesting their frustrations and thoughts about Guatemalan struggles, I understood that their feelings of impotence were shared by all the colleagues.

However, they would cope with these feelings of frustration by either supporting each other by vocalizing that each was doing their best with what was possible and by overworking or stretching the budget to make the project work. In parallel to this intimate moment where CS advocate would exteriorize their thoughts and concerns with the current state of corruption and inequality that Guatemalan has, there is also an 'official' or widespread explanation of why programs like the CS initiative can improve livelihoods. This reason has been developed and become embedded in society through the implementation of several programs of development in the past century in parallel with the role that Pentecostal religion has played in sacralizing desires of prosperity of middle class (Rocha, 2020). In other words, the middle class plays an important role in reproducing the hegemonic ideology of self-improvement that has been reproduced and transferred to rural Guatemala.

In Guatemala, throughout the Civil War and after the peace accords individual improvement through knowledge has been operationalized through numerous development programs. In other words, mechanisms of improving or changing the Guatemalans' practices are not new to CS initiatives. Individual improvement has long been deployed through capacitaciones. Nicolas Copeland (2019) mentions capacity building or *capacidad*, as the characteristic that development programs sought to incorporate into the people. This is an individual capacity development that undermines the community. He states that *capacidad* is a "blanket term" that refers to an individual capacity that involves knowledge and skill building by incorporating NGO's teachings, regardless of if the person has completed high school education. Over a long term, only a minority manages to become *capacitado* and learn how to navigate state institutions to their benefit and to the detriment of alternative organizations and communal improvement. Overall, we find particular characteristics that distinguishes the *capacitado* from the none *capacitado* because the latter has less Spanish skills, no image-managing practices and does not engage in long term calculations²⁸. I found it troubling that transferring responsibilities could potentially be harmful because it feeds on the idea that the poor and hungry are poor

²⁸ I disagree with the idea that peasants and farmers do not engage with long term calculations. This has been well argued by the historian Yuval Noah Harari's work (2014), other academics argue that peasants are risk averse.

because they do not make the best decisions or because they are unwilling to listen and learn. As one of my interviewees declared, "even if we reach small farmers, they are not going to change just because the PhD tells them to", they will keep their practices.

Overall, there is the idea that the *nocapacitados* are not developing or stubborn. Despite evidence that Maya communities like Achí people are interested in incorporating new ideas to their practices to work in synergy with their traditional knowledge (Einbinder et al., 2022). These categorizations carry a sense of guilt and responsibility that is transferred to the small farmers. The Institutional Strategic Plan 2021-2026, unlike its predecessor, even mobilizes FAO's literature to argue that agriculture is responsible for large quantities of greenhouse gas emissions due to deforestation and malpractice. Other scientific literature is used to address issues of soil erosion and poor water infiltration to argue for the implementation of modern and desirable practices against the inefficient ones that are currently being used by small farmers. The report continues to elaborate on their concern with sustainable development by mobilizing key words that include "improving, technify, diversify, and transfer technology". These statements materialize in programs of soil conservation and soil management programs that become compulsory for farmers to receive stipends – that usually arrive as late as October when planting seasons is over, and the first harvesting season has already ended -. In this context, technicians and crop advisors do not want to risk becoming a nocapacitado and thus perpetuate the demand of technical solutions such as what modern climate knowledge offers. In the Capital city, students and other low-tier officials take university courses on CS to improve their chances of prosperity and entrepreneurship like those championed by Copernicus with the Central American universities. Individual improvement is therefore embedded in wider ideologies of liberal progress and colonialism that sets the person apart from the traditional and communal.

5.3.3 Climate Services in a market-oriented context

CS advocates always made it clear to me that CS would never become private. CIAT official told me that "INSIVUMEH made it clear from the beginning that the information provided would be public" and that the LTAC "do not receive funding, it is not an

institution but an agreement among institutions". This affirmation does not however ensure that the information can be used with other political interests or certain particular groups. Specifically in Guatemala's free-market capitalism context in which agriculture policy focuses on crop exportations. The question here is more about how CS embodies neoliberalism.

Neoliberal Guatemala drew experience of controlling the public and private lives from the military state (Schirmer, 2010) into that of the laborers. For instance, sugarcane plantations through the Center for Corporate Responsibility have shaped "economic policy and create a new ideological consensus, a vision of a future of 'enlightened' – and unchallenged – elite rule" (Oglesby, 2013, p. 146). This new model of development has reduced labor contracts from six to four months, along with cuts to health care, severance pay, and retirement benefits for the wage workers. It has also improved productivity during harvest through subtle improvements of the laborer's wellbeing by incorporating meat and chicken to the diet but also applying statistical and numerical analysis to each wage worker and improve the efficiency (e.g., adapting the weight of the *machete* or training on the most efficient movement to cut sugarcane) (Oglesby, 2013).

In light of what I have mention above, one of the concerns I raise with CS is if it could also allow the private sector to use CS for projection on working demand and elaborate precise temporal working contracts to their increase profits. In other words, could CS increase the gap between the rich and poor by delivering higher quality of data in the regions where big monoculture farms are operating than in those located in the corners of the country -most of which have poor access to transportation and communication- (I discussed the gap between LTACs with private participation than those with no private participation in chapter three). In Guatemala the LTAC are independent from one another and thus have different levels of engagement. Therefore, the LTAC located on the Pacific Coast which also benefits from private collaboration from the ICC that works alongside sugarcane companies could potentially provide CS data that allows decision-making regarding labor management. Another example is the LTAC-*Centro* whose collaborator ANACAFE provides them with 15 extra weather stations. In the current state, the CS could potentially offer better information to conventional monoculture farming. Currently, what CS do address is the need to diversify crops and introduce hybrids varieties to adapt to climate change. These characteristics are akin to market-oriented solutions. Correspondingly, the LTACs that have ANACAFE functioning as a boundary organization thus emphasize coffee production. Ironically, coffee is still regarded as a cash crop for improving livelihoods (FAO, IFAD, et al., 2018). Recently, it has been argued that coffee production also creates conditions for food insecurity as peasants are sometimes "prioritizing fertilizer for coffee production over access to a sufficient diet during a 3-year investment, or time constraints from labour work limiting on-farm production" (Beveridge et al., 2019, p. 10). In the same research, it was identified that food security would also be related to droughts, sickness -which absorbs most of the household income to afford expensive medicine-, social marginalization, high start-up costs, migration, and lack of education opportunity. To keep up with coffee plant demands, Mariano Ponciano (Conde-Caballero, García-Arias, et al., 2021; J. L. García & Juárez, 2006) detailed how some peasants would skip meals as a mal-adaptation strategy to buy the fertilizers or other agricultural inputs. To further progress the analysis of CS in Guatemala, it is also necessary to discuss colonial legacies. Sultana's climate coloniality also provides a framework for this discussion however the next section will also draw on work done in Guatemala.

5.4 Colonialism

On this fourth section I address the concern that climate coloniality has with the ways in which growth ideologies mentioned above coalesce with colonial dynamics that "harm ... entire countries in the global South" (Sultana, 2022). In Guatemala, the project of modernization of the countryside to increase yields has been reinforced with a colonial and racist Guatemalan State (Cojtí, 1991) through the creation of the "otherness". Charles Hale states that terms like *indígena* are "best understood as historically constructed cultural-political perspective" (Hale, 1994, p. 11). In other words, it is a complex historical process of construction of identity. Regarding CS, the categorization that racialized sectors of Guatemalan society undergo matters because for the Elites and the Guatemalan State, western knowledge has always been desirable and superior to the traditional knowledge that these groups have. The discourse of development have always carried a colonial logic and an racist component (Guzmán Böckler & Herbert, 1970). During the civil war the

structural oppression of the Maya communities saw the implementation of new mechanism of control through violence and back by ideologies of development and superiority of the Elites.

In a context in which the governmental apparatus and social imaginary pursues western ways, mostly through enforcing behavior and war, CS become one of many desirable modern tools. Concretely, Guzmán Böckler and Herbert had pinned this motivation as an intellectual vassalage in which one desires modern western knowledge over the traditional indigenous one (1970). Higher education has also been criticized for securing the Elite's interests, perpetuating liberalism and individualism as well as producing a *burguesía de servidumbre*²⁹ (Böckler, 1969). In the implementation of CS, efforts of teaching farmers, peasants and Mayan descendants about modern climate knowledge is a continuation of Guzmán Böckler's critique. On the one hand, CS become the modern tool that will allow the food production sector to "keep up with modern climate challenges" as the CS advocate stated in the LTAC's introductions, on the other hand CS allows the middle-tier officials, and the CS advocates to believe that their efforts are worth working on.

In the following subsections, I will examine how the CS 'users' are continually categorized and recategorized according to different political motives. Unlike the previous chapter that talked about the heterogenous user as a mechanism to generate collaboration between institutions, this chapter sees categorization as a way of explaining the social challenge of reaching the users or the potential failure of CS initiatives. This categorization is reductionist in two ways. First, it is used to refer to a diverse sector that is later characterized under the expression of *es cultural* -its cultural-. Second, the idea of culture is used with no nuances. That is to say that culture and the 'cultural' becomes an allencompassing idea to englobes 'them', every nonmodern and stubborn Guatemalan in opposition to the institutions and other Guatemalans that are self-regarded as efficient,

²⁹ Bourgeoise of servitude refers to those Guatemalan who, unlike the agro-exporting bourgeoise which are landlords who inherited Spanish controlled land and privileges, decided to take sides with the liberal discourse. This decision was a consequence of the terror of being identified as communists during the Civil war period and/or under the promise of self-improvement.

modern, and outcome driven. Concretely, "culture" is a euphemism for indigenous and it is used with negative connotation.

Culture has been a slippery word in anthropology and geography as well. In the following subsection I will engage with the concept of culture. However, I acknowledge the role that 'culture' has in the imaginary of CS advocates, governmental officials, and foreign officials of other development programs. Although culture has been examined from an individualistic or group perspective, as James Duncan (1980, p. 198) argues: "culture defined as a superorganic entity is not only unconvincing as an explanatory variable, but impedes explanation by masking many problematic social, economic, and political relationships". In other words, I will reflect on how culture becomes the scapegoat to explain failure or to avoid complex social issues. In their views, traditional culture contrasts with the institutional culture that is regarded by the CS advocates and governmental reports as being "objective", "rational", "science-based" and outcome-driven.

5.4.1 For whom are we working for? Categorization and recategorization

In the new MAGA's Institutional Strategic Plan, peasants and farmers are strongly criticized and denigrated by expressing judgmental ideas of their practices and behaviors. In contrast with the preceding Institutional Strategic Plan, the current report provides a simplistic glossary with definition of several terms regarding the types of rural households. For instance, the Institutional Strategic Plan of 2016 - 2021 defines subsistence agriculture as a sector that "despite using part of its production for self-consumption, they contribute in rather atomized and globally in large to the national production of staples and other products for internal market" (Ministerio de Agricultura, 2016, p. 36). The report also acknowledges that subsistence producers do not have access to financial credit or technology and that they are partly responsible for advancing the agricultural frontier. In contrast, the Institutional Strategic Plan 2021-2026 is less concise in a definition that says that subsistence agriculture "produce staples for self-consumption in small plots of land, [and] they do not hire external labour" (ibid., p. 8). Later in the same document in p. 29 they mention that "the production is insufficient for the economic development of rural areas; they have a high impact on the degradation of natural resources". The Strategic Plan

of 2021 also repeatedly reminds the reader that subsistence producers are incapable of managing natural resources in sustainable ways. The message is charged with blame and lack of context allows the MAGA to build an argument for their work as teachers and service provider.

