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Good data are not enough: Understanding limited information use for climate risk and food security management in Guatemala

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ABSTRACT

Climate extremes are one of the main drivers of acute food insecurity. In Guatemala, acute food insecurity reaches alarming levels when the usual dry period during the bimodal rainy seasons is extended or starts earlier than expected. Drought has a slow-onset which theoretically leaves sufficient lead-time for addressing impacts on food security. In practice, emergency response to drought is often reactive and arrives late, starting when the crisis is already evolving. Climate services and food security information systems are key ingredients for integrated climate risk and food security management worldwide. In Guatemala, stakeholders broadly agree on the usefulness of this type of information for decision-making and direct significant efforts towards improving information availability and quality. But the impact of agro-climatic and food security information on decisions is *ad hoc* or not systematic. Through a mix of qualitative, ethnographic, and participatory methods, we investigated why this situation occurs. We found that different aspects lead to this phenomenon: the impact of drought on food security is mediated by different socio-economic, political, and institutional factors that tend to differ strongly between regions or even communities across the country. This puts special requirements on information provision for decision-making. Information use patterns can be explained by technical, data-related aspects as reliability, timeliness, or accessibility. But only by considering the institutional and organizational context we get a complete understanding on what frames the information-use patterns in climate and food security management in Guatemala. Our research shows that investments in technical aspects of data provision and infrastructure for increased climate and food security management need to address institutional and organizational challenges in order to be effective.

1. Introduction

Seasonal climatic conditions and climate variability can severely affect food and nutrition security. Effective and dynamic management of climate risks for food and nutrition security needs improved data and information for decision-making ([Coughlan De Perez](#)

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and Mason, 2014; Enenkel et al., 2015b; Pulwarty and Sivakumar, 2014). Many organizations around the world are developing and improving information for food security management, yet often the information is on a coarse scale to inform donors for humanitarian response and assistance (Mock, Morrow, & Papendieck, 2013). Different efforts are attempting to overcome these shortcomings to better inform national and local decision-making.

In Guatemala, periods of acute food and nutrition insecurity related to climatic patterns occur frequently with significant impact on small-scale farm families (Food Security Information Network, 2018). In 2019, more than 3 million Guatemalans were in a critical food security situation (Food Security Information Network, 2020). Multiple actors are investing in the improvement of information provision for better climate and food security management and emergency response. Several organizations collect, collate, interpret, and provide agro-climatic and food security information. But we have observed that despite the substantial effort on improving information provision, this information has a limited and unsystematic influence on decision-making and policy implementation for climate risk and food security management. Here, we attempt to explain this paradox.

One possible explanation of the gap between availability and use of information is the mismatch with the needs of information users, requiring a more tailored approach (Enenkel et al., 2015a; Moss et al., 2016). The determining factors of climate information use for decision-making in different sectors as agriculture or water management have been relatively well understood (Lach and Rayner, 2017; Lemos et al., 2012; Rayner et al., 2005; Saylor Mase and Prokopy, 2014; Soares and Dessai, 2016). Food and nutrition security are complex, embracing multiple dimensions. Adequate management and response need contextualized analysis to consider causal interdependencies (Mock et al., 2013). This includes information on climatic aspects, but also on agricultural and socioeconomic indicators. In the literature explaining climate information use for decision-making, little attention has been paid to the use of climate and food security information for managing food insecurity.

Patterns of information use can be explained through characteristics of the information itself (accuracy, credibility, salience, timeliness) and the process of production of the information (Lemos, 2015). But a sole focus on technical explanations might fall short in explaining climate and food security information use as it does not consider the role of context, institutions, organizational culture and norms ins shaping decision-makers behavior (Flagg and Kirchhoff, 2018; Saylor Mase and Prokopy, 2014; Vogel and ÓBrian, 2006). For example, Rayner et al. (2005) use an institutionalist perspective to explain why US water managers hardly use weather forecasts, demonstrating how institutions and organizational culture influence information use. The role of contextual and institutional factors shaping information use for climate risk management is gaining increased attention but requires more in-depth research to understand important dimensions in different settings and cases (Flagg and Kirchhoff, 2018). Such understanding is needed as investments in better food security information systems might have little effect, unless they contribute to contextual or institutional changes that will foster information use in decision-making. To examine patterns of information use for climate risk and food security management, we conducted an in-depth, multi-year case study in Guatemala. We used multiple sources of qualitative and quantitative data to build a picture of information usage patterns referring to two different frameworks, one referring to the institutional determinants of information use in decision-making (Thompson and Wildavsky, 1986) and the other referring to different dimensions of data quality (Wang and Strong, 1996). This allows to consider data-related and contextual and institutional aspects.

The paper is structured as follows. We start with a presentation of the data collection and analysis approach in chapter 2, explaining the different sources and how we triangulate the different data and information. This is followed by two contextual chapters that give an insight into the food security situation in relation to climatic factors in Guatemala and into the information management strategy of

Table 1
Details on data collection activities.

