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From bits to bites: Advancing adaptive capacities in urban food security through information systems. A case in Guatemala City.

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ABSTRACT OF THESIS submitted by: Isaac GUZMAN ESTRADA
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The use of Information Systems for Food Security has been used as a tool to deliver information for the decision-making. However, the urban food system is still a field not fully researched, hence there is a lack of understanding of the different insecurities and vulnerabilities for the citizens concerning urban food security. So far most of the information systems have been developed from central government without the involvement of local stakeholders. In Guatemala, the use of the information system is centralized at national level detached from the political discussion hindering the effective use of the information. This in turn delinks institutions vertically and horizontally. Firstly, the present thesis aims to point out the characteristics to achieve urban food security and denote the need for local government involvement. Secondly, it analyses and proposes the use of novel methods such as Community Informatics approach as a means to collect bottom-up information for the analysis and decision-making at the local level. The use of a community indicator system feed from the citizens can deliver first-hand information and can enhance the monitoring and evaluation, reflecting on information that can build social learning and impact the adaptive management and governance capacities. This work concludes that institutions already in place in Guatemala and Guatemala City have the potential to explore the use of Community Informatics to foster social learning, adaptive governance and management capacities to better connect the different institutions and decentralize the decision-making and action with the local government.

Keywords: Urban food security, community informatics, information systems, adaptive governance, adaptive management.

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When I said *Alea Iacta Est* He responded….

To my family, for their support in all the journey, their encouraging words and remembering home now and then.
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List of Acronyms

CI	Community Informatics
COCODE	Community Commission for Development [Comisión Comunitaria de Desarrollo]
COCOSAN	Community Commission for Food and Nutrition Security [Comisión Comunitaria de Seguridad Alimentaria Nacional]
CODEDES	Department Commission for Development [Comisión Departamental de Desarrollo]
CODESAN	Department Commission for Food and Nutrition Security [Comisión Departamental de Seguirdad Alimentaria y Nutricional]
COMUDE	Municipal Commission for Development [Comisión Municipal de Desarrollo]
COMUSAN	Municipal Commission for Food and Nutrition Security [Comisión Municipal de Seguidad Alimentaria y Nutricional]
CONASAN	National Council for Food and Nutrition Security [Consejo Nacional de Seguirdad Alimentaria y Nutricional]
CUBs	Unique Neighborhood Committee [Consejos Comunitaros de Barrio]
ELCSA	Latin America and Caribbean Food Security Scale [Escala Latinoamericana y del Caribe de Seguridad Alimentaria]
ENCOVI	National Survey of Life-Conditions [Encuesta Nacional de Medios de Vida]
ENSMI	National Infant-Maternity Survey [Encuesta Nacional Materno-Infantil]
FAO	Food and Agriculture Organization of United Nations
FIVIMS	Food Insecurity and Vulnerability Information and Mapping System
HDI	Human Development Index
ICTs	Information and Communication Technologies
INE	National Statistics Institute [Instituto Nacional de Estadística]
INCOPAS	Social Consult and Participation Instance [Instancia de Consulta y Participación Social]
MODA	Acute Malnutrition Monitoring [Monitoreo de Desnutrición Aguda]
MONICA	Canicula Monitoring Actions [Monitoreo de las Acciones por la Canícula]
MONIMEFI	Municipal physic goals of Zero Hunger Plan [Seguimiento a Metas Físicas a Nivel Municipal]
MONIMIL	1000 days window [Monitoreo de ventana de los mil días]
MSPAS	Ministry of Public Health and Social Assistance [Ministerio de Salud Pública y Asistencia Social]

PHC	Zero Hunger Pact [Plan Hambre Cero]
POASAN	Operative Annual Plan for Food and Nutrition Security [Plan Operativo Anual de Seguirdad Alimentaria y Nutricional]
SESAN	Secretary for Food and Nutrition Security [Secretaria de Seguridad Alimentaria y Nutricional]
SIMON	Monitoring System for Food and Nutrition Security [Sistema de Monitoreo de Acciones de Seguirdad Alimentaria y Nutricional]
SIINSAN	Information System for Food and Nutrition Security [Sistema de Información de Seguridad Alimentaria y Nutricional]
SINASAN	National Food and Nutrition Security System [Sistema Nacional de Seguridad Alimentaria y Nutricional]
SNP	National Planning System Sistema nacional de Planeación
SISCODE	Development Councils System [Sistema de Consejos de Desarrollo]
UNICEF	United Nations Chidlren's Emergency Fund

"The future can't be predicted, but it can be envisioned and brought lovingly into being. Systems can't be controlled, but they can be designed and redesigned. We can't surge forward with certainty into a world of no surprises, but we can expect surprises and learn from them and even profit from them. We can't impose our will upon a system. We can listen to what the system tells us, and discover how its properties and our values can work together to bring forth something much better than could ever be produced by our will alone.

We can't control systems or figure them out. But we can dance with them!"

Meadows, D.
Dancing with systems

1. Introduction

Urban food security is a complex, multi-dimensional problem. In the circumstances of urban growth population and increasing socio-economic inequities, marginalization of the poorest and social issues that undermine basic services -health and malnutrition, poor water quality, mobility constrain- are challenges that urban centers in Latin America face (FAO, 2011; 2015; Prado-Córdova, 2011; Valladares, 2003).

Except for a few frontrunners, many cities to date do not adequately recognize or incorporate urban food systems in their development agenda and environmental strategies (Pothukuchi and Kaufaman, 2000; Morgan, 2009). City planners, civil society, academia, decision-makers, and the population in general need to understand the current status of food insecurities and the need for a strategic and integrated approach in order to ensure food security.

Information is essential for learning both at the individual and institutional level, and as such it can impact in the adaptive governance capacities. In contrast with information, for the purposes of this research information ***systems*** are defined as complex constructs with conceptual, technical, organizational, institutional, human and financial dimensions. An information system is a tool which can enhance multi-level, inter-sectorial and interagency coordination related to urban food security. Adaptive management, coupled with learning-by-doing strengthens social learning capacities, closing the loop between decision-making, and policy-making's impact through measurement and evaluation.

Urbanites play a key role in agri-food systems as consumers and shapers of food trends. Understanding the full urban food cycle, from production to process, transportation and retailing, to consumption patterns and waste produced is important. The latter can allow to identifying the food insecurities in urbanities. The challenges of understanding and addressing food security

effectively at the urban level requires accurate, timely and relevant information when and where needed and in easily accessible formats.

Guatemala has the highest malnutrition rate in Latin America and one of the highest worldwide. Urban areas, however, are often less visible due the acute problem in rural areas and other higher-profile urban problems such as mobility and security. Nonetheless, the rates of malnutrition in urban areas are parlous increasing (FAO, 2011; 2015; Ruel et al.,1998; Tacoli et al., 2013). While malnutrition also occurs in the countryside, its dynamics, causes and solutions can be different from urbanities.

The development of new technologies allows facing old challenges from a new perspective. That is the case of statistical measurement and information systems that have been in use for few decades for the collection and organization of data, analysis, and communication to support public decision-making. In the early 1990's a growing movement started to develop measurement and indicator systems not only at the national, but also at the community level. Indicators built within the communities as parameters to set goals and measures as *bits* of information to provide a more comprehensive picture (Philips, 2003)**.**

The use of novel methods to collect information as 'community informatics' seeks to enhance the participation at community level connecting the socio-cultural aspects with the use of technology and information to advance specific or broader community development goals. The experiences with community system indicators, his allows constructing information systems that closely reflect the context of citizens' situations providing more reliable information to support decision-making focused on urban food security.

The latter can also enhance the monitoring and reporting, providing in-puts to the decision-makers creating feedbacks incentivizing social learning and ultimately adaptive governance and management in the institutions.

1.1 Identification of the Problem

Two main problems are intended to be addressed in the thesis. The first problem is that the current state of knowledge on urban food systems, continues to be limited. This is due, in part, the differences in the context and underlying characteristics of cities and the absence of local governments' appropriation of the agenda to work in understanding more in depth the urban food securities and insecurities (Pothukuchi and Kaufaman, 2000); Morgan, 2009).

Second, the use of information systems is often detached from decision-making, providing only a partial picture of urban food security in Guatemala City. Through the use of novel approaches as community informatics, based on the integration of cultural, social, political dynamism of communities, can leverage feedback loops which can enhance adaptation in governance and management.

1.2 Aim of the Thesis

The thesis presents urban food systems and food insecurity at the local level, identifying what dimensions of urban food security can be reflected in an information system that supports the decision-making to address food insecurity. Secondly, it analyses how the use of the food security information system can enhance adaptive governance and management in the context of Guatemala City.

In order to address food security and insecurity, decision-makers, civil society and the population at large- need to understand the current status of urban food systems, its key dimensions, and possible future trends. Therefore, reliable, meaningful and clear quantitative and qualitative information has to be collected, analyzed and communicated clearly to decision-making actors. The proposal of novel methods such as community informatics approach can promote the collection of bottom-up information advancing to adaptive governance and management capacities through social learning feedbacks.

1.3 Research Questions

The research questions of this thesis follow three stages: (1) *diagnostic questions*, (2) *analysis of urban food security and* (3) *use of information system in adaptive capacities* relating to the decision-making. However the core of this thesis lies on the last research question: '*use of information system in adaptive capacities'*, where it is studied how the people and organizations – in Guatemalan context- use the food security information system in adaptive decision-making.

The (1) '*Diagnostic questions'* will build understanding to the current state of knowledge of urban food security and the use of community informatics systems.

- What is the current status and what are the current trends of urban food security?
- What is the current status of community informatics related to food security?

Meanwhile (2) *'Analysis of urban food security'* draws in the dimensions of the urban food insecurities in Guatemala City context and through the analysis of four key areas for the development and operationalization of an information system –governance, technical capacities, participation process and use of the information system- explore .

- What are the dimensions of food insecurity that should be taken into consideration in an information system?
- How is the use of the information system for addressing the food insecurities according to the following components?
    - Governmental: Institutional structures and capacities
    - Technical capacities: Information and content itself.
    - Participation process: Social process of participation to create and maintain the information
    - Use of the information system

Finally, (3) *'use of information system in adaptive capacities',* aims to bridge the adaptive socio-ecological framework under Guatemala City context with the analysis of adaptive governance and management capacities in the city.

- How can information systems improve adaptive capacities in cities (Guatemala City)?

1.4 Methodology of the Research

This thesis adopts an exploratory research approach based on qualitative research questions (Neville, 2007). In order to answer the research questions, multiple methods were used: desk research focused on the academic and relevant gray literature, a survey with a limited sample size and semi-structured interviews.

In desk research, a variety of documents were analyzed: articles in academic journals and books, United Nations and relevant NGO reports, and government documents. This research intended to provide an understanding of urban food systems, the conceptual underpinnings of analyzing food insecurities, and their reflection in information systems and community informatics. The need to build an understanding of this related realms was important for the conceptualization of food security information systems and their role in policy development, implementation and evaluation.

The application of the conceptual approach to a specific case study area required the collection of data and information from the news media, academic literature and government documents to help understand current state and trends, in preparation for a field visit.

To complement desk research, a field trip was organized to Guatemala City to gather primary data through a survey and semi-structured one-on-one interviews with key stakeholders from different areas, including national government, international organizations, research centers, and NGOs (see Annex 8.1 for the list of participants). The advantages of studying a case study is

the opportunity to understand in-depth a particular phenomenon within a particular subject, allowing to describe the issues and/or challenges in a real-life context (Yin, 2009).

Using snowball sampling, a technique to find research subjects asking for the name to another research subject and so on (Arkinson & Flint, 2001), allowed to set 15 different stakeholders. However, the short time spent in Guatemala City significantly limited the number of stakeholders interviewed, the most significant case was not to interview any representative of the Municipality of Guatemala.

The survey and semi-structured interviews were tailored to understand first-hand the context and realities of Guatemala City with the issues, challenges and opportunities of food security.

After explaining the aims and purposes of the research, interviewees were asked for their consent to record the interview. Followed by a small survey based on *yes/no* answers to build a general diagnosis understanding of food security and the use of information systems in Guatemala City among the different stakeholders.

Meanwhile, the use of semi-structure interviews provide flexibility to the interviewee to direct the interviews according to the characteristics of the stakeholder and his/her answers (Neville, 2007). Nevertheless, the interviews were framed around the following four categories of interest: governance, technical capacities, participatory process and use of the information system.

The responses of interviewees on the use of information in decision-making in food security-related programs or policies was used in the subsequent analysis using the thesis' theoretical framework. The collected information, from primary and secondary sources, helped carry out analysis in four areas (see Section 4.4) and finally match the theory and case study in the thesis Discussion (see section 6).

- Government approach to food security, who gathers, monitors and analyzes the information, under which body, the attributions of the body and capabilities. Identify the governmental institution where the information system is anchored and local government appropriation of the urban food security agenda.
- Technical capacities of Guatemala City related to the *software* and *hardware* –human capacities and technological tools-, the type of quantitative and qualitative, spatial/non-spatial information that needs to be collected. How is the information it is stored and packaged? How is analyzed and retrieved for use in decision-making?
- Participation process to incorporate other stakeholders in the development and decision-making of urban food security. Communication of the information, through various platforms and channels. Identification of institutional bodies to promote the organization and participation of the communities in the city.
- Use of the information. How is data related to food insecurity used, how can it help identify success and failures. Use of the indicators for the decision-making and policy elaboration. Amount and format of information for public access.

1.5 Scope and limitations

This thesis attempts to focus on the use of information systems in food security aspects at urban areas and the participation of communities for information systems. It aims to grasp a basic understanding of both realms aiming to provide a general understanding of food security information systems.

Food security problems are highly context dependent. This thesis is focused on the capital of Guatemala, Guatemala City. Guatemala has been chosen as a case study due its *sui generis* characteristics. Guatemala is a country with levels of malnutrition as some countries in Sub-

Saharan Africa and currently the highest one in Central America. In contrast with this situation, Guatemala actually has good agro-ecological potential for producing food.

The extension of food systems makes difficult to cover every detail of food security information system and even though there have been developed at the global, regional or national level, there are few equivalents at the local scale. Considering the short time available for fieldwork in Guatemala, only a very limited number of stakeholders could be interviewed. One of the most important was the representative of the Municipality of Guatemala City. Despite this limitation, interviewees represented a wide crosscut interest group and the interview data obtained provided a rather detailed view and understanding of the food security problems, challenges and opportunities ahead.

It is acknowledged that the budgetary capacities to develop, implement and operationalize an information system are vital and required, however, the thesis did not analyze in depth neither in budgetary barriers nor budgetary opportunities.

Finally, due the current information system in Guatemala City is centered-managed by the government, it was not explored the possibilities or options to develop an aside information system from the civil society neither private, however it is explored and incorporated the participation of the civil society in collaboration of the government to produce information through community informatics approach.

1.6 Thesis Outline

Building on the research questions, the thesis outline is as follows:

- Chapter 1: Introduction
    - Provides an initial description and relevance of the topic. It explains the problem identification and the aim of the thesis. It gives the research questions that this thesis

seeks to answer and describe the methodology pathway to answer them. Finally, reveals the scope and limits that the thesis considered.

- Chapter 2: Literature Review
    - Provides an overview of the academic and grey literature on urban food systems and related food insecurities, followed by an explanation of information systems and community informatics, including indicator systems. The literature review represents a brief snapshot of the current state of knowledge of both realms, the importance of food security in the urban context and the role of bottom-up participation in building information system on food security itself.
- Chapter 3: Theoretical Framework
    - Presents the theoretical framework based on adaptive socio-ecological systems that describes the relationship between the couple human and natural environment as a complex and dynamically changing entity. Explores how social institutions need to adapt to the environmental changes through adaptive cycles and capacities. Adaptive management under a learning-by doing and adaptive governance to react at multi-level and multi-actors needs. Also it is explain social-learning triple loops for acquiring knowledge and hence adapt.
- Chapter 4: Guatemala City Fieldwork
    - Presents the fieldwork in Guatemala City and describes the current state of urban food security in four dimensions: governance, technical capacities, participation process and use of information through the lens of food security focused information systems.
- Chapter 5: Findings

- Building on the four dimensions in Chapter 4, this chapter presents the bottleneck findings of the Information system in Guatemala City.

- Chapter 6: Discussion
  - Explains how the use of community informatics can enhance adaptive governance and management capacities in an urban food security information system framework through the use of social learning loops. This chapter connects the use of information systems to adaptive governance and management.

- Chapter 6: Conclusions
  - Wraps up the final considerations learned through the thesis research and highlights areas for further research areas.

2. Literature Review

The importance of identifying the current state of knowledge and trends of urban food security and community informatics helps to answer the first research questions, related to *'diagnosis'*. It is central for this thesis to build an understanding of urban food systems and related food insecurities so that the differences between urban and rural insecurities can be drawn and they can help inform the design of more finely tuned polices.

Figure 1 shows how information systems and urban food security connect around the concept of food security focused information systems. The use of information on urban food security can support decision-making and help develop adaptive governance and management capacities through social learning processes (Heeks & Ospina, 2015).

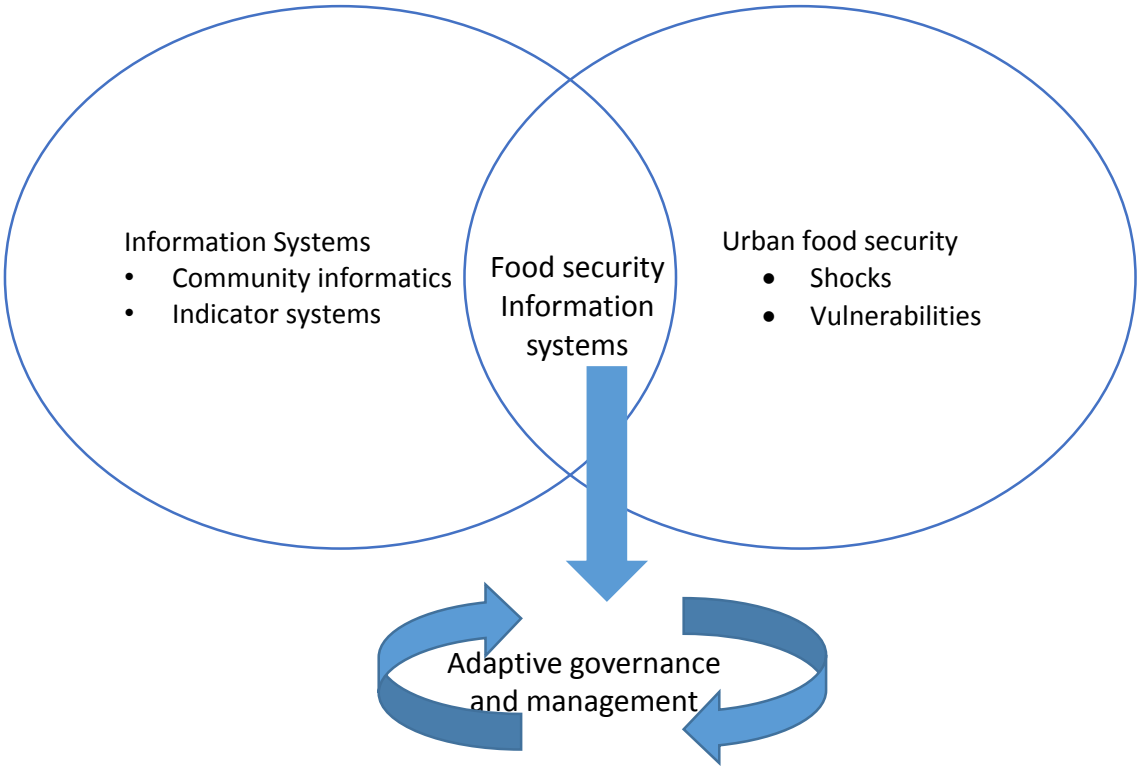

Figure 1. Food security information system for adaptive governance and management

Source: Own diagram based on the thesis research

2.1 Urban Food Systems

Current urbanization and poverty rates increase the pressures on cities and with it the vulnerabilities and food insecurities, hence the appropriation of the food agenda at the local level is fundamental to enhance the visibility of the problems and integrated in the policy process through the production of information at community level through the use of novel approaches as community informatics.

Generally speaking, the food systems consists of not only the access to food, but all the stages before and after acquiring food. Food and food systems are arguably a vital intrinsic part of our everyday life with tight links to economy, politics, culture and health. However, these links are not always clear to all actors, and the degree in how far these links are taken into account differs.

Understanding the food system can allow us to identify the different activities that take place in it. It helps to create awareness of the different roles that stakeholders play within the system, and understand the high complexity and dynamics of the food system. The understanding of the system can go beyond the inter-linkages to other areas that impact the functionality of the food system (Capone et al., 2014).

Urban food access differs from rural. While in the latter the possibility of self-produce or trade crops are options to ameliorate hunger, in the city these options are usually very limited or non- existent. In cities, the population is generally dependent on food purchases and markets (Ruel et al., 1998). This is true despite the growing interest in urban food production that is still far from becoming a dominant aspect of urban food supply.