The effects of categorizing people for development programs have been well documented by Arturo Escobar (2012) on his work in Colombia. In Guatemala, this process of categorizing farmers into subsistence and infra subsistence producer is also coated with attributes that are given without context and become rather violent. For instance, the fact that unequal land distribution has around 190 000 households (over one million people) categorized in the group of infra subsistence and subsistence farmers (Ministerio de Agricultura, 2021), is rarely mentioned in comparison with other attributions that include, lack of education or knowledge to produce food in sustainable ways, or incapable of understanding the market.

It is worth mentioning that the process of categorization is not fixed as producers are also re-categorized into traditional and modern producers within the same document. Despite the previous established differences between infra subsistence, subsistence, surplus and commercial producers³⁰ MAGA decides to recategorize them into these two wider ideas which are not defined throughout the text. This recategorization also serves a purpose of having MAGA remain relevant and capable of working with its limited budget by producing numerous workshops on technification, sustainability, or legal requirements for commercial purposes. I will develop more on how MAGA's current programs align with those of the CS advocates.

Guatemala's food system, according to government reports, is only conceived through the production process. In other words, governmental institutions and food security actors are overly concerned with producing components and less so on consumption and distribution,

³⁰ SESAN targets subsistence and infra subsistence producers in their efforts to alleviate food insecurity because surplus and commercial producers are farmers who have access to national and international markets and make farming profitable.

despite the wide critique of the lack of roads between rural and urban centers³¹. Efforts are thus tailored towards small farmers' lack of knowledge about environmental sustainability, genetics to improve cattle and seeds, modern technology, the correct use of fertilizers and pesticides, and market behavior. I argue that climate change and CS are the last couple of subjects added to an informal curriculum imparted by MAGA's officials. Efforts to teach and prepare small farmers to make better decisions contrast with the critique the report makes regarding the farmers' capacities to collaborate and work collectively. The report says they have "the habit of working individually" (Ministerio de Agricultura, 2021, p. 52) and therefore Mayan communities cannot organize to produce quantities that are desirable for the supply chain.

5.4.2 Culture as scapegoat

Besides having a negative connation, the "culture" also works as a safe against potential failure that development project might face. When CS advocates deploy CS on the ground, they follow the 'step-by-step guidebook' from The World Meteorological Organization and the *Guía detallada sobre la implementación de las MTA, paso a paso*³². These handbook-like reports strongly suggest the incorporation of a gender inclusive perspective and traditional knowledge. In this section, I will discuss how the term "culture" is mobilized by CS advocates and state officials when they meet challenges that surpassed their possibilities of response. For CS advocates in Guatemala, this usually meant the inclusion of lunar cycles (see Figure 42), the incorporation of Mayan languages in the agroclimatic bulletins (not been done so far despite efforts), and the active participation of women at the LTAC.

³¹ One interview with an Academic mentioned the lack of road and transportation to the Guatemalan Highlands. He stated that the University Rafael Landívar had done research and designed projects to push forward the road development.

³² A guide that details how the Local Technical Agroclimatic Committees are to be developed and implemented. This guide was developed by the International Center for Tropical Agriculture, CIAT.



Figure 42. Use of lunar cycle in agroclimatic bulletins. Source: Agroclimatic Bulletin 09 to 13 May 2022

As seen through the fieldwork, the efforts on knowledge and gender inclusion were met with challenges, limitations and resistance from both CS advocates and users alike. For instance, crop advisors in Escuintla asked for lunar cycles information and the use of a 10day (decadía) framed forecast instead of regular 15-day time frame. In a friendly manner, the CS advocate curiously asked about the real use of lunar information. As an agronomist and fellow technician, he wanted to know if lunar information had real potential use. As a response, the person in charge of the crop advisor of Escuintla said that pests were influenced by lunar activity and that some plants would also behave differently according to the lunar cycle. After providing a response, he added with humor that lunar cycle is important for the plants regardless the fact that some people (indirectly referring to the CS advocate) viven en la luna, which is a Spanish expression that means that some people are clueless. Overall, the inclusion of the lunar cycle and the *decadia* are also a sort of spectacle that responds to a lack of capacity to include alternative knowledge in the CS initiatives. It also hints about how CS initiative also guides the conversation and focuses on modifying individual's habits. Overall, CS advocates and state bureaucrats are not capable of working with Maya communities nor do they engage with existing literature and experience that values traditional knowledge and preventive agroecological practices that already exist (Einbinder, 2020; Einbinder et al., 2022; Morales et al., 2001).

The incorporation of alternative knowledge responds to the need of creating CS products that are transferable to the users. Globally, it is also part of wider initiatives from the United Nations' Sustainable Development Goal (Gobierno de Guatemala, 2014), European programs like Euroclima+ (Euroclima+, 2019) or Copernicus Central America. This meant that any alteration of agricultural practices from the peasants and farmers was regarded as

successful CS transfer. One of the most palpable ways of measuring it was through the quantity of enhanced seed used. However, the reticence from the Mayan communities to incorporate such seeds was well known. Although looking for the reasons of such resistance is not the goal of this research, I went into the fieldwork knowing that corn is sacred for Mayan communities, but it also came to me from one young MAGA technician who reflected on the fact that Guatemalan officials and institutions were not always welcomed. They reminded me that the government that now seeks to assist peasants and Mayan communities had recently burned and destroyed many villages in the countryside in a 40-year civil war that ended in the 90s. In this regard, an academic from the university told me this institution had easier access to the people. This trust was built over time thanks to the Jesuit priest S.J. Ricardo Falla ³³ who "works a lot with communities. So, I believe that at a community level, in the countryside the people know we are Jesuits...it is a strength we have". His work on memory, social justice and documenting the civil war granted the university a better image than that of the government.

Regardless of these reflections, most governmental officials thought that the resistance posed by the communities to accept seed variety was a product of the people being culturally stubborn. Some, like CIAT's director and officials from international organizations like Famine Early Warning Systems Network told me that communities did not like the taste of other seeds. Communities are so precise with their preferences that communities from western highlands did not want the seeds from the eastern side, or that farmers will continue to plant in the same dates they have done so for centuries despite the agricultural calendar that the agroclimatic bulletin offers.

5.4.3 Culture and money

The international organizations projects and governmental initiatives materialize in projects of soil management, handing out agricultural inputs and food (Guatemala, 2010; Ministerio de Agricultura, 2016, 2021). These projects and approaches have changed with

³³ Ricardo Falla is a priest and anthropologist, founder of Institute of research and social projection. He has written several publications regarding the Civil war and resistance. His ethnographical work, developed under violent context, has served to document resistance and genocide inflicted by the military during the Civil War.

each Guatemalan government since Oscar Berger in the early 2000s to the former President and ex-military Otto Perez Molina (Rivero Jiménez et al., 2021). Each government also changed SESAN's name, powers, and way of working with other institutions. Part of the difficulties of implementing these initiatives was producing lasting effects and sustainable projects that could outlast fundings. Officials had experienced that most of the time, practices taught in the programs ended with the funding and that people would only participate if they were given money, food or other material goods. One of the concerns was to overcome the 'cultural issue' of asking for money. As a result, institutions were now only giving out small sums of money and government officials gave out incentives only to those who had put into practice soil management techniques throughout the year. Generally, the idea was that peasants and Mayan communities had developed a culture of asking for money before trying anything out. While some government officials stated that it was the government's populism to be blamed for this, most of the discussions and interviews agreed that it was the people that forced these situations. Others, like CIAT's official argue that:

Guatemala is one of the countries most affected by malnutrition and that has resulted in a lot of cooperation, but it has damaged the culture in some ways because it has now become a culture that is highly dependent on these programs. It is a culture that expects cooperation and others are not willing to do anything. ... for instance the World Food Program now gives them small amounts of cash in a symbolic way as these amounts of money will not cover their needs or *jornales*³⁴, but they are given a small amount of money when they change certain productive practices which at the end of the day will improve their livelihood... and once the project ends, these people are trained to keep on doing these practices and improving their nutrition. (CIAT's official, Guatemala City, 2022. My own translation).

In contrast, the Guatemalan academic viewed the government and the top-tier officials as those who had the practice of begging for donors and money. With much disappointment they mentioned how they had personally experienced this with a vice-minister. During Otto Perez Molina's presidential mandate, they told me:

³⁴ Jornal: is a day's work.

I had to present the project to the new minister who would not receive me because he had another meeting. He assigned the vice minister, and the vice minister told me the research and project seemed really good and so we (the University Rafael Landívar) should look for international funding to make it work. They washed their hands with us when we were presenting the study so they could invest in infrastructure. But they told us to look for money and to make the roads ourselves. (Academic, Guatemala City, 2022. My own translation)

According to the academic, the government institutions like MAGA did have enough economic resources to operate, but they did not put them to good use. They stated that political and personal interests along with endemic corruption were a serious threat to any project or initiative. These kinds of interventions were eye-opening in the sense that the modern discourse and the CS initiatives that align with it conceal the roles and responsibilities of higher up officials who enjoy a degree of anonymity. The blame on citizens by middle and low tier officials exempts high tier officials from being easily targeted or being accessible even when, as pointed by the academic, INSIVUMEH's former director was a fugitive from justice over charges of having bought overly priced equipment.

5.4.4 Culture and women

Inclusion of women in CS comes from the WMO in a top-down perspective. As seen in chapter four, it can be traced back to international reports in the use of language and image and it goes down until it reaches the "ground" and materializes in practices and speech. Nevertheless, experience showed that CS advocates and technicians had no practical mechanisms to generate change or incidence in women's wellbeing. In this sense, when it comes to women, CS advocates would consider female participation in the LTAC as a way of measuring their impact.

First, we make sure that agroclimatic information reaches men and women alike. We even try to design agroclimatic information that is specifically tailored for men or women. ... we understand the reality and context of the country is sexist, and that most of the government officials, especially technicians are men and we have seen this in the participants ... 70% of the LTAC participants are men, 30% are women. This varies between the eastern and western part of the country. In the eastern part

the difference is smaller, maybe 40% are women and 60% are men. (CIAT official, Guatemala City, 2022. My own translation)

Generating these kinds of data is a way in which CS advocates dilute their effects. Measuring women participation in terms of numbers of assistance creates an illusion of democratizing knowledge, of modernity and relevance. The message that is sent after months of participation is that inclusion is being taken seriously with the numbers and percentages to show it. It also creates immediate measurable data for future use either by governmental officials or other humanitarian organizations that wish to work on the area. The interviewee added:

We are making efforts to include more women not only in the institutions but also include institutions that focus on women... it has not been an easy job, but we have some good examples of success. Regarding the transfer of information, the view changes drastically when we implement a participatory approach with producers. We have realized that most of the people are women, up to 79% are women and 21% men, well some of these are children but this is due to the fact that things are different in the countryside where men are working on their fields and women have available time to assist to these workshops to get information. ... we have seen women are becoming more empowered in the countryside. We see this in the transfer of information, and this is satisfactory because the information reaches the women, and they share it with their husbands who ends up making the final decisions. (CIAT official, Guatemala City, 2022. My own translation)

Female participation is how CS advocates measure their impact on gender. However, agriculture as a job remains dominated by men. It is unclear how women have decision-making power in this area. Despite efforts of inclusion, ASOPUENTE's communicator Ms. Edna de Morales³⁵ had an opposite view. When I asked about women's inclusion in their projects of food security, she argued that this was a Western view that ignored the Guatemalan context. She said that women already had numerous responsibilities that included taking care of children, cooking, gathering firewood for cooking, collecting water and family health among others. Ms. Edna went further in a very critical manner and added that international institutions and their new discourses wanted women to also be in charge of the family's income. This did not empower women but gave them more

³⁵ She asked that her name was kept.

responsibilities than they could bare. She concluded saying that what was needed in Guatemala was to work with men on gender and other masculinities and to have them acquire new responsibilities regarding household management. A success she attributed to her work in the organization was making men take their kids to the clinics and having them become more responsible parents. However, it is also known that women in Guatemala organize and work on the *milpas* in the plots that are available to them. Interestingly, their agricultural methods focus on practices of prevention and care of the environment rather than destruction and regeneration (Einbinder, 2020; Einbinder et al., 2022).