Type	Information	Respondents/Participants
1. Survey, convenience sample	Information preferences, information use, decisions that should be supported by information using different food security scenarios	33 respondents from different public sector organizations and NGOs from municipal and central level
2. Semi-structured interviews, purposeful and snowball sampling	Information use at the municipal level, decision to be supported, rating and evaluation of the existing information	22 respondents from public sector organizations at the municipal level
3. Semi-structured interviews, purposeful and snowball sampling	Stakeholder-based evaluation of existing information products	40 decision-makers from public and international organizations, central and municipal level (see Bouroncle et al., 2019; Bouroncle et al., 2017)
4. Semi-structured interviews, purposeful and snowball sampling	Understand decision-making processes, budgeting and use of forecasts for public planning in selected municipalities if the Guatemalan dry corridor	45 decision-makers and technical staff from municipal organizations, mainly MAGA, Mayors and Community Council members
5. Workshops	Decision-making cycles, co-design and prototyping of information products and information system,	Around 80 participants in 4 workshops, mainly from SESAN central and municipal level, but also other public institutions
6. Roundtables	Discussions on which data are needed, problems of the existing data system, barriers to data use	From public institutions, NGOs and international organizations
7. Meetings	Personalized meetings among project partners and SESAN to understand problems and needs, to coordinate activities	SESAN delegates, mostly central level
8. Secondary data and reports	Main source was www.reliefweb.int, depository for reports from official governmental and non-governmental sources on crises and disasters.	

the government in relation to this in chapter 3. In chapter 4, we describe with a concrete example, how food security responses are influenced (or not) by the information available to decision maker. We then analyze decision making and information use in more detail in chapter 5. The paper closes with concluding remarks in chapter 6.

2. Data collection and analysis

We used an in-depth, longitudinal case study approach that enables us to explore complex linkages in a situation that evolved over time. Throughout the case study, we used a mix of quantitative and qualitative research techniques according to data availability, contextual factors, and specific research interest. All information and data used in this research was generated throughout a project on the development of an agro-climatic and food security information system for the Secretariat for Food and Nutrition Security (SESAN) from 2015 through 2018. This project was financed by the CGIAR program on Climate Change, Agriculture and Food Security and was implemented with the support of the Tropical Agriculture Research and Higher Education Center and *Acción contra el Hambre* (ACH). During the project we addressed different research questions (e.g. about the usability of information products (see Bouroncle et al., 2019) or decision-makers information preferences (unpublished thesis by Granados, 2017)). This research uses the different data and information collected to address our specific research question.

We used a mix of different data collection methods as outlined in Table 1. Most of the data collected during the project period focused on Guatemala City, the capital, and the Department of Chiquimula. This area forms part of the so-called Guatemalan Dry Corridor, where climate-related acute undernutrition is especially of concern. Firstly, much of the data were collected through participatory observation during the project activities as field trips, stakeholder workshops, and project meetings.

Secondly, more structured data came from one survey and three rounds of semi-structured interviews to get a more systematic understanding of information use and needs, and to evaluate existing information products. During the course of the project and the different research activities, we interviewed around 140 central and municipal level decision-makers and technical staff from the public sector, NGOs and international donors relevant for food security (see Table 1).

Thirdly, we used secondary data and official reports from the government and non-governmental actors to complement our data collection efforts. For both, qualitative and quantitative data we applied a non-random sampling approach as the idea of a case study is to dive deep into purposefully selected few cases in order to explore patterns (Gobo, 2004).

We applied a mix of stratified purposeful and snowball sampling to select respondents. Systematic selection criteria were developed and included for example professional occupation, geographical location, and experience in the topic.

To analyze the data, we applied simple descriptive techniques to the quantitative data. We applied content analysis to the qualitative data, for some of the contents applying computer-assisted qualitative data analysis using the R package RQDA (Chandra and Shang, 2017). Content analysis allows to identify concepts, patterns or relationships that describe the phenomenon under study (Elo and Kyngäs, 2008). We used document analysis to analyze secondary, mostly unstructured data coming from official reports (data type 8 in Table 1). We used a deductive approach (going from the general to the more specific) parting from the model of data quality developed by Wang and Strong (1996), explained in chapter 5, to explore patterns of data quality. We used an inductive approach for exploring the role of contextual factors as we did not identify an adequate conceptual framework.

2.1. Context: Food security and drought in Guatemala

Seasonal hunger is a recurring phenomenon in Guatemala and the level of acute food insecurity, especially among children under 5 years, is alarmingly high (Food Security Information Network, 2018). Acute undernutrition is related to the occurrence of an extended dry spell that coincides with a critical phase for crop development in staple grain production (FAO and ACH, 2012). This so-called *cánicula* occurs between the two rainfall peaks in the bimodal annual rainfall pattern and is related to the ENSO-cycle (Magaña et al., 1999). During the *El Niño* phase of the ENSO cycle, the onset and duration of the dry-spell changes significantly: it may start earlier and last longer than normally expected by farmers. Since small-scale producers rely much on their own grain production, dry periods directly affect food security, but also indirectly through the potential impact on food prices or the availability of off-farm employment. Extended dry spells occur with increasing frequency and over an expanded area in recent years (Acción contra el Hambre, 2015a).

Drought has a slow onset, which in theory would leave sufficient lead time for preparation and response. Acute food insecurity usually does not come by surprise. Seasonal climate forecasts of drought based on ENSO are increasingly reliable and make it possible to anticipate drought occurrence (Palmer and Weisheimer, 2012). We also observed an increase in information available that could support the proactive management of climate-related food security problems.

In spite of the increasing skill of seasonal climate forecasts, it is still difficult to predict the onset, duration, and exact location of droughts (Enenkel et al., 2015a). A clear definition or typology of drought is still lacking in Guatemala and many other contexts. Even though the relationship between drought and food security is clear, the impacts of different types of drought on socio-economic indicators and food security is not straightforward (Enenkel et al., 2015a) and is mediated by several factors as for example availability of off-farm labor, food prices, out-migration and remittances (Hedlund, 2007). So, despite the long lead time, the effect of drought on food security is surrounded by a degree of uncertainty that makes decision-making far from straightforward.