Food sources for households include markets (both supermarkets and open markets), street vendors, transfers from assistance programs and in some cases self-production. The latter entails other aspects as how efficient the food marketing and distribution system is, these variables will impact the variety of products that can be accessed, the household purchasing patterns, and finally where those in need can access food aid through food banks. In Latin America and other developing

countries, it is common to find street vendors and street food access. These types of food, can enhance food availability, however, it can be a source of other types of risk such as hygiene and sanitation factors (Kimani-Murage et al., 2014).

In order to understand urban food system, Figure 2 shows a diagram of the food cycle from inputs and outputs (Goodman, 1997). It includes (a) production or agro-biodiversity –crops selection and cultivation, livestock-; physical infrastructure used in all the steps for (b) distribution –harvesting, processing, packaging, transporting-; the process of (c) acquisition –retailing, street vendors- and food (d) consumption –marketing, dietary requirements intake-. Finally, the disposal of the food, which should consider food-related waste in all steps (FAO, 2011).

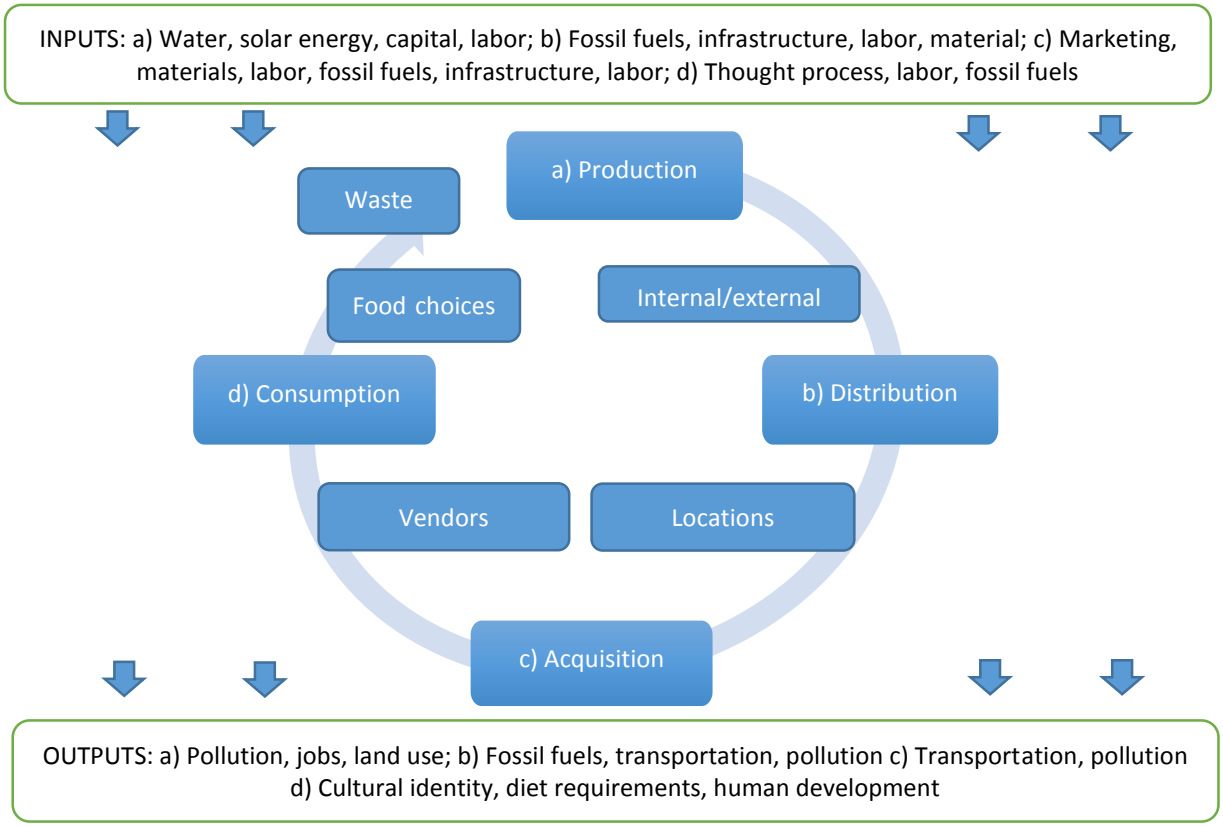

Figure 2. Urban food system

Source: Based on Cassidy & Patterson, 2008.

The food cycle described previously occurs inside the cities. As an example, urban agriculture never disappeared in developing countries, and it is now an increasing activity in developed cities (Morgan, 2009). Food-industry, retailers and markets need to distribute the food supply to food shops, restaurants, etc., and the same time dealing with big amounts of food-waste.

Pothukuchi and Kaufaman (2000) have described food systems as 'a stranger for planners'. They identified several reasons why urban planning agencies avoid or did not take into consideration food systems. The responses of the planners range from the identification of food as a rural problem, narrowed in production, to food systems being part of a larger market system driven through supply and demand forces and therefore it is a national and global concern.

Meanwhile, Morgan (2009) provides two strong arguments why food systems need to be taken into consideration at the local agenda. First, the food system is inter-linked to several other areas, such as public health, social justice, energy, water, land use, economic development, transportation and so on. Second, emerging urban agriculture initiatives cannot be ignored and need to be leveraged by local public policy.

Nonetheless, over the last decades a literature engaging with the capacities of action at the city level to develop policy tackling the most important issues afflicting the world, has emerged. Climate change is one example to understand how cities start to play a more active role in the city itself and outside creating international coalitions among cities to target effects of climate change have been increasing as well.

The attention to food systems have surged in several local governments. For example, the Seoul Declaration for Sustainable Cities, pronounced during the ICLEI World Congress in 2015, they *"encourage sustainable urban food production projects and resilient city-region food systems programs"* (ICLEI, 2015). The Milan Urban Food Policy Pact, which consist of a series of

commitments pursuing sustainable urban food policies, focused on food security, waste reduction, tackle hunger and obesity, etc. (Foster et al., 2015).

It is not possible to ignore the current trend of urbanization which is happening worldwide According to the United Nations (2014) urbanization projections, the population will increase to 2.5 billion by 2050 with a higher rate in developing countries.

In 2030 projections, Latin America is the one with the highest increase up to 80 per cent. This will impact the urban food systems increasing the vulnerabilities of the system considering the production, access, distribution, consumption and food-waste. The vulnerabilities of the population will increase as well, adding more people to compete for the resources and into the poverty line. This panorama will become an additional challenge for decision-makers in the cities having the task to decrease urban poverty and malnutrition rates, otherwise, those numbers will increase at maximum extent as the population grows (Ruel, et al. 2008).

The increase of urbanization rates come together with other challenges that cities need to address in the context of urban food systems and insecurities. The population growth, increasing pollution, competition for land use, increased motorization rates, more voracious food consumption patterns, increasing inequality, among others. All this has confronted the ways of production, distribution and consumption of food already (FAO, 2011).

Even though the prevalence of urban poverty is dependent on the country experiences and policies, it is most likely that urban poor will increase and within, growth in peri-urban, marginalized areas. This represents challenges for building the required infrastructure services of water, sanitation and energy. Similarly, health services, mobility connections from the periphery to the inner city and effective markets, will impact directly the food insecurities and with it the rate of malnutrition. (Ruel et al., 1998).

Despite the latter, most of the population in urban areas, including decision-makers, have a false sense of food security. They are not fully aware of the implications and linkages with human health and human development, which stems from a general lack of knowledge and understanding of food systems at the local level, and translates into missing the issues and opportunities within. (Cassidy & Patterson, 2008). Therefore, the need to encourage and increase the involvement of local governments and civil society to participate in building conceptual frameworks for urban food systems. It is necessary to transform the view and understanding of the urban food systems and its insecurities through the development of information at community and individual level of the society.

The urban food distribution is an important aspect of the urban food system, especially because the products can come from the city periphery, from other regions of the country or even from abroad as import products. The latter implies a strong responsibility to different actors as traders, distributors, processors and retailers. They are bridges from production to consumption.

Therefore, distribution of food in cities is still a big issue, individuals or families need to commute –for some longer distance- to acquire groceries, in some countries through open-markets or street food. The consumption and dietary requirements in order to fulfill human physical and mental development are not equally acquired, being poverty and health main barriers. The lack of planning in urban food systems visualization is notorious. Thus understanding food insecurities not only as access matters but also as supply and availability of food for all.

The inter-linkages of urban food system can be spotted in different areas. Economically speaking, in the local level food is one of the sectors that employ more people –directly and indirectly- impacting the local and national economy, likewise the general income that is used for food purchases account for the bulk in a household. In Central American countries are net basic food consumers, spending in Guatemala 48 per cent versus a 12 per cent in the United States

(Cohen & Garrett, 2010). In public health affairs, malnutrition and obesity rates increase in urban areas. Just in Latin America and the Caribbean circa 34.3 million people suffer hunger (FAO, 2015) and finally in the environment sector, the use of energy and water, put into stress other resources and the use of pesticides, and industrial waste pollute watersheds (Pothukuchi & Kaufman, 1999).

The urban food systems are object to multiple stressors. Sudden shocks as floods, droughts, unemployment, price increase in the market; or gradual changes as climate change, population growth, land degradation, socio-economic marginalization and land degradation, create instability in the system and with it insecurities and vulnerabilities. Most likely these stressors will increase rather than lower down (Hart, 2009). The sum of all these stressors results in food insecurity in the cities.

2.2 Urban Food (In)Security

Regularly food insecurity is understood as a national or global problem, linking global markets and macroeconomic questions. This broad national-global context plays an important role in food security and its challenges have been studied in depth (see: FAO The state of Food Insecurity or Word Agriculture Reports). As an outcome, countries and international forums developed and enforce policies around the topic. However, most of the times the participation and involvement of local governments has been minimized to follow a vertical policy dictated from national and international organizations, deviating the attention of local policy-makers' engagement with the food security agenda.

The most recognized definition of food security was presented during the World Food Summit in 1996 by the United Nations Food and Agriculture Organization (FAO) it states:

> *"Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life."* – World Food Summit, 1996.

Nonetheless, in order to adequately address food security, it is necessary to include a general human rights framework since it is recognized as a precondition to achieve the right to food. Recognized as a right in the Universal Declaration of Human Rights in 1999, the latest definition has an addition from the United Nations Special Rapporteur on the Right to food which states:

> *"The right to have regular, permanent and unrestricted access, either directly or by means of financial purchases, to quantitatively and qualitatively and qualitatively adequate and sufficient food corresponding to the cultural traditions of the people to which the consumer belongs, and which ensure a physical and mental, individual and collective, fulfillment and dignified life free of fear"* – FAO. Special Rapporteur, Mr. Jean Ziegler para. 14, 2001.

The fact that it is recognized as a universal right provides a status under International Law obliging the member States to use all their capacities and resources to overcome hunger and malnutrition guaranteeing food security to all.

Both definitions integrate three pillars to achieve food security: Access to food, meaning having the sufficient resources to market access and purchasing power to obtain food. The second one, availability of food, entails the physical presence of food for all at the individual, household, local level, proper food supplies into the markets is required to achieve sufficient availability. Finally, food utilization, it is related to the absorption of healthy nutrients for a proper human physical and mental development. In addition, in order to maintain food security over the time, it is required stability in the three pillars described (UNICEF & WFP, 2009).

The above mentioned can reflect an urban food and nutrition security conceptual framework. Figure 3 illustrates the links between the economic, social and health impacts of food intake and utilization in the body. These are sustained by the stability of the food during the time and the capacities of access to food, availability of food and its utilization. To achieve it at different levels: Community, Household, and Individual.

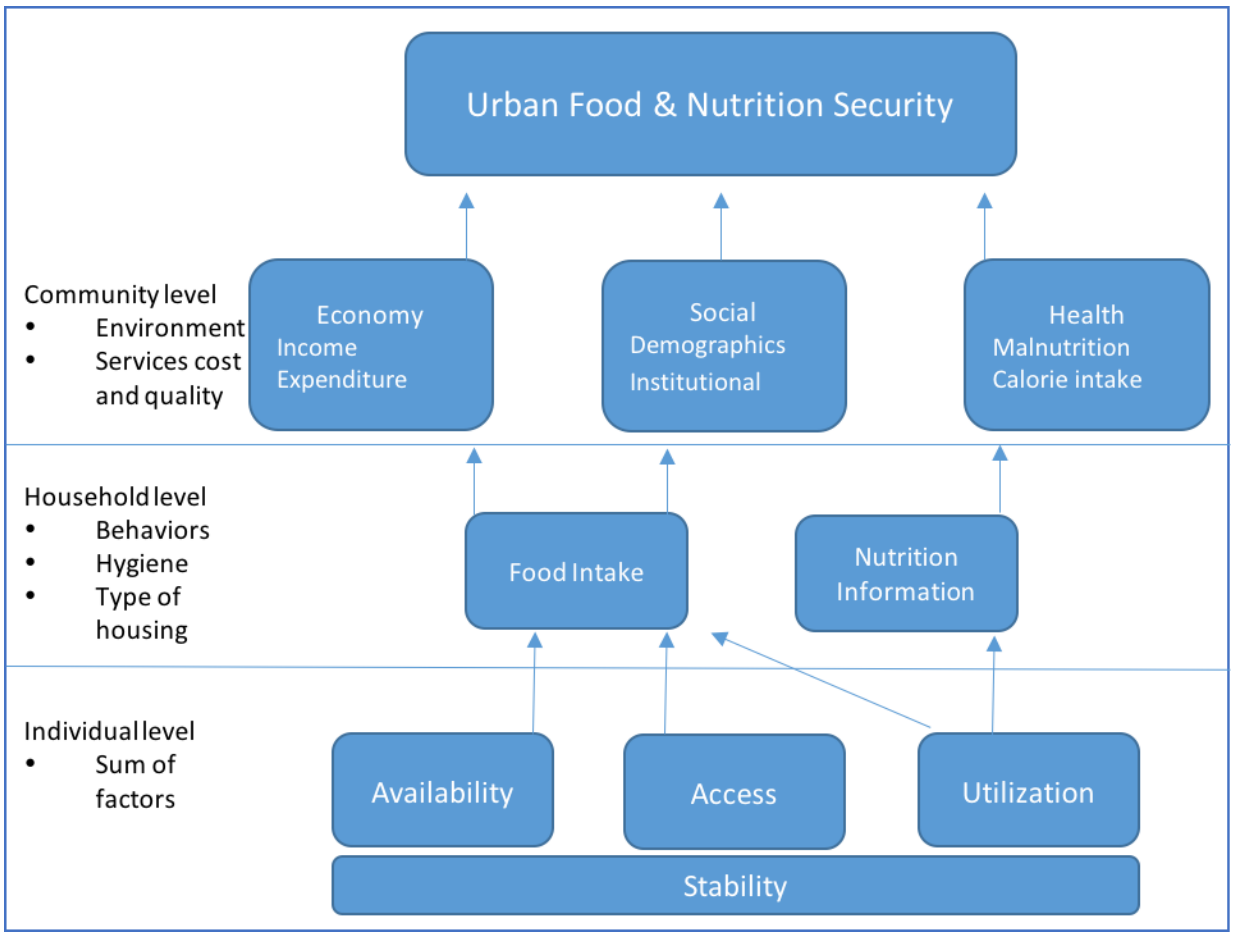

Figure 3. Food security conceptual framework
Source: Adapted from FIVIMS framework on food security and Food Secure Working Paper.

The dependence of urban population on purchasing food, the lack of sufficient wages, irregular settlements with a lack of adequate and sufficient livelihoods, hence the lack of proper water, energy, and sanitation services, limits the physical and economic access to food for some segments of the population. Other adverse impacts like climate change and land use competition are some factors that have been identified as contributors to food insecurity in urban areas (Kimani-Murage et al., 2014). Those inter-linkages and shocks are shown on Figure 4.

Figure 4. Urban food security stressors

Source: Own synthesis based on different readings

Food prices and household income are crucial factors to take into consideration for the food access. Especially when the level of poverty is higher, increasing the challenges to fulfill the food security definitions in the section *'physical and economic access'*. Under this view, the poor population in urban areas is the most vulnerable, in some places food expenditure can be as high as the 60 to 80 percent of total low-income urban households (Ruel et al., 1998).

This also represents a barrier to the access to food, small neighborhood shops located more often in low-income areas do not have diversified products, usually selling some food, snacks or basic staples, meanwhile big stores and supermarkets tend to be in areas more populated with middle or high levels of income. They have more diverse products, resulting in a social context differentiator where the store is located and what sells (Freedman & Bell, 2009).

As mentioned before, food insecurity does not include only the lack of access or availability to food but also the lack of the requirements nutrients for physical and mental development. That means having access to food can result in lack not be able to fulfill the physical and mental development, and the presence of diseases as diarrhea originated due the lack of clean water, sanitation and healthcare services impact in the levels of malnutrition.

The lack of proper nutritional intake in the first days of life the physical and mental development are undermined jeopardizing the capacities to continue further education preventing them to aim better jobs, limiting the capabilities of better economic development and perpetuating to live under low-income and poverty creating a perverse cycle (FAO, 2008).

Nyaradi et al. (2013) support evidence that malnutrition can impair cognitive development from the first pregnancy stages to the age of two, referred as stunted or chronic malnutrition. When the lack of food and the proper nutrition levels are higher acute malnutrition occurs. Acute malnutrition can threaten the life of the people. According to Save the Children every year circa 5 million children under the age of 5 die globally due to direct and indirect malnutrition (Save the Children, n/d). For those who can survive, their life is fated due stunted. According to UNICEF (2015) data, Asia is the most affected region with children stunted. However, the case of Guatemala in Central America has even higher malnutrition rates than Asian or African cases.

Amartya Sen, introduce the concept of entitlements. Which explain how different communities and households can use different strategies to obtain food, through the social or financial wealth entitlements. In Sen's words:

> *"the set of alternative commodity bundles that a person can command a society using the totality of rights and opportunities that he or she faces*". – Sen, 1984, p. 497

According to Sen, a direct entitlement occurs when a family can produce their own food. Indirect entitlements occur when a family works for a wage and need to that income to purchase food through vendors. And finally, transfer entitlements occur when food is obtained by any charity

channel. Food insecurity arises when a family cannot change towards another method once their original one has been disrupted for some reason. Sen's entitlement categorization produces another perspective on food security; he changes the discourse of food security from food supplies towards affected people who cannot access adequate food even if food supplies and markets are functioning well (Devereux, 2001). Nonetheless, Sen's entitlement approach has been largely discussed, especially in the conceptual and empirical individual approach prioritizing the economic aspects above the sociopolitical factors (Devereux, 2001).

Fraser et al. (2005), explain Amartya Sen's entitlement conceptualization into the lenses of larger communities in the city. The general conceptualization can be translated into an urbanized areas, where the food produced in the city or at the periphery can be translated as a direct entitlement, meanwhile imported food and bring from the region is an indirect entitlement and finally, food aid or global good banks are transfer entitlements.

Deepen understanding of urban food systems and security requires of accurate data and proper analysis of the information in favor of effectively target the most vulnerable and at-risk population in the cities. Under that premise, Information Systems are key in achieving the collection, the flow of data and analysis to the final decision-making, also as a tool in devising those indicators which can help to set the thresholds and goals to measure the performance needed for the food policy, especially when we talk about urban food systems. Acquiring good information and analysis can shorten the path of trial an error trying to guess the best policy to attend malnutrition or other issues.

2.3 Information System and Community Informatics

In simple words, an information system manages and processes information. As a software system capable of capturing, transmitting, storing, retrieving, manipulating data or displaying information, with an ultimate purpose of supporting the organization or even other software systems (van der

Aalst & Stahl,,2011). The interest of this thesis is the use of such information system, namely in the effects and influence it can have on governance or decision making. Thus, Information Systems can be understood as a tool to improve governance and management by providing available information that can influence the decision making, based on more data and information to feed the decision-making (Berisha-Namani, 2010).

Previously information systems were used to support operational functions, mainly looking for efficiency and effectiveness under industry context. However, nowadays their use is more extended. Berisha-Namani (2010) offers a general definition of information system stating:

> *"(Information systems are) systems to convert data from internal and external sources into information and to communicate that information in an appropriate form to managers at all levels in all functions to enable them to make timely and effective decisions for planning and controlling the activities"* – Berisha-Namani, 2010, p. 113

An information system as presented in Figure 5 is capable of first gathering and store data, process and analyze it, and finally, give it a use, through the decision-making and/or the dissemination of the information. That being said, the ultimate function of an information system is not only the collection of data *per se*, moreover, it is the production of information for action and facilitate the decision making (Berisha-Namani, 2010).