Although this dissertation does not focus on feminist studies, I acknowledge the importance of this approach and the relevance. For instance, the feminist geographers Dianne Rocheleau and David Edmunds (1997) provide a more complex vision to identify shifting powers along with conflicts and affinities over gender and access to resources. Only by focusing on social relations at community level could they shed light on the 'multidimensional nature' of the rights over resources in communities of Kenya and other parts of Africa. From this, they point out the "gendered nature of resource use, access, control and responsibility with respect to trees and forests" (Rocheleau & Edmunds, 1997, p. 1351) from which development programs could risk modifying and negatively affecting women's access to resources. Furthermore, Kristin Cashman (1991) argues that modernization efforts carried by Western ideas of progress have affected negatively women's position within agriculture in the Third World by reinforcing the patriarchal system in programs of development.

Overall, women's role in CS and agriculture needs further attention. Although I support their inclusion, it was also clear that the CS advocates struggled in this subject and were forced to meet western gender-based requests. In this sense, progress in this subject was measured by participation and felt more as a checkbox to be filled than an important social component. What they do is that they present their data in a way that allow objectives to progress and women organizations to collaborate regardless of the original goal of impacting food security and reaching out with the climate information. Important for Guatemala's context is Aura Cumes' (2012, 2017) analysis. She states that the disparate

inequalities that indigenous women in Guatemala go through are a product of patriarchy along with colonial and racial dynamics. Similar to Kimberlé Crenshaw's (1989) intersectionality Cumes argues that, without taking away the responsibility from Guatemalan Mayan men, female Mayan descendants saw themselves becoming increasingly oppressed by them. Cumes says that the cause of this increase in oppression by the male counterpart was the product of lost privileges men had in the public space. As a result, men increased their dominance in the private areas. Additionally, white Guatemalan women, despite being feminists, would feel closer to men mostly due to racial similarities, this would set them away from female Mayan descendants. In other words, the LTACs are not conceived to challenge or defy patriarchal dynamics of Guatemalan state and society nor do CS advocates have the tools to measure the effects of including women.

5.5 Conclusions

In chapter five, I try to elucidate the reasons why CS advocates continue to build on the CS promise of improving small farmers and peasants' livelihoods. I have raised the question of how and why locally relevant CS initiatives find arguments to continue being deployed? In the process of exploring these questions, Sultana's concept of climate coloniality provided a framework of analysis capable of identifying some characteristics of the CS initiatives that allow reflection around these questions. These characteristics gain relevance because they function as a set of overlapping discourses that reinforce the CS discourse and, subsequently, the CS advocates' belief in their products. In other words, by drawing insight from Sultana's concept of climate coloniality, this chapter sheds light on the ways in which wider systems of oppression have repercussions on the CS initiatives in Guatemala and on the CS advocates, their practices, and beliefs.

Regarding the systems of oppression – capitalism, colonialism, and patriarchy- in which CS initiative operates, power begins to manifest in the ways in which the existing global consensus of climate change dictates what and how Guatemala needs to act upon at national and municipal scales. As a result, the middleman responsible for producing, translating, and transferring CS becomes two things, on the one hand, an element forced to believe the CS discourse to remain relevant within their institutions and communities. On the other

hand, technicians and CS advocates alike also become active elements and enablers of mentioned systems by aligning with neoliberalism through ideals of self-improvement and prosperity and with colonialism through a racialized state and society.

In other words, the ideas of self-improvement and prosperity proclaimed by the CS discourse finds fertile territory in the Guatemalan society. This is the result of the work that the Guatemalan government, universities, and organizations have had in developing a sense of individual improvement on their citizens through *capacitaciones*, innovation projects, and numerous workshops. Interestingly, material dearth and economic constraint in which governmental institutions and government officials navigate not only have repercussions in the wider society but also play a role in the discourse of improvement and CS initiative. For instance, the translation and transfer of CS to small farmers translates into a practical transfer of individual responsibilities. Under the umbrella of individual improvement, the statement "*we have to work with what we have*" evokes the individual "will to improve" that citizens are expected to show despite other socioeconomic constraints. In turn, this attitude reduces responsibility from the state towards its citizens. In this context, it makes sense to expect that small farmers and peasants should make informed and rational decisions with the information given to them because, paraphrasing what another interviewee said: everyone shares responsibilities in decision-making.

However, I also acknowledge that personal and professional struggles related to material dearth and job precarity within governmental institutions impedes further reflection and critique. As a result, the governmental apparatus and other organizations must rely on measuring outcomes (e.g. number of participants, workshops given, reports provided, municipalities visited) to push forward their efforts and remain relevant. This comes at the detriment of other discussions that peasants and small farmers have about their needs and the structural challenges they face. Throughout this chapter we explored how the efforts of including women - by measuring their participation -, and traditional knowledge - by including the moon cycle and other time frames like *decadías* - becomes a sort of spectacle in which documents and reports provide an incomplete and deceiving picture of how CS have direct impact in women empowerment. In accordance with Sultana's critique that climate colonial programs are characterized by a "performance, [that] erases historical and

spatial geopolitics and power relations" (2022, p. 2), these aspects of the agroclimatic bulletins become detrimental to those who are meant to assisted.

Regarding colonialism, Aura Cumes' (2012) analysis of the racisms and sexism endured by indigenous women provides important insight on how state officials and technicians mobilize self-improvement to differentiate themselves from the others by categories of "backwardness", "stubbornness", and "traditional". Differentiation and the promise of prosperity are two overlapping aspects that bring other implications worth mentioning. For instance, the provision of modern knowledge to improve decision-making and livelihoods also reminisces colonial and modernist ideologies -akin to Foucault's conduct of conductthat aim at developing "desirable" behaviors on the peasants and Mayan communities. In this manner, Maya women are also expected to become economically active thus increasing the number of responsibilities they already must endure. Framing solutions as technical allows the Ministry to gain relevance as they become a key actor capable of offering concrete solutions to complex issues. In this context the CS advocates, willingly or not, believe in the CS by allowing themselves to ignore the structural challenges, colonial practices, and their own limitations that might affect their implementation.

Finally, what we have gained from chapter five is the possibility, if not boldness, to suggest the reimagination of the CS. In this thesis, climate coloniality provided a gateway to rethink CS, not to solve issues or curate CS from its colonial and capitalist traits, but to ameliorate it or at least to allow new discussions. Although the absent voices of peasants and small farmers become a weakness in this thesis, I do not claim to speak for their needs or demands. I have, however, mentioned that this research has been done, always thinking about small farmers and peasants. In this manner, chapter six will reimagine the CS as a wider instrument that can inform Guatemalan food policy and not as a locally relevant tool. Next chapter will also make use of food scholarship on climate-smart agriculture to explore the current and potential future effects that CS can have in food security and Guatemala's small farmers and peasants.

6 Rethinking the Climate Services

6.1 Introduction

Overall, this dissertation has focused on identifying the implications of implementing CS for food security in Guatemala. In doing so, it has focused on the middlemen who oversee the CS cycle. As a result, this research argues that the implications materialize in several ways, like compromising misunderstanding of who the user is over growing collaboration or in believing that responsibilities are evenly distributed throughout the process. Other implications manifest in a shallow understanding of how the food system works and most importantly, how it does not work. Other research questions that focused on identifying where the policy regimes meet, enabled interesting thoughts about the ephemeral existence of the LTACs in which voluntary participation makes these transient spaces akin to any workshop or seminar in which individuals take the knowledge for themselves with no major repercussions. These spaces also allowed me to engage with key actors and talk about their understanding of the food system to evaluate how discussions about food insecurity are generally framed. What this research found is that food security continues to be discussed as an issue caused by the lack of modernization and knowledge. This framing of the issue translates into the demand for more programs that focus on "teaching" small farmers about climate change to modify their habits and practices but also of developing the climate infrastructure and modernizing the countryside. As a result, it is of no surprise that the CS initiative's claim of being locally relevant makes it attractive to national and international institutions, mainly because this approach does not challenge the conventional food system, nor does it promote structural change.

Using the figure of page 10 of this thesis, I have now included some of the actors institutions and individuals- as well as discussions and products that the CS cycle gathers. As a result, Figure 43 tries to expand upon the three sites of focus explored throughout this research include the primary and secondary stakeholders. The image shows that as each site progresses, new collaborators are made part of the process thus increasing a sense of demand of the CS. However, contributing to the CS discourse is also done by adding followers and producing documents, reports, bulletins, workshops, academic innovation contests and conferences. It is important to highlight that, as the sites progress, the CS become an individual tool of decision making in the sense that small farmers and peasants are left alone to decide what to do with the information given to them whereas the participants tend to disappear from the process of food production.



Figure 43. The cycle of the climate services

The following subsections will present the main objectives and research questions organized according to the CS cycle above. Once this is done, section 6. 2 discusses the role that food scholarship has in providing further insight to the CS initiative and new perspectives for future CS research. This section aims at encouraging future research to take into account recent food scholarships on climate-smart agriculture and governmentality. For instance, using biopolitics or agribiopolitics, Hetherington (2020) and Stock & Gardezi (2021) raise concerns over the expansion of capitalism in agriculture. Finally, this thesis ends with section 6.3, by inviting us to reimagine a different kind of CS,

one that redefines them and the LTACs and allows the CS advocates to curb or calibrate their promises.

6.1.1 The Climate Services discourse and the production of climate data

The CS discourse refers to the belief that tailored climate information can inform users and improve their livelihoods. Using a policy regime perspective, this research has approached the process of production of climate data and the CS discourse by first acknowledging the capacity that the epistemic communities (Haas, 2008) have of influencing policy and discourse. This approach allows me to analyze how weather and climate scenarios are produced by INSIVUMEH, but more importantly - to reflect on its motivations, how the discourse of CS is produced, and how these aspects affect the implementation of the CS.

- 1. This thesis traces how the global and national consensus regarding the need of adapting to climate change has effects in pushing forward certain programs of development in Central America and Guatemala in particular (Sistema Guatemalteco de Ciencias del Cambio Climático, 2019). In parallel, food insecurity and climate hazards like hurricanes and droughts have encouraged the National Meteorological Institutions of the Central American region to collaborate with each other. Striving to become relevant to the wider public, the National Meteorological Institutions also aim at influencing development programs and policies (Solano Garrido & Ochoa, 2019). However, when using a policy regime approach, it is possible to examine the epistemological tensions between the complex food system and the positivist view of the CS advocates.
- 2. These tensions have remained unidentified thus allowing the CS advocates to expect that food insecurity can be assessed and predicted in a similar manner to their climate projections. They tend to envision a future that, despite being well intentioned, does not take into account the futures imagined by their users, nor the possibilities of bifurcated futures (Kurniawan & Kundurpi, 2018). This means that CS advocates believe that agricultural production can be altered and improved through rational and informed decision-making. At a practical level, while CS advocates
struggle to evaluate or prove that the CS initiative generates a positive impact in decision-making.

3. Other tensions were scale related. As seen in chapter four, the challenges of implementing CS manifested as scales shifted from macro to micro. In other words, the discourse of CS and food security at a global and Central American scope was challenged when the CS were implemented at a micro scale. For instance, the variety of social-historical and political context of each community and municipality, the issues with urgency and the multifactorial causes of food insecurity were all a mélange of tension that CS discourse could not take into account and CS advocates were not capable of addressing or responding to.

However, all these challenges did not hinder collaboration, mainly because the quality of climate information is conditioned by the production of the data available. INSIVUMEH also worked on alleviating its economic constraints by collaborating with private institutions like ANACAFE or ICC to access weather stations to improve the climate data. Additionally, they also rely on NGO collaboration to find volunteers who are available and willing to supervise weather stations and communicate the measurements via mobile phone. However, collaboration is much more complex due to the context and a set of characteristics that include the historical legacies, limitations, and politics that each actor and institution brings to the process. For instance, whereas the Universidad Rafael Landívar enjoyed a degree of trust in the countryside, the ICC and the government produced an opposing effect in communities that currently were being affected by monoculture farms and had suffered extreme violence during the Civil war era.