2.2. Context: Food security information management in Guatemala

Over the last ten years, Guatemala has seen significant effort from public and international actors to improve the regulatory

framework for food security and climate risk management in Guatemala. In 2008, the National Food and Nutrition Security System (SINASAN) was established by law as the institutional framework to strategically organize and coordinate all food and nutrition security related activities by public, private and non/governmental actors in the country (Gobierno de Guatemala, 2008). The main objective of SINASAN is to impulse interventions to eradicate food insecurity and implement the national food and nutrition security policy. As shown in Fig. 1, the SINASAN integrates different administrative levels: the National Council for Food and Nutrition Security (CONASAN) is the governing body, comprised of the ministers of all Ministries related to food and nutrition security and the Vice-president (Gobierno de Guatemala, 2008). The CONASAN impulses policies and actions supporting food and nutrition security in Guatemala. SESAN is the coordination body of the SINASAN and responsible for technical planning and coordinating and articulating all national and international actors working in food and nutrition security present in the country. There are food and nutrition security councils at the department (CODESAN), municipal (COMUSAN) and community level (COCOSAN), although the law doesn't specify their functions within the SINASAN. The system has a hierarchical structure and follows a linear model where information flows from the local to the national level and the decisions are made in a top-down manner. The system has a weak integration of actors outside the public sphere and does not foresee these interactions for information exchange and decision-making.

The 2008 Law states different objectives to reach food and nutrition security. The objectives are defined around the four pillars of food and nutrition security: food availability, access to food, utilization, and stability over time. As one mechanism for monitoring, evaluation and early warning, the law foresees the development of a National Food Security Information System (SIINSAN) that is coordinated by SESAN. Different public institutions and organizations are supposed to feed information into the system. A main contributor outside the SESAN is the Ministry of Public Health (MSPAS). The data coming from these different actors is openly accessible at www.siinsan.gob.gt. The platform integrates the different monitoring schemes for acute and chronic undernutrition, for pregnant women and children under two in public health centers and monitoring of the food and nutrition related activities. Most of the information available on the platform are performance indicators (e.g. how many health centers are operating; how many doses of supplements are available etc.). PronósticoSAN, the food security outlook generated by SESAN in coordination with a network of government and non-governmental actors, is available for download.

Recognizing the information problem for early response to acute undernutrition in Guatemala and responding to its legal obligation to implement an early warning system, SESAN adopted in 2014 a community-based monitoring and early warning system based in sentinel communities (Secretaría de Seguridad Alimentaria y Nutricional, 2014). The method was initially developed by ACH (2013).

SESAN and different international NGOs implemented the system in prioritized municipalities. Local food security committees (COCOSAN) were supposed to provide information on relevant indicators related to seasonal hunger, such as rainfall, damage and loss in staple crops, undernutrition, or off-farm labor opportunities (Acción contra el Hambre, 2013). This information was integrated into the SIINSAN to support decision-making at different levels. Eventually, the system lost government support after a political change in 2016 and was discontinued in practice. In 2018, SESAN adopted an improved community information system with national coverage that was co-developed with the support of our project. The system provides local information to decision-makers at the municipal and national level.

3. Drought and food security response, 2014–2015

To understand the complexities that surround decision-makers when it comes to food security management, we reconstructed the response of the Guatemalan government to the 2014–2015 droughts and resulting food insecurity. We analyzed official reports from the Government, international organizations like FAO or World Food Programme, and NGOs like Oxfam or ACH (see data type 8 in

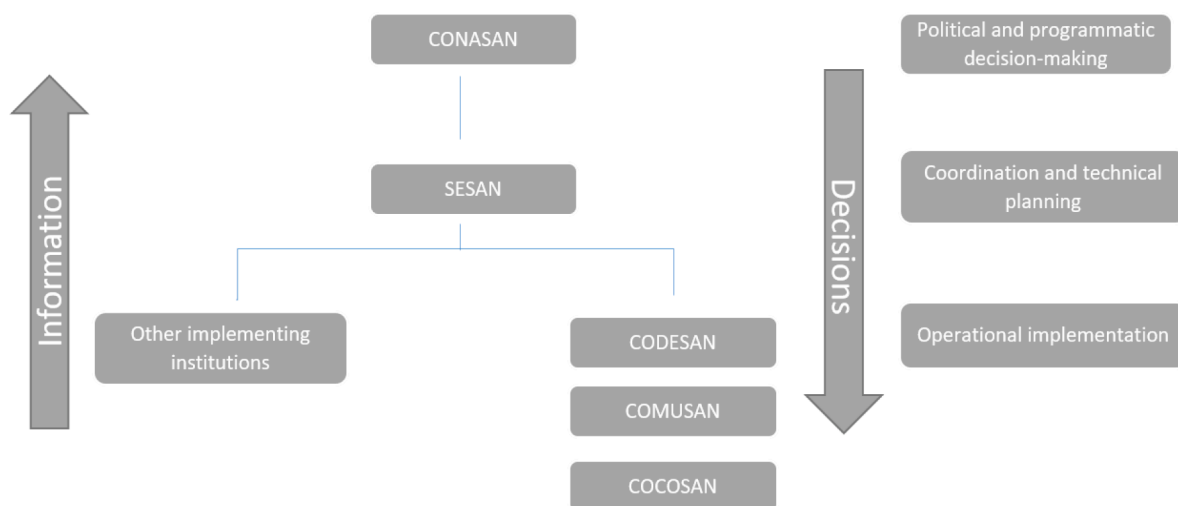


Fig. 1. Model showing information flow and decision-making in the SINASAN.

Table 1).