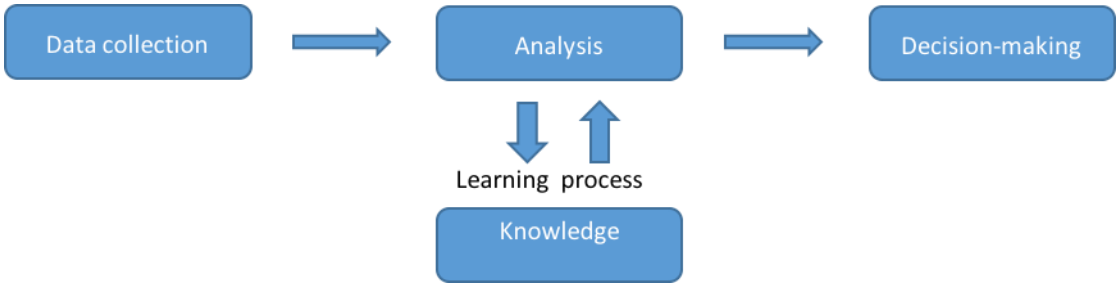

Figure 5. Information system chain

Source: Heeks & Ospina, 2015)

The information system can be a precondition to facilitate the direction of the decision-making enhancing the capacity of a better direction based on the information. Also, it is required in order

to assess and identify the priority areas in where is best allocate resources in the urban food system. It is essential for an informed decision-making process. As same as food systems, information systems are a complex and non-static system with a high degree of complexity.

The realm of information system can be really broad and use in many areas. However, there is a relatively new approach which is of this thesis interest. Gurstein (2007) presents Community informatics (CI), as an evolution of Information Systems which integrates the dynamism and adaptability of the communities.

More as an approach rather than an application itself CI seeks to capture the social, political and cultural community orientations rather than the commercial and organizational orientations characteristics of the regular use of Information Systems (Stillman & Linger, 2009).

CI base on Information and Communication Technologies (ICT) as a mean to both deliver and produce "content", either locally or global, aims to provide means and opportunities to re-thing the ways communities engage participating more active in the implementation of information systems, offering leadership and reaffirming the important role of communities (Gurstein, 2007).

Through those means CI enable and empower community processes and participation through the use of ICTs. This entails a common critic regarding the "access" to ICTs tools for lower-income communities provoking gaps among actors at different socio-economic levels and their opportunities to access ICTs and the use of tools, known as "digital divide" (Gurstein, 2003).

CI focus on 'access' for all the population to be able to deliver information, and ensure 'access' and public concern in order to overcome the "digital divides". CI provides access adapting and developing usable ICT services to support organization and social structures enable the communities to access to a range of benefits directly as service delivery and indirectly as training, local employment creation and expenditures (Gurstein, 2007)

Also CI support local economic development, social justice and political empowerment (Gurstein, 2007), moreover, the debate about access can be moved towards a more relevant topic, "effective use". This means to go beyond to the access issue and more into the use or uses of the information that ideally will benefit the communities, including the integration of the ICT use in the pursuit of the accomplishment of the community goals.

The potential to create information from different sectors of the society implies several advantages. However, in order to take the biggest advantage of this is required that the most marginalized areas are included as well with the ultimate goal of enable different actors to produce and deliver information according to their own needs and conditions. At the same time strengthens local communities and organizations empowering their participation.

CI approach based on the direct participation of the communities has high value as a bottom-up complement to top-down process and enhance the capabilities to participate and influence in the decision-making. Incentivizing the empowerment of individuals and communities as a people-centered, process-oriented and contextualized in a local setting grants the opportunity of self-representation fostering the means of expressing their needs. Ultimately, leading to self-reflection of power relationships within the social structures and socio-cultural context, some studies have reveal that people living in low-income or poor areas have pointed out the need of a voice is a priority over economic needs. Developing those capacities can also help to overcome the typical fail of not involving the users of the information system from the beginning (Sundar, 2007).

It is in this sense that communities are recognized as another stakeholder to take in consideration for the development of policies. Being said that, the governance behind the information systems and how it takes the decision-making should be feed with first-hand information of the area. However, the recognition of 'communities' might entail a definition problem when it is applied in urban areas. Mainly due 'communities' are recognized as rural figures

of participation and interaction. Nonetheless, the neighborhoods also function as communities, but as a more extended community, where an individual can be part of multiple communities. E.g. the neighborhood where he/she lives, but also the neighborhood where he/she works (Gurstein, 2007).

In addition to the participatory means, there could be an impact in the empowerment of the communities. Piotor Konieczny (2014) emphasizes that the means on how the community can deliver their needs is a strong tool to empower change and concludes in his paper that ICT's linked to growing literacy can empower social actors, including those who were in less advantages circumstances contributing and pursuing social change.

CI can be link directly with resilience and adaptive capacities. Ospina and Heeks (2015) in their paper identified the connections between ICTs and resilience properties. They concluded how an ICTs and CI approach can foster community resilience and the need of build resilience in the cities, especially for the vulnerable segments of the population.

In this sense, ICTs by itself do not generate participation in the citizens. ICT's are not democratic by default, however they are tools to communicate and link the relationships supporting information (Frinquelievich, 2000). Hence it need to be clarified that relying in ICTs have the danger potential of perpetuating and expand the power relations and inequalities in a determined area, yet a proper implementation of CI could enable the development of fully democratic processes empowering the communities, hence it is important to note that one tool should not be seen as a panacea, in other words, it should not be dependent on it (McIver Jr, 2003).

2.4 Indicator Systems

Information systems can use indicators as parameters to set goals and measures. In simple words, indicators work as a tool which can be used for multi-purposes; assessment, education, monitoring progress, among others, but also, for leading the path of decision-makers. An indicator can be defined as a quantitative mark; however, it includes crucial information needed to consider

for the understanding of a bigger picture of a topic. An indicator system can provide comprehensive information to create frameworks for strategies, measuring performance and evaluate measures. It has the task to present in a simple manner complex problems with easily understandable explanation (Sirgy et al., 2009).

They can relay in the information that indicators can provide for the elaboration of policy-making. Even though the use of indicators has been used extendedly the gap between theory and practice still need to be narrowed down to find better results. (Hezri, 2004).

However, as Meadows (1998) points out, *"indicators are just a partial reflection of our reality"*, they work to standardize views, monitor system and measure a specific area of interest. Being said that, indicators are merely proxies of what can be in the real world. At local level indicators can promote performance measurement. Hence, indicators can determine thresholds and measures of the current stage of a certain issue in a society, helping to a better understanding and guiding the policy-makers.

Indicators are multi-use. They can seek to measure different topic with numerous goals. They can be used as information systems. Indicators look to deliver information that supports the decision-making either by monitoring policy towards a specific goal or encourage changes in the policy through the patterns track or prognosis of a specific subject (Sirgy et al., 2013).

Over time, the use of indicators can educate and produce organizational learning of the current conditions, providing better understanding if the governmental approaches are having a positive or negative effect, and how close they move the set goals or moving far from them.

There has been a rise in community local indicators as a response to several failures in more traditional systems, in this way they can set their own values, own concerns and especially own well-being. They gain the capabilities of tracking their own issues and promote decision making for the community (Teodoro, 2015).

According to Philips (2003), a community indicators are *"bits of information that combined generate a general picture of what is the status in a local system"* The objective is to provide a general picture of the community status in a specific topic or topics. However, it has a strength characteristic of the promotion of involvement ad active participation of the citizens, as well as community informatics, it is based on the idea to bridge the gap of appropriation of action and deliver information through different means, such as ICTs, for the development of indicators and information. In order to represent as close as possible the needs and interests of the community the participation of the society needs to be previous, as Meadows (1998) suggest, the process of indicator selection and delimitation is as important and the indicators itself, and as well during the selection, categorization, and conceptualization. Finally, strong commitment and engagement of participation feeding the system with data and information.

However, indicators can be two-edged, either they can be fully efficient to attend different problematic gaps or needs in a region or well they can cause misleading reactions deepen the issue intended to solve. Hence, indicators need to be chosen carefully and as accurate as possible. Haddad et al. (1994) recommend the choice or selecting of indicators should be as simple as possible, to avoid deep complications of measurement, validation, and continuity of getting the information, yet provide valid and reliable information, but still straightforward to collect and analyze.

It is worth to mention that the task of this thesis is not to deepen in an indicator system elaboration, rather to show the links in how community-based indicators can also incorporate food security variables, especially under an urban context, whereas it has been described the realities and insecurities differ from the rural area.

It is widely agreed that indicators development need to incorporate the participation of local communities providing a more contextualized understanding, but also a national-level data can

provide a global assessment. As Reed et al. (2006) describe, there must be a balance between community-base, bottom-up and national top-down in the indicators development. The weaknesses and strengths of both approaches can be complemented. As same as in information systems, the information collected at community-base can build in the construction of understanding the realities and localize gaps, meanwhile the national efforts can provide a bigger picture of the problem.

The inter-linkages of the indicators need to be acknowledged as well, in this sense indicators should not be treated as isolated variables, rather as linked –in some cases with a higher impact, in others lower - but at the end the linkages can also help to determine different aspects of the same problem.

2.5 Food Security Information Systems

The connections between food security and information systems can be spotted quickly. There are several food security stressors, therefore, information and indicators can help to understand the current state, measure the severity and localize the vulnerable groups. Food security information systems are needed in order to generate well-oriented decision-making to attend the challenges. The need of information systems to deliver action and proper policy making, recognize that during situations under crises the demand of information systems increase.

Even though information systems for food security have been developed at the global or national level, there are few equivalents at the local scale, hence the development of community indicator systems often miss to incorporate fully urban food security.

Several metrics have been developed to measure the food availability, access, and utilization of food, even the stability through time. Most of the times these metrics are drawn from the national, regional, household or individual data. The development of indicators can array from those simple, for quick collection and easy analysis to more complex and comprehensive measures

which required detailed information over the time, most of the time high resource-intensive and sophisticated analysis is needed (Jones et al. 2013).

One attempt to categorize the several Information Systems that deals to measure and understand more the food security status at different levels is through the FAO (2005) classification. They consider and identify different information systems displayed worldwide. Some humanitarian information systems can be described as follow:

- Baseline vulnerability analysis and poverty assessments; attempts to describe and analyze the risks for specific vulnerable populations. The information is used with a long-term approach as poverty alleviation, social safety-net, national disaster management, etc. It is useful at the national level to draw useful background and baseline on risks, livelihood systems, and population groups, providing indicators for early warning systems.
- Early warning information for food security: intend to provide enough information for predicting and mitigation the impact of shocks before an emergency. Those systems operate at different levels. At the global level we can find the Global Information and Early Warning Systems on Food and Agriculture (GIEWS); the Famine Warning System Network (FEWSNET). The Famine Early Warning System (FEWS), was a precursor and trigger to develop Food Insecurity and Vulnerability Information Mapping System (FIVIMS) in some countries (McCalla & Mock, 2004). Supported by USAID the FEWS moves the early warning methods from national production-oriented indicators and looks down to household access and nutrition.
- Those systems are based on statistical representative data, or sentinel sites, to monitor best versus worst populations/cases. It is necessary to use a common standardized type of variables.

- Food Insecurity and Vulnerability Information and Mapping System (FIVIMS). As well, some regional initiatives can be found in Africa like: The Southern Africa Development Community (SADC) or at the national level the Intergovernmental Authority on Development (IGAD). However, these types of systems might not be the most relevant at the local level indicators.
    - Agricultural production, market information and health and nutrition surveillance, demographic data, and economic variables (macro and micro level) are common aspects use in theses systems.
- Impact evaluation: The objective is to evaluate if the goals or expected impacts have been achieved, in order to provide a critical feedback for the design and implementation of interventions.
- Community-based food security and nutritional systems: are autonomous and/or complement national early warning or food security and nutrition information systems. Usually is used when it is required information with local groups. It will require an investment oriented to training and deploy the personnel to operate the system. However, this is a payoff due local-level identification and ownership of the data collected. It can be collected a combination of normative and location-specific indicators. The data can be incorporated into ongoing activities. A key feature of a community-based information system is the possibility to support local problem identification, analysis, and even action. However, the extent of use of this systems is not strong or not continue which lower the advantages mentioned before.

The food security information systems are intended to gather relevant data and information for processing, analyzing and acting to address food security and nutritional challenges. The difference of the components determines the extent of its use, level, group targeting, etc. The diversity of the

metrics and systems raise different questions to the decision-makers, like: What components of food security need to be measured? The purpose: early warning or screening at-risk households? The available resources and the capacities are enough?

2.5.1 Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS)

FIVIMS can be defined as a framework in which diverse activities can be carried out, at the national and international level, with the intention to support improved information to help achieve food security. In other words, FIVIMS is not a single information system, it is a network of different information systems that gather, analyze data to measure and monitor food insecurity and vulnerability (FAO, 2000). FIVIMS represents a good example to understand more how food security and information systems meets. It was envisioned in the World Food Summit Plan as a response to the food security crisis stating:

> *"It is necessary to target those people and areas suffering most from hunger and malnutrition and identify causes and take remedial action to improve the situation. A more complete, user-friendly source of information at all levels would enable this."* – World Food Summit Plan of Action, para. 4, 1996

Since the World Food Summit was foreseeing the need of information which could help to identify those who are insecure and vulnerable, at what degree of low food intake or malnutrition are and at the same time identify the causes. The deployment of these initiatives around the globe have proliferated, however the view has been, in most of the cases, at a global approach, therefore it has been acknowledged that there is a lack of good information at the sub-national and household level and the advantages of a community base system.

FIVIMS has the capacity to incorporate nutrition indicators, but it must be linked with health care data, and at the same time with poverty rate and economic indicators. However, through this vision as national and global level, seeks to produce information from a top-down approach, meanwhile, one difficulty is the capacity of produce community-base information in a bottom-up

approach, which can integrate household-level analysis and even gender-disaggregated information.

As mentioned before, there has been an increasing recognition of the livelihood and household data collection approaches. Some development agencies have been monitoring, assessing and even mapping food insecurity and vulnerable groups. The strength in the approach of livelihoods it is at the same time a limitation when it tried to incorporate within the government the high level of disaggregation and holistic information is difficult to handle and require high qualify human capital. Hence household surveys are an unexploited source. Conventional household surveys provide relevant data for food security analysts, but the sampling frames can no be large enough for disaggregating by livelihood category (McCalla & Mock, 2004).

National and local decision-makers rely on accurate and timely information on the incidence and causes of food insecurity. The information that they can collect, analyze and retrieve for decision-making allows developing effective policies and programs to address the needs of food insecure.

2.5.2 Latin American and Caribbean Food Security Scale (ELCSA)

As described before the most common methods to measure food insecurity are based on economic and productivity indicators and the availability of food in the national and regional markets. These methods are expensive and relay in the national capacities to develop those indicators; however, it is difficult to show the household realities with those indicators.

It was in 2012 when the Scientific Committee of the Latin American Food Security Scale gathered to produce the "Application and use manual for the Latin America and Caribbean Food Security (ELCSA by its acronym from Spanish). The outcome was a document which compiles the history, uses and manual of how to implement the ELCSA (Comité Científico de la ELCSA,

2012). It highlights its advantages versus other information systems, but as well some weaknesses can be spotted. This section draws on the main features and weaknesses of the Scale.

As a regional validated, experience-based measure (Jones et al., 2013) the ELCSA permits capture different underlying dimensions of food insecurity as a method that allows to directly measure the household food insecurity experience. Under an easy questionnaire that explore the strategies to cope food insecurity. The importance of the household experience allows to understand the strategies to cope with food insecurity. This framework shows the steps of food insecurity at the household level, moving from 'concern and anxiety' –soft – towards reduce the quantity and quality of food intake for adults –moderate- and children –severe-.

One of the weaknesses of the ELCSA is that during the process of application it requires trained staff under a workshop aimed for that. Standardization of its application among the interviewers in order to lower slant of any kind at the minimum. The ELCSA needs to go under a qualitative and quantitative validation according to the country. Aspects as langue and representativeness of the interviewees, among others need to be taken into consideration, which can bear hard difficulties. Nonetheless, achieving well trained staff and good validation will increase the validity of the information collected and with it the reality of the families.

It is needed to mention that ELCSA's objective is to measure the food insecurity experience at the household level. In other words, its task is to measure the food access at the household level, hence, other dimensions of food security as utilization and availability are not considered.

The reason why the ELCSA do not consider the three features of food security is due the idea that no indicator can describe by its own the food insecurity, instead other indicators need to complement the ELCSA (Comité Científico de la ELCSA, 2012). In this sense, other indicators can capture additional dimensions of food insecurity. In order to identify other inequalities linked with different social vulnerabilities, such as gender or ethnicity. In Latin America has been used

as complement with other indicators as a diagnosis tool for food insecurities or to follow up and measure policies and programs for food security, such is the case of Guatemala with the "National Survey of Life-Conditions" (ENCOVI by its acronym from Spanish).

2.6 Socio-Ecological System Framework

Socio-ecological systems involve a relationship between humans and nature: social systems – made-up by people, organizations, culture, and history- managed an administrated by institutions and ecological systems where organisms interact with each other and their environment in a self-regulatory way.

The term social-ecological system emphasizes the concept of humans in nature and the delineation between social and ecological systems as arbitrary and artificial invented by humans to delimited some areas. Such system deals with a reciprocal feedback, and the cross-scale and interaction is integrated into multiple states (Folke, 2006).

The socio-ecological model on Figure 6 reflects the understanding that all resources used by society are part of a continuous, complex and dynamic relationship between people and their environment, emphasizing the importance of the social, institutional and cultural context (Ostrom, 2009). The model and the underlying theory are proposed to study and understand the interventions and interrelations between different actors and their surrounding resources and environment (Gregson et al., 2001).

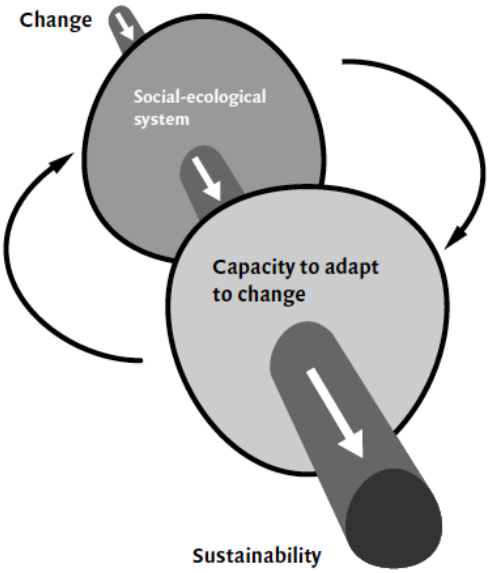

Figure 6. Adaptive capacity for sustainability

Source: Berkes, 2008

Yet environmental and societal problems add the difficulty of constant, complex, multi-layered and inter-linked interactions. Societies and cities are in constant transformation, evolving and adapting, reproducing and reinventing themselves. In this context food systems and information systems are not contrary to this, been inherently dynamic and complex (Berkes, 2008). Due to the complexity and dynamic of socio-ecological systems, change is constant, with high reciprocal feedbacks; thus, the system needs to learn to adapt socio-ecological systems.

2.7 Summary

There are several numbers of information systems established at the national and global level to deal with food security worldwide; however, those systems are under several inter-related constraints: lack of political engagement, mainly due the difficulty to perceiving the immediate and tangible benefits of creating those systems. Other constrain is the Institutional failures, especially with the lack of effective inter-sectorial and cross-ministerial linkages and cooperation, sometimes doubling efforts or not sharing information. Also technical constraints can also reflect

as the lack of new computer-based analytic tools plus the lack of trained human resources to manage and analyze complex information at different levels. There is also a lack of an inclusive participatory process and involvement with the communities. Finally, financial constraints which can reduce the efficient and effective operation of the information systems. Especially when it requires the deployment of survey collection. (FAO, 2000).

As pointed out previously, there are four aspects of the information system relies upon: the governance of the system, the institutions, and legal framework which support it. The technical capacities are required for the development of the tool, the available technology, and the qualified human sources to operate it and produce information with the data collected. The participatory process which can gather all the voices of the different stakeholders, especially at the communities-base level where the needs of the population need to be addressed. Finally, the use of the information, the more crucial part, how this information is delivered for the decision-making and how it can bridge the process from data collection to target the programs, projects or policies to ameliorate food insecurity. The use of the information can impact the adaptive capacity of the governance of the system and the management as well.

As presented in the previous chapter, reveals at glance the current stage of urban food security and the lack of understanding from city planners to integrate the food dimension in the development agenda. The limited picture of the full food system from decision-makers at urban level have created a false sense of food security. At the same time, national and global initiatives have put in place several tools to measure and collect information on food security. However, most of the times from a top-down approach, even household-based tools which can provide great advantages are build on a top-down sampling approach. Finally, it is possible to understand food systems and information systems under a context of socio-ecologic systems, where human-made institutions and natural ecosystems interplay, in a continuous transformation and adaptation.

3. Theoretical Framework

This chapter seeks to develop a conceptual framework to understand the use and governance of an information system built with the community informatics principles for food security in urban areas, this system promotes social learning for adaptive governance and management increasing the resilience of the cities.

It also underpins the thesis to fit a community informatics urban food system under a social learning process framework to foster the adaptive process from government institutions to cope with the challenges and the management of the policies under a learning-by-doing approach. , in an adaptive socio-ecological system context,

However, it is possible to aim for a community-based information system that feeds the central information system, resulting in shorter periodicity for collecting the data. The use of ICT's under a community informatics approach can support bridging the data collection. Yet, this entails other challenges as the analysis of the information, the proper delivery to decision-makers and the final use of the information.