6.1.2 Translation of climate data

The WMO understands that modern climate data is not useful if it is not translated to respond to the users' needs and demands. In this sense, the CS advocates have generally focused on co-producing the CS as a mechanism to gain trust from the users and have them appropriate climate knowledge. To do so, they have implemented the Local Technical Agroclimatic Committees (LTACs) as spaces of dialogue between the various participants. This dissertation shows how the participants and potential users discuss and coproduce

agroclimatic bulletins and learn about climate change through climate alphabetization which can also be understood as vulgarization of science.

- In this manner, chapter three demonstrated that participation does not always translate to action or meaningful contribution to food security, nor even to the quality of the agroclimatic bulletins. What happens is that through participation, the actors and organizations of the LTACs become quantifiable variables which, according to the CS advocates, represents a growing demand for their product. Empirical work also showed that the CS advocates tend to mobilize data on demographics to provide a picture of the diverse and inclusive nature of the LTACs (e.g., by categorizing the participants into students, citizens, organizations, women, and Maya communities).
- 2. While there is a degree of diversity in the LTACs, the CS advocates' reports also identifies that the majority of the participants are state officials (Giraldo et al., 2019; Hernández-Quevedo et al., 2022). In accordance with the global UN's sustainable development goals, the data they produce is used to argue that inclusion and participation is happening in these ephemeral spaces, and therefore having an impact on communities. However, a geographical approach on the sustainable development goals and the contradictions on the way they are being implemented is also worth addressing (Liverman, 2018). An important contradiction lies in how unprepared and/or incapable CS advocates are of addressing colonialism and patriarchy in their initiatives. As a result, these projects continue to measure the representation of gender through enrollment ratios (Liverman, 2018). As argued in chapter five, these measurements and representation quotas become a sort of spectacle that reproduce climate colonialism which will not be able to challenge structural inequalities (Sultana, 2022).

In parallel to the exercise of self-evaluation and accountability that CIAT has done in the past years there is also a growing discourse regarding the relevance and acceptance that CS have had in Guatemala. As CS advocates try to evaluate their performance, their goal of reaching more users and participants becomes an objective about logistics (e.g., challenges that involves reaching rural Guatemala, adding new participants, finding weather stations

operators, creating more LTACs, and producing climate related reports in a timely manner) and less so related with issues of food insecurity. In other words, the objective of improving communication tends to neglect the original premise of supporting food security or attending to other food related challenges.

6.1.3 Transfer or dissemination of Climate Services

Once the CS are produced and translated, they are ready to become widespread and be transferred to all users. At this instance, the diversity of the institutions involved in the process caused confusion regarding who the users were.

- 1. Despite the differences between food producers, small farmers, subsistence farmers, peasants, and Maya communities, the CS advocates and other participants would either use the term 'user' as an umbrella to refer to them all or use any of the cited terms in an interchangeable manner. As one of the governmental officials said, this confusion reached crop advisors who did not always know whom they were supposed to assist. It was also challenging for CS advocates and other participants to talk about the CS and food insecurity on a micro-scale. In the LTACs, when the CS advocates discussed food insecurity at the municipal scale, the idea of alleviating hunger would tend to disappear from the meetings and conversations and be replaced by other issues or goals, such as teaching about the production of organic fertilizers, focusing on the advice based on the numerous micro-climates of the municipality, or managing soil and other resources. As mentioned before, this challenge showed how the global discourse of CS and food security becomes less clear when local conditions are considered.
- 2. Similar to the work done by Lemos et al. (2014) I have also addressed the role that crop advisors have of providing their expertise and disseminating the CS in the countryside. Despite their importance, this thesis also shows how CS advocates and crop advisors are conditioned by unstable working contracts. In order to secure their jobs or to prolong their contracts, CS advocates, crop advisors, and other low tier government officials have to continually deliver the results they are capable of working on. For instance, for CS advocates it means focusing on increasing the

number of LTACs without taking into account that most of the participants are government officials and not the expected users. In parallel, crop advisors and other governmental bureaucrats are socially pressured to participate in workshops as a way of being *capacitado* or trained. In a context where modernity is thought of as a desirable state and the concept of tradition is loaded with prejudice, training crop advisors reinforces the idea of "us versus them", "us" being the technical, rational, and modern state officials as opposed to "them" being the traditional and stubborn small farmers and peasants. One problematic aspect of this dichotomy between traditional and modern is that it serves as an excuse, or the scapegoat -as I mentioned in chapter five- to failed programs or objectives. Whenever government officials meet technical or logistical difficulties that affect the performance of the project, culture becomes the unquestionable reason for failure. This is also problematic for a State that has a racist structural configuration (Cojtí, 1991).

3. Overall, the CS initiative, as other development programs (Copeland, 2012, 2019b; Hale, 2002), displays neoliberal traits that continue to push forward the belief of individual improvement in the CS initiatives. In this logic, as farmers become the end users, the responsibility of their improvement depends on their willingness to become modern. In parallel, temporal working contracts and the precarity of the Guatemalan state intertwines with colonial and racial legacies in which failure to deliver results is explained through blame on cultural stubbornness. Another side-effect is that this also prevents critical reflections and transfers the blame away from structural social issues and towards the individual small farmer they are trying to assist.

The tensions and incommensurable differences that the CS process undergoes in these sites of interest are manifestations of collisions of the policy regimes. Efforts to implement CS under the current practices are not only inadequate to the Guatemalan context but they also generate further effects and discrimination towards the small farmers and Maya communities. CS also become a tool or *dispotif* that encourages conventional development narratives that foment modernization through the technification of the countryside and the modification of human behavior.

6.2 Where do we go from here?

This dissertation has managed to identify some challenges and implications that CS advocates face in the process of implementing CS in Guatemala. It addressed the challenges of coordination that users, academia, government officials and NGOs encounter and the struggles of identifying the users. In their work in Nigeria, Ruth Butterfield and Philip Osano not only raised these and other questions, but also suggested asking how "would improve coordination influence the requirement for new climate services?" (Butterfield & Osano, 2020, p. 7). In this manner this section will discuss future research that could improve our understanding of the side effects that CS initiatives can have on their users and food policy in general. As mentioned at the beginning of this research, the production of agroclimatic bulletins and the subsequent transfer of the information to a wider audience comes with a series of implications -which include taking for granted the incommensurable differences between the policy regimes-.

If CS initiatives continue to ignore the set of implications discussed throughout this dissertation, the CS discourse will risk remaining unchallenged and unchanged. This means that the CS initiatives that tend to work with adaptation and resilience programs influenced by disaster risk reduction studies will continue to fail in "question[ing] the framing values and political context of decision-making and fall short of addressing adaptation as transformation" (Pelling, 2011, p. 58). A side effect is that these efforts often tend to maintain the status quo of inequalities. In this sense, in conjunction with the global view on adaptation and resilience to climate change through food security, the CS advocates will continue to promote programs that focus on changing production processes instead of providing space for wider discussions. In other words, the CS initiative will reinforce current food policies that prioritize efforts of making hybrid seeds available and improving the livestock genetic material, among other strategies. The lack of reflection and proactivity to tackle the conventional food system translates into a continuous reinforcement of the current Guatemalan food policy regime that focuses on modernization, marketization, and competition and that has failed to alleviate food security. Overall, the CS initiatives work in conjunction with a Guatemalan food policy that has not addressed structural challenges

and has failed to establish a solid and sustainable practice to improve food security (Conde-Caballero, García-Arias, et al., 2021).

6.2.1 What can food scholarship bring to the CS initiatives?

Apart from providing a framework of analysis, food scholarship also brings insight and experience over the effects that structural systems of oppression have on food security (Prado-Córdova, 2011; Prado-Córdova & Bailey, 2021) and raises awareness of the complex web of dynamics between the food components and climate change (Ingram et al., 2012) or the influence that international policy has in developing food policy (McMichael, 2013, 2020; Rioux, 2018). As mentioned at the beginning of the thesis it is important to highlight that CS initiatives and the CS advocates tend to exclusively focus on food production in a decontextualized, de-historicized, disconnected and apolitical manner. However, CS conceived as an add-on of the Green Revolution does open new paths of research. In other words, a climate-smart agriculture that is characterized by its goal of doing agriculture that mitigates and adapts to climate change (Takács-György & Takács, 2022) enables future research to focus on the digitalization process and the side-effects it generates.

By focusing on how to improve yields, CS advocates fall into the trap of asking "unsystemic questions" that, paraphrasing Donella Meadows (2009), tend to focus on certain elements rather than the interconnections, purposes, and the set of elements of the food system. This reflection matters because it raises concerns with the role that capitalism has in the CS initiative. Food scholarship already warns us about how agriculture is still a fertile territory for capitalism and CS certainly opens new possibilities. Therefore, CS as climate-smart agriculture "can be situated within a new logic of accumulation based in the commodification of personal data through digital interfaces" (Stock & Gardezi, 2021, p. 196) which in turn tends to "modify [the farmers] actions to fulfill the policies and ambitions of the agricultural tech providers (ibid, p. 195). As seen throughout chapters three, four, and five, the Guatemalan State and the CS advocates do work in conjunction over how agriculture and livelihoods are to be improved. National and international

institutions also focus on digitalization and modernization of the countryside. In these cases, Stock & Gardezi (2021) warn that,

human actors of precision agriculture (technologists, users, bureaucrats) do not only dictate which data and technologies will be developed and used, but in this process, also carefully select which systems of crop production (e.g. grain crops, specialty crops) and labor configurations (e.g. migrant, seasonal) will prevail. (p. 201).

As mentioned in chapter one, Guatemala's food production relies on internal migration and short working contracts in which Mayan communities and peasants -most of them landless infrasubsistence and subsistence farmers- migrate from the highlands to the Pacific coast for harvest seasons. The question is, could CS and digitalization assist conventional monoculture farms to raise their profit at the expense of the seasonal labor? How would innovation and the development of new Apps -by academia or the private sector- champion certain kinds of seed, cultivation methods and inputs to the detriment of others? After all, the CS do not need to be privatized to have the effect of widening the gap between the rich and poor -as it is believed. These questions along with the continued process of commodification of agriculture offer new areas of interest and concern over the use that private companies (e.g. conventional monoculture farms) can make of the CS.

By discussing the 'unusual' disappearance of agriculture and plan health from biopolitics Kregg Hetherington (2020) studies Paraguay's Green Revolution through a biopolitical lens. His approach allows him to make an important relation between Foucault's analysis of state management of public health and agricultural technology by which plant health is "devoted to the protection of plant genetic purity and vigor through controlled reproduction and the elimination of non-viable lines from the national stock" (Hetherington, 2020, p. 683). In a similar fashion, the interest that national and international organizations have on public health and food security in Guatemala, relies on the management of people and their production practices. Along with the state's management of its citizens, CS research could also focus on conventional farming instead of small farmers.

As an important element of the food system landscape, the implementation of CS by conventional monoculture farms raises concerns. On the one hand, resonating with Hetherington's analysis of the Green Revolution in Paraguay, CS used by conventional extensive farmers can be linked with modern agricultural practices in the sense that it resonates with determinism and eugenics of crops. In this context, the environment is heavily modified, and crop varieties are improved to detriment to other, less profitable, or uncommodifiable plants. Although this already happens, for countries like Guatemala it means, weaponizing science -more- against rare and local varieties that might consume more water or produce lower yields. On the other hand, CS can also be used for adjusting the temporal working contracts -in harvest season- to raise profit. Research on agriculture has shown how reducing the weight of *machetes* to cut sugar cane or adding protein to the laborers' lunch were means calculated by sugarcane farmers to raise efficiency (Oglesby, 2013). In other words, CS could open new scenarios in which conventional monoculture farms could maximize their profit at the expense of labor while enjoying positive recognition through green labelling by reducing the use of water, pesticides, and fertilizers. Overall, CS can remain an instrument of public access yet private companies with better computational equipment and human resources will always have better opportunities to take advantage of them.