In 2014, after several years of irregular rainfall, Guatemala experienced an early-onset *canícula* with an unusual long duration, resulting in a poor agricultural harvest (Acción contra el Hambre, 2015b). In August 2014, the government realized a country-wide agriculture loss and damage assessment (Gobierno de Guatemala, 2014). More than 20% of the surveyed families experienced partial or total losses. In more than 50% of the communities, farmers did not have enough inputs (mainly seeds) to produce in the next season (Gobierno de Guatemala, 2014).

Guatemala declared a state of emergency (Diario de Centro América, 2014). This allowed the government to access emergency funds and triggered a response by the international community. Although the unusual *canícula* was the event that triggered the alarms, the deterioration of the food security situation was related to a more complex interplay of factors. In 2014, food grain reserves were almost exhausted due to low harvests in the previous years. Central America was experiencing a serious crisis in the coffee sector due to the coffee rust epidemic, which reduced coffee harvest by 10–16% and thus reduced the employment rate in the coffee sector (Avelino et al., 2015). Off-farm employment in the coffee sector is a relevant coping strategy for communities in the lean period (FAO and ACH, 2012). Missing off-farm employment affected the already weak household economy in the drought-affected regions (World Food Programme, 2015). At the same time, the Guatemalan state was not able to provide basic health care. Many public health centers were not operating at all or with low resources, unable to fulfill their functions in providing proper attention to acute malnutrition cases (ACH, 2015a). The Guatemalan government had to admit difficulties in funding the attention of the food security crisis (Prensa Libre, 2014).

In 2015, persistent *El Niño* conditions suggested there was a high probability of an extended *canícula*, and the food security situation was not expected to improve (Secretaría de Seguridad Alimentaria y Nutricional, 2015). After the 2014 crisis, families did not have the possibility to recover and many had depleted their food stocks and household and farm assets (WFP, 2015). An estimated 70% of the farmers were not able to undertake the investment needed for sowing in the following season (Aguilar et al., 2014).

The reduced availability of off-farm employment opportunities continued, while prices of basic food items rose (WFP, 2015). The WFP estimated 1.3 million people to be affected by the extended drought, 54% were food insecure (WFP, 2015). Among subsistence farmers, loss and damage in grain production was estimated to reach up to 70% for the second consecutive year (Equipo Humanitario de País Guatemala, 2015). The Government of Guatemala was calling for international support to overcome the food security crisis (Gobierno de Guatemala, 2015).

Despite the urgency of the situation, MAGA did not present any official data on the impact of the drought in 2015 (ACH, 2015b). These data are essential for declaring a state of emergency, which opens mechanisms to redirect national and international funds for emergency response (Müller et al., 2019). Guatemala did not declare a food security emergency. According to government officials we talked to, this was due to the limited availability of government funds. The government seemed afraid to raise expectations it could then not fulfil. The crisis was occurring during a politically very critical time. In 2015, presidential elections were to be held and the country was in turmoil due to a big corruption scandal that involved high government officials. The attention of the chronically underfinanced public sector was diverted to actions for electoral effect.

Comparing 2014 and 2015 shows that the government response is not predictable from the status or forecasts of climate and food security. The 2015 crisis was not less serious than in 2014 but did not trigger the same response. In other types of emergencies, emergency protocols leave little room for political and institutional improvisation. In the case of drought-induced acute malnutrition, the institutional response is more complex and less predictable, and the lack of closely defined procedures provides more opportunities for political and institutional maneuvering (Müller et al., 2019). This highly negotiated character of government food security responses in Guatemala is important to explain the patterns of information use in food security management in the next sections.

4. Decision making and information use

To get a clearer picture about the decision-making context, we started asking which decisions key actors in the area have to make in terms of climate risk and food security management. These decisions comprise a broad field of technical, management and budgetary decisions that differ according to the administrative level (see Table 2). Most respondents across all administrative levels stated to

Table 2

Main decisions at different administrative levels.

Main decisions, categories	Frequency of responses per administrative level		
	Central	Department	Municipal
Training and capacity building for technical assistance	1	0	0
Design and manage interventions and prevention strategies	6	9	9
Technical recommendations for agriculture	7	10	14
Divulagation of information	6	10	6
Institutional and budget planning	6	4	0
Geographical prioritization	7	16	11
Distribute non-governmental funds, request international assistance	0	3	2
Food and Nutrition Security Evaluations	3	10	7
Number of respondents at administrative level	22	25	27
Total number of respondents	73		

Aggregated results from survey 1 and 3, Table 1, multiple answers were possible

make decisions around technical recommendations and geographic prioritization. A key technical decision would be the recommendations on sowing dates considering climatic forecasts, like the predicted onset and duration of the *canícula*.

One key decision on geographic prioritization is about which communities to cover in what they call in Guatemala a *barrido nutricional*, a representative nutrition survey. This is a (nearly) exhaustive survey to detect children with acute undernutrition. This type of survey is necessary as not all malnourished children are captured by statistics: they are not taken to health centers and reporting systems are deficient. This survey provides more reliable information for triggering a decision, e.g. to prioritize specific communities for interventions that needs reliable and representative information to assure affected communities are attended.

We describe decision making and data use patterns in Table 2 using descriptive results from two different surveys (Survey 1 and 3 in Table 1). The main difference between the administrative levels refers to aspects of institutional and budgetary planning decisions. This is very prominent at the central level and plays no role at the municipal level, reflecting the centralized governance structure in Guatemala. Many civil servants we interviewed at the local administrative level stated that they have limited decision-making power, e.g. on the allocation of public funds. The central government makes most budgetary decisions. Other important decisions mentioned are the design and management of food security interventions and the divulgation of information.

