QUITO'S RESILIENT AGRIFOOD SYSTEM

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Figure 1: 85% of urban and peri-urban farmers of Quito are women, they provide organic and healthy produce to the city. (Photo credits: AGRUPAR)

INTRODUCTION

The right to food is recognized as one of the fundamental human rights within the global framework for sustainable development and it is embedded in different agendas. In order to promote prosperity and quality of life for all, the Right to the City, recognized in the New Urban Agenda signed in Quito, promotes ensuring that all inhabitants, both present and future generations, without discrimination of any kind, can create cities and human settlements, that are just, safe, healthy, accessible, affordable, resilient and sustainable. Furthermore, the Milan Urban Food Policy Pact recognizes that rural-urban connections, tied to land use planning and territorial governance, can provide for a balanced exchange of resources (goods, people and knowledge) to prevent their depletion and enhance ecosystems recovery and use of renewable energies.

Within these frameworks, the Resilience Strategy of the Metropolitan District of Quito (released in October 2017) proposed building urban resilience with several actions, among them, placing food economy as one of the main pillars. As a result, a Multi-Actor Platform, called the Agri-Food Pact of Quito (PAQ) was assembled consisting of members from the private and public sectors, academia, civic society organizations, and cooperation agencies. This group proposed the signing of an Agri-food Letter of Quito, in October 2018 and worked on a sustainability plan for the Eco-Agrifood system of Quito as an input to the city's food policy.

Today the city of Quito is dependent, vulnerable and diverse. Dependent because there is a large gap between what it produces and consumes, if we consider the total production and consumption. Vulnerable due to three factors: 1) risks of natural and anthropic hazards that could impact almost all of its territory, especially the most disadvantaged areas, 2) lack of awareness, preparation and the absence of actions to reduce risk, and, 3) concentration of supply goods in two opposite points of entry in the city that, in turn, connect with large areas of the country that are highly vulnerable in terms of food production. Diverse because the food situation differs significantly in its territory (north, center, south, or west) in relation to availability, accessibility and consumption (inequality), and because its territory (rural-urban divide) and social relations are heterogeneous in terms of their capacity for food resilience.

The present approach understands the city as a series of complex systems where, what we named the "Eco-Agrifood System" has a fundamental role. In fact, as the city evolved, its requirement for food has been incorporated into the urban development pattern in response to a wealth of rules and regulations, social associations, and human and natural capital that enables food provision.

Under these circumstances, this article is part of an ongoing work that identifies the main agents of the Eco-Agrifood System of Quito and its vulnerabilities and strengths from a systemic point of view. The analysis takes into account the factors that contribute to food security and to its natural and anthropogenic threats. It also recognizes the characteristics of the population that exacerbate vulnerabilities, in addition to factors such as climate change that amplify threats. As a result of this analysis, general strategies are proposed to form a comprehensive food resilience plan for the city of Quito.

CONTEXT

In general terms, it could be said that sustainable development and resilience reinforce each other. The more we take care of the environment, that is, if we do not cross "the planetary limits within which we hope that humanity can operate safely"[1], the world will be less turbulent. This balance between sustainability and resilience is displayed by agriculture. Balance is needed in farming activities which include: nitrogen and phosphorus overload[2], CO_2 emissions, the consumption of 70% of all fresh water extracted from the ground, shared responsibility for 60% of all biodiversity losses, and, land degradation on a large scale[3]. In turn, it is estimated that agriculture provides employment to around 1,500 million people, including farmers (small and large), landless workers, relatives and migrants (legal and illegal).

Figure 2: Amidst mountains and valleys, Quito Metropolitan District, Ecuador's capital, is near a 3 million people population. (Photo credits: Municipality of Quito)

Although the system produces enough food and calories to feed all of the people on the planet[4], 800 million people suffer from hunger. This could be explained by inefficiencies in the production processes, by inequality in terms of food access, especially for the most disadvantaged, and by food waste. The Food and Agriculture Organization of the United Nations (FAO) estimates that 6% of global food losses occur in Latin America and the Caribbean[5]. This is equivalent to 15% of the food available in the region, even though 47 million people in the region still suffer from hunger.