6.3 Redefining the Climate Services

As I demonstrated in chapter five, inclusion, and co-production of knowledge in CS initiatives do not translate into decolonial practices. Furthermore, the CS initiatives experience increasing popularity and participation that will continue to grow regardless of the side-effects they produce. After identifying the implications that come from the process of implementation (e.g., misidentifying the user and issues with scale among others) and discussing some of the concerns I have with CS in Guatemala, this section will focus on reimagining the CS. To do so, I review some of the questions posed at the beginning of chapter five that are worth reflecting upon. For instance: Why should CS be locally relevant? In other words, can the CS exist without the promise of providing locally relevant climate information? Can we produce CSs that are socially engaged but not locally relevant? If so, what does this mean for the people who suffer from food insecurity? What can CS do for small farmers regarding climate change and food insecurity?

To reimagine CS as a non-locally relevant tool means that CS advocates can redefine their mechanisms of implementation, reconsider the users, reflect about decision-making, and reframe their goals as well as the impending need to provide immediate results. At the beginning of this thesis, the CS were defined as a modern tool that provides seasonal and sub seasonal climate forecast for decision making. In practice, it translated to the implementation of the LTACs as spaces of dialogue "... with the goal of providing knowledge of the behavior of the climate in a locality" (Hernández-Quevedo et al., 2022, p. 13; my translation). In discourse and practice, CS advocates place emphasis on "decision making" and "locality" which is what guides their efforts.

As a result, I propose a couple of things, first to reconsider how decision making is thought of by CS advocates and second to remove "locality" from the definition. With these two changes, we can now think about the LTACs differently and alleviate some of the implications this thesis has identified. On the one hand, by reconsidering who makes decisions, the LTAC can become a space of dialogue between policy makers, associations, academia, cooperatives, small farmers, and NGOs among others with the goal of developing food policy. This means that CS and the LTAC can provide mechanisms and agreements over procedures of response to droughts, floods, and other climate phenomena that directly alter the development of crops. However, these mechanisms should also consider food production, distribution and consumption which means it should be capable of engaging with actors at every component of Guatemala's food system. Instead of targeting small farmers and municipalities, the LTAC focuses on developing response to major macro-climate regions. On the other hand, focusing on other participants of the food systems takes away the urgency of delivering the climate information in which CS advocates are meant to produce various kinds of reports. Instead of overproducing and duplicating information about food insecurity and meteorological data, new reports could provide a framework for MAGA, SESAN and other international organizations to coordinate efforts before food stress or crisis arrive and allow them to set short-, mediumand long-term goals accordingly.

I am aware that proposing for the CS to become political might not be well regarded by the CS advocates. When I discussed policies and questioned the voluntary nature of the LTAC,

some interviewees made it clear to me that they would rather keep the LTACs as voluntary sites of participation. However, this thesis argues that it is worth rethinking the WMO's posture or understanding of the political. Aware that the WMO was created during a Cold war context in which the United States of America and the USSR fought over the control of the geophysical sciences, it is reasonable that these institutions have grown with the fear of politicized control (Edwards, 2010). However, when discussing food security, the CS should be able to become a modern tool that provides seasonal and sub-seasonal climate forecast for policy development on food, water, energy, disaster risk reduction and health. Otherwise, its potential could be lost on short-term goals that have government officials working as "firefighters putting out fires" instead of planning sustainable projects.

6.3.1 Reformulating the promises: What else could the CS produce?

Removing locality and rethinking decision making does not mean that small farmers should no longer participate in the LTACs. It means that participants of the LTACs could ask who makes which decision. What decisions are the different kinds of participants expected to make? Should CS advocates no longer expect that their CS products will be able to improve food security and adaptation to climate change? In this regard, CS advocates can reconsider scales and be capable of incorporating food policy into climate science in a holistic fashion.

Defying locality also means surpassing the binary of micro or macro scales approach. The LTACs offer a site in which heterogenous actors involved in the food policy regime (e.g., small farmers, crop advisors, policy makers, and high-tier officials) could meet and discuss profound structural issues. In this sense, a legally conformed LTAC could provide stable working contracts in which state functionaries along with NGOs and community leaders are taken into account to develop policy initiatives. For instance, if a drought or a flood are to be expected, the Guatemalan government could provide an affordable seed bank to prevent prices from rising. A case study in Indonesia suggests that climate smart agriculture should work in conjunction with agricultural justice that attends social disparities and marginalization. In this sense, a multi-disciplinary approach that allows social sciences to address the challenges of translating and transferring the CS will allow a rich political

discussion in which small farmers have better participation and the power to change policy (Arienfiansyah & Webber, 2021; Findlater et al., 2021).

The practice of coproducing knowledge could also benefit from these new LTACs. Instead of coproducing a product thought by CS advocates and thought for small farmers and peasants, coproduction would involve producing knowledge that upscales. In other words, CS advocates are not in charge of making the agroclimatic bulletins appealing to the users (e.g., by adding the moon cycle, the *decadia*), instead the crop advisors and small farmers can also give advice and communicate their concerns about food production that is seriously taken into consideration by ministers and other high-tier officials. Otherwise, the act of coproducing agroclimatic knowledge that integrates small quotas of acceptable traditional knowledge will continue to be a spectacle.

Regarding scales, a CS that focuses on the national scale could potentially "divide" Guatemala into wider meteorological regions or watershed -as the WFP technician advised-to produce mechanisms of response according to each wider region. For instance, drier areas like those on the Dry Corridor would have access to certain agricultural packages and crop insurance that are different from those in the highlands, the rainy Pacific Coast where rivers cause floodings or the humid jungles of Petén. Decisions, in this case, are to be taken by ministers and high-tier officials to respond, ahead of time, to potential drought, floods or pests. In this sense, the LTACs would provide a valuable site of encounter between Guatemalan society and politics.

Regarding adaptation, for CS advocates and Guatemalan officials to address climate change and resilience, it is important to change the paradigm from adapting *for* climate change to adapting *with* climate change to give a sense of a continued process (Pelling, 2011) in which peasants and small farmers should not be expected to reach a modern and adapted state. Pelling (2011) argues that, in order to understand adaptive capacity, one has to look into organizational behavior and governance regimes along with individuals' actions, values and feelings. Therefore, governmental institutions and citizens should coordinately and continuously be transformed.

The CS products and the LTACs can become sites of encounter that manage to engage high tier officials. Instead of producing volume -the rising number of LTACs and agroclimatic bulletins- CS advocates and small farmers would be partially released from the responsibility of improving food security to focus on discussing wider structural issues of the food system. For instance, acknowledging the role that crop advisors have in reaching small farmers and peasants or the value that their knowledge and experience could bring to the improvement of the CS. An example from the empirical work shows how crop advisors have already hinted at the tensions that collaborating with monoculture farms and private research institutes can have on the LTAC. In this sense, it is in the best interest of everyone to take these observations seriously and address the tensions before moving forward into teaching about climate. For the state officials, it means redirecting a meagre budget and their limited work force into sustainable projects instead of diluting their efforts amongst numerous workshops and the over production or obsession with producing data. For CS advocates it means producing profound CS that can inspire critique and generate change in policies, instead of producing dozens of simplified bulletins. In other words, by transforming the outcome-driven practice of state officials, they could engage with researchers without the risk of compromising their jobs. For the small farmers, peasants, and Maya communities, it means treating them as agents of knowledge, capable of knowing their own challenges and of informing policy instead of ignorant or empty receptacles.

Overall, this research offered an alternative approach to studying CS by focusing on understudied actors. Doing so allowed this research to put into question the CS discourse that champions the need of using and producing locally relevant climate knowledge for decision making regarding food insecurity. In this sense, moving beyond local relevant CS means releasing some of the pressure the CS advocates carry to encourage new questions and allow the identification of potential side-effects. Otherwise, in the CS cycle of production, translation and transfer, the discourse and mechanisms used to achieve the goal of massifying and vulgarizing climate information will continue to overshadow the pervasive side effects engendered by structural systems of oppression.

References

- Agnew, J. (2005). Sovereignty Regimes: Territoriality and State Authority in Contemporary World Politics. *Taylor & Francis Group*, 95(2), 437–461.
- Alexander, M., & Dessai, S. (2019). What can climate services learn from the broader services literature? *Climatic Change*, *157*(1), 133–149.
- Alonso-Fradejas, A. (2012). Land control-grabbing in Guatemala: the political economy of contemporary agrarian change. *Canadian Journal of Development Studies*, 33(4), 509–528. https://doi.org/10.1080/02255189.2012.743455
- Andersson, L., Wilk, J., Graham, L. P., Wikner, J., Mokwatlo, S., & Petja, B. (2019). Local early warning systems for drought – Could they add value to nationally disseminated seasonal climate forecasts? *Weather and Climate Extremes*, 100241. https://doi.org/https://doi.org/10.1016/j.wace.2019.100241
- Arienfiansyah, R., & Webber, S. (2021). Creative farmers and climate service politics in Indonesian rice production. *Journal of Peasant Studies*.
- Ayanlade, A., Radeny, M., & Morton, J. F. (2017). Comparing smallholder farmers' perception of climate change with meteorological data: A case study from southwestern Nigeria. *Weather and Climate Extremes*, 15, 24–33. https://doi.org/https://doi.org/10.1016/j.wace.2016.12.001
- Bebbington, A. (1993). Modernization from below: an alternative indigenous development? *Economic Geography*, 69(3), 274–292.
- Beveridge, L., Whitfield, S., & Challinor, A. (2018). Crop modelling: towards locally relevant and climate-informed adaptation. *Climatic Change*, *147*(3), 475–489.
- Beveridge, L., Whitfield, S., Fraval, S., van Wijk, M., van Etten, J., Mercado, L., Hammond, J., Davila Cortez, L., Gabriel Suchini, J., & Challinor, A. (2019).
 Experiences and drivers of food insecurity in Guatemala's Dry Corridor: Insights from the integration of ethnographic and household survey data. *Frontier in Sustainable Food Systems*, 3(65). https://doi.org/10.3389/fsufs.2019.00065

- Bourbeau, P. (2018). A genealogy of resilience. *International Political Sociology*, *12*(1), 19–35.
- Bouroncle, C., Girón, E., Imbach, P., Müller, A., Pérez, S., Portillo, F., & van Etten, J. (2017). Oferta y demanda de información para la gestión de las sequías en el Corredor Seco de Guatemala: ¿cuál es la percepción de los tomadores de decisiones?
- Bouroncle, C., Müller, A., Giraldo, D., Rios, D., Imbach, P., Girón, E., Portillo, F., Boni, A., van Etten, J., & Ramirez-Villegas, J. (2019). A systematic approach to assess climate information products applied to agriculture and food security in Guatemala and Colombia. *Climate Services*, 16, 100137.
- Boyd, W., Prudham, W. S., & Schurman, R. (2001). Industrial dynamics and the problem of nature. *Society Natural Resources*, *14*(7), 555–570.
- Boyer, J. (2010). Food security, food sovereignty, and local challenges for transnational agrarian movements: the Honduras case. *The Journal of Peasant Studies*, *37*(2), 319–351.
- Broome, A., & Seabrooke, L. (2012). Seeing like an international organisation. In *New political economy* (Vol. 17, Issue 1).
- Brown, J., & Purcell, M. (2005). There's nothing inherent about scale: political ecology, the local trap, and the politics of development in the Brazilian Amazon. *Geoforum*, 36, 607–624.
- Bruun Jensen, C., Harvey, P., & Atsuro Morita. (2016). Downscaling: From global to local in the climate knowledge infrastructure. *Infrastructures and Social Complexity: A Companion*, 357–369. https://doi.org/10.4324/9781315622880-43
- Buontempo, C., Hutjes, R., Beavis, P., Berckmans, J., Cagnazzo, C., Vamborg, F., Thépaut, J.-N., Bergeron, C., Almond, S., Amici, A., Ramasamy, S., & Dee, D. (2020).
 Fostering the development of climate services through Copernicus Climate Change Service (C3S) for agriculture applications. *Weather and Climate Extremes*, 27, 100226.