In another survey we asked several stakeholders at the municipal level how their decisions would change if the available information would better fit their needs (see survey 2 in Table 1). Out of a sample of 22 respondents, 12 (55%) told us their decisions would be more specific in terms of what to do and where to act. 12 respondents (55%) said decisions would improve if there would be a follow-up and monitoring of the outcome of the decisions. 9 respondents (40%) stated that decisions would improve if they can be made in a timelier fashion. For 6 respondents (27%), an improved decision would be a more trustworthy and solid. A lower fraction of the respondents perceived that decisions and their implementation should be better coordinated among actors at the local level (5 respondents or 23%) and should respond to a strategic planning framework (3 or 14%).

Despite a common agreement on the usefulness of agro-climatic and food security information for decision-making, we found evidence of the unsystematic and ad hoc use of information in decision-making among the respondents. Often, it was not clear from the responses how concrete decisions are linked to concrete types of information. A semi-structured survey with 40 respondents revealed that more than 20% did not use any climate and food security information product at all or could not specify which information they use for their decision-making. Those who used the information did use it for example for prioritizing areas for emergency interventions (e.g. to distribute food or vouchers) or to define the sowing date and recommend varieties. At a more strategic level, the information is used to develop yearly work plans or to decide on budget and staff needs for future time periods. Without the adequate information at hand, these decisions may not have enough substance. Interviewees mention that they criticize or not support decisions that have been done based on what they assume inadequate data.

4.1. Data quality

In order to understand the unsystematic and *ad hoc* use of information for decision-making, we first discuss our findings in the light of a framework of data quality and its different dimensions (Wang and Strong, 1996). The concept provides a good (but, as we show, an insufficient) framework to describe information use patterns in our study context.

Data quality refers to “data that is fit for use by data consumers” (Wang & Strong, 1996, p 6.). This implies a user-centered perspective. Based on a study of consumer perceptions, (Wang and Strong, 1996) identify four dimensions of data quality: intrinsic, contextual, representational data quality and accessibility of data. Intrinsic data quality consists of data accuracy and objectivity, believability and reputation. Contextual data quality means that data quality is assessed according to the context of the data use and includes relevancy, timeliness and appropriateness, among others. Representational data quality describes aspects like easy understanding and interpretation and consistent representation. And finally, accessibility is about the importance of unrestricted access of data.

To shed light on the topic of data quality we refer to the different qualitative data collected during the project period, coming from semi-structured surveys and participatory observation (See data collection type 4 – 7 in Table 1).

4.1.1. Intrinsic data quality

Scale mismatch: One of the main factors explaining mentioned by interviewees to explain their use of information for decision-making is the incorrect temporal and spatial scale. The coarse nature of most of the available agro-climatic and food security information is usually sufficient for central programmatic or policy decisions affecting the whole country. Decisions affecting the municipal level, however, where the execution and implementation takes place, requires localized information. The incidence of drought and its impact on food security can vary significantly between communities and depends on multiple factors. To prioritize the distribution of scarce resources (personnel, budget, aid), it is crucial to have information on the situation in the different communities. Most of the official information products including SESAN’s food security information bulletin “PronósticoSAN” only make a broad differentiation between regions in their data analysis and recommendations. The spatial scale of information is an important aspect that has been identified as a barrier to climate information use for decision-makers in Guatemala (Bouroncle et al., 2017) and elsewhere (Rosas et al., 2016). During our study we observed that in different municipalities, locally produced information about rainfall, damage and loss in grain production or cases of children with acute undernutrition, was produced and used for decision-making. But this remained unsystematic and ad hoc, depending on the motivation of an individual decision-makers and did not necessarily involve official or systematically collected information.

Incomplete data: Respondents and stakeholders often mentioned that the incompleteness of official information. In 2014–2015, MSPAS suffered from severe budget problems with health centers shutting down in many regions of the country. The situation in

MAGA was similar: the extension system was understaffed and underfunded. These two institutions are the main players to generate drought and food security information at the local scale. The crisis resulted in inconsistent reporting. For example, during the crisis in 2014, only around 70% of the health centers were reporting to the SIINSAN ([Secretaría de Seguridad Alimentaria y Nutricional, 2014](#)). Many stakeholders, especially from NGOs, were reluctant to use official information for their decision-making.

Data representativeness: In response to the problem of spatial scale and the need of the decision-makers to have localized information, SESAN worked towards filling this information gap through the establishment of a system of sentinel site communities providing localized information to the SIINSAN. But this information remained unused and tells another important story about why decision-makers refuse to use information.

Decision-makers mainly at the central level questioned constantly whether the selected sentinel communities were producing representative data. This is a common critique of sentinel-site information systems. Although, per definition, sentinel sites are not meant to produce representative data but rather represent a cost-effective way of producing proxy indicators to monitor trends ([Doledec, 2014](#)). In the Guatemalan case, stakeholders were criticizing that there were no formal selection criteria for sentinel communities in place. As the coverage of the public health and extension system in the rural areas was low, stakeholder feared that only those communities were selected as sentinel sites that had good coverage with public services and thus lower rates of food insecurity. This could introduce an observational bias in the information, assuming that acute malnutrition is lower in communities covered by public assistance. Stakeholder were thus reluctant to use the information. Decision-makers from the local level on the other hand did find the information useful. But they have little decision-making power within the SINASAN system and as soon as the information leaves the context where it has been generated it loses its usefulness.

The problem of observational bias in sentinel surveillance for food security is well-known ([Grellety et al., 2013](#)) and regular rotation of sites, stratified random sampling or of clearly defined selection criteria is recommended. Overcoming this problem seemed tricky: public organizations and NGOs select communities because of logistical reasons, security issues or path-dependency. This makes it difficult to convince decision-makers of rotation or sampling strategies. For defining selection criteria, the use of secondary data is necessary, where we return to the problems mentioned already: wrong scale, incompleteness, inaccurate or outdated data.