3.1 Adaptive Socio-Ecological Systems

Socio-ecological systems, as the integration of humans in nature and the social human-made institutions and organizations, require to adapt due the external and internal conditions. Organizations -as individuals- can 'learn', hence society and institutions can also learn and adapt. The process known as adaptive capacity is the capability of a system or organization to shape in accordance to the external and internal drivers that it is exposed (Iain et al., 2008). Thus, adaptive capacities are needed and more punctual in governance and management, as two feedback loops that occur inside the bigger socio-ecological picture.

Adaptive socio-ecological systems need to deal with the changes and dynamics; hence, require adaptive capacity around a plan-do-learn cycle, increasing adaptive management and adaptive governance can increase the resilience of the systems with better-connected institutions.

Understanding the different properties that shape a system, the components and interactions and how they operate together is essential, however in complex systems –as food system and information system- some parts, and connections cannot be easily identified, however according to Berkes (2008), there are five attributions of a complex system.

- Nonlinear: Inherent uncertainty, meaning that there are not simple solutions or pathways to follow, the system will organize around several possible equilibrium options.
- Uncertainty: the system under certain conditions will change –rapidly or gradual- the way it will transform, some proxies might be calculated or modeled; however, is rarely predictable.
- Emerge: due alterations the system can develop adaptive capacities in order to adapt to change.
- Scale: the system is made-up of different sub-systems, organize in a hierarchic set – vertically but as well horizontal- through local to global, and between sub-systems at the same level may be coupled by feedback relationships, encouraging the transfer of information among them.
- Self-organization: Due the feedbacks capacity the system can expand to new forms of organizations and create different possible new states.

While the model shown in Figure 7 shows the interactions between the social and ecological domain, it is necessary to call the attention to adaptive management, as the capacities of learning-by-doing, prioritizing the feedbacks allowing to close the loop, meanwhile adaptive governance

collaborative process among different stakeholders, at different levels and different social and ecological scales.

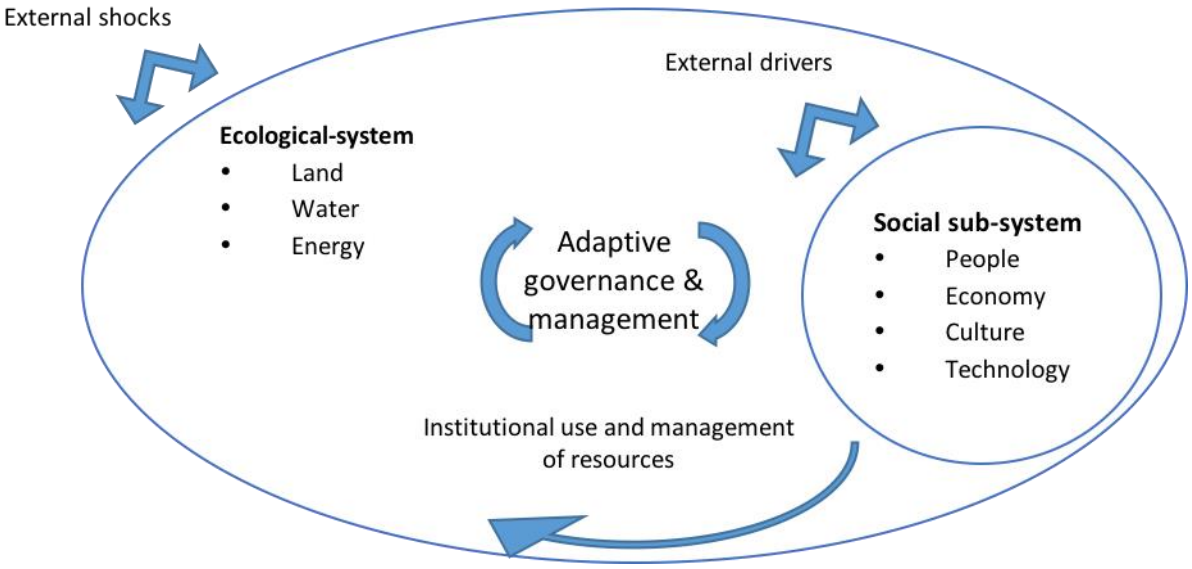

Figure 7. Socio-ecological system framework

Source: adapted from Goulburn Broken Catchment Management Authority

With the aim to build adaptive capacities which can allow dealing with shocks, hence as an outcome, builds to resilience. Socio-ecological systems are inherently dynamic and may go through four phases, explained through the adaptive cycle in Figure 8: growth /exploitation (r), conservation (K); release (Ω) and finally reorganization (α). The changes from r to K are incremental and slow, progression from K to Ω allows learning, and Ω to α allows the mobilization of resources to reorganize the system. The cycle may replicate itself in 'panarchies', which are adaptive cycles interacting across multiple scales (Resilience Alliance, n.d). The concept of panarchy capture the dynamics of adaptive cycles that are nested within one another through space and scales, in a continuous way.

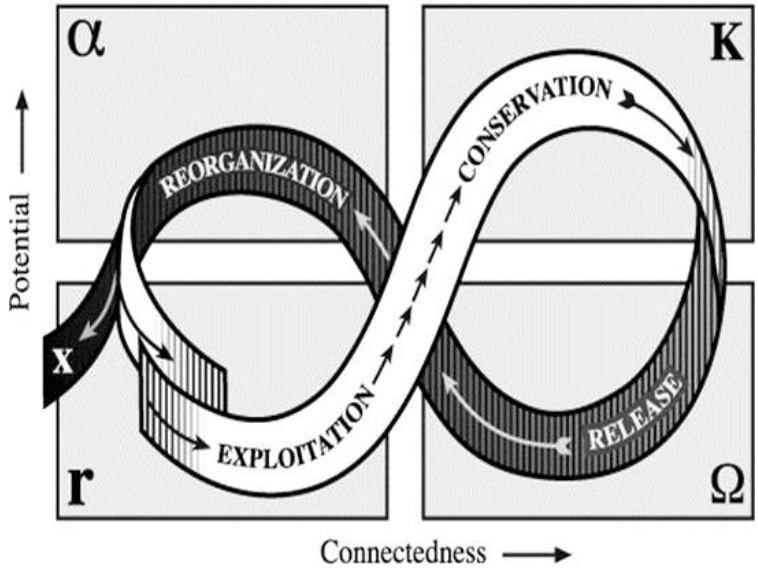

Figure 8. Adaptive cycle
Source: http://www.resalliance.org/adaptive-cycle

As an important aspect to consider in adaptive systems is the cross-scale and cross-systems interactions. Across temporal and spatial scales and different levels of organizations. The decision in one area might affect people elsewhere (Folke, 2007).

Observation and interpretation, generate learning process, followed by knowledge. Experiences are social capacities of responding to environment changes in the form of adaptation. These adaptive capacities can be reflected in two areas: governance and management. Adaptive governance provides the capacity to bridge different stakeholders to collaborate and learn across sectors and scales, adaptive management provides the capacity of learning-by-doing in a more operative way.

It is required flexible institutions and regulations which can adapt to the context requirements, beating cross-scale linkage, improving communication among stakeholders and enable conditions for collaboration as an outcome resilience of socio-ecological systems will be enhanced. Hence, it is necessary to understand that adaptive governance and adaptive management

are complementary to overcome barriers that both will face and need to respond within the social scale and change with an informed knowledge (Folke, 2006).

3.2.1 Adaptive Governance

According to Folke (2008), adaptive governance is built from four parts: 1) understand ecosystem dynamics; 2) develop management practices to interpret and respond to ecosystem feedbacks with continuous learning process; 3) build adaptive capacity to respond to uncertainty and surprise; and 4) support flexible institutions and social networks through multi-level governance systems.

The governance capacity to adapt under uncertainty and surprise builds sustainability in time increasing capabilities of reaction against shocks. Government system can gain experience building adaptive capacity to what best fit (Pahl-Wostl, 2009).

Adaptive governance relies on the collaboration of different stakeholders at different scales within multi-level institutions. Therefore, rely on social networks to put together different stakeholders will enhance the adaptive governance. It can be understood as an extension of classic management, incorporating formal institutions, intermediaries (e.g. organizations and networks) and individuals, where intermediates can enable the adaptive capacities allowing novel approaches, facilitating communication among actors and providing flexibility to the institutions (Craig & Garmestani, 2015).

According to Craig and Garmestani (2015) it is necessary to advance from the limited policy based on steady-state to novel means, in order to lower vulnerability and increase adaptive capacity to the system, beyond a short term aiming for structural transformations, legislations, and different policies can contribute to a solid governance framework, establishing a vision and achieve the implementation.

Adaptive governance can be operationalized through adaptive co-management, based on the collaboration of different stakeholders, working at different levels through the use of networks.

Co-management argues for decentralization or share of power management through multiple links among institutions, vertically and horizontally.

Organizations can adapt to uncertainty by modifying their information-processing-capabilities. This is through increasing the capacities for information acquisition storage and retrieval. According to Huber (1991), there are four ways in how an organization can acquire knowledge and learn: knowledge acquisition, information distribution, information interpretation and organizational memory.

Information systems can be used as a tool to acquire knowledge in food security and incentive social learning capacities. With the proper use of the information bridging the gap for oriented policies fostering the adaptive government capacities and improving the horizontal and vertical governmental relations and the adaptive management of the policy implementation.

3.2.2 Adaptive Management

Management understood as the capacity of organization and coordination of a system, institution or entity can be improved when it is capable of cope with the uncertainties. In the way how uncertainties are managed it can increase or decrease the capacity of reaction. In this sense management capacity need to be flexible and able to deal with changes around it.

Adaptive management capacity of a system refers to learning-by-doing. The way the system can learn is either –or a combination of- through treating policies as 'experiments' where managers can learn from it or through the exchange of information and feedbacks within the institutions which shape the policy and when the process of the feedbacks is short, clear and concise the learning process can be faster (Berkes, 2008).

The latter can be applied to local-level institutions, where the respond to the feedbacks is shorten being physically closer to the user area than centralized agencies avoiding slow

bureaucratic processes. At local level, the management capability of doing is increased and hence the learning process occurs from the bottom line as well (Iain et al., 2008).

There has been a generalized agreement of the involvement of different stakeholders and promote participation for adaptive management, creating more democratic processes and decision-making. By embracing different stakeholders the information flow is enhanced in order to every one of them be able to learn from each other (Stringer et al., 2006)

Information plays a key role in adaptive management capacities, especially the one provided in the feedback, this can reduce the gap of uncertainty, the use of qualitative information can support the decision in the decision-making (Berkes, 2008).

Most of the times how participatory approaches are performed through main stakeholders such as scientist, managers, community leaders, specialized agencies or NGOs falls into a slanted theocratic approach. This leaves outside the population their views and experiences maintaining elusive power sharing (Stringer et al., 2006). But with the use of community-base mechanisms, such as community informatics, it can be fostered the participation from the local communities starting from the small unit scale of the community scaling up to decision-makers.

A multi-stakeholder approach and participation will increase the results with better management plans and the participatory methods can capture information and perspectives which are required to manage socio-environmental systems (Stringer et al., 2006).

3..2.3 Social Learning

As mentioned before, institutions and organizations as humans can "learn". This has been explored through the study of social learning theory (Wenger, 2000). The process of learning-by-doing of adaptive management and the capacity to deal with uncertainty and surprise of adaptive government can be translated to social learning processes. Folke (in Price, 2004) remarks the need of social learning as a mean to cope with the uncertainty and change through the continuous

learning processes and knowledge generation. According to Pahl-Wostl (2007) the conceptual framework for social learning presented in Figure 9 formed by multiparty collaboration and working for specific context leading to specific outcomes. The most interesting part is the idea of a feedback loop between outcomes and context. wolf

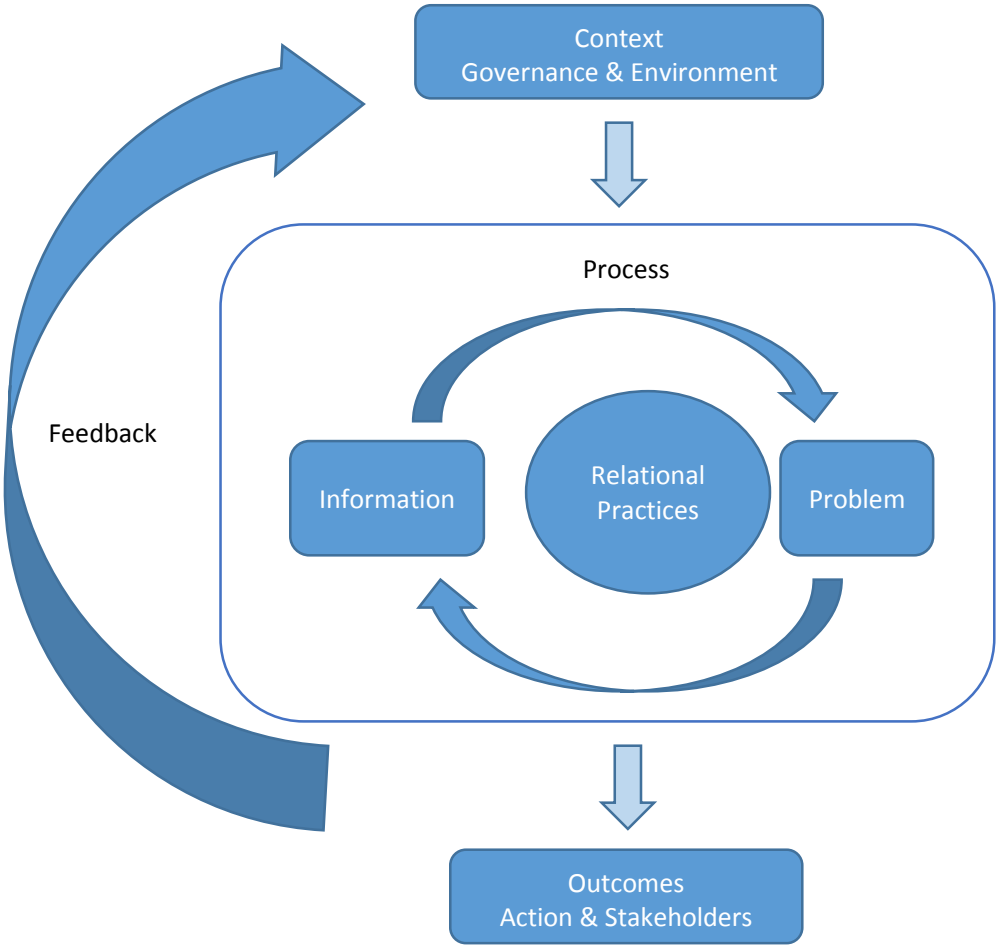

Figure 9. Conceptual framework for social learning

Source: Pahl-Wostl et al., 2007

The framework is divided into three areas, the top is the context, understood as the governance structure and natural environment; follow by the core processes performed by multiparty or network interactions integrating relational practices process of information and management problems solution. The outcomes refer to the direct implementation of actions to address the

problem and empower the stakeholder to act towards the problem. Lastly, there is a feedback loop from the outcomes to the context where it made possible the learning process.

The social learning process is not static; it can be scale on three different levels. Figure 10 represent the triple loop learning process from short to medium time scale, between collaboration stakeholders and process, which represent a change in strategy and therefore it is faster to perform. The double loop and third loop aim to longer structural and systemic changes

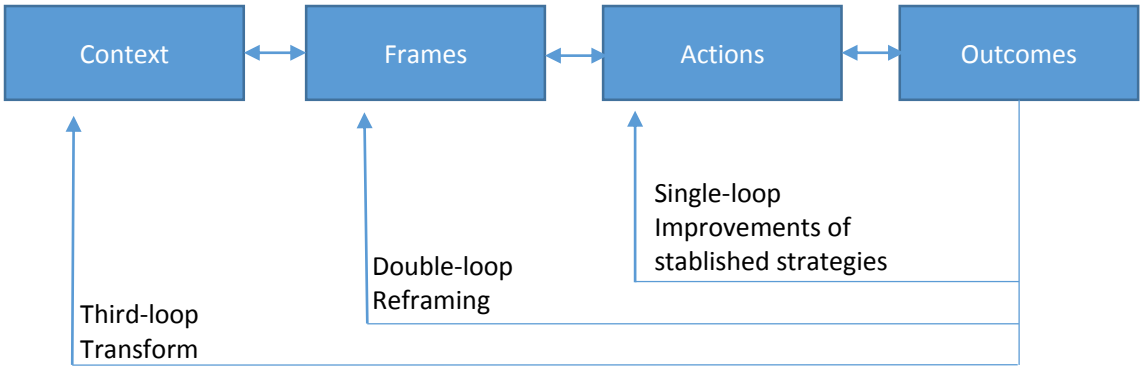

Figure 10. Learning cycles with triple-loop approach

Source. Pahl-Wostl, 2009

The single-loop aims to adjust actions or change the strategies. The double-loop seeks to change the way it is frame the current problem, 'reframing' it with new lenses through the experiences or information obtained from the single-loop fosters to change how to achieve the goals. The third-loop looks to 'transform' the structural context. In order to transform how the problem is framed, it requires recognition to move forward from the known paradigm to new ones (Pahl-Wostl, 2009).

According to Pahl-Wostl (2009), there would not be change neither innovation without critical self-reflection leading to learning processes linked to adaptive capacities. The knowledge produce at one level will impact the process in other levels.

3.2 Summary

The presented theoretical framework of adaptive socio-ecological systems understanding the interplay between nature and human focus in the dynamic changing conditions of institutions and nature requesting to adapt in order to deal with the situations.

In this sense, adaptive management and adaptive governance capacities can allow the system to perform learning-by-doing and modify the collaborative roles of institutions. The use of an information system can promote social learning capacities at the different levels.

An information system has the capacity to provide feedback on policy implementation and allows to analyze how well a strategy is performed the strategy, but also to question the broader framing and even the paradigm.

Overall, the potential use of an information system to foster adaptive governance and management through building social learning capacities might require novel approaches to collect and analyze data in a faster method and with shorter pathways to reach the decision-making.

4. Guatemala City Fieldwork

This chapter will describe the study area to set the stage for understanding the context for the use of information in food security related decision-making and the potential use of an information system in food security-related adaptive governance. It will explore the current conditions of Guatemala and Guatemala City in four dimensions – governance, technical capacities, participation process and use of the information- with respect to food security and present availability and use of related information system.

4.1 Guatemala General Context

If food security is highly context dependent, then urban food security is even more. Therefore, in order to contextualize and narrow the issues, challenges, and frame how a community informatics system can be used to enhance the adaptive management and adaptive governance, it is necessary to work in the field in a concrete geographical area. In this case, Central America and the Caribbean have been regions with different political, economic and environmental issues. The challenges faced in the region call for attention which can build into future projects.

Located in Central America and the Caribbean, Guatemala is considered a very diverse country in demographic, geographic, ethnical and social aspects in a region with high biodiversity and agro-ecological richness; however, it's facing several political, economic, social and environmental issues. The 2014 Human Development Index (HDI) places Guatemala in the 128 position out of 188 countries, when inequality value is discounted the HDI falls even more, showing big inequality issues (UNDP, 2015). Meanwhile with respect to food, Guatemala is identified as one of the countries with the worst level of malnutrition in the Western Hemisphere, and the first in Latin America (Feed the Future, 2016).

Figure 11. Map of Guatemala

Source: Modify from www.freeworldmaps.net/guatemala

According to USAID (2015) Guatemala has the fourth highest rate of chronic malnutrition in the world and by far the highest in Latin America and the Caribbean. Meanwhile, as Figure 12 reveals, 48 per cent of the children in the country are under food deficit malnutrition, or stunt, and 4.9 per cent in overweight (FAO, 2015). The trends are not promising; the rate has been growing steady from 16 per cent in 1991 to currently at 30 per cent. Guatemala is susceptible to natural shocks generated by the 'El Niño' phenomenon, which modifies rainfall, causes droughts and crop failures, limits agricultural production, and leads to social tensions, income loss and worsens inequity. Additional to these natural shocks, the extreme poverty in the vast majority of the population increases the vulnerability.

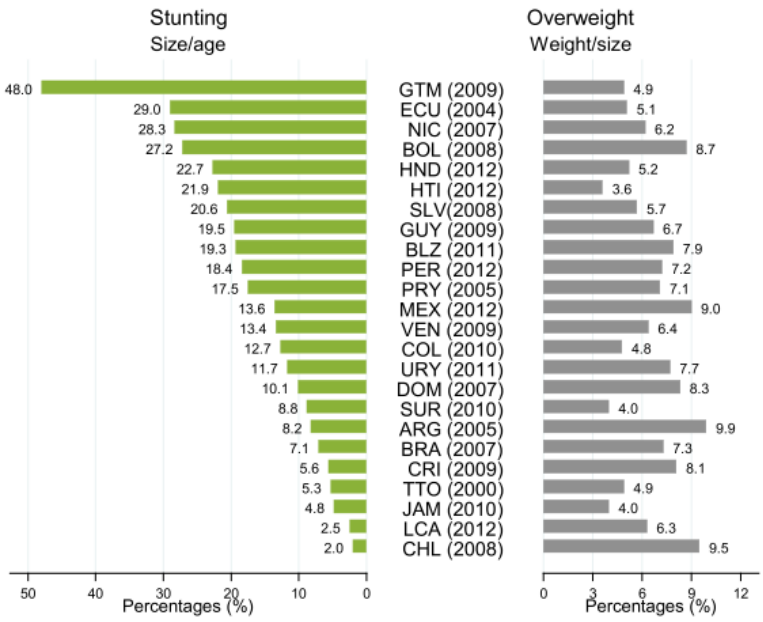

Figure 12. Malnutrition under 5 years old children in Latin America and Caribbean

Source: FAO, 2015. Latin American and the Caribe(FAO, 2015)

In 2010 Oliver De Shutter –UN Special Repporteur on the Right to Food delivered his report of the right to food of Guatemala country mission in 2009. It was able to understand the historic inter-linked roots which have played a role in the hunger perpetuation in Guatemala, a systemic failure from the economic system under the agricultural exported model, inequities in power concentration from the elites and lack of continuity management- these are just a few examples of different failures (Prado-Córdova, 2011).