- Butterfield, R., & Osano, P. (2020). Improving the co-production of climate services for agriculture: a case study from Nigeria.
- Calderón, C. I., Jerónimo, C., Praun, A., Reyna, J., Santos Castillo, I. D., León, R., Hogan, R., & Prado Córdova, J. P. (2018). Agroecology-based farming provides grounds for more resilient livelihoods among smallholders in Western Guatemala. *Agroecology and Sustainable Food Systems*, 42(10), 1128–1169. https://doi.org/10.1080/21683565.2018.1489933
- Cameron, E. (2011). Securing Indigenous politics: A critique of the vulnerability and adaptation approach to the human dimensions of climate change in the Canadian Artic. *Global Environmental Change*.
- Campbell, T., & Sitze, A. (2013). Biopolitics: A Reader. In *Political Studies Review* (Vol. 13, Issue 3). Duke University Press.
- Cardona, J. (2014). Recomendaciones técnicas para el cultivo de maíz para zonas de producción comprendidas entre 0 a 1400 msnm.
- Castree, N. (2003). Commodifying what nature? *Progress in Human Geography*, 27(3), 273–297.
- Castro, J. de. (1952). The geography of hunger (Vol. 74). Little, Brown.
- Clapp, J. (2014). Food security and food sovereignty: Getting past the binary. *Dialogues in Human Geography*, 4(2), 206–211.
- Clapp, J., & Cohen, M. J. (2009). *The global food crisis: Governance challenges and opportunities*. Wilfrid Laurier Univ. Press.
- Cleaves, C., & Tuy, H. (2015). Análisis sistémico y territorial de la seguridad alimentaria y nutricional en Guatemala: consideraciones para mejorar prácticas y políticas públicas. Cara Parens.
- Cojtí, D. (1991). *La configuración del pensamiento político del pueblo maya*. Asociación de Escritores Mayances de Guatemala.

- Conde-Caballero, D., García-Arias, M. Á., & Mariano-Juárez, L. (2021). Hunger, politics(S) and development cooperation in 21st century Guatemala. A critical view from anthropology. *Revista de Antropología Social*, 30(2), 109–117. https://doi.org/10.5209/RASO.77893
- Conde-Caballero, D., Lorenzo, M., & García Arias, M. Á. (2021). Hambre, Política(s) y Cooperación al desarrollo en la Guatemala del siglo XXI. Una mirada crítica desde la Antropología. *Antropología Social*, 109–117.
- Copeland, N. (2012). Greening the Counterinsurgency: The Deceptive Effects of Guatemala's Rural Development Plan of 1970. Development Change, 43(4), 975– 998.
- Copeland, N. (2019a). Meeting peasants where they are: cultivating agroecological alternatives in neoliberal Guatemala. *The Journal of Peasant Studies*, 46(4), 831–852. https://doi.org/10.1080/03066150.2017.1410142
- Copeland, N. (2019b). The democracy development machine: Neoliberalism, radical pessimism, and authoritarian populism in Mayan Guatemala. Cornell University Press.
- Crampton, J. W., & Elden, S. (2007). *Space, knowledge and power: Foucault and geography.* Ashgate Publishing, Ltd.
- Crenshaw, K. (1989). Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics. University of Chicago Legal Forum, 1.
- Cumes, A. (2012). Mujeres indígenas patriarcado y colonialismo: un desafío a la segregación comprensiva de las formas de dominio. *Hojas de Warmi*, 17. https://idus.us.es/handle/11441/61360
- Cumes, A. (2017). La cosmovision maya et le patriarcat : une interprétation critique. Recherches Féministes, 30(1), 47–59. https://doi.org/10.7202/1040974AR
- Daly, M., & Dilling, L. (2019). The politics of "usable" knowledge: examining the development of climate services in Tanzania. *Climatic Change*, *157*(1), 61–80.

- Davies, A. (1990). Forty years of progress and achievement: A historical review of WMO (A. Davies, Ed.). WMO publ.
- Dayoub, M., Helminen, J., Myllynpää, V., Pope, N., Apiola, M., Westerlund, T., & Sutinen, E. (2018). Prospects for Climate Services for Sustainable Agriculture in Tanzani. In N. Tsounis & A. Vlachvei (Eds.), *Advances in Time Series Data Methods in Applied Economic Research*. Springer Nature.
- de Sousa Santos, B. (2015). Epistemologies of the South: Justice against epistemicide. Routledge.
- de Sousa Santos, B. (2018). The end of the cognitive empire: the coming of age of epistemologies of the South. Duke University Press. http://public.eblib.com/choice/publicfullrecord.aspx?p=5452392
- Declaración de Atitlán Consulta de Los Pueblos Indígenas Sobre El Derecho a La Alimentación: Una Consulta Global (2002).
- Douglas, M. (1986). *How institutions think*. Syracuse University Press.
- Drèze, J., & Sen, A. (1991). *The political economy of hunger: Entitlement and well-being* (*Vol. 1*). Clarendon Press.
- Duncan, J. S. (1980). The Superorganic in American Cultural Geography. Annals of the Association of American Geographers, 70(2), 181–198. https://doi.org/10.1111/J.1467-8306.1980.TB01306.X
- Edwards, P. (2010). A vast machine: Computer models, climate data, and the politics of global warming. The Mit Press.
- Einbinder, N. (2020). Lessons in Resilience from the Maya-Achí. Journal of Latina American Geography, 19(4), 264–268.
- Einbinder, N., Morales, H., Mier y Terán Giménez Cacho, M., Ferguson, B. G., Aldasoro, M., & Nigh, R. (2022). Agroecology from the ground up: a critical analysis of sustainable soil management in the highlands of Guatemala. *Agriculture and Human Values*, 39, 979–996.

- Escobar, A. (2012). *Encountering development: the making and unmaking of the Third World*. Princeton University Press.
- Euroclima+. (2019). Informe Consolidado Euroclima+. Union Europea. http://euroclimaplus.org/images/informes/Informe-actualizado-a-noviembre-2019.pdf
- Ewbank, R., & Aid, C. (2016). *Developing climate services in the Philippines*. Christian Aid.
- Fairclough, N. (2013). Critical discourse analysis: The critical study of language. Routledge.
- FAO. (2016). Corredor seco América Central. Informe de situación. FAO. http://www.fao.org/emergencies/recursos/documentos/recursos-detalle/es/c/422100/
- FAO, IFAD, UNICEF, WFP, & WHO. (2018). The state of food security and nutrition in the world 2018. Building climate resilience for food security and nutrition. FAO.
 www.fao.org/publications
- FAO, OPS, O. P. de la S., WFP, W. F. P., & UNICEF, U. N. I. C. E. F. (2018). Panorama de la seguridad alimentaria y nutricional en América Latina y el Caribe 2018. http://www.fao.org/3/CA2127ES/CA2127ES.pdf
- Ferguson, J. (1993). The anti-politics machine: "Development", depoliticization and bureaucratic state power in Lesotho. In *Taylor & Francis* (Vol. 10, Issue 4). https://doi.org/10.1080/03768359308439720
- Findlater, K., Webber, S., Kandlikar, M., & Donner, S. (2021). Climate services promise better decisions but mainly focus on better data. *Nature Climate Change*.
- Fischer, K. (2016). Why new crop technology is not scale-neutral—A critique of the expectations for a crop-based African green revolution. *Research Policy*, 45(6), 1185–1194. https://doi.org/10.1016/J.RESPOL.2016.03.007

- Fischer, K., & Hajdu, F. (2015). Does raising maize yields lead to poverty reduction? A case study of the massive food production programme in South Africa. *Land Use Policy*, 46, 304–313. https://doi.org/10.1016/J.LANDUSEPOL.2015.03.015
- Fleming, J. R. (2016). Inventing atmospheric science: Bjerknes, Rossby, Wexler and the Foundations of Modern Meteorology. The MIT Press.
- Foster, J. B. (2000). Marx's ecology: Materialism and nature. NYU Press.
- Foucault, M. (2013). Right of death and power over life. In T. C. Campbell & A. Sitze (Eds.), *Biopolitics: A reader*. Duke University Press.
- García, A., Tun, L., Samayoa, G., Zúñiga, K., & González, N. (2023). Capacidades de los servicios climáticos en Guatemala: Implementación del Marco Nacional para los Servicios Climáticos (MNSC).
- García, J. L., & Juárez, L. M. (2006). HAMBRE, INTERVENCIÓN SOLIDARIA Y CONTEXTO CULTURAL EN LA REGIÓN CH'ORTI'DEL ORIENTE DE GUATEMALA. Seguridad Alimentaria y Políticas de Lucha Contra El Hambre, 215.
- Giraldo, D., Camacho, K., Navarro-Racines, C., Martinez-Baron, D., Prager, S., & Ramírez-Villegas, J. (2019). Cosecha de alcances: Valoracion de las tranformaciones producidas por las Mesas Técnicas Agroclimáticas (MTA).
- Giraldo-Mendez, D., Martínez-Barón, D., Loboguerrero, A. M., Gumucio, T., Martínez, J.
 D., & Ramírez-Villegas, J. (2018). Mesas Técnicas Agroclimáticas (MTA): Una guía detallada sobre la implementación de las MTA, paso a paso. https://cgspace.cgiar.org/server/api/core/bitstreams/f560b6b8-0917-4e72-ad6e-0ea96c67c67e/content
- Gobierno de Guatemala. (2014). Plan Nacional de Desarrollo K'atun Nuestra Guatemala 2032.
- Gobierno de Guatemala. (2022). Plan estratégico institucional 2021 -2026 MAGA Gobierno de Guatemala.

- González, C. (2019). 2018 Scoping mission in Guatemala: Food systems, stakeholder analysis, and climate services analysis. In *Frameword of Columbia World Project and* ACToday project. IRI.
- Grandia, L. (2014). Modified landscapes: vulnerabilities to genetically modified corn in northern Guatemala. *Journal of Peasant Studies*, *41*(1), 79–105.
- Grandin, G. (2011). *The last colonial massacre: Latin America in the Cold War*. University of Chicago Press.
- Green, L. (2011). The nobodies: Neoliberalism, violence, and migration. *Medical Anthropology*, *30*(4), 366–385. https://doi.org/10.1080/01459740.2011.576726
- Grove, K. (2018). *Resilience* (First edition.). Taylor and Francis. https://doi.org/10.4324/9781315661407
- Guatemala, G. de la R. de. (2010). Diagnóstico a nivel macro y micro del corredor seco y definición de las líneas estratégicas de acción del MAGA (ganadería y alimentacion M. Ministerio de agricultura, Ed.; p. 37). https://www.maga.gob.gt/download/macro-micro.pdf
- Guido, Z., Rountree, V., Greene, C., Gerlak, A., & Trotman, A. (2016). Connecting climate information producers and users: boundary organization, knowledge networks, and information brokers at Caribbean climate outlook forums. *Weather, Climate, Society Natural Resources*, 8(3), 285–298.
- Gupta, A. (1995). Blurred boundaries: the discourse of corruption, the culture of politics, and the imagined state. *American Ethnologist*, 22(2), 375–402. https://doi.org/10.1525/AE.1995.22.2.02A00090
- Gupta, A. (1998). Postcolonial developments: agriculture in the making of modern India. 409.
- Gürcan, E. C. (2018). Theorizing Food Sovereignty from a Class-Analytical Lens: The Case of Agrarian Mobilization in Argentina. *Agrarian South: Journal of Political Economy*, 7(3), 320–350.