Reliability and perceived reliability of the information: Stakeholders complained about the low reliability of the data, especially locally generated data on food security and production indicators. In the case of local sentinel site information, decision-makers questioned extension-agents or community members' ability to produce meaningful information, as they are often not well-educated. The information was perceived as unreliable.

In stakeholder meetings that we attended, decision-makers especially from NGOs, were constantly questioning official data. One example frequently mentioned was data about the level of acute undernutrition among children under 5, reported by MSPAS. During 2014 and 2015, several municipalities of the southern coast region demonstrated the highest prevalence. The region does not form part of the dry corridor. Stakeholder at the central level had serious concerns about the reliability of this data and thus did not act upon this information. They argued they knew that the employees of the health center of that region were not skilled in detecting acute undernutrition and the centers had a very bad data management. Thus, the numbers would not reflect the real situation of seasonal hunger hot spots in the country. Decision-makers preferred to trust their own impressions or experience rather than the official data.

4.1.2. Contextual data quality

Data bloat: The complex relationship between drought and acute food insecurity makes it difficult to get the "right" information for decision-making. As participatory observant in multiple stakeholder meetings, we could witness long and controversial discussions around the selection and definition of the information that is needed to support decision-making. SESAN's intention to establish a localized information system within the SIINSAN was partly hampered by the fact that every technical extension agent in the field reported different variables with different measurements without continuity across reporting periods. Some would report the number of undernourished kids in a community, others the percentage share; some would report days without rain and others reported damage in crop production as a proxy for the presence of drought. This left decision-makers with a lot of information that was difficult to analyze and use for somebody not directly involved in the data collection process. The missing agreement on which indicators would best support decision-making and the missing clearness about how this information should support decision-making, resulted in what we perceived as data bloat.

Timeliness of the information: The timeliness of the information, an aspect of contextual data quality, is another critical factor for decision-making. Decision-makers were complaining that the publication of relevant information is regularly delayed or not published at all, so the information is no longer relevant, or the decisions have been made without consulting the information. In the case of the information on climate-related damage and loss in production provided by MAGA, for example, interviewees were complaining that the information was not published on a regular basis so it was difficult to include it into routine decision-making.

4.1.3. Representational data quality

Unprocessed information: Representational data quality relates to format and meaning of data and is important for user's ability to interpret the information. Agro-climatic and food security information in Guatemala is often only available in a raw and unprocessed format. It is difficult to contextualize the information and relate it to a specific decision-making context. The food security and health data available through the SIINSAN platform are basically raw data and does rarely provide any analysis, conclusions or recommendations, nor does it provide user-friendly data presentations. This makes it hard to analyze the data in a meaningful and decision-supportive way. This is also reflected in official information products that do not present the information in a user-friendly way. A systematic evaluation of information products in Guatemala revealed that they mostly show technical language difficult to understand for a lay person, with a lot of text and graphs of low quality without explanation ([Bouroncle et al., 2017](#)). Forecasts and agronomic

information are presented with little supporting analysis that could guide stakeholders in using the information for their context-specific decisions.

Probabilistic nature of information: Information users expressed difficulties in using and interpreting probabilistic information, like the seasonal ENSO forecast. We found strong resistance towards using probabilistic information among various decision-makers as the perception was that probabilistic information is unreliable. We saw some differences in the attitude towards forecasts between the central and the local level: whereas probabilistic climate forecasts are widely referred to at the central level (which does not mean that they are used for decision-making), skepticism at the local level is much more widespread. We perceived that probabilistic information in the Guatemalan context is not presented in a way that allows the decision-makers to easily understand and contextualize the information (Bouroncle et al., 2017).

4.1.4. Accessibility data quality

Access to information is an important factor for use as in Guatemala access to information technologies is often restricted. We saw clear differences in access to food security information: at the central level, the access to official information coming from SESAN, MAGA or MSPAS is more widespread than at the local level. Most information products relevant for drought and food security management are issued and circulated at the central administrative level and are not broadly known, circulated or used at the local level (Bouroncle et al., 2019). When talking to civil servants at the local level we often heard that they had to report regularly on the food and nutrition security situation but they seldom receive information from the central administrative level. Several interviewees from the municipal administration of the dry corridor explained that they often refer to unofficial information for their decision-making, e.g. when planning their field activities. Sources might be farmers or members of women groups in the communities. At the local level, official and unofficial information is often distributed word-of-mouth in meetings or among colleagues. There are no well-established information distribution channels between the central and the local level. The unsystematic use of information or the use of unofficial information or field impressions could introduce significant bias in drought and food security management, leaving for example population in need unattended.

4.2. Institutional factors influencing information use

We outlined in detail how different technical dimensions of data quality influence information use by decision-makers for drought and food security management in Guatemala. During our research project we gained a deeper insight into how a focus on technical aspects of data alone does not solve the underlying problems of (non-)use: institutions, contexts and norms also shape strongly how information is used for decision-making. Without considering these factors, improvements in data quality and technical dimensions will likely not lead to the full potential of data use in decision-making. We discuss and underpin this argument in the following.

We interpret our findings referring to institutional theory in a neo-Durkheimian tradition explaining data use as part of institutional processes and incentive structures (Douglas, 1986; Thompson and Wildavsky, 1986). The organizational context can have a significant influence on the information culture in an organization and in how individual members manage, use and exchange information (6 et al., 2004). This perspective suggests that for increasing information use in decision-making in a given context we do not only have to think about reducing the technical barriers to usage (Lach and Rayner, 2017; Rayner et al., 2005). Context as a shaping factor of information use and its role in the era of increased information and digitization is starting to gain more attention in research. The political environment at the meso-level, the characteristics and dynamics that surround individual behavior at the macro level and the characteristics of the individual user play an important role in information use for decision-making (Flagg and Kirchhoff, 2018). In the following we show how attitudes, bureaucratic structures, political instability, political interference and fatalism are important factors to consider when explaining information use in our case-study context.