Food security is also affected by corruption. 2015 was marked by a major corruption scandal involving the former president Otto Perez Molina and the vice-president Roxana Baldetti (Elías, 2016). This scandal culminated in the arrest and indictment of both. This event marked an important inflexion point in Guatemalan history. On the one hand, it shows the empowerment of a broader range of stakeholders to demand better administration and on the other hand, public servants probably become more cautious in policymaking and finance. It is not the task of this thesis to explore and analyze those issues and events; however, it is important to acknowledge

them in order to understand the current situation and the long time food insecurity has maligned the country.

The lack of studies to identify all the actors in the urban food systems misses the understanding of the socio-economic participation of the food system at local level. According to the Guatemalan National Bank the food and beverage sectors are the second most important economic activity in the country and it is the third for employees' income (Super Intendencia de Bancos, 2012); however, this measure just considers these sectors as industries (e.g. food process industry, bottled water industry, etc.), it does not consider a bigger scope of the food system as retailers, intermediaries, restaurants, street food among others.

According to national statistics, around the 62.2 percent of the economic active population is categorize in the informal sector, which is defined as workers with low productivity, most of them are in the agricultural sector (40.5%) followed by the commerce (31.2%) (INE, 2013a).

4.2 Guatemala City Context

Almost half of the population of Guatemala live in urban areas and the number of people has been increasing steadily in the last 15 years. It is in Guatemala City and the Metropolitan Region where the challenges differ from the rest, as an urbanized area accounting for 21.1 per cent of the total population (3,257,616 million inhabitants) (INE, 2014a) and accounting for the biggest urban population of 87.3 per cent (INE, 2014b).

Population growth has been steadily increasing during the last 50 years, resulting in an expansion of the city, sometimes as much as 20km from the center, pushing to the periphery lower-income families where almost a third of the population lives. Settlements in the periphery lack of proper public services like water, sanitation, and energy, suffer inefficient health care services and bad public transport. These factors all contribute to food vulnerabilities in these areas (Valladares, 2003).

Under these National and Local contexts, Guatemala faces several challenges of many kinds, food security being one of them. The main challenge to ensure food security is related to the access to food, this can be divided mainly in three measures: 1) indirect, such as poverty levels; 2) causes, such as availability; 3) effects, such as malnutrition (Sergio et al., 2013).

Poverty and health are two key drivers to perpetuate the food insecurities, also population security and education are both underlying systemic failures that contribute to these challenges. Security issues and gang problems influence the societal dynamics, as gangs take over the youngsters, reflecting in the abandonment o education.

In sum, this undermines the opportunities to qualified jobs, increases difficulties to food access and expand the –already high - poverty gaps and inequalities; at the same time, malnutrition undermines health, with low weight and height in children under five years is the biggest rates in Latin America of children with chronic and acute malnutrition rates.

4.2.1 Poverty

One of the main tools to measure the poverty levels and inequality is through the "National Survey of Life-Conditions" (ENCOVI by its acronym from Spanish) conducted by the National Institute of Statistics (INE by its acronym from Spanish). According to ENCOVI, from 2006 to 2014 the poverty increased by 2.9 per cent resulting in a rate of 59.3 per cent of the total population under poverty. Extreme poverty increased from 1.9 to 5.7 per cent from 2000 to 2014 (INE, 2015).

This increase in poverty affected both rural and urban areas. While the highest rates were recorded in the rural areas, in cities poverty increased from 30.2 to 42.1 per cent. It was in Guatemala province where was the biggest increase of poverty reaching a third of the population, 33.3 per cent, under the poverty line (INE, 2015). It needs to be mentioned that the level of disaggregation of the ENCOVI is at province level, it does not reach the municipal level.

Poverty is measured by the minimum cost of food basket indicator (canasta básica alimentaria), the amount of food necessary to satisfy basic human needs. Those who cannot access the basic food basket are considered to fall under the extreme poverty line. Those who can only access to the cost of that basket are poor. A separated indicator, the vital basic basket (canasta básica vital) considers food plus goods and services for satisfying the basic needs for the well-being in a family.

The food basket was calculated at 3,671 Q (US$481.44)[1] in February 2016; meanwhile, the vital basic basket was in 6,700.21 Q (US$878.68) (INE, 2016)[1]. The minimum wage set in this year (2016) is 2,497Q (US$327.47)[1] per month (MTPS, 2016). In other words, under those minimum wages it is insufficient to cover the cost of the food basket, reflecting in urban food insecurities at household level.

Extreme income disparities represent another major challenge. According to the ENCOVI 2014 there was a decrease from 0.56 to 0.53 in Gini coefficient (INE, 2015); however, this coefficient does not consider the wealthiest 1 per cent in the country. This is relative when, according to a study 260 Guatemalans possess a capital equivalent to the 56 per cent of the national GDP (Rodas, 2015).

In the context of poverty, it is important to mention slums areas or irregular settlements, mainly because those areas, the urban fringe, located in the periphery are more vulnerable and often not represented in surveys.

In 1991, there was a joint effort between UNICEF and SEGPLAN (Planning Secretariat) to categorize and survey irregular settlements. The survey identified 232 precarious settlements inhabited by 702,100 people, adding to those numbers, the 'palomares' (old deteriorating buildings with improvised enlargements where a family lives per room) and tenements the total adds up to

[1] Currency change at 7.625 Quetzales per US dollar according to Guatemalan Bank at June 1st, 2016.

975,000 inhabitants in precarious conditions in 1991(Valladares C. , 2003). It is most likely that the number has increased during recent years.

The quality and availability of basic services, such as water, sanitation and electricity are lower or non-existent in these areas; they also struggle with mobility, as public transport is irregular and in bad conditions, requiring the population to do longer commute to their jobs or schools, as well as to access other services such as health, supermarkets or food stores with a bigger selection of food products, rather than the typical smaller stores in the neighborhood.

The ENCOVI data could be an underestimate, considering that it is a projection, based on a limited survey. If we consider that the precarious settlements are non-registered, there is a high probability that they are not fully taken into consideration in the surveys.

One of the governmental ways to monitor and measure the food security rates is through the use of ELCSA (see section 2.5.2). The ELCSA has been used in the 2011 and 2014 ENCOVIs, and results show no major changes. There was an improvement of 3 per cent of safe homes, moving from 19.2 per cent to 22.6 per cent.

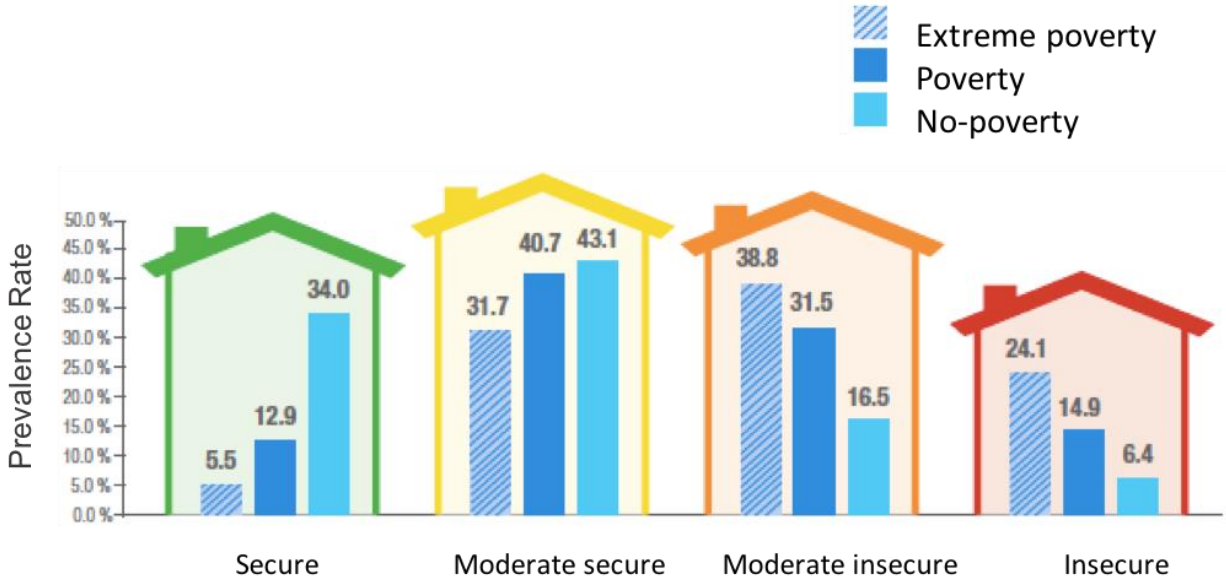

Figure 12. ELCSA-Food insecurity by poverty level in Guatemala

Source: FAO, 2015

As expected the correlation with socio-demographic variables reflect that poverty levels, service conditions and household location impact the food security. Households that score low on these factors are the most vulnerable, as Figure 13 reveals.

4.2.2 Health and Malnutrition

Food insecurities affect the health of the population especially those under 5 years old resulting in acute and chronic malnutrition. Malnutrition is the result of different factors. As described previously, poverty is a key driver. Bur individual and household decisions, community connections, natural environment and cultural-traditional behaviors also impact malnutrition. To this can be added other underlying systemic problems such as corruption, security, education level and external effects of global economic crises.

Malnutrition can be understood as deficiencies, excess or imbalances in the intake of macro and micronutrients (FAO, 2008). In Guatemala, malnutrition is a well-known and persistent problem. The main statistical tool of the government is the use of the National Infant-Maternity Survey (ENSMI by its acronym from Spanish), to measure the levels of malnutrition in children

and pregnant women. The 2014-2015 ENSMI included an anthropometry section with the weight and height of children under five years of age to determine the level of chronic and acute malnutrition. The survey found that currently 47 per cent of children experience chronic malnutrition and 17 per cent acute malnutrition. In the case of Guatemala province chronic malnutrition stood at 26.3 per cent of children under chronic malnutrition, which is the lowest in the country (MSPAS, 2014).

Chronic malnutrition has serious consequences for those who are affected. It affects children's physical and mental development. This leads to poor academic performance, resulting in high school drop rates, reduced employability and access only to low paying jobs (Martorell, 2012). Meanwhile, acute malnutrition comes with an extreme loss of weight threatening the life of those who suffer from it. Figure 14 shows the current status of malnutrition and the correlation between poverty, ethnicity, education and rural versus urban location against malnutrition. As the figure shows, the level of poverty, education and indigenous ethnicity has a strong influence on the rate of malnutrition, revealing inequalities that the country needs to confront.

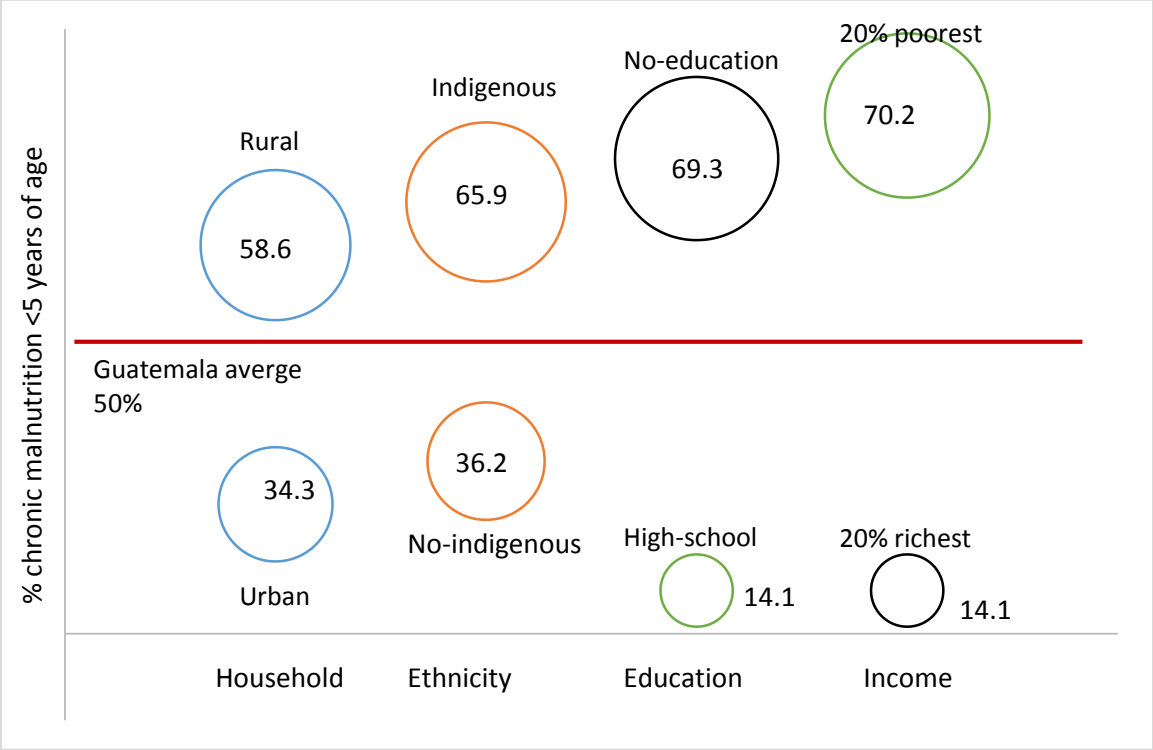

Figure 13. Percentage of malnutrition in children under 5 years of age by household, ethnicity, education and income

Source: Based on UNICEF 2011 and MSPAS (2009) ENSMI 2008/2009. Retrieved from CONASAN, 2011

Other two aspects that influence the level of malnutrition beyond food intake but are close linked are: diarrheic diseases and the quality of water-sanitation services (MSPAS, 2014; CONASAN, 2014). In Guatemala, diarrheic diseases account for 14 per cent of child mortality under five years of age. Meanwhile, the access to water services has been increasing during the last years, reaching 77.8 per cent by 2014. However, access to services is unequal in the country and even between different areas of Guatemala City.

The links between water-sanitation access, diarrheal diseases, and poverty are closely related, as a chain of causes. Poverty leads to subpar living conditions and location of the settlements with low levels of access to services as water-sanitation and health, leading to malnutrition related vulnerabilities of the affected population.

4.3 Urban Food Security and Information Systems in Guatemala City

As described in the literature review, the main barriers that an information system needs to overcome can be divided into four areas: (1) the governance framework that will support the operationalization and link the produced information and analysis to the decision-making process; (2) technical capacities, available technology and human resources to operate it, (3) the participatory process that includes the voices of all the stakeholders, vertically and horizontally, especial bottom-up participation; finally, (4) efficient information system use to support decision-making and adaptive governance and management.

This section describes the current status of Guatemala and Guatemala City in these aspects, providing the basis for the discussion chapter, where the challenges and barriers will be explored in further detail.

4.3.1 Governance

Guatemala has put in place a National Food and Nutrition Security Policy Law in 2005 (SESAN, 2005), developing a governance framework which allows to support and legitimize the actions towards food insecurity. It established the Secretariat for Food and Nutrition Security (SESAN by its acronym from Spanish), which is directly under the authority of the vice-president and in charge of developing the national policy in food security affairs. It also needs to coordinates and organizes the efforts and actions of different Ministers, decentralized institutions and facilitates the participation of local governments. The Secretariat establishes the guidelines and thematic axes to promote food and nutrition security in Guatemala, integrating sectorial and regional strategies for food and nutrition security (SESAN, 2005).

Since 2005 the food and nutrition security scale as a priority in the national agenda. However, despite building a governmental framework, food insecurity and nutrition security rates

have not decreased on the country: poverty and health issues have increased and with it urban food insecurities.

In the 70's the Guatemalan national government started to outline the first national policy for food security, but it was not until 2000 when it started to implement the National Food and Nutrition Security Policy as it is today, establishing a legal framework and passing related laws only in 2005 (INCOPAS, 2014).

The National Food and Nutrition Security Law, established new bodies in the government to ensure the operationalization of the new system, those are reflected in Figure 15. The main bodies are:

a) CONASAN: National Council for Nutritional and Food Security, the guiding body of the Law, integrated with 24 different stakeholders, from different National Ministers to private and civil society representatives;
b) SESAN: Food and Nutrition Security Secretariat, it is in charge of the technical planning and coordination with different Ministers and at different levels;
c) INCOPAS: Body for Social Participation and Consultancy, integrated from different segments of the civil society, such as the church, indigenous groups, Universities, etc.
d) GIA: Support Institutions Group, Technical support organizations from the international cooperation and other Institutions not included in CONASAN;

The SINASAN established three decentralized Commissions to support the operationalization of the Law at different levels.

a) CODESAN: Departmental Commission for Food and Nutrition Security
b) COMUSAN: Municipal Commission for Food and Nutrition Security
c) COCOSAN: Local Commission for Food and Nutrition Security

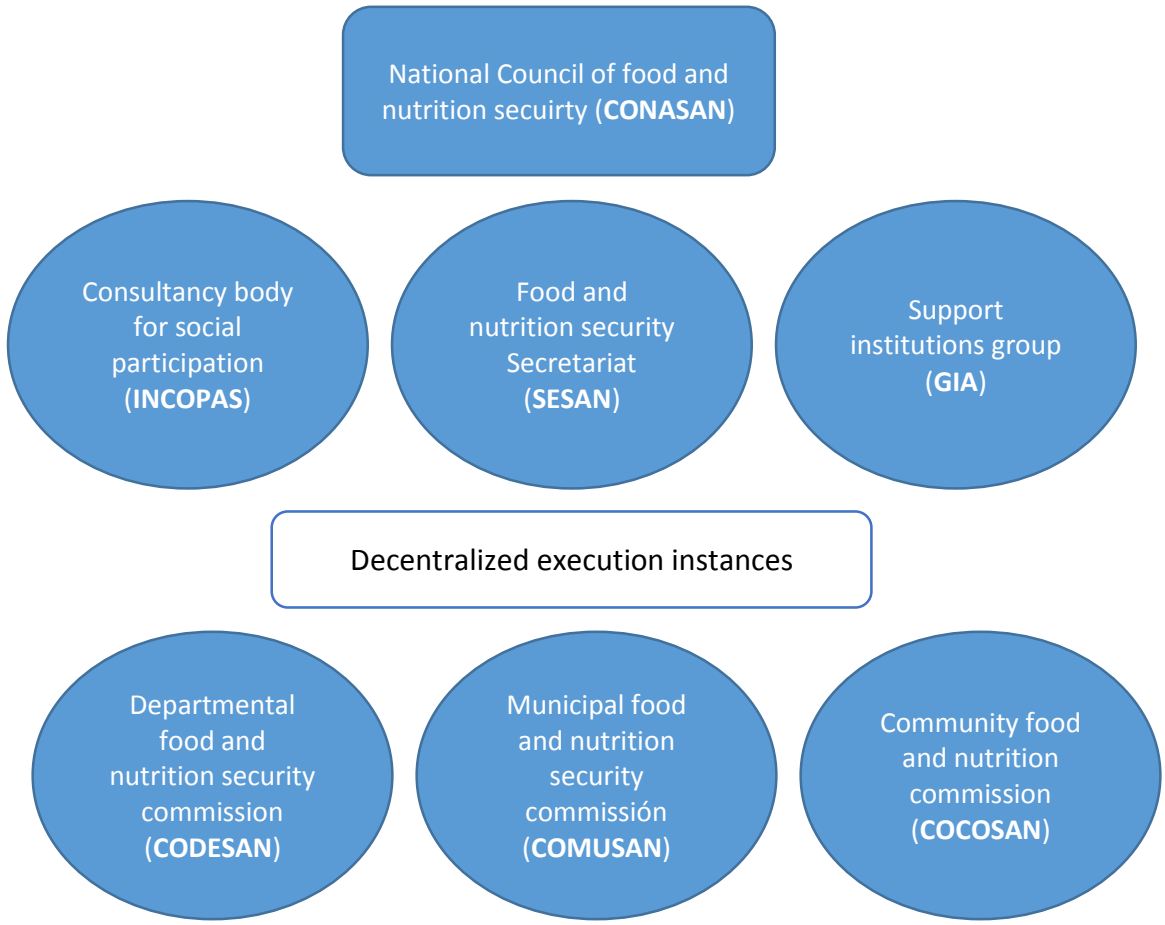

Figure 14. Institutional bodies which form the National Food and Nutrition Security System (SINASAN)

Source: Pacto Hambre Cero,

One of the main documents to implement the SINASAN is through the Strategy for Food and Nutrition Security 2012 – 2016 (PESAN by its acronym from Spanish). The strategy is a national effort to coordinate different sectors through objectives, components and sub-components, with macro actions leading to tackle food and nutrition security in Guatemala. The PESAN was guided by a multi-sectorial vision organized in five objectives with nine programmatic axis, and four transversal axis (see annex 8.2). These objectives responded to the food and nutrition security pillars: availability, access, consume and utilization (CONASAN, 2011).