- Guzmán Böckler, C., & Herbert, J.-L. (1970). *Guatemala: Une Interpretación Históricosocial.* Editorial Cholsamaj. https://books.google.ca/books/about/Guatemala_Une_Interpretaci%C3%B3n_Histor ico.html?id=Wia0wgEACAAJ&redir_esc=y
- Bockler, C. G., & Bockler, C. G. (1969). Colonialismo, violencia y universidad. *Revista Mexicana de Sociología*, 31(4), 1027. https://doi.org/10.2307/3538929
- Haas, P. (2008). Epistemic communities. In D. Bodansky, J. Brunnée, & E. Hey (Eds.), *The Oxford handbook of international environmental law* (pp. 791–806). Oxford University Press.
- Haigh, T., Morton, L. W., Lemos, M. C., Knutson, C., Prokopy, L. S., Lo, Y. J., & Angel, J. (2015). Agricultural advisors as climate information intermediaries: Exploring differences in capacity to communicate climate. *Weather, Climate, Society Natural Resources*, 7(1), 83–93.
- Haile, M. (2005). Weather patterns, food security and humanitarian response in sub-Saharan Africa. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 360(1463), 2169–2182.
- Haines, S. (2019). Managing expectations: Articulating expertise in climate services for agriculture in Belize. *Climatic Change*, 157(1), 43–59.
- Hale, C. R. (1994). Between Che Guevara and the Pachamama: Mestizos, Indians and identity politics in the anti-quincentenary campaign. *Critique of Anthropology*, 14(1), 9–39.
- Hale, C. R. (2002). Does multiculturalism menace? Governance, cultural rights and the politics of identity in Guatemala. *Journal of Latin American Studies*, 34(3), 485–524.
- Hansen, J. W., Zebiak, S., & Coffey, K. (2014). Shaping global agendas on climate risk management and climate services: an IRI perspective. *Earth Perspectives*, 1(1), 1–12.
- Harari, Y. N. (2014). Sapiens: A Brief History of Humankind. McClelland & Stewart. https://www.penguinrandomhouse.ca/books/237149/sapiens-by-yuval-noahharari/9780771038518

- Harjanne, A. (2017). Servitizing climate science—Institutional analysis of climate services discourse and its implications. *Global Environmental Change*, 46, 1–16.
- Harvey, D. (2006). The Limits to Capital. Oxford: Blackwell.
- Herbert, S. (2000). For ethnography. Progress in Human Geography, 24(4), 550–568.
- Hernández-Quevedo, M., Navarro-Racines, C., Ajquejay, S., Giraldo, D., & Ramírez-Villegas, J. (2022). Monitoreo y evaluación de las Mesas Técnicas Agroclimáticas (MTA) en Guatemala.
- Hetherington, K. (2020). Agribiopolitics: The health of plants and humans in the age of monocrops. *EPD: Society and Space*, *38*(4), 682–698.
- Hewitt, C., Buontempo, C., & Newton, P. (2013). Using climate predictions to better serve society's needs. *Eos, Transactions American Geophysical Union*, *94*(11), 105–107.
- Hewitt, C., Mason, S., & Walland, D. (2012). The global framework for climate services. *Nature Climate Change*, *2*(12), 831.
- Holt-Giménez, E. (2011). Food security, food justice, or food sovereignty. *Cultivating Food Justice: Race, Class, Sustainability*, 309–330.
- ICTA. (2013). Recomendaciones técnicas para el cultivo de maíz en la Franja Transversal del Norte de Guatemala.
- ICTA. (2015a). Recomendaciones técnicas para el cultivo de maíz en el altiplano central.
- ICTA. (2015b). Recomendaciones técnicas para el cultivo de maíz en el oriente de Guatemala.
- Ingram, J., Ericksen, P., & Liverman, D. (2012). *Food security and global environmental change*. Routledge.
- Jonas, A. E. G. (2006). Pro Scale: Further Reflections on the "Scale Debate" in Human Geography. *Royal Geographical Society*, *31*(3), 399–406.
- Joras, U. (2007). The role of the private business sector in peace negotiations. Lessons from Guatemala. *Security and Peace*, *25*(4), 177–183.

- Keele, S. (2019). Consultants and the business of climate services: implications of shifting from public to private science. *Climatic Change*, *157*(1), 9–26.
- Knudson, C., & Guido, Z. (2019). The missing middle of climate services: Layering multiway, two-way, and one-way modes of communicating seasonal climate forecasts. *Climatic Change*, 157(1), 171–187.
- Koselleck, Reinhart. (2004). Futures past: on the semantics of historical time. Columbia University Press.
- Kreft, S., Eckstein, D., Junghans, L., Kerestan, C., Hagen, U., & Germanwatch. (2014). Global climate risk index 2015: Who suffers most from extreme weather events? Weather-related loss events in 2013 and 1994 to 2013. Germanwatch.
- Kurniawan, J. H., & Kundurpi, A. (2018). Integrating human geography into futures studies: Reconstructing and reimagining the future of space. *Geography Compass*, 1– 12.
- Lahsen, M. (2004). Transnational locals: Brazilian experiences of the climate regime. *Earthly Politics: Local Global in Environmental Governance*, 151–172.
- Larner, W. (2000). Neo-liberalism: Policy, ideology, governmentality. *Studies in Political Economy*, 63(1), 5–25.
- Larosa, F., & Mysiak, J. (2020). Business models for climate services: An analysis. *Climate Services*, *17*, 100111. https://doi.org/https://doi.org/10.1016/j.cliser.2019.100111
- Latour, B. (2005). First Move: Localizing the Global. In *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford University Press.
- Laurier, E. (2010). Participant Observation. In N. Clifford, S. French, & G. Valentine (Eds.), *Key Methods in Geography* (Second Edition, pp. 116–130). SAGE.
- Lefebvre, H. (2004). *Rhythmanalysis: Space, Time and Everyday Life* (S. Elden & G. Moore, Eds.). Continuum.

- Lemos, M. C., Finan, T. J., Fox, R. W., Nelson, D. R., & Tucker, J. (2002). The use of seasonal climate forecasting in policymaking: lessons from Northeast Brazil. *Climatic Change*, 55(4), 479–507.
- Lemos, M. C., Lo, Y.-J., Kirchhoff, C., & Haigh, T. (2014). Crop advisors as climate information brokers: Building the capacity of US farmers to adapt to climate change. *Climate Risk Management*, 4, 32–42.
- Li, T. M. (2007). The will to improve. Duke University Press.
- Lipsky, M. (1980). *Street-level bureaucracy: Dilemmas of the individual in public services*. Russell Sage Foundation.
- Liverman, D. (2018). Geographic perspectives on development goals: Constructive engagements and critical perspectives on the MDGs and the SDGs. *Dialogues in Human Geography*, 8(2), 168–185.
- Loboguerrero, A. M., Boshell, F., León, G., Martinez-Baron, D., Giraldo, D., Mejía, L. R., Díaz, E., & Cock, J. (2018). Bridging the gap between climate science and farmers in Colombia. *Climate Risk Management*, 22, 67–81.
- Longhurst, R. (2010). Semi-structured Interviews and Focus Groups. In N. Clifford, S. French, & G. Valentine (Eds.), *Semi-structured Interviews and Focus Groups* (Second Edition, pp. 103–115). Sage.
- Lourenço, T. C., Swart, R., Goosen, H., & Street, R. (2016). The rise of demand-driven climate services. *Nature Climate Change*, *6*(1), 13–14.
- Lowe, R., Stewart-Ibarra, A. M., Petrova, D., García-Díez, M., Borbor-Cordova, M. J., Mejía, R., Regato, M., & Rodó, X. (2017). Climate services for health: Predicting the evolution of the 2016 dengue season in Machala, Ecuador. *The Lancet Planetary Health*, 1(4), e142–e151. https://doi.org/https://doi.org/10.1016/S2542-5196(17)30064-5
- Lynch, P. (2008). The origins of computer weather prediction and climate modeling. *Journal of Computational Physics*, 227(7), 3431–3444.

- Madhuri. (2023). How do climate information services (CIS) affect farmers' adaptation strategies? A systematic review. *Climate Services*, *32*.
- Marston, S. A., Jones, J. P., & Woodward, K. (2005). Human geography without scale. *Transactions of the Institute of British Geographers*, 30, 416–432.
- Martínez Peláez, S. (2009). *La Patria del Criollo* (W. G. Lovell & C. H. Lutz, Eds.). Duke University Press.
- McCann, E., & Ward, K. (2012). Assembling urbanism: Following policies and "studying through" the sites and situations of policy making. *Environment and Planning A*, 44, 42–51.
- Mccormack, D. P., & Schwanen, T. (2011). Guest editorial: The space-times of decision making. *Environment and Planning A*, 43(12), 2801–2818. https://doi.org/10.1068/A44351
- McMichael, P. (2009). A food regime genealogy. *The Journal of Peasant Studies*, 36(1), 139–169.
- McMichael, P. (2013). Food Regimes and Agrarian Questions. Practical Action Publishing. www.jstor.org/stable/j.ctt1hj553s
- McMichael, P. (2020). Does China's 'going out' strategy prefigure a new food regime? *The Journal of Peasant Studies*, 47(1), 116–154.
- Meadows, D. H. (2009). Thinking in Systems (D. Wright, Ed.). Earthscan.
- Millman, S., & Kates, R. (1990). Toward Understanding Hunger. In L. Newman (Ed.), Hunger in History: Food Shortage, Poverty, and Deprivation (edts, pp. 3–24). Basil Blackwell.
- Ministerio de Agricultura, G. y A. (2016). Plan Estratégico Institucional 2016-2021.
- Ministerio de Agricultura, G. y A. (2021). Plan Estratégico Institucional 2021 2026.
- Mitchell, T. (2002). *Rule of experts: Egypt, techno-politics, modernity*. Univ of California Press.

- Morales, H., Perfecto, I., & Ferguson, B. (2001). Traditional fertilization and its effect on corn insect populations in the Guatemalan highlands. *Agriculture, Ecosystems and Environment*, 84(2), 145–155. https://doi.org/10.1016/S0167-8809(00)00200-0
- Muller, J. C. Y. (2014). Adapting to climate change and addressing drought learning from the Red Cross Red Crescent experiences in the Horn of Africa. *Weather and Climate Extremes*, 3, 31–36. https://doi.org/https://doi.org/10.1016/j.wace.2014.03.009
- Navarro-Racines, C., Zúñiga, A., Ajquejay, S., Muñoz, Á., González-Romero, C., Ríos,
 D., Giraldo, D., & Ramírez-Villegas, J. (2020). Desarrollo de un instrumento de monitero y evaluacion para las Mesas Técnicas Agroclimáticas (MTA) en Guatemala.
- Nelson, D. M. (2010). Reckoning the after/math of war in Guatemala. *Anthropological Theory*, *10*, 87–95.
- Neumann, R. P. (2009). Political ecology: Theorizing scale. *Progress in Human Geography*, 33(3), 398–406. https://doi.org/10.1177/0309132508096353
- Newman, L. F., & Crossgrove, W. C. (1990). *Hunger in history: food shortage, poverty, and deprivation.*
- Nost, E. (2019). Climate services for whom? The political economics of contextualizing climate data in Louisiana's coastal Master Plan. *Climatic Change*, *157*(1), 27–42.
- Oficina de Derechos Humanos del Arzobispado, J. D. Informe. S. de la niñez en G. (2005). Hambre siempre ha habido... Desarrollo, empobrecimiento y hambre en la región Ch'orti'. RCT.
- Oglesby, E. (2013). "We're No Longer Dealing with Fools": Violence, Labor, and Governance on the South Coast. In C. McAllister & D. Nelson (Eds.), *War by other means: Aftermath in post-genocide Guatemala*. Duke University Press.
- Paparrizos, S., Dogbey, R. K., Sutanto, S. J., Gbangou, T., Kranjac-Berisavljevic, G., Gandaa, B. Z., Ludwig, F., & van Slobbe, E. (2023). Hydro-climate information services for smallholder farmers: FarmerSupport app principles, implementation, and evaluation. *Climate Services*, 30.