Attitudes towards climate change, food security and information use. At the institutional and individual level, among the interviewed decision-makers we found a broad consensus on that climate variability and extremes are significantly and increasingly affecting food security. Interviewees were also quite certain that agro-climatic and food security information would allow them to improve their decisions in terms of timeliness, credibility, effectiveness and targeting. This is important as personal attitudes towards the role of climate and climate change seem to be a significant determining factor especially for climate-information use (Flagg and Kirchhoff, 2018). These attitudes seem to support information use among individual decision-makers.

Bureaucratic structures and centralization. Decision-making structures in ministries, the public administration and the SINASAN are hierarchical and centralized. Information usually flows upstream and is seen more as an instrument to prove compliance with bureaucratic obligations than a tool to reach impact in climate risk management and food security. This culture of satisfying bureaucratic needs can be a strong factor influencing information use (Byrne and Sahay, 2007; Luís Mosse and Byrne, 2005). Decision-maker criticized the missing focus on the impact of the decisions: information in the SINASAN is collected to fulfill obligations and not to reach an intended impact on food security on the ground. The SINASAN for example reports the stock of medicine in the health centers, the number of children attended or the number of supplements distributed, but there is no measure on how effective this is. If decisions are made and implemented, there is hardly a follow-up, not to speak of monitoring and evaluation, of the effects of the decisions. This in turn reflects what Thompson and Wildavsky (1986) describe as a bureaucratic-hierarchical approach to information use: the outcome of information use is secondary. Information is produced and used to prove that bureaucratic procedures are followed.

Budgeting and planning in public institutions in Guatemala is a centralized process. Decentralization efforts in Guatemala are stagnant. Official directives and decisions come from above with little scope for actors at the lower administrative level (municipalities, department dependencies) or individuals to make decisions according to the specific situation in the locality (Bossuyt, 2013; Willis

et al., 1991). Ministries define the budget at the central level. Decision-makers at the local level do not have any decision-making power to make budget adjustments, if they see e.g. a tense food security situation coming. Funds for drought-related food insecurity can only be liberated after the Government has officially declared an emergency (Müller et al., 2019). The situation is similar for municipal authorities. Legally, municipalities are not able to allocate funds or adjust the budget considering information on a drought forecast or data indicating difficulties in agricultural production and food security. Again, they are only able to release or reallocate funds once the Government declares an emergency. One mayor stated that he would need a 100% certainty that the event would occur to be able to consider it in the yearly operational budget. When municipalities plan their yearly operational budget, we often heard that the information that is used to prioritize communities e.g. for infrastructure projects, comes from informal sources. Decision-makers rely on their own impression or have a trusted person in a community or institution they contact. This reflects the ad hoc and person-dependent character of information use and does not provide the context for pro-active, crisis-avoiding climate risk and food security management. Whereas the institutional structure is centralized and hierarchical and the collection and flow of the information from the local to the central level is regulated, the use by decision-makers for response and the dissemination of the information at different administrative levels in contrary is characterized by a lack of organizational protocols and procedures, and seems to be ad hoc and person-dependent. This leads to the paradox that although there is the “right” information available, decision-makers might not know how to apply and use the information in their decision-making context (Müller et al., 2019). Although highly bureaucratic and centralized, the system has no clear authority that establishes in a reliable way universal technical standards and protocols for data collection, analysis, use and response to manage climate risks and food security.

Constant renegotiation and political change. Political decision-making in the area of drought management and food security is surrounded by suspicion of inappropriate use of resources and being mainly guided by political interests and not by data and information. Also, insecurities about (future) political priorities seem to have a strong impact. This can influence the continuity of efforts to improve the technical dimension of information use problems: projects aiming at overcoming certain constraints, e.g. through generating local information or harmonizing indicators, might lose political support abruptly, as we experienced ourselves. Relevant information might not be used as actors are reluctant to make decisions due to a political instable situation. At the macro-level we observed a constant renegotiation of efforts to improve information for food security, nothing seems to be constant in the face of the political uncertainty. With every change in political leadership within SESAN or a government change, we had basically to justify and renegotiate every step and major decision of our project. Again, we see this pattern of ad hoc and unsystematic information policies and low levels of formalization of procedures in the context of highly bureaucratic structures (Thompson and Wildavsky, 1986). Government institutions are influenced by how national politics function in Guatemala. Charles W. Anderson (1962) observed that the political sphere in Guatemala and other Central American countries is conceived as a space in which factions that compete for power reach arrangements through constant negotiation. The sources of power of these different factions are highly diverse and based on access to resources or control over social forces and processes. This is far from the ideal of a representative democracy and the constant renegotiation of power pervades government institutions as well.

Interference in information generation and use. Drought and food security information has a political dimension and decision-makers information use is likely to be influenced by the (perceived or actual) political interference in relevant information. After a drought impacts production, a key information for decision-makers is the list of affected farmers to plan distribution of emergency support (in-kind or vouchers for food and agricultural inputs). The compilation of beneficiary lists for public subsidies is one area where political loyalty seems to play a stronger role than actual drought damage and loss in subsistence production (Asociación de Investigación y Estudios Sociales, 2012; Universidad Rafael Landívar and Universidad de San Carlos de Guatemala, 2013). The before mentioned relative absence of protocols for data generation, analysis and use, opens the door to political interferences at different stages: (Müller et al., 2019).

Fatalism and failure avoidance. We perceived that the combination of these contextual factors led to a strong attitude of fatalism among decision-makers and stakeholders, paired with a dominant culture of failure avoidance especially in the public sphere. We often heard that improving decision-making through sound agro-climatic and food security information would anyway not make any difference as the chronically underfunded public sector was not able to respond or response would be subject to political interference and delayed through democratic procedures. Individual decision-makers felt powerless to act upon relevant information because of existing structures and power balances. But fatalism expressed itself also as a feeling of predetermination and the influence of uncontrollable external forces (Díaz et al., 2014). We heard from different decision-makers especially at the local level that God influences the impact of climate on food security and there is nothing to do about it.

We also perceived a strong tendency towards failure avoidance in individual decision-making, e.g. fear that the individual would contradict official decisions or held accountable if a decision was based on a forecast but the forecast did not come true. In many public institutions in Guatemala, staff fluctuation due related to the political instability is very high (Müller et al., 2019). Positions often depend on (political) loyalty which leads to a high employment insecurity among many civil servants. Combined with strictly hierarchical structures in the public sphere, this leads to a strong failure avoiding and risk reducing behavior and inaction among decision-makers to reduce accountability for (possible) erroneous decisions. Structures incentivizing failure avoidance instead of motivating early actions are a significant obstacle to information-based early action (Ewbank et al., 2019). Thompson and Wildavsky (1986) describe this strategy of information use as individualistic survival in fatalistic organizational settings.

5. Discussion and conclusions

Climate services and food security information are considered important ingredients for drought related food security management. Nevertheless, in Guatemala the use of information for decision-making in drought and food security management is

unsystematic and ad hoc. Our research aims at explaining patterns of information use in the management of climate-related, seasonal food insecurity in Guatemala. We show that the relationship between extended midsummer-drought and acute food insecurity is complex and not straightforward, which makes it difficult for decision-makers in Guatemala to contextualize available information into their considerations for on-the-ground risk management, early actions and crisis response.

Our results show that main decisions that are or should be supported by information are geographical prioritization of interventions, technical recommendations for agriculture and institutional planning. The relative importance of these decisions differs according to the administrative level. At the central level, the decisions are more of strategic and at the local level of operational character, reflecting the centralized structure of the public administration in Guatemala. This structure leaves little scope for decision-makers at the local level to include climate and food security related information into forward-looking planning decisions. We show that information use for decision making is often unsystematic. We argue that one of the main reasons for this pattern is the missing fit between the available data and information and users' needs in terms of characteristics like scale, reliability, accessibility, representativeness or timeliness of information. We argue that these factors alone cannot fully explain patterns in information use in our case-study setting.

We look beyond the different technical dimensions of data quality and show that information use patterns are closely aligned with the institutional and organizational context surrounding decision-makers. In Guatemala, centralized structures in institutional planning and budgeting, undefined procedures as well as public lack in response capacity and fatalism determine actor's willingness to include relevant information into their decision-making.

Although many factors related to the different dimensions of data quality and the institutional context outlined above seem to inhibit information use in decision-making, it is not that food security and agro-climatic information is not used at all for decision-making. We saw a broad consensus among the people we talked to and observed during different our research that information is necessary to improve food security and drought management and to realize the shift from reactive crisis response to proactive management. There are interesting cases and anecdotal evidence on decisions made based on information, for example of successful changes in the sowing date or the timely attention of a community at risk of acute food insecurity. What we experienced is an un-systematic and ad hoc way of using agro-climatic and food security information, and often decision-makers refer to unofficial, more "trustful" sources, e.g. their colleague or own field impressions, to base their decisions on. This mirrors Anderson's observation of the importance of *confianza* (trust), meaning mutual empathy based on personal relationships, in the Guatemalan political system (Anderson, 1962). Contextual and institutional factors as described dominate and shape incentives to information use for decision-making.

These findings have important implications. They imply that an investment in improving the delivery and scientific value of food security information will not automatically lead to better decisions and outcomes, if the institutional context is not providing a supportive environment. Thus, efforts to improve data and information for decision making should go hand in hand with supporting institutional and governance processes, otherwise institutional incentives might undermine the effort. Studies in other contexts come to similar results and confirm our statement (Sandefur and Glassman, 2015; Srinivasan et al., 2011). Technical barriers to information use might also be related to contextual factors and thus need a more integrated approach to problem solving.

In the case of Guatemala, we found it was useful for decision-makers to have more guidance in terms of decision-support structures through the development of information use and response protocols that consider the scope of decision-making power of an actor for example at the municipal level. The integration of digital tools for data collection and processing can address different technical obstacles, for example by reducing time to collect and upload data, automate analysis and visualization. But digital tools also hold the promise to reduce entry points for political interference in public information. By integrating stakeholders in all stages of the design process, the participatory co-design of information systems can be a useful approach to assure the sustainable insertion of solutions into a decision-making context. Collaboration with key stakeholders from the public sector, NGOs and civil society is crucial in order to understand challenges to information use and to assure that the development of new technical solutions or the improvement of existing mechanism goes hand in hand with an effort of creating or supporting the institutional enabling environment. The process required to achieve meaningful change in this context, however, is not limited to digital design, but also involves institutional design.

Information use for decision making is a every time more urgent topic. With the rise of digital tools in many developing countries to support decision making, it is of researchers and practitioners' responsibility to assure the match between data and decision-making. Future research should go beyond case-study evidence and develop more systematic studies to how information can make a difference in decision-making.

Declaration of Competing Interest

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