The government established a results-based management approach to follow up and achieve the goals in the PESAN, thus the government implemented a monitoring an evaluation

mechanism to the Strategy. However, the previous PESAN did not account with a base line in the indicators nor the goals missing a better evaluation of the interventions. It was in this period where a new set of indicators where stablished to measure the results and impact in food and nutrition security. This is linked with the programmatic Annual Operational Food and Nutrition Security Plan (POASAN by its acronym from Spanish), which is based on the national budget which can be tracked according to the expenditure by Minister (CONASAN, 2011). The PESAN prioritize in the 166 municipalities with highest rates of chronic malnutrition, but considering scale up to 213 municipalities by the end of 2015.

From the PESAN 2012 – 2016 to the newly presented 2016 – 2020, a big change can be identified. The visualization of food and nutrition security has been changing and evolving, the learnings that the government has achieved are significant. The new PESAN is based on four programs and five transversal Strategies, with a clearer idea of what to achieve. The four programs are oriented to the 'final users', the population; meanwhile the five transversal strategies are oriented to strengthen institutional capacities, as Figure 16 reveals. One axis is oriented to the information system and another towards the monitoring and evaluation of the actions.

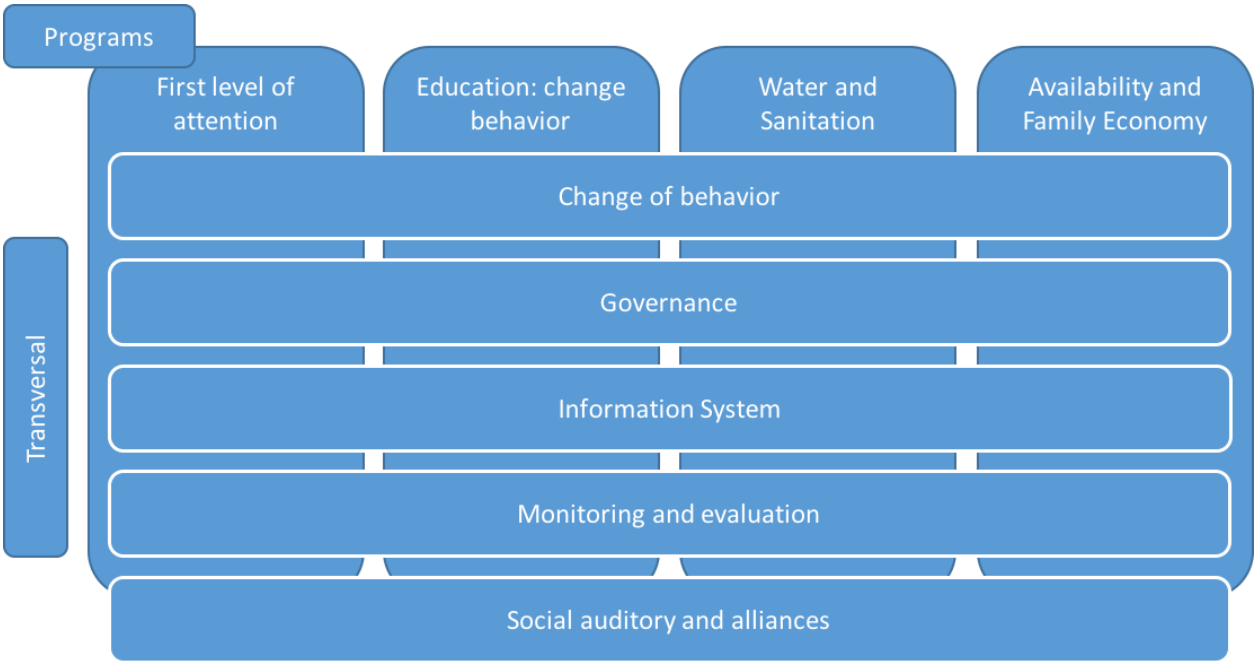

Figure 15. Programs and transversal strategies PESAN 2016-2020
Source: National Strategy Chronic Malnutrition Prevention. Presentation. N.d.

In order to operationalize the PESAN 2012 – 2016 the national government established The Hunger Zero Pact (PHC by its acronym from Spanish), with its respective plan. Signed in 2012 the PHC has two goals: reduce chronic infant malnutrition and mitigate periodic hunger, and avoiding acute malnutrition related deaths.

The PHC, prioritized in specific target groups –children under two years of age, pregnant women- for chronic malnutrition through the program "1000 days window", based on the Scaling Up Nutrition approach, looks to provide the proper nutrition from pre-birth till up to two years of age, the pregnant and breastfeeding women; in acute malnutrition to the children from zero to five and the pregnant women. The other priority indicator is through geographic coverage of 166 municipalities with the highest malnutrition rates, increasing eventually to 213.

The Departmental (provincial level), Municipal and Communitarian Food and Nutrition Councils are the institutional bodies in charge of discussing the SINASAN policy and the PESAN under their respective levels, linked with the National Planning System.

One of the guiding principles of the Law is the decentralization, meaning that the province can be in charge of the responsibilities, decision-making and resources management at the local level, in the territorial limits of the province and municipalities inside the province. The Urban and Rural Development Council Law, the Decentralization Law and the Municipal Code, support independent actions for addressing the food insecurities in their territory (SESAN , 2005). In this sense, local governments have at some liberty to decide how to reach the goals that have been set at the national level.

The framework aims to pursue a bottom-up approach where the COCOSAN gathers the civil society allowing to present proposals and identification of priorities within the community, afterward scales up to the COMUSAN, where the proposal can be integrated into the Municipal Planning with priority criteria. This is sent to CODESAN to be integrated with the province plan, with the support of the Departmental Development Councils (CODEDES) (CONASAN, 2011).

Finally, it is worth to mentioning another technical tool known as "situational rooms" (salas situacionales), whose objective is the presentation of data for analysis and interpretation, leading to decision-making proposals for specific problems. Currently, this tool is being used by the Ministry of Health and aimed at health and nutrition related decision-making. The operation of the situational room is as follow: (1) data collection and processing (down to the household level); (2) data analysis (including other stakeholders); (3)problem identification; (4) decision-making; (5) decision implementation; and (6) monitoring (PROSAN Guatemala, CNE, SIAS, 2010). Experience with the tool is promising, however, the initiative has been led by the Ministry of Health and not oriented fully towards food security as in the case of SESAN.

4.3.2 Technical capacities

The creation of a National Food and Nutrition Security Information System (SIINSAN by its acronym from Spanish) was established in the Food Security National Law and operationalized by the PESAN 2012 – 2016.

SIINSAN, as a public and governmental interface database, was conceived as a tool to support and facilitate the decision-making, a decentralized system, which can gather, administrate, utilize and disseminate information related to food and nutrition security, with a high level of disaggregation at national, provincial, municipal and local levels for the final decision-making at national level. It should allow the monitoring and evaluation of the current stage of food security and the performance of the Plans and Strategies (CONASAN, 2011).

SESAN is in charge of the design, implementation, management, and, coordination of SIINSAN, in collaboration with other Ministries and institutions to feed the system with data. (SESAN , 2005).

Figure 17 presents the operation of SIINSAN with two sub-systems –Sentinel Sites and SIMON- and with a third level of sub-system –MONIMEFI, MONIMIL, MODA, MONICA-.

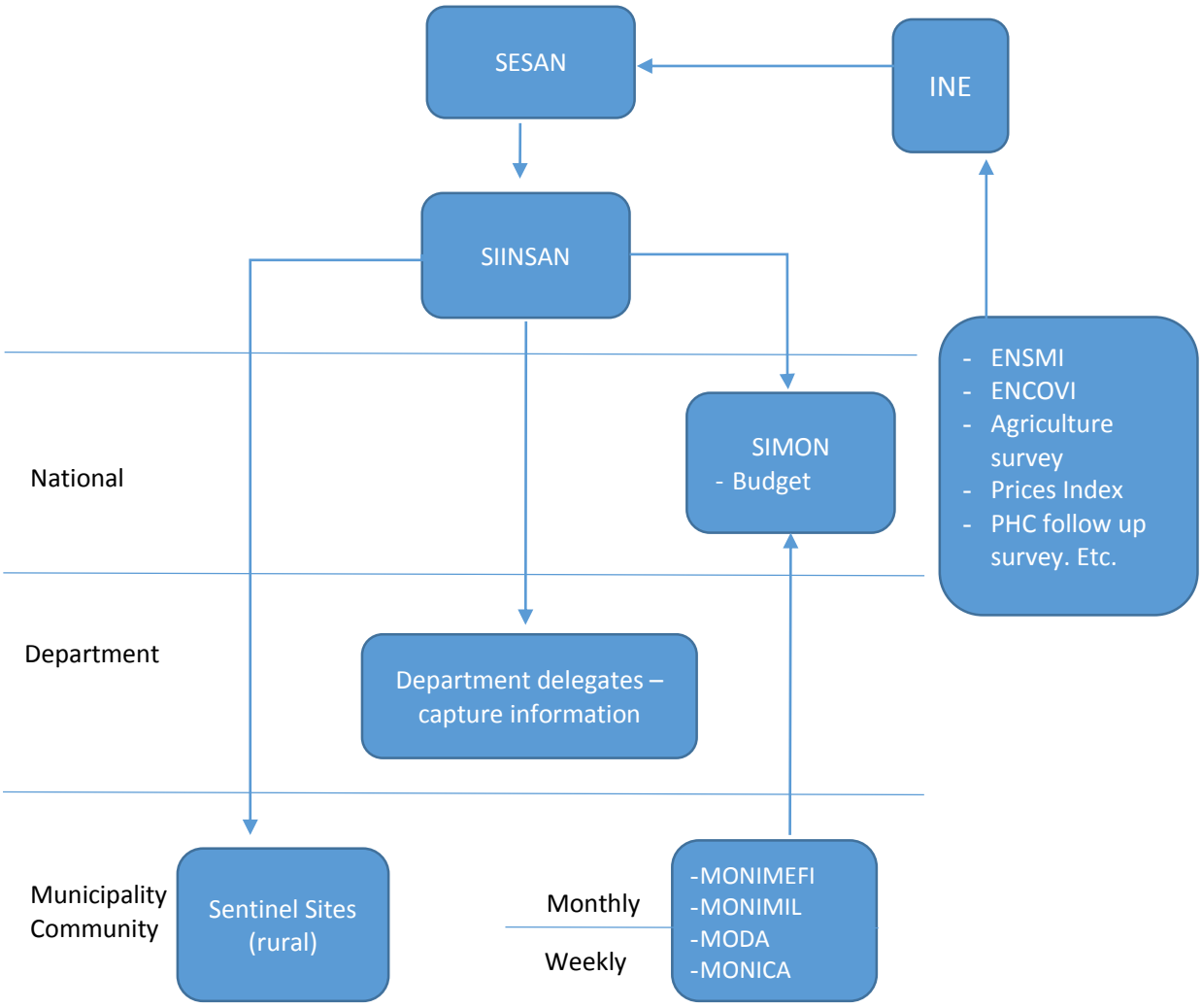

Figure 16. Food security information system of Guatemala

Source: Own elaboration based on Guatemala official documents and SIINSAN website.

Sentinel Sites are a network of stations spread around the country in rural areas to monitor potential threats to food and nutrition security based on certain indicators. This early warning system is supported by international partners. It seeks to support short-term and fast track local action in response to weather-related, economic and social shocks. Currently, there are 78 sites are in operational (see map in annex 8.3) (CONASAN, 2011).

The second sub-system is the Monitoring and Evaluation System platform (SIMON by its acronym from Spanish). It is a tool which provides data to follow up the established programs in

the ‘1000 days window’ (MONIMIL) and Municipal Physical Goals of Zero Hunger Plan (MONIMEFI) in a monthly periodicity. The Acute Malnutrition Monitoring (MODA) is based on tracking visits to the health care centers and review the registered information on children experiencing acute malnutrition. Finally, the last type of measure is the Canicula Monitoring Actions (MONICA), which measures the assistance to the families who face harvest failure due to damage to their soil by an extended rainy season.

The department delegates from different Ministers upload weekly and monthly data to help follow-up of the goals. The SIMON platform also integrates the follow-up of the National Budget oriented to Food and Nutrition Security linked between the different Ministries and their individual projects, established in the PESAN and PHC.

The current platform that SIINSAN is using (see annex 8.4) was released in 2015. It is a friendly, interactive and easy to access platform. However, it requires a certain degree of academic preparation to be able to understand how it works and the information that is presented.

It is important to mention that the National Statistical Institute (INE by its acronym from Spanish), by law is in charge of planning, coordinating and supervising the National Statistical System as the main entity for the national statistics formulation. It has as task dealing with the statistical collection, analysis and distribution of the information with the collaboration of different Ministries (INE, 2013b).

In surveys like ENCOVI or ENSMI the INE plays a key role in the collection and analysis of data. INE is in charge for the calculation of the ‘basic food basket’ and the establishment of the National Price Index with support of the specialized Ministry, among other data collection. The SIINSAN use those resources to feed their database and process it under food and nutrition security lenses.

According to the INE 'work memories 2011' under inter-institutional agreement, the cooperation between SESAN and INE has been framed as a raw data provider to the SIINSAN and supporting the field work with personnel for the conduction and follow up of interviews for the PHC. The INE deliver the ratio calculation of the gap between the minimum wage and the cost of the basic basket food (INE, 2011). In the 'work memories 2014', the INE deliver database results of the Survey PHC 2013 and planning meetings, selection of staff in field and cartographers for the results of the Survey PHC 2014 (INE, 2014d). The relation between the INE and other Ministers is different. Such is the case between, the Ministry of Health and INE, they collaborate in closer basis for the ENSMI survey. The agreement is more extended and both parties participate in the analysis and production of information.

The establishment of an information system can bring some complications. The more sophisticated and highly technical the system, the more opportunities it presents for the manipulation of data but it also requires more skills to manage, plus the cost of *software* need to be taken into account. Even though the access to the system is open and free to everyone, the dissemination of information for educational purposes is missing so far.

4.3.3 Participation

In accordance with the Law and the PESAN, the public participation should be a strong pillar for the decision-making and the sustainability of the SINASAN. Therefore, both key policy documents –the Law and the Strategy- support and promote the civil society participation and its inclusion in decision-making.

The framework of the SINASAN includes three levels of action as can be seen in Figure 18. The aim of this approach is to link the different stakeholders to decision-making at the different levels, every one of them with different responsibilities.

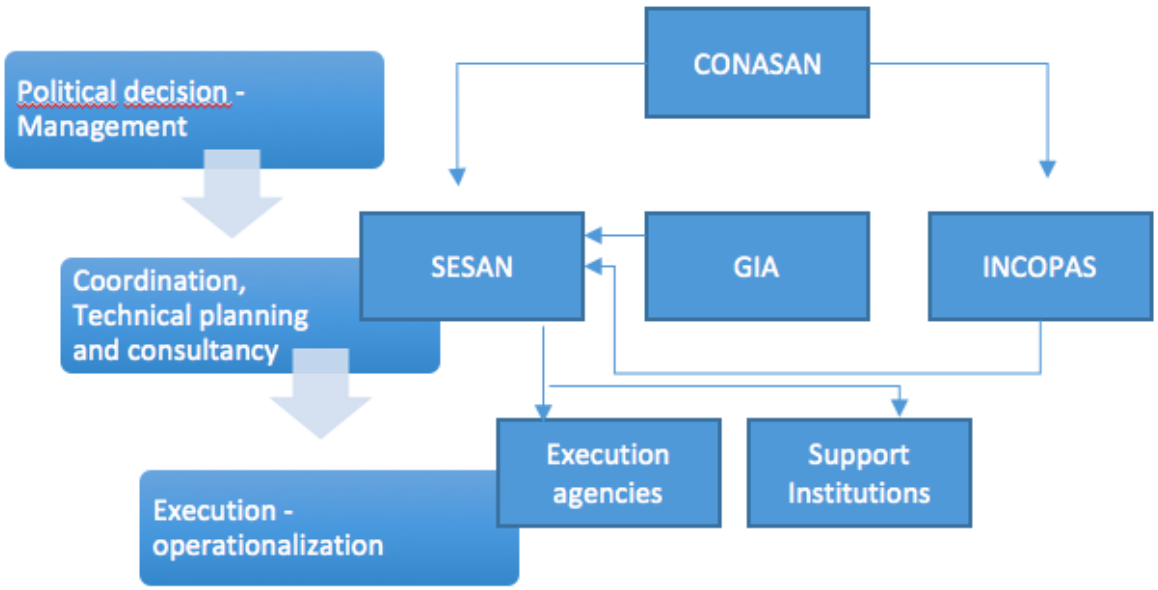

Figure 17. SINASAN levels of action

Source. Based on CONASAN, 2011

The main institutionalized body according to the Law for the coordination of the civil society and public participation is the INCOPAS, which has the mission to bridge the communication and participation space between the civil society and the governmental bodies. It can deliver proposals to CONASAN for discussion and prioritization of actions. It is integrated with indigenous people, peasants, private sector, unions, NGOs, Universities and research institutes, among others. The INCOPAS aims to participate in the decision-making at Municipal, Departmental and National level (SESAN , 2005).

It is supported at the Municipal and Community level through the Municipal and Community Councils for Food and Nutrition Security (COMUSAN and COCOSAN by their acronym from Spanish). Under those Councils the civil society and population can participate, trying to scale-up the recommendations and proposals to the INCOPAS and ultimately to the CONASAN.

In parallel, the SINASAN framework needs to match with the National Planning System (SNP) and the Council for Urban and Rural Development System (SISCODE), as the main legal body for public participation and planning process in Guatemala (SNP, 2002), and follow the same Departmental (CODEDE); Municipality (COMUDE); Community (COCODE) councils. The vertical approach of councils is to scale-up the proposals or initiatives from the communities towards the INCOPAS (CONASAN, 2011); however, it has a counter effect, making it slow and discouraging the public participation due the slow process respond and the bureaucratic barriers.

The situation in Guatemala City differs from the rest of the country, mainly because there is no COCOSAN. Instead the city has a Unique Neighborhood Committee (CUB by its acronym from Spanish), as the main social organizational framework for public participation in Guatemala City. It follows the rules established in land use planning regulation, which defines the purpose of CUBs as the means to represent the population and link them with higher-level bodies through the Social and Development Direction in the Municipality, following the hierarchy shown on Figure 19. The CUBs intend to deal with and communicate to higher level of government the demands of the problems found in a specific place of the city such as water access, mobility, etc. CUBs therefore are not focused only on food security as a COCOSAN does (Ochoa & Ovando, 2009).

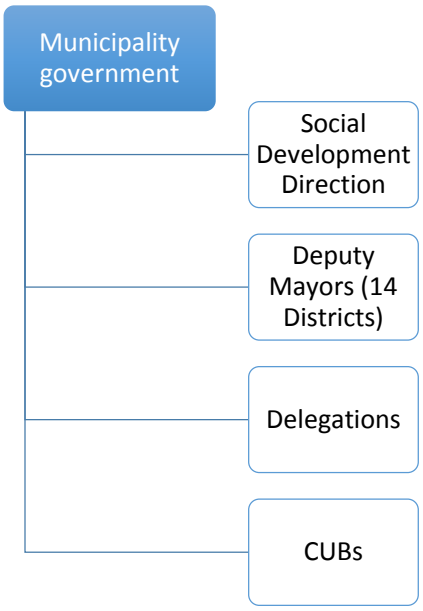

Figure 18. Hierarchy in public participation in Guatemala City

Source: Ochoa and Ovando, 2009

This difference in Guatemala City from the rest of the country set a burden to the Departmental delegate from SESAN in Guatemala City, because it limits and fragments community participation, plus the fact that the public participation it is not a strength Guatemalan society in general yet. According to the ENCOVI, in Guatemala City the participation of individuals in any type of organization, group or association is 5.4 percent (INE, 2014b).

4.3.4 Use of the Information

As previously discussed, the ultimate purpose of an information system is supporting decision-making with reliable and timely information. The three areas reviewed in the previous three sections, governance, technical capacities, and participation are aimed at increasing the functions and capacities to use the information.

In other words, the establishment of a solid governance framework, supported with technical capacities and involvement of the stakeholders can impact the final use of the information system. So far SIINSAN has been used as a platform to follow up the PHC and the '1000 days'

window' programs established in the PESAN, linked to monitoring the expenditure use by Ministry to accomplish the goals in Food and Nutrition Security through the SIMON. The other area where the SIINSAN operates –to some extend independently- is the information collected and used for the Sentinel Sites.

The information collected from different actors through the SIINSAN is used to strengthen the decision in those programs within the 166 priority Municipalities and intended to be extended to the 213 municipalities and eventually to the entre country. The information that SIINSAN processes can be divided into three main areas and it is distributed in different parameters and indicators shown in Table 1.

Table 1. Parameters and indicators found in SIINSAN

Economic	Health	Socio-demographic
Consumer price index (IPC): ▪ Minimum Food Basket price ▪ Minimum Vital Basket price	ENSMI: ▪ Chronic Malnutrition ▪ Acute Malnutrition ▪ Global Malnutrition ▪ Death rate ▪ Breast feeding	Population projections (base line 2002) ▪ Gender ▪ Age ▪ Ethnicity ▪ Urban/Rural
National Employment and Income Survey	PHC survey: ▪ Anthropometry ▪ Hemoglobin ▪ Anemia	Education level
ENCOVI: ▪ Poverty rate ▪ Inequality	Height and Weight by school	Water and Sanitation services
National budget expenditure follow up (MONIMEFI)	Monitoring the state and supply of the First Level Health Centers Network (MONIMIL and MODA) ▪ Breastfeeding promotion and support ▪ Food supplements ▪ Vitamin A supplement ▪ Zinc supplement ▪ Deworming and vaccination for children	

Source: Own based on SINASAN-SESAN-SIINSAN reports

The monitoring and information indicators processed in the Sentinel Sites is presented in Table 2. The task of the Sentinel Site is follow up these indicators in the region it is located, and has the function to cover a radio area beyond the specific location it is based.

Table 2. Sentinel sites indicators

Food availability	Food access	Food Utilization
Rain fluency	Employment	Water quality
Days without rain	Migration	Amount of water
Sick poultry	Purchase price of basic grains	Malnutrition children under 5
Sick pigs	Price for agriculture inputs	Sickness in children under 5
Sick crops	Sale price of basic grains	
Sick cattle		
Natural phenomenon		
Forestry fire		
Plagues		
Number of producers with seeds		
Reserves		
Crop yields		

Source: SIINSAN, 2014

The actions that SESAN has been implementing and the information system have revealed a picture of the challenges that the governments need to confront. So far, the data reveal that a significant part of the population, especially children with malnutrition (for deficit and overweight) wither under chronic malnutrition or acute malnutrition.

The next section presents the findings from the field work in Guatemala City, to contrast how the system is *expected* to work according to official papers and actually how it *actually* works, identifying the bottlenecks that prevent the full implementation of the SIINSAN and SINASAN.

5. Findings

Despite the short time available for the field work in Guatemala City. Experts on food security, and diverse stakeholders, main government institutions, research institutions, and international organizations were interviewed. Their informed opinion on the topic helped to foot the opinions that are expressed here. The analysis of the food security information system is divided into four key areas, governance, technology, participation and use,that have been drawn previously as requirements that any information system needs to consider before and during its implementation.

Every interview started with a small seven question survey to diagnosis the current state of information system in those four aspects in Guatemala City. The purpose of the survey helped to understand the current stage and the valorization of the use and effectiveness of the information system. Table 3 present the answers of the interviewees. It needs to be noted, that even though the survey was seeking a yes/no answer, sometimes the answer could not be limited in that spectrum. Yet the answer presented here reflect a general orientation, the variability in the responses is very limited, supporting the view that the deficiencies are well known among stakeholders.

Table 3. Stakeholders diagnosis survey

Stakeholder	Does the local Government have the technical capacity to deploy a food security information system? (Technology)	Is there a governmental framework which can support a local information system? (Governance)	Is civil society is taken into account in decision-making processes related to food security? Is there public access to the information? (Process)*	Is the use of the collected information adequate? (Use)**
FAO	Yes	Yes	No – Yes	No
SESAN-Department Delegate	Yes	Partial	No – Yes	Yes
INE	Yes	Yes	No – Yes	Partial
CISU	Yes	Yes	No – Yes	No
FWESNET	Yes	Yes	No – Yes	No
ICEFI	Yes	Yes	No – Yes	No
ASIES	Yes	Yes	No – Yes	
TECHO	Yes	No	No – Yes	No
CIEN	Yes	Yes	No – Yes	No
SESAN	Yes	Yes	Yes – Yes	Partial
SIINSAN	Yes	Yes	No – Yes	No

Source: own with information collected through interviews.

All of the interviewees agreed on the technical capacities in Guatemala City, and if there is any Municipality in the country with the human and budgetary resources and capacities, it would definitely be Guatemala City. Almost all –thirteen interviewees- agree that the current governmental framework supports the local level participation, those who disagree was due that even though it is mentioned in the law, the participation of local governments it is not strong enough to urge their participation.

There was near consensus –fourteen- who agreed that there is no public participation in decision-making, even though the institutions are in place; however, it needs to be noted that in

some areas of the country there might be more community involvement, especially in rural areas. This is diverse in Guatemala City as well, some CUBs are more active than others, however overall there is no strong participation.

Regarding the access to information, it should not miss lead the 'yes' consensus. The Law of Information Access grants powers to the population to request information from any government agency or institution and entitled to receiving a response. However, the quality of the response might be deficient, fragmented, unclear or inaccurate; also understanding it may require a higher educational background to.

Finally regarding the 'use', -just one- answer 'yes' due the information is uploaded successfully to the *software* interface, and it is in functions on what the current budgetary and human capacity allows, however it can be improved. Meanwhile those who respond 'no' –fourteen- coincide in the problem to bridge the use of information into the local level and those who needed more.

5.1 Findings by four areas of analysis: Governance, Technical Capacities, Participation Process and Use of the Information-.

This section summarizes the 'bottlenecks' identified through the literature review, mini-survey and interviews, identifying a general challenge to overcome in every one of the four areas of analysis. These reflect the difficulties that currently Guatemala and Guatemala City face in urban food security.

- **Governance framework**: it will support the system from the legal perspective and link the information collected and analyzed to the political discourses, while supporting and legitimizing political actions and decision-making.

Governance

Challenge	Coordination among the different stakeholders and management of the policy
Bottlenecks	Lack of strategy harmonization
	Lack of Mayors involvement
	Lack of detail information of the urban food security in Guatemala City
	Lack of installed capacity in the Municipalities
	Centralize design of the Policy, hence centralization of the SIINSAN

The main challenge in the governance of the information systems is the need to coordinate several stakeholders and manage resources (physical, financial, and human). At present there is limited collaboration between the Planning Secretariat (SEGEPLAN by its acronym from Spanish) and SESAN.

As a result, there is a lack of harmonization among strategies, Ministries have their own strategies with specific goals, but the strategies and actions are not always oriented in the same line with food security. Therefore, horizontal coordination should aim for common goals and look for crosscutting areas in food and nutrition security where synergies are possible, trying to cover the issues through the different Ministries.

The Food security policy was elaborated under rural lenses from a national approach, where the Municipalities at large were not included in the discussion of the policy. Hence, they are limited to just 'respond' to the policy and follow hierarchical decision-making. The latter reflects the slow downstream process of information to the local level, reducing their participation and capacities in contextualizing their specific needs and challenges related to food insecurities.

At the local level, in Guatemala City, there is a lack of involvement from the Mayor, due perhaps to the lack of understanding and accurate picture of urban food security in Guatemala City,

where it has not been analyzed in depth. Producing in-depth analysis on food insecurities in Guatemala City could provide a better understanding of the realities, lifting the veil on food security in the city. However, currently there is a lack of installed capacity in the Municipalities to support such analysis.

Finally, the centralization of the SIINSAN acquiring information from departmental delegates leads to fragmented information, requesting to corroborate data at minimal detail through different stakeholders, the absence of uniform monitoring in the information system to keep track of different inputs (e.g., number of health care centers visited and number of acute malnutrition patients may differ from different sources) difficult tot track progress through different Ministries.

- **Technical capacities**: denotes the *hardware* conditions to operate different information systems and as the *software* needed with related human capacities and knowledge to perform and conduct proper analyses.

Technical capacities

Challenge	Strong local capacities for collection of data and information analysis
Bottlenecks	Lack of collection at micro level area//bottom-up information
	Lack of coordination with INE (National Statistics System)
	Lack of an updated Census
	Lack of academic involvement in the analysis and support
	Lack of performance evaluation

The technical capacities at national levels differ greatly from the local level, however, Guatemala City is one of the few Municipalities with the technological capacities (*software* and *hardware*) to be able to support collection of information and analysis from the local level.

The amount of information collected can range from good to deficient depending on the lenses through which it is viewed. That means that the data collected at macro level can be good when it refers to macroeconomic indicators, however the lack of an updated census constrains the acquisition of micro data to identify the number and location of those with higher vulnerability in the city. The cooperation and coordination with INE could boost technical capacities, however INE is restricted in the lower disaggregation of data - as identification of people - but SEGEPLAN or SENSAN are not limited to identify and follow up specific target groups. Currently, there is no accurate information on the number and location of people experiencing food insecurity in Guatemala City.

The government can be supported by academia or different universities and research centers, however the centralization of the information limits to some degree the collaboration with other actors for the analysis of information.

SIMON and the sub-systems (MONIMIL and MONIMEFI) are designed for monitoring and evaluating, the performance of the PHC. However, it is narrowed in health equipment supply (in health centers) and budgetary information, lacking of performance evaluation of the strategy actions, which is a key indicator for creating a feedback loop.

- **Participation process**: under a community informatics approach, open participation of civil society and citizens it is needed. Participation should be *apriori* and *aposteriori* reflecting the information inflow and the feedback loops of monitoring. As the technical capacities also is interested in the dissemination and access to the information from the population.

Participation Process

Challenge	Incorporate bottom-up participation in the system and dissemination of accessible information
Bottlenecks	Slow vertical bottom-up scale of participation from: COCOSAN → COMUSAN → CODESAN → INCOPAS → CONASAN
	Lack of strong interest from the communities
	Lack of dissemination and accessible information to the communities
	Lack of empowerment to participate in the decision-making
	Lack of organization in the COCOSAN and CUBs
	Lack of dissemination of the information and easy access

The participation process in the Food and Nutrition System reveals linked causational problems. First, the public participation was planned under a vertical hierarchical approach from the bottom line level to the the higher national level. Scaling up from COCOSAN or CUBs which gathers, proposals or complains related to the topic in the municipal level, to after scale-up to department and national level, making it a slow and bureaucratic process until it reaches decision making. This results in low participation from the communities due the lack of confidence of the spaces and the lack of empowerment to be capable to participate, bigger actors as private sector can cope the spaces diminishing social participation or deviating the discussions to interest group issues.

Guatemala City foes not account with COCODES, only CUBs. The characteristics of every CUB will contrast according to the neighborhood where it is located, differing from the level of organization and the level of participation.

There is a lack of recognition of food insecurity by the communities itself in the city. The low level of education and traditional behaviors, e.g. identification of children malnutrition cases in overweight and deficit of nutrients. This can be driven due the lack of dissemination of relevant information that can be easily comprehensive from the different groups in the cities, barriers like

language, focus group, and gender role impact in the recognition of the problem, hence the active participation, situation that contrast from rural areas.

Finally, there is an absence of providing useful information for educational and informative purposes to the general population, this should consider different educational levels and different languages to be accessible to all.

- **Use of Information** of the information: as explained through previews chapters, the "effective use" of an information system needs to be reflected in the type of policies oriented to fulfill the common goals in food and nutrition security, also to the capacity of evaluation and monitoring.

Use of Information

Challenge	Bridge the information and analysis to the decision-making Effective use for evaluation and monitoring
Bottlenecks	Lack of leadership at local level in the analysis and use of the information
	Different set of strategies in the Ministries. Lack of a common goal and strategy resulting in How the information is presented following as best fit the Ministies.
	Lack of timely response to the information collected
	Lack of consistency in the monitoring and evaluation information
	Fragmented use of the information.

The current SIINSAN system, use the information collected from different Ministries to create a general picture of the food security situation in the country, also has created the SIMON system to follow up the progress of the PHC.

Most of the interviewees agree as 'enough' the use of the information system considering what they account now at the national level. However, it is also considered as 'underused' with

room for improvement. Meanwhile, they recognized that at the local level there is 'no adequate use', reflected in slow time respond and the gaps that still the policy cannot address.

The information system accounts with fairly good amount of information already; however, the main challenge, is the capacity to improve the analysis and bridge it to the decision-making embedding the information system to the political discussion.

The information is uploaded to the electronic platform of the SIINSAN and SIMON to follow up the PHC; however, the information is uploaded by the delegate ministry representative and it can be inconsistent with the information provided by other stakeholders, a problem linked in the technical capacities as well.

Finally, the use of the information has been fragmented. Having strong weight in some sectors than others, and the policy has not been consistent to avoid food insecurity, especially when it concerns to the local level use.

As final remarks it is important to point out some underlying difficulties that hindered the function and use of the system:

- Budgetary constraints at the national level; however, it can be explored the participation of local government with budget affairs as well.
- Security, the gangs play a role that refrains the public participation and in occasions the government initiatives too.
- Corruption at local level is high and looks for 'political favors' and targeting actions that will bring votes
- Other social problems as mobility in Guatemala City attract more attention from the citizens than food security
- Short national government period constrains the long-term policies.

6. Discussion

The research question: 'how can information systems improve adaptive capacities in cities?' can be answered through the potential of information systems to create social learning through feedback loops with the use of indicators and monitoring.

It is proposed the use of information systems with a community informatics approach at the local level. The use of ICTs could promote bottom-up participation to feed-in data and monitor programs, enhancing feedback loops in decision-making. As a result the feedback loops can create social learning capacities through different institutions fostering the adaptive governance and management capacities.

Food security information systems can be a powerful tool to deliver information in support of decision-making. The use of indicators can help create a picture of the situation and keep track of the performance of implemented projects. Moreover, if the information systems are built under a community informatics approach –thus enhancing the participation of the citizens through the use ICTs and empowering the communities - they can reflect in a more comprehensive way the associated urban realities. This chapter will draw upon through the use of information systems in the policy making and how it relates to adaptive governance and management.

6.1 From Information Systems to Policy

Indicators and information systems aim to deliver information to guide policy-making. The approach can differ between national and local levels, also it might also differ who participates in the construction of the system, government-centered or community-centered. Whatever is the case, according to Herzi (2004) information systems used in public policy involves five stages: creation, dissemination, diffusion, utilization and policy learning to close the feedback loop.

The SIINSAN is a centralized system which collects, analyzes and uses the information top-down stream. Even though by Decentralization Law (Law14-2002) the municipalities are able

to address the needs of the population on their own, allowing them to develop tools and policies towards the specific needs of every Municipality, in matters of food security and information system none have taken action, relying only on the centralized decision-making.

International experiences in community indicators can be informative given that most implementation challenges are not too different from those in Guatemala City. Malaysia's case presents some lessons that Guatemala can take into consideration given the characteristic of the *Malaysia quality of life index* and the Guatemalan SIINSAN. The challenges that Malaysia needed to deal with are similar to Guatemala, barriers at policy level as policy-making culture and the 'rules of the game', referred by Herzi (2004) as 'meta-policy'.

Malaysian lessons show that macro information systems need to be embedded in both the policy and political contexts. It needs to be harmonized with the administrative organization and political activities (Hezri, 2004). Technical barriers in budget and human resources constrains the type of technology, communication issues –inside and outside- and levels of participation.

Other aspect that the Malaysian experience revealed is that indictors and information systems can contribute to learning processes. Indicators may inform general policy – or specific decision-making - but it is necessary to bridge the theoretical gap from the knowledge in the information systems to the utilization in public policy (Hezri, 2004).

In contrast national information systems community indicators systems identify and track at local level the goals that have been set. The system involves citizens' participation and elaboration of the indicators allowing them to track, share data, or make information available with access to all. Similar as CI approach, Guatemala City could consider this community-based bottom-up information to fill the gaps that SIINSAN as macro information system miss.

As an example *'Peg'* is a community indicator implemented in Winnipeg, Canada. It seeks to reflect and measure the city's well-being, divided in eight theme areas capturing the views and experiences of the population aimed to orient the decision-making process (Peg, n.d.).

The *Peg* experience has revealed learning areas, such as the lack of definition of frontiers of correspondence among the institutions in management, communication, and collection. Aiming for better horizontal coordination among stakeholders harmonizing the tasks.

Overall, both national and community approaches reveal that the information and analysis both are needed to be used as both management tools that can provide a picture of the urban food system in Guatemala City. Information needs to be linked with the planning process and embedded in the political discussion in the different levels, vertical and horizontal.

Neither the collection of data nor the production of information are relevant if they are not properly used. The data processed and filtered through analysis need to be linked with the planning process, as a pre-requirement for programs and projects to be based on a proxy of reality. The information system must rely on monitor and evaluation schemes to measure the degree of success or failure.

The food security information system, intends to collect and provide information on key qualitative and quantitative aspects of food insecurities in order to inform and enrich the debate in the decision-making process while joint complex socio-ecological systems over time and at different levels.

In order to enure an efficient use, the information needs to be linked directly to food security policy processes that leads to planning and decision-making and it can be used for learning process through feedbacks.

6.1.1 Learning Loops for Adaptive Capacities

As a precondition to adaptation, learning is essential to cope with changes and uncertainties. The theory of social learning is useful in the context of understanding the means of how new information through the collaboration of stakeholders, crucial for adaptive governance, it is used in strategies/policies, with the monitoring capacities to increase the learning-by-doing of adaptive-management. Social learning process can help to close the loop of information as: in-put (base-line), process (strategy) and output (actions) to the feedback monitoring loop.

Pahl-Wostl et al. (2007), explores the social learning in river basin management. This experiences can be applied to other sector, such as food security. Through a conceptual framework presented in Figure 20 shows the process of multi-level social learning using food security information systems. Social learning is essential to link with adaptive capacities at larger levels. Considering CI as the ICT tool, with the potential to support social learning, the social entity as a whole can learn and adapt through space and scale.

According to Pahl-Wostl (2009) and fitting the model to the current vertical Food and Nutrition Security Policy in Guatemala –from CONASAN, SESAN, PESAN, PHC- single-loop learning seeks to improve the performance of the PHC (outcomes) to the actions without actually change the deeper structures. It is a questioning the established plan –PESAN- asking if the PHC is the best strategy?

Through CI approach and the use of ICTs (e.g. cellphone apps, café-internet), it could promote feed the information system, followed of monitoring and evaluating the outcomes -in Guatemala context, the Zero Hunger Plan (PHC) and the PESAN- can be tracked under that method.

When bottom-up information can scale up even more, there is a double learning loop, questioning the system on how has the food security policy been framed in Guatemala? How do they frame the type of information that SIINSAN requires and under which lenses is it analyzed?

Finally, a the triple learning loop reach higher institutions, in this case it can be directly the CONASAN as a major guiding institution, where a radical transformation might be needed and it questions that if paradigm that it is following is the adequate.

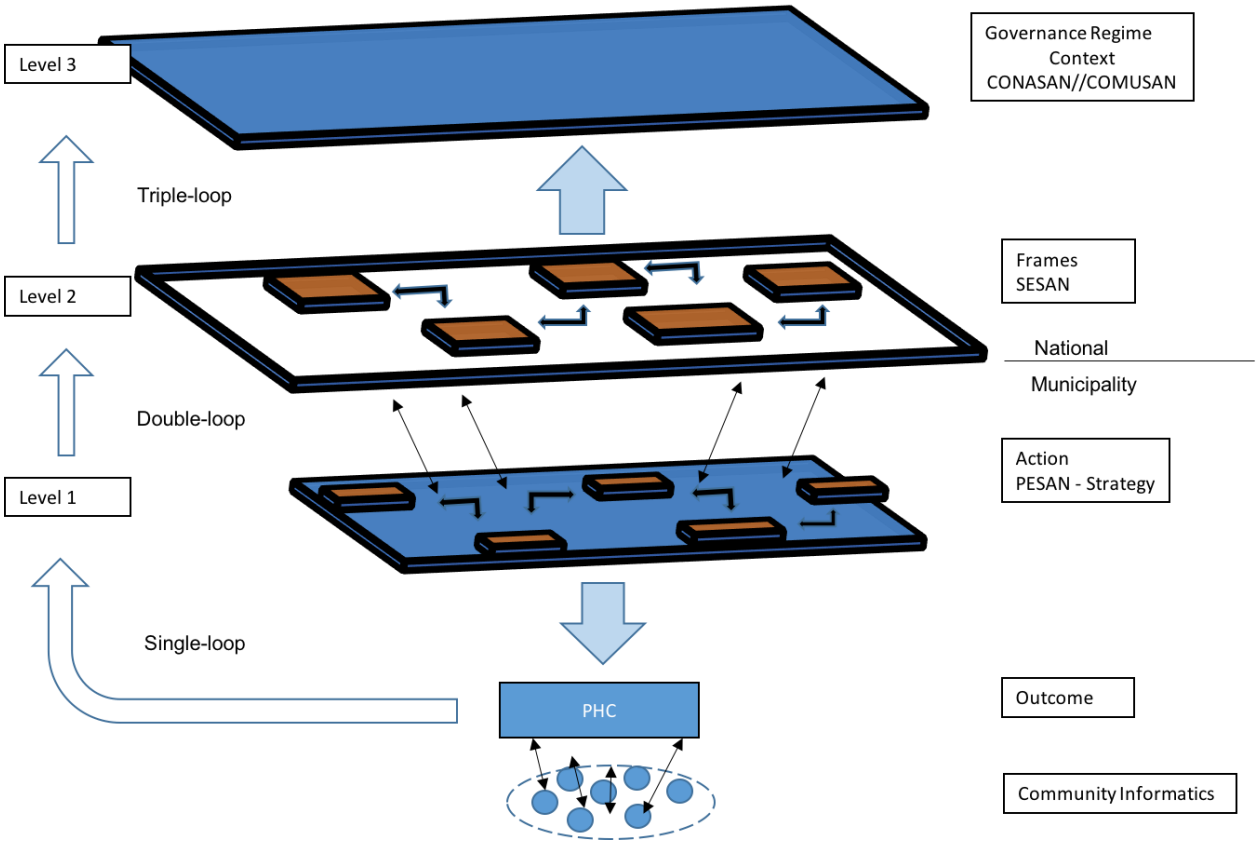

Figure 19. Social learning and adaptive capacities framework in Guatemala food security information system

Source: Based on Pahl Wostl et al., 2007

The feedback loops seek to answer those questions through evaluation and monitoring, beyond a quantitative data and moving to qualitative analysis. Even though it seems to be that the social learning process moves only vertically, inside the different levels, there should be communication

and collaboration between them, inside and horizontally with other institutions, co-management is required to distribute the responsibility and decentralize the core of the system.

In this aspect the CI approach can add a new stakeholder as networks that can feed the information system with timely information through selected community indicators providing novel methods to collect data.

When the resources are limited, their use needs to be efficient and well prioritized. It is important that information systems be understood not as isolated components of decision-making, instead as a part of decision-making itself.

Looking at adaptation as a learning process in response of stressors, governance and management need to use tools to learn. CI and ICTs offer a novel approach to generate bottom-up information, which functions as a direct feed information but as well in the feedback process. The inclusion of CI and ICTs entails different challenges, the most significant can be government openness to the use of ICTs. This implies decentralization of functions to several stakeholders, increase of flow of horizontal-vertical information and an increase in public participation and informing citizens (Frinquelievich, 2000).

According to Frinquelievich (2000) most governments in developing countries ignore the potential of ICTs, adopting a vertical and hierarchical information system, implementing top-down decisions and limiting public participation. Hence, governments must include an ICT policy concerned in implementing bottom-up processes and structures to link the electronic service and the user.

6.2 Fostering Adaptive Governance and Management in Guatemala City Through Information Systems

As described in chapter 4.3, the information system established in Guatemala – SIINSAN - has the final goal to support decision-making with information. However, despite the national institutional framework and the newly stablished online platform, the information system is underused.

The information provided here barely scratches the surface of the real problem. The level of disaggregation does not reach lower and marginalized areas, instead the samples just reflect the realities of some, and the socio-economic gaps polarize the information that hides reality, hence different data collection processes may be needed that help to capture the diverse realities.

Guatemala has taken the first important steps towards establishing the basic technology and human capacities for the collection, processing and storage of food security information, with the support of a legal framework with the CONASAN as the political decision-maker, the SESAN as the policy coordinator and the PESAN as strategy pathway. However, this centralized top-down view also limits the action and the possibilities of expanded stakeholder involvement.

The challenge lies in utilization of the information, the capacities of those who use the information and their capacities to influence decision-making. In other words, if the people who are involved in the analysis of the information are not directly linked to the political discussion the decision-making will be driven not by the information collected, instead it will be driven by the believe of what it might be the best solution.

In this sense the evaluation and monitoring of the programs play a key role, to measure the degree of effectiveness of those decisions. Monitoring and evaluation process can close the loop of learning in a policy process, increasing the management adaptive capacity rerouting the policy when needed or fostering if it is the case.

National statistics and national approaches usually are slow and imply heavy bureaucratic load resulting in slow changing process in governance, even if in ‘surprise’ events faster and

adequate action is needed as dictated by the circumstances. Therefore, the approach to incentivize the local governments to appropriate food systems and food security in the urban agenda and followed by promoting information system and monitoring culture. Encouraging the collection of data, processes and use of the information for the local-level action.

Adaptive management based in learning-by-doing can come with novel ideas and proposals to tackle the problems. It has been proven that bottom-up approach has high potential to deliver information but it is often underused. Reflecting in Community Informatics and Community Indicators through the use of ICTs can bring benefits for a fast-track action, local data collection and dissemination of the information. Figure 20 presents a diagram of how institutions use information. The high rate of cellphone penetration in Guatemala – in urban centers 90 per cent of households have a mobile phone (INE, 2014c) - can facilitate the use of the tool, based on the characteristics of a Sentinel Site, where specific indicators for urban food system can be identified (e.g., the physical location of food markets, type of food fairly distributed, among others). This information is linked directly with the SIINSAN. In order to avoid long decision-making processes, the technical tool of situational room can be use to discuss, analyze and come with local decision-making.

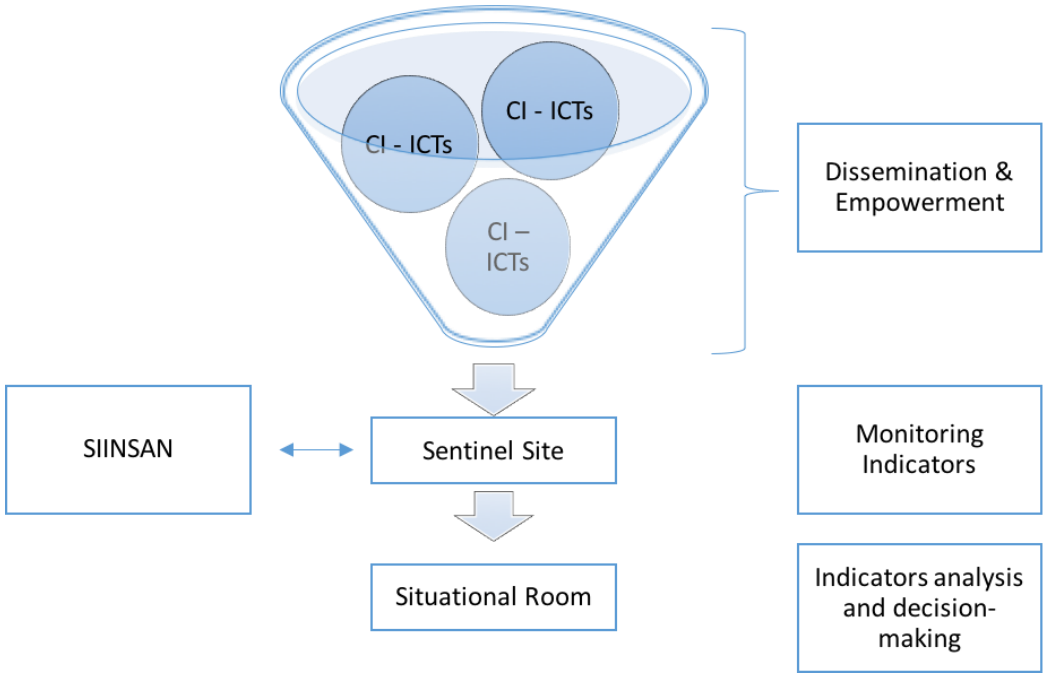

Figure 20. Proposal for the use of CI and ICTs with Sentinel sites and situational rooms for effective use of information

Source: Own based on readings

It is necessary to think of both the supply-side and demand side of information systems: what does the demand side needs to create the best policy but what does supply can provide and how does that information affect decisions.

The use of indicators provides the capacity of multi-dimensional range in political scope but also in a technical area. The type of use of the indicator will determine whether it ends up having influence on actual policy and outcomes. Therefore, the indicator selection that an 'urban sentinel site' can develop with community participation is as important as the indicator itself.

So far, Guatemala has created a food security framework with the establishment of the SENSAN, however it is still slow to respond. Moreover, it is not recognized the urban approach need to participate more actively. This mainly due the different challenges that the country and, more in specificcally Guatemala City faces.

Information systems can deliver information but they are also a good tool to keep track of programs and actions already implemented. With that it is possible to influence opportunities and transformative potential.

Social learning to promote adaptive governance can be developed already from the electronic infrastructure that SIINSAN has created. The centralization of the food and national security system need to divide the tasks to promote co-management, as we can recall from Figure 14 which presents the institutional bodies of SINASAN; we can find there are no linkages among central and decentralized institutions, working in a sense independently.

However, the adaptive governance approach recognized the need for linkages that can promote the flow of information vertically and horizontally. As mentioned before, co-management can support the operationalization, through the collaboration of different stakeholders working at different levels, promoting certain degree of decentralization.

Adaptive governance in Guatemala can be operationalized through adaptive co-management, based on the collaboration of different stakeholders, working at different levels through the use of neighborhood networks such as CUBs**.** Co-management argues for decentralization or share of power management through multiple links among institutions, vertically and horizontally.

Figure 21 puts together the previously shown Figures 19 and 20, showing how an adaptive governance framework can be applied to Guatemala with learning-loops and adaptive management and governance. The collaboration through CI approach feeding a Sentinel Site creating a Situational Room for urban food security at the local level, creating a first network of operationalization and decision-making with a feedback loop. The information continues scaling-up to the two specialized agencies, INE and SIINSAN with link and cooperation of Guatemala City and inter-institutions (CODESAN), creating other feedback loop through the monitoring of

the plans and strategies. Finally, the information reaches the central government, where the National Food Security Policy can be strengthened, but avoiding the slow scale-down of action, dealing with structural difficulties and the local governments dealing with a fast track decision.

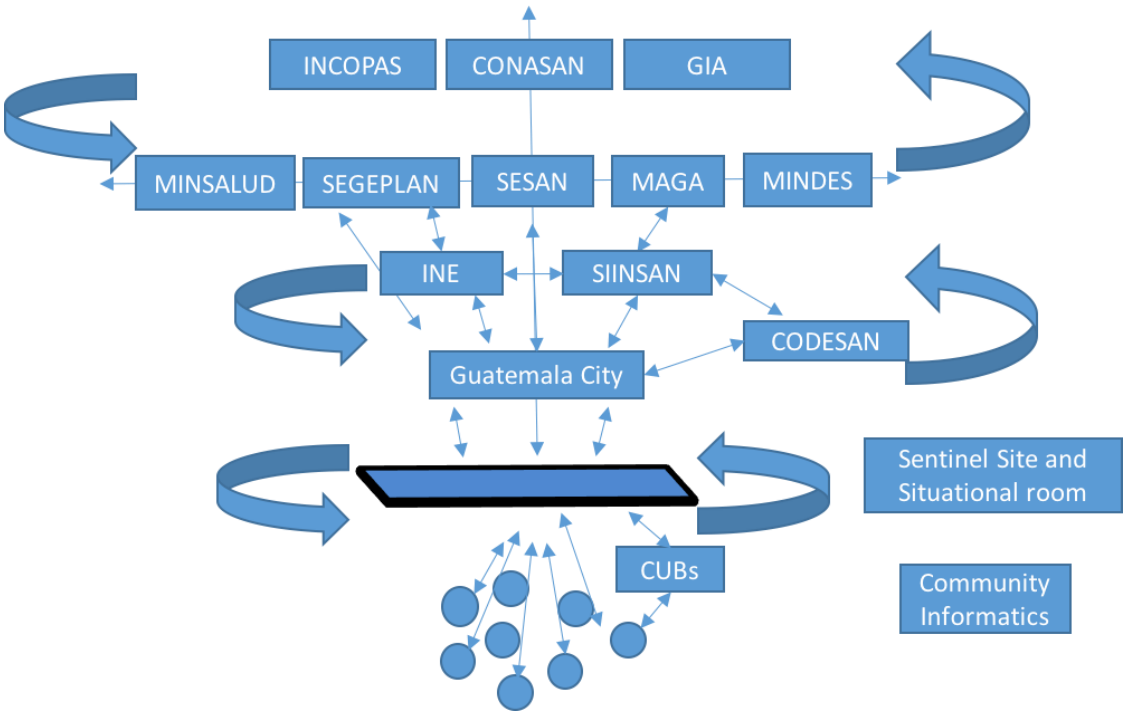

Figure 21. Adaptive governance in Guatemala food and nutrition security with feedback loops

Source: Own based on social learning loops Pahl-Wostl et al., 2007

The conceptualization of the adaptive governance for Guatemala City envisions the capacity of feedback loops at several stages, promoting social learning and the participation of different stakeholders. Civil society needs to be integrated through the established instances. Also the information needs to flow down as dissemination to the population in a more accessible easy way for educational and informative purposes.

6.3 Conclusions

The latter was studied under the context of Guatemala City. The analysis of urban food systems and insecurities in Guatemala City is not an easy task. Especially considering the lack of a homogenized definition of 'urban' area among the Ministries, the diverse precarious areas in the

periphery of the city where the irregular settlements are not registered, hosting great amount of people under property with lack of physical access to food, either by distance to the markets and economic constrains

This thesis has drawn upon two key areas. First, the current state of knowledge of urban food security is still under development and requires the appropriation in local agenda. A better understanding of the urban food system, carrying the specific context characteristics, is needed to identify the main food insecurities in the urban area. This entails understanding and recognition of the differences between the rural and urban areas in relation with food security. This first step can allow targeting better the populations who are in need.

Secondly, the use of information systems with community informatics approach might be a potential tool to collect information through community indicators and monitoring the projects and programs of food security bottom-up, fostering the adaptive governance and management through the feedbacks at different scales promoting social learning.

It has been studied the use of the food security information systems as a tool to produce a general picture of the situation, carried from national statistics or household's samplings to meet the level of anxiety for food security are practices well established in Guatemala, however the rate of malnutrition in children under five years old is increasing and considerable high.

The objective of the SIINSAN is to provide the necessary information for the decision-making, however the centralized government and use of the information creates a low response from the government, moving a heavy slow machinery hindering a fast-track response.

The information system cannot be established as a tool for just the collection of data, the further analysis needs to be integrated to the political discussions and in the decision-making more in depth, considering the contextual political scenarios, both at local and national level.

The approach of CI in the use of Information systems can add a social community-based component through the use ICTs. This approach can develop social participation in the construction of community indicators and the means of how to deliver first-handed information in the system.

The potential to create feedback loops through social learning from the lower level can allow to re-think if the strategy has been implemented correctly or identifying gaps. This can lead to adaptive management in the conceptualization of food security information system. Reorganizing the feed-in information from the communities through CI and the use of ICTs, delivering the information into a local body as the Sentinel Sites to process and analysis of the information footed in the local government. In order to present it after for the discussion and decision-making in a "Situational Room".

The information system can also impact in how the adaptive governance in Guatemala and Guatemala City can be envisioned as a system better connected, vertically and horizontally, with better communication flow –in and out government organizations-, fostering collaboration and cooperation among them. Co-management is needed as a resource to decentralize the use of information, promoting the local government capacities to act for themselves. In the case of Guatemala City, as the bigger city in the country with the technical, financial and human resources to take the agenda, should be a need.

Community informatics can empower the communities to speak-loud for the necessities and requirements in urban food security. Hence, it is needed to work in the type of indicators that need to be required in an urban setting space and a feedback of information to the population as well.

The depth and complexity of food security and information systems are difficult problems to be solve, however this should encourage the stakeholders to act more actively and with novel approaches in order to deal and tackle food insecurity, especially with high rates as Guatemala City

has. Therefore, a series of recommendations can be highlighted in the next section, divided in governance and management adaptation.

6.3.1 Recommendations

- Governance adaptation
    - Reduce the centralization of the use of the information
    - Promote co-management through different Ministries and local level authorities.
    - Promote in Guatemala City the use the Geographic and Information Direction for coordinating the collection of urban food security indicators, supported with the other directions (Health, Environment, Social Development, etc.) to create crosscutting urban food security analysis and eventually *ad hoc* programs and plans in urban food security
- Management adaptation:
    - Use of ICTs for developing information through the community levels (high level of phone penetration in Guatemala)
    - Use the conceptualization of Sentinel Sites at urban level with established indicators (build as community indicators)
    - Use of the ICTs to disseminate information with educational proposes
    - Extended use of situational rooms
    - Feedback loops for monitoring and evaluation to determinate the effectiveness of the strategy

6.4 Further research

Finally, further research can be done still in this topic deepening in the further implementation of the recommendations and piloting here suggested that were drawn through the theory field and understanding of the current tools and schemes in Guatemala.

Other areas mentioned (and not mentioned) in this thesis can be researcher more in depth as well, especially considering the urban delimitations and urban food systems: the roles of all the actors in the urban food systems could not be discussed in depth, analyzing the social and economic participation from production-transporting-retailing and consumers. Also urban gardening was not mention in this thesis; however, its potential cannot be denied to cope with urban food security.

Other areas of important research can be the use of new tools as ICTs to empower the community-base capacities to enhance bottom-up action to meet the top-down government action, joining efforts to tackle the current issues. The creation of a community indicator system of urban food system can be an interesting task, in order to identify the community requirements and where are the gaps to meet them.

Those briefly research areas are easily identified, however there might be several more to research.

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8. Annexes

8.1 Names and organization of the interviewees

Organization	Name	Position
Food and Agricultural Organization of United Nations (FAO)	Luisa Samayoa	Regional Initiatives Focal Point
Secretariat of Food and Nutrition Secretariat (SESAN)	Otto Estuardo Velásques Vásquez	Planning, Monitoring and Evaluation Director
SESAN	Ana Gabriela Rosas	Territorial operations. Former Guatemalan Municipality
SESAN	Carlos Alvarado	Departmental representative. Guatemala Department
National Statistical Institute (INE)	Luis Pérez	Technical expert in GIS
Urban health research institute (CISU)	Dr. Ernesto Velázquez	Coordinator Researcher
Famine Early Warning System Network (FEWSNET)	Gilda Maria Walter Guerra	National Technical Manager
Institute for Central American Fiscal Studies (ICEFI)	Ricardo Castañeda	Economist researcher
Social studies research association (ASIES)	Pedro Prado	Coordinator Researcher
TECHO	Sabrina Vega	Census settlement Director
Research of national economics center (CIEN)	Ricardo Lavarreda	Researcher
Food and Nutrition Information System (SIINSAN)	Sergio Hugo Gonzáles	Coordinator

8.2 Relation objectives, programmatic axis and transversal axis

Objectives	Programmatic Axis
National food availability	Food availability

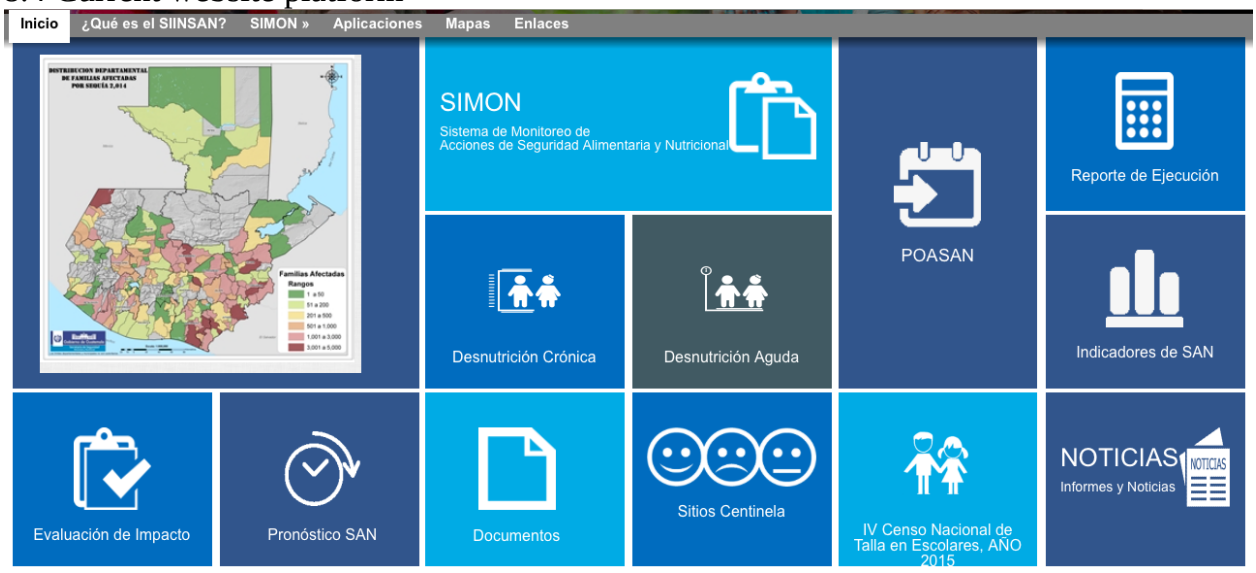
Food access	Access to food to the population
Food consume	Food consume
Food utilization	Food utilization
	Prevention and treatment to malnutrition
Coordination	Information and monitoring systems. Early warning systems
	Institutional Strengthen
	Budget allocation
	International Cooperation
Multi-cultural aspects	
Gender equality	
Risk management and climate change	
Territory	

Source: CONASAN, 2011
Source: SIINSAN, 2016

8.3 Sentinel Sites location

Source: SIINSAN, 2016

8.4 Current website platform



Source: SIINSAN, 2016