In Ecuador a study[6] found that although food security has improved during the last decade, the country is not self-sufficient in food production, and in some cases the population's access to food is limited. Agriculture remains the major employer in Ecuador, and an especially important source of jobs for women[7], however its importance is beginning to decline.

At the same time, the energy, water and food nexus is of particular importance. The consumptive use of water for agricultural purposes accounts for 80% of the used flow, followed by domestic (13%) and industrial (7%) use. Meanwhile 53% of the total surface flow is required for generation of hydroelectricity. Hydroelectric generation is the greatest non-consumptive user of use water[8]. The balance between consumptive and non-consumptive demands create a high level of uncertainty regarding the availability of this resource in the future.

These global, regional and national scenarios set important challenges for the future of food security in Quito. Food security is fundamental for economic development due to the role of nutrition in healthy growth and the development of human capital[9]. This is especially true in Quito which has a potential demographic bonus, where working age population exceeds the number of dependents. In the future, the population group between 0 and 17 years old will be the one with the least grow, while the population group that will grow the most in number and proportion will be between 45 and 64 years old. Not taking advantage of this opportunity could mean a deeper chronic social stress, reinforcing socio-economic vulnerability.

From the perspective of urban growth, socio-economic vulnerability can mean the creation and augmentation of risk. Socio-economic levels define the quality of living conditions and affect the resilience of human settlements when facing natural disasters[10]. In these settlements social and spatial inequalities are concentrated: insufficient living space in quantity, quality and safety, unsafe land tenure, deficient access to basic services[11], an increased complexity for the collection of urban solid waste[12], and, in turn, high food insecurity and low food diversity[13].

METHODOLOGY

The efforts to strengthen the Eco-Agrifood system face various challenges arisen mainly from its own complexity, its dependence on the environment and services provided, its importance to human health, its contribution to labor and development, and, its handling along the Eco-Agrifood chain. These challenges are magnified by the dynamism of the system over time and by spatial factors determined by its location in a territory facing multiple risks derived from natural and anthropic threats. In order to propose effective strengthening strategies, the study presents a comprehensive analysis of the Eco-Agrifood chain with a systems perspective that allows the identification of key agents, connections, vulnerabilities and threats.

FOOD SECURITY IN QUITO'S CONTEXT – COMPLEX SYSTEMS AND SYSTEMS THINKING

Arnold & Wade (2015) argue that Systems Thinking a "system of thinking about systems" can be a useful tool to visualize and understand the complexity of our food network. Although, systems thinking does not yet have the required importance in educational systems[14], its benefits and practical utility has been acknowledged[15]. According to the Merriam-Webster dictionary, a system is defined as "a regularly interacting or interdependent group of items forming a unified whole"[16]. Aristotle contributes to the definition of systems thinking as the ability to think of a system as something greater than just its parts or the sum of them[17], Following this line of reasoning, it is evident that systemic thinking uses the same logic as a system, as argued by Arnold & Wade (2015), who also affirm that "systemic thinking is a set of synergistic analytical skills that are used to improve the ability to identify and understand systems, predict their behaviors and design modifications to produce the desired effects. These skills work together as a system."

Systemic thinking encompasses three elements: 1.) Agents, in this case with attributable characteristics, 2.) Connections or interconnections which define the way in which agents are related and/or feed from each other, and 3.) A function, purpose or goal[18]. Often, the latter is a crucial determinant of system's behavior[19]. On the other hand, "understanding of interconnections"[20], and the need to "consider and use multiple perspectives"[21] is key in the construction of a system when using descriptive information[22]. This is because problems must be analyzed and understood from a wide range of perspectives, based on appropriate concepts and assessments in order to be critically evaluated[23].

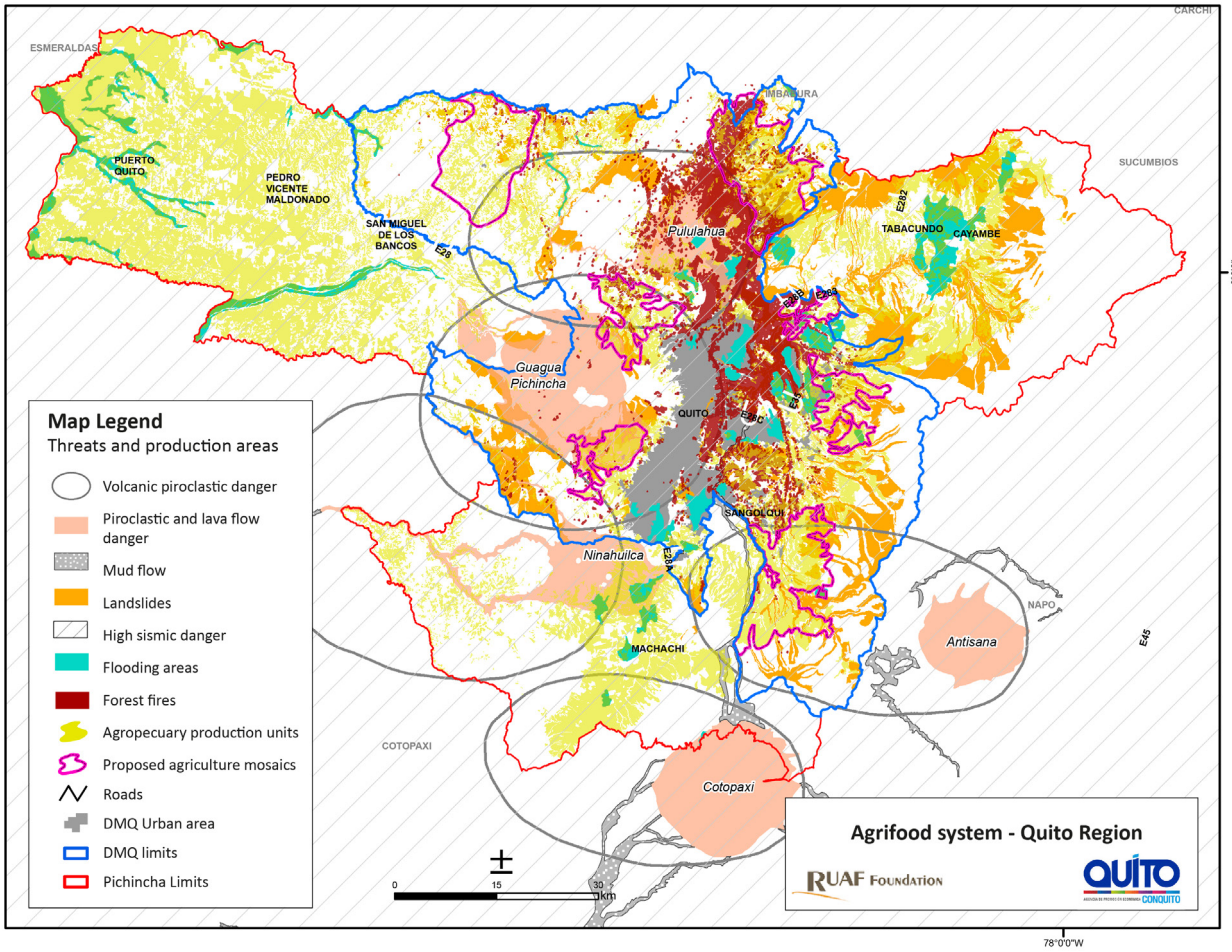

Figure 3: Quito-Region is a territory where natural threats, production and urban development are intertwined. To better understand the agrifood system these factors, as well as socioeconomic, politic and environmental factors, need to be considered. (Credits: María Cristina Cruz – RUAF Foundation)

Stave and Hopper (2007) identify seven key characteristics of systemic thinking: first is the recognition of interconnections, second is identification of feedback loops, third pertains to understanding of the dynamic behavior of the system, fourth relates to differentiating types of variables and flows, the fifth is the use of conceptual models, the sixth focuses on creation of simulation models, and, the seventh emphasizes on testing of policies and behavior. Through the proposed methodological approach, and with food security as the goal of the system analysis, the first 6 points are addressed. The seventh point can be addressed when designing the different programs and projects that derive from the possible strategies proposed in this work.

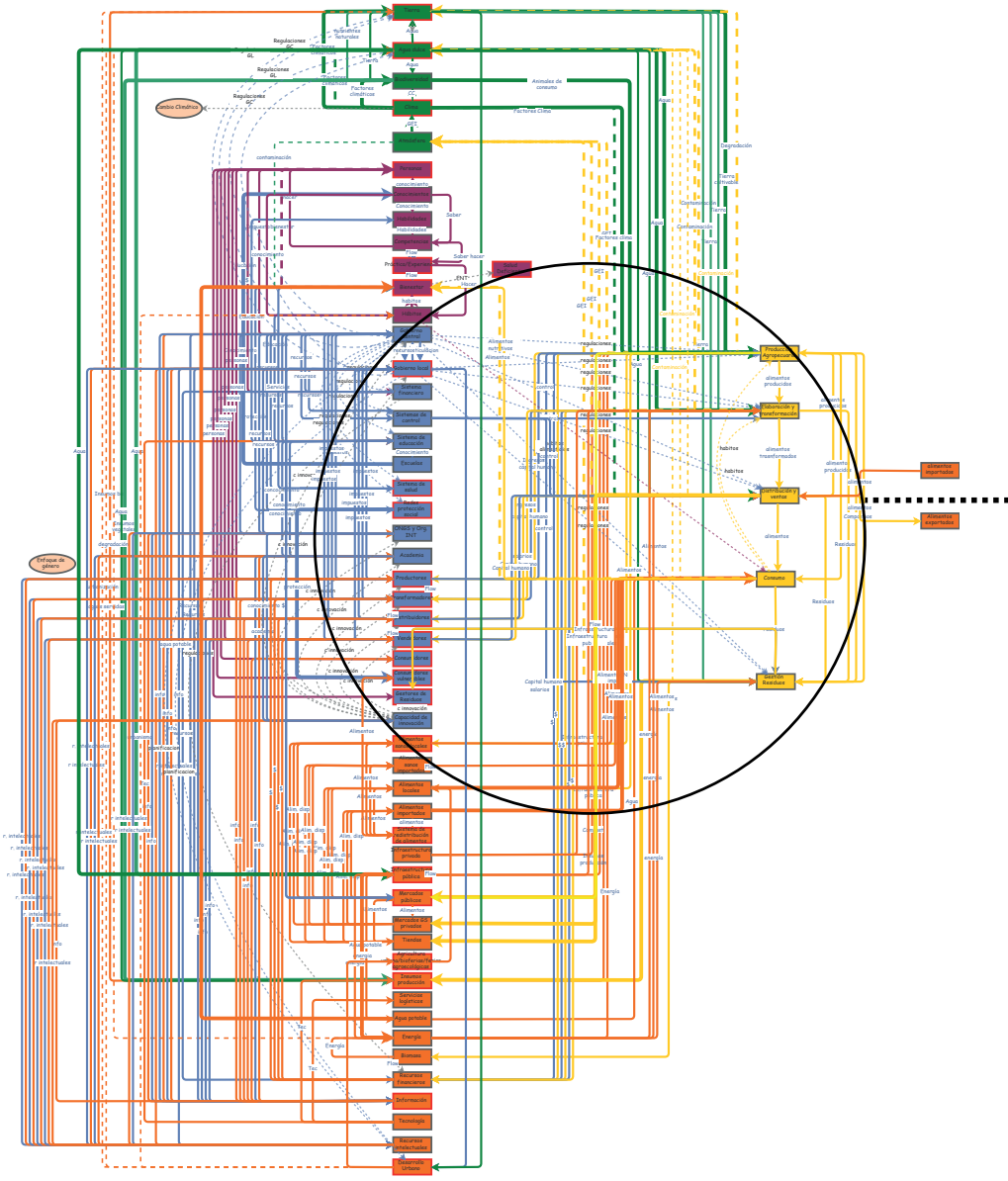

Figure 4a: Quito's Eco-Agrifood system was mapped using an open source software. Natural, Human, Social and Produced Capitals related to the system were identified and connected to the different links of the Agrifood chain. Connections, interactions, feedbacks and flows can be identified. Credits: Authors

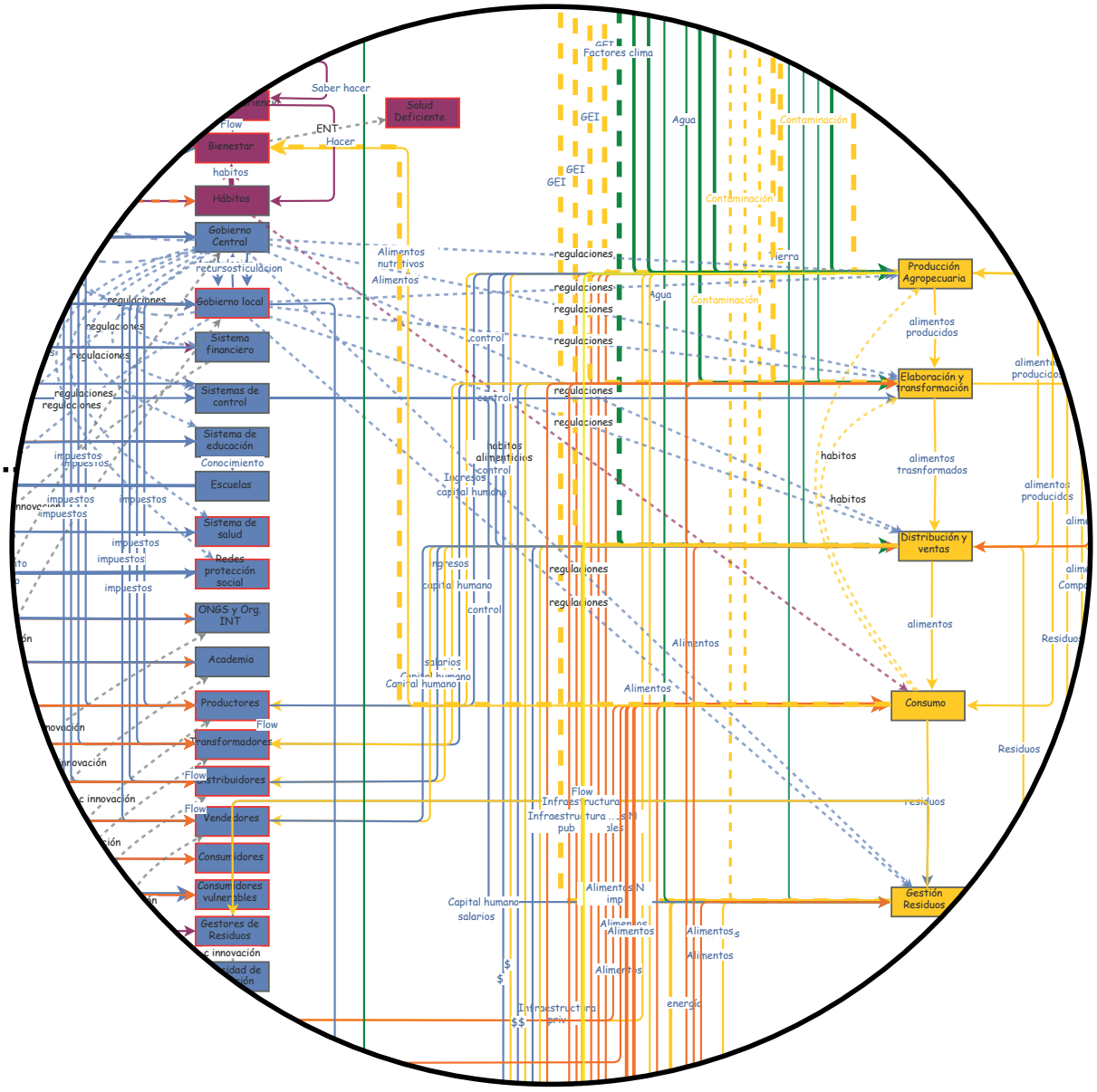

Figure 4b: Detail mapping of Quito's Eco-Agrifood system from Figure 4a

In order to understand the Eco-Agrifood system, the following steps were followed to construct a model. The model serves as a navigation chart to design strategies to strengthen the system:

Bibliographic review

Establishing the framework	*Considerations*
• Identification of sources of information, data and studies about Quito's Agrifood system • Consultation with experts and system organizations or individuals (including urban and peri urban producers all members of the PAQ) through meetings and workshops. • Review of studies and literature on systems thinking, complex systems, agri-food system analysis methods, preparation, resilience and climate change adaptation.	• The study benefited from Quito's Agri-Food Strategy diagnosis and knowledge of experts in the field. • The focus was mainly on sources that address food and its management from a systemic perspective.

Understanding the system operation

Understanding the system	*Understanding interconnections*	*Considerations*
• Based on workshops and semi-structured interviews. The objective was to understand the system holistically, considering all its agents, subsystems, links and capitals[24].	• Workshops and semi-structured interviews aim to gain knowledge and the ability to understand vulnerabilities, relationships and interdependencies between the agents of the system, as well as the results of these interactions. (These conditions help identify the points of change of a system, that is to say, those points that if approached in an adequate way, will generate changes in the whole system).	• Considering multiple perspectives (system experts and organizations or individuals) allows a better understanding of the system from different points of view[25]. • Understanding the system without getting tangled in detail[26]. • Tolerance to ambiguity and uncertainty[27]. • Interviews on broad and varied topics[28]. • Experienced interviewees [29].

System modeling

Drawing the system	*Considerations*
• Use of a simulation tool for modeling dynamic systems based on agents. • The tool allows to represent the system and gather information about its functioning. • The system is organized based on the different capitals (Natural, Human, Social and Produced) required for the operation of the system and its role in each link of the agri-food chain. • Agent-based modeling allows to granularly separate the details if necessary.	• The web-based tool used is Insight Maker. • The tool does not need downloads or add-ons. • The tool allows network collaboration. • Insight Maker is an open source tool.

System vulnerability		
Food security	*Weaknesses, threats and critical agents*	*Considerations*
• The contribution to food security of each link in the agri-food chain is determined and evaluated on a framework based on the dimensions of food security: accessibility, availability, adequate use and stability in time. This allows to identify vulnerable agents and critical nodes within the system.	• Evaluates the weaknesses of certain links and/or agents within the agri-food system regarding the factors that contribute to food security. • Describes the natural and non-natural threats that can affect the stability of the agri-food system or by link. • Establishes the critical components that need to be addressed to strengthen the link from the most critical agents.	• Weaknesses are addressed based on a framework that evaluates the functioning of the food system with universal food security as the result of its proper functioning[30], which related to the human right to food. • How well the system operates before a crisis influences the resilience of a system after a crisis. [31]. • Natural and non-natural threats are established by Quito's Preliminary Resilience Assessment. • Critical agents for the proper functioning of a link are identified with experts.

System analysis		
Examining the system	*Examining the behavior*	*Considerations*
• Establishes rules to determine agents and connections that later allow proposing the route to achieve the proposed changes. • Determines the critical agents, their connections and the quality of those connections. • Identifies the agents or critical links in which an action has major impact • Determines the scope of the proposed strategies	• Evaluates possible actions and their impact in the system by amplitude and magnitude.	• The rules to determine the impact of an action on agents and connections consider inputs and outputs, control over agents, contribution or inhibition of a flow, relevance of the agent in the system (based on expert criteria).

Recommendations and strengthening strategies		
Recommendations	*Strategies*	*Considerations*
• Based on the analysis and vulnerability evaluation of the system, recommended actions to strengthen are provided.	• Describes experiences in other cities that can contribute to the strengthening of the system.	• Recommendations include expert's contributions. • Strategies arise from the initial literature review and other relevant sources.

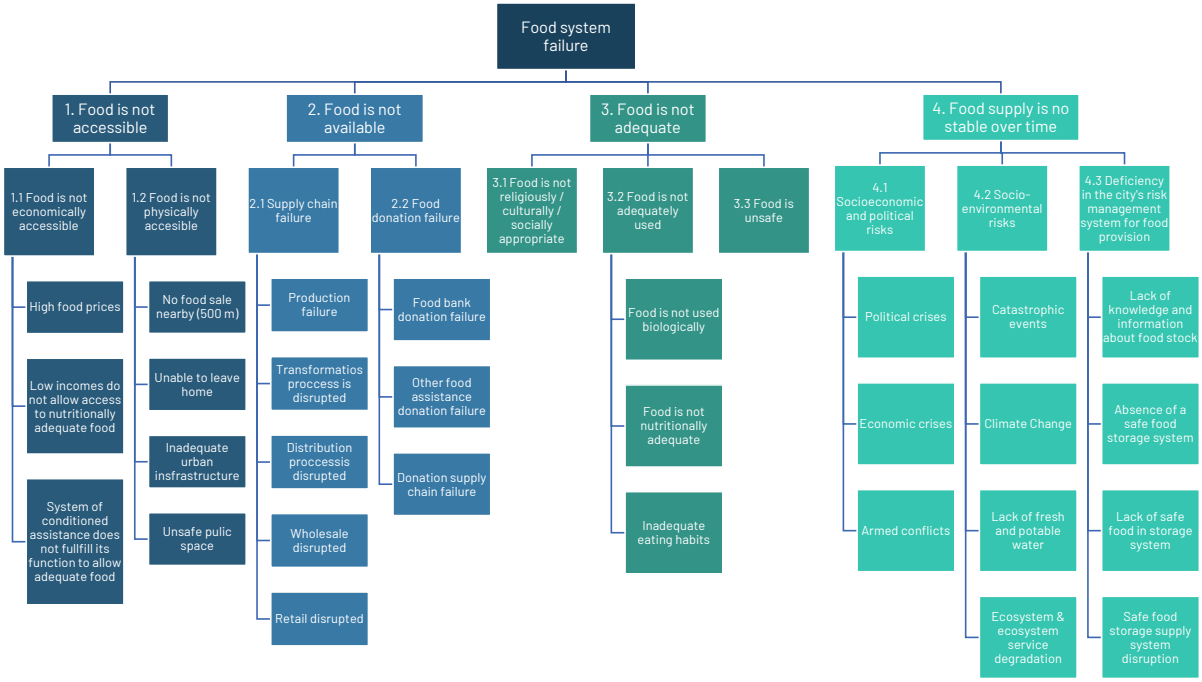

Figure 5: Quito's Food Security Evaluation Framework, based on the Baltimore System Resilience Advisory Report's framework. (Credit: Authors)

FOOD SECURITY AND QUITO'S AGRIFOOD CHAIN.

It is impossible to consider an isolated food system. Quito's Eco-Agrifood system is deeply intertwined with other urban and rural systems. Therefore the crises that affect any of these other areas can affect the food security of the city's residents, while the strengthening of the agents in these systems can guarantee the continuous functioning of the city's food system and its response to crisis. The recommendations derived from this work focus mainly on the food system, but other systems may need to be addressed, such as mobility or waste collection.

PRODUCTION

Production is key for food security in relation to all its dimensions, especially when considering the food system failure factors of:

1.1 food is not economically accessible,
2.1 supply chain failure,
3.3 food is not safe,
4.1 socio-economic and political risks, and,
4.2 socio-environmental risks.

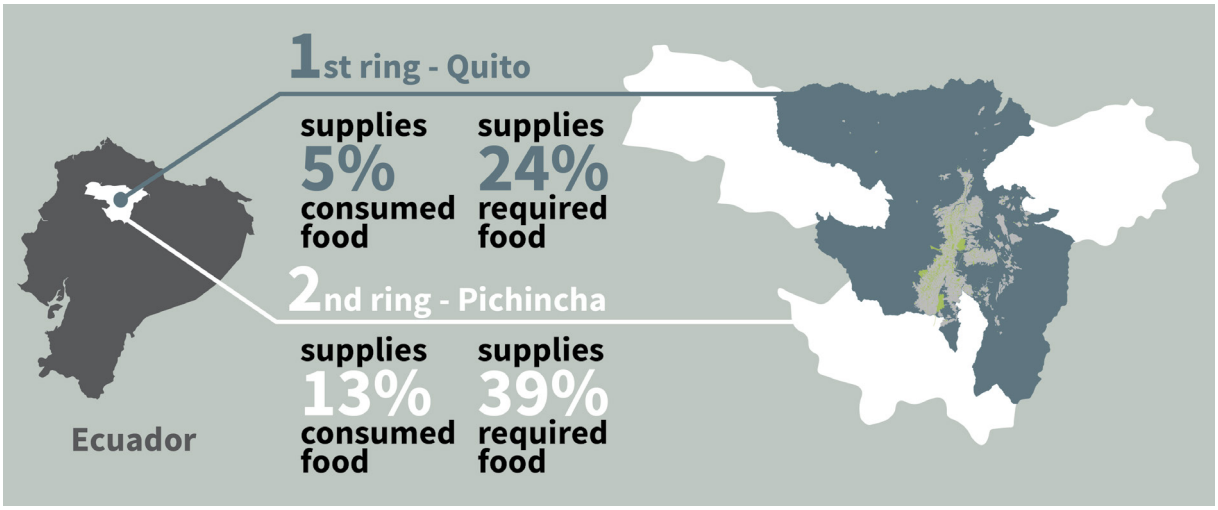

Figure 6: To better understand the ability of the city to self supply its own food, Quito has been divided in three rings: Ring 1 (423,074 hectares) corresponds to the Metropolitan District of Quito, ring 2 (953,600 hectares) includes the Province of Pichincha, the third ring is composed of 12 surrounding provinces. (Credits: Authors)

Food resilience relies on the ability of the city to supply its own food. Based on the tool developed by RUAF Foundation and FAO to assess the city region food system, Quito has two concentric rings. Ring 1 (423,074 hectares) supplies 5% of the total food requirement and corresponds lands within the Metropolitan District of Quito. Ring 2 (953,600 hectares) supplies 12.7% of the food requirement and corresponds to lands in the Province of Pichincha. Ring 1 and 2 also supply 26% and 36% of the requirements of five important items of the local diet[32]: cereals, fruits, vegetables and tubers and dairy. Despite this local production, the city of Quito requires food from the rest of the country's provinces. Fortunately, they manage to produce food to satisfy their own requirements and food surpluses to supply the country's large urban centers. In addition, food comes from imports (legal and illegal) from other countries.

However, the agricultural efforts in the Quito region are inefficient. Thirty-six percent of the production area is overutilized or underutilized, and only 23% of the cultivated land has access to water for irrigation[33]. Access to credit (public and private), the lack of land legalization, especially in rural areas, and vulnerable road infrastructure are factors that impede the growth of production. Also, the city's urban sprawl reduces land with available for farmers.

In the future climate change will diminish the quality of food as a result of higher sugar content in grains and fruits, and a decrease in the protein content in cereals and legumes[34]. The dependence on certain supplies from international trade[35], could affect local food prices to the detriment of the most vulnera-

Figure 7: The Participatory Urban Farming Project of the city-AGRUPAR, guides farmers for the implementation of organic production farms. In occasions this includes raising of small animals, food processing and the sale of surpluses through BioFerias. (Photo credits: AGRUPAR)

ble[36]. On the upside, there are currently more than 1,400 urban and peri-urban farms that engage more than 4,500 people each year in self-production activities linked to the local program AGRUPAR (Participatory Urban Agriculture). This ample network mainly supports women heads of household (84%) and their families, as they can access local, healthy, fair and diverse foods.

TRANSFORMATION

The following key factors for transformation were identified in context of food system failure:

2.1 supply chain failure,
3.3 food is not safe, and,
4.2 socioenvironmental risks.

Vulnerability in the transformation stage is the result of several issues including: the lack of proper control systems and regulations that result in products of dubious quality being marketed in the streets and stores of the city, and technological, technical and infrastructure issues that prevent artisanal industry to grow.

The food manufacturing industry of Quito region is important for the local and national food supply. In 2016 the city housed around 36.6% of manufactured food sales, 30.6% of total registered jobs and 9.5% of the country's total food manufacturing companies[37]. However, the participation of these sectors in the