- Pelling, M. (2011). Adaptation to climate change: from resilience to transformation. Routledge.
- Perrels, A., Le, T.-T., Cortekar, J., Hoa, E., & Stegmaier, P. (2020). How much unnoticed merit is there in climate services? *Climate Services*, 17, 100153. https://doi.org/https://doi.org/10.1016/j.cliser.2020.100153
- Pietilainen, E. P., & Otero, G. (2018). Power and dispossession in the neoliberal food regime: oil palm expansion in Guatemala. *The Journal of Peasants Studies*, 46(6), 1142–1166. https://doi.org/10.1080/03066150.2018.1499093
- Prado-Córdova, J. P. (2011). The foundation of hunger perpetuation in Guatemala. *Agricultura, Sociedad y Desarrollo, 8*(1), 79–88. https://www.google.com/search?q=el+sustrato+jose+pablo+prado&rlz=1C1CHBF_ enCA856CA856&oq=el+sustrato+jose+pablo+prado&aqs=chrome..69i57j33i160l2. 6054j0j9&sourceid=chrome&ie=UTF-8
- Prado-Córdova, J. P., & Bailey, D. (2021). Forum introduction: Decolonising green Marxism: Capitalism, decolonialism and radical environmental politics. *Capital & Class*, 45(1), 3–9.
- Rioux, S. (2015). Mind the (theoretical) gap: On the poverty of international relations theorising of uneven and combined development. *Global Society*, *29*(4), 481–509.
- Rioux, S. (2018). Rethinking food regime analysis: An essay on the temporal, spatial and scalar dimensions of the first food regime. *The Journal of Peasant Studies*, 45(4), 715–738.
- Rivero Jiménez, B., Conde Caballero, D., Pedret Massanet, C., López-Lago Ortiz, L., García Arias, M. A., & Mariano Juárez, L. (2021). Malnutrition, stunting, development and evidence generation in Guatemala: a systematic review. *Journal of Development Effectiveness*, 13(4), 343–359. https://doi.org/10.1080/19439342.2021.1953567

- Rocha, J. L. (2020). El capitalismo globalizado que se instala en la Guatemala del siglo
 XXI. In *Perfil sobre dinámicas globales y territoriales: Desequilibrios* (1st ed., pp. 1–438). Editorial Cara Parens.
- Rocha, J. L. (2023). *Populismos del siglo XXI en Centroamérica: El Salvador y Nicaragua*. UCA Editores.
- Rose, G. (2001). Visual methodologies: an introduction to the interpretation of visual materials. Sage.
- Sain, G., Loboguerrero, A. M., Corner-Dolloff, C., Lizarazo, M., Nowak, A., Martínez-Barón, D., & Andrieu, N. (2017). Costs and benefits of climate-smart agriculture: The case of the Dry Corridor in Guatemala. *Journal of Agricultura Systems*, 151, 163– 173.
- Schirmer, J. (2010). *The Guatemalan military project: A violence called democracy*. University of Pennsylvania Press.
- Semazzi, F. (2011). Framework for climate services in developing countries. *Climate Research*, 47(1–2), 145–150.
- Shiva, V. (2019). Oneness Vs the 1%: Shattering Illusions, Seeding Freedom. New Internationalist.
- Shriar, A. J. (2002). Food security and land use deforestation in northern Guatemala. Food Policy, 27(4), 395–414.
- Singer, E. G., Green, G. P., & Gilles, J. L. %J S. R. (1983). *The Mann-Dickinson thesis:* reject or revise? 23(3-4), 276–287.
- Sistema Guatemalteco de Ciencias del Cambio Climático. (2019). (SGCCC). In *Primer reporte de evaluación del conocimiento sobre cambio climático en Guatemala*. Editorial Universitaria UVG.
- Skelton, M., Fischer, A. M., Liniger, M. A., & Bresch, D. N. (2019). Who is 'the user' of climate services? Unpacking the use of national climate scenarios in Switzerland

beyond sectors, numeracy and the research-practice binary. *Climate Services*, 15, 100113. https://doi.org/https://doi.org/10.1016/j.cliser.2019.100113

- Snipstal, B. (2015). Repeasantization, agroecology and the tactics of food sovereignty. *Canadian Food Studies*, 2(2), 164–173.
- Solano Garrido, A. L., & Ochoa, W. (2019). Agricultura y seguridad alimentaria. In E. J. Castellanos, A. Paiz-Estévez, J. Escribá, M. Rosales-Alconero, & A. Santizo (Eds.), *Primer reporte de evaluación del conocimiento sobre cambio climático en Guatemala* (pp. 108–141). Editorial Universitaria UVG.
- Stock, R., & Gardezi, M. (2021). Make bloom and let wither: Biopolitics of precision agriculture at the dawn of surveillance capitalism. *Geoforum*, *122*, 193–203.
- Stoddard, E. (2015). Neoliberal governance and environmental risk: 'normal accidents' in North Carolina's hog industry. In *Political Ecologies of Meat* (pp. 159–180). Routledge.
- Sultana, F. (2022). The unbearable heaviness of climate coloniality. *Political Geography*, 99. https://doi.org/10.1016/J.POLGEO.2022.102638
- Taddei, R. (2012). The politics of uncertainty and the fate of forecasters. *Ethics, Policy & Environment*, 15(2), 252–267.
- Takács-György, K., & Takács, I. (2022). Towards climate smart agriculture: How does innovation meet sustainability? *Ecocycles*, 8(1), 61–72.
- Tall, A., Coulibaly, J. Y., & Diop, M. (2018). Do climate services make a difference? A review of evaluation methodologies and practices to assess the value of climate information services for farmers: Implications for Africa. *Journal of Climate Services*, 11, 1–12.
- Temenos, C., & McCann, E. (2012). The local politics of policy mobility: learning, persuasion, and the production of a municipal sustainability fix. *Environment and Planning A*, 44, 1389–1406.

- Temenos, C., & McCann, E. (2013). Geographies of Policy Mobilities. *Geography Compass*, 7(5), 344–357.
- Tracy, S. J. (2020). *Qualitative Research Methods: collecting evidence, crafting analysis, communicating impact* (Second Edition). WILEY Blackwell.
- Tsing, A. L. (2005). *Friction: An ethnography of global connection*. Princeton University Press.
- United Nations Development Programme. (2012). Alimentos Nutri-Naturales, Guatemala.
- van Huysen, T., Hansen, J., & Tall, A. (2018). Scaling up climate services for smallholder farmers: Learning from practice. *Climate Risk Management*, 22, 1–3. https://doi.org/https://doi.org/10.1016/j.crm.2018.10.002
- Vaughan, C., Buja, L., Kruczkiewicz, A., & Goddard, L. (2016). Identifying research priorities to advance climate services. *Climate Services*, 4.
- Vaughan, C., & Dessai, S. (2014). Climate services for society: origins, institutional arrangements, and design elements for an evaluation framework. *Wiley Interdisciplinary Reviews: Climate Change*, 5(5), 587–603.
- Vaughan, C., Muth, M. F., & Brown, D. P. (2019). Evaluation of regional climate services: Learning from seasonal-scale examples across the Americas. *Climate Services*, 15, 100104. https://doi.org/https://doi.org/10.1016/j.cliser.2019.100104
- Velásquez Nimatuj, I. A. (2016). Struggles and obstacles in Indigenous women's fight for justice in Guatemala. *LLILAS Benson Latin American Studies and Collections*. https://doi.org/10.15781/T2Q52FV8H
- Vincent, K., Daly, M., Scannell, C., & Leathes, B. (2018). What can climate services learn from theory and practice of co-production? *Climate Services*, 12, 48–58. https://doi.org/https://doi.org/10.1016/j.cliser.2018.11.001
- Watson, M. K. (1978). The Scale Problem in Human Geography. Geografiska Annaler: Series B, Human Geography, 60(1), 36–47. https://doi.org/10.1080/04353684.1978.11879429

- Webber. (2019). Putting climate services in contexts: advancing multi-disciplinary understandings: introduction to the special issue. Springer.
- Webber, S. (2015). *Adaptation ecologies: circuits of climate change finance, policy, and science in the Pacific Islands*. University of British Columbia.
- Weis, T. (2010). The accelerating biophysical contradictions of industrial capitalist agriculture. *Journal of Agrarian Change*, *10*(3), 315–341.
- Wittman, H. (2009). Reworking the metabolic rift: La Vía Campesina, agrarian citizenship, and food sovereignty. *The Journal of Peasant Studies*, 36(4), 805–826. https://doi.org/10.1080/03066150903353991
- Woolley, C. (2009). Meeting the mixed methods challenge of integration in a sociological study of structure and agency. *Journal of Mixed Methods Research*, *3*(1), 7–25.

World Meteorological Organization. (n.d.). Compendium of GFCS Projects.

- World Meteorological Organization. (1974). WMO Bulletin: Vol. XXIII (Issue 3).
- World Meteorological Organization. (1977). WMO Bulletin: Vol. XXVI (Issue 1).
- World Meteorological Organization. (2010). WMO Bulletin (Vol. 59, Issue 1). https://library.wmo.int/viewer/58807/?offset=#page=1&viewer=picture&o=bookma rk&n=0&q=
- World Meteorological Organization. (2011). Climate knowledge for action: A global framework for climate services—Empowering the most vulnerable. In WMO (Vol. 1065). WMO.
- World Meteorological Organization. (2012). World Meteorological Congress: Extraordinary session.
- World Meteorological Organization. (2013a). *Regional Workshop on Climate Services at the National Level for the Caribbean*. WMO.
- World Meteorological Organization. (2013b). Stakeholder Consultation on Climate Services in Belize-Agriculture and Food Production. WMO.

- World Meteorological Organization. (2014a). Annex to the Implementation Plan of the Global Framework for Climate Services User Interface Platform Component. In *GFCS-Global Framework for Climate Services*. WMO.
- World Meteorological Organization. (2014b). Development of the Global Framework for Climate Services at the national level. WMO. https://library.wmo.int/doc_num.php?explnum_id=4335
- World Meteorological Organization. (2014c). Implementation Plan of the Global Framework for Climate Services. In GFCS-Global Framework for Climate Services. WMO.
- World Meteorological Organization. (2014d). Report of National Stakeholders Consultation on Global Framework for Climate Services for Dominica (GFCS, Ed.).
- World Meteorological Organization. (2014e). Report of National Stakeholders Consultation on Global Framework for Climate Services for Dominica (GFCS, Ed.).
- World Meteorological Organization. (2014f). Report on the National Consultation Workshop for the Global Framework for Climate Services (GFCS) Adaptation Project in Malawi. WMO.
- World Meteorological Organization. (2014g). *Taller regional en servicios climáticos a nivel nacional para América Latina* (GFCS, Ed.).
- World Meteorological Organization. (2016). Taller regional sobre servicios climáticos de iberoamérica: Hacia la explotación del mayor potencial de los servicios climáticos.
 WMO.
- World Meteorological Organization. (2018). Consultative Workshop on National Framework on Climate Services in Ethiopia. World Meteorological Organization.
- World Meteorological Organization. (2019). Concept note: Establishment of the Sierra Leone National Framework for Climate Services. WMO.
- World Meteorological Organization. (2020). Global Framework for Climate Services: Progress Report 2009-2019. WMO.

- Yap, C. (2023). New geographical directions for food systems governance research. *Progress in Human Geography*, 47(I), 66–84.
- Ybarra, M. (2018). *Green wars: conservation and decolonization in the Maya forest*. University of California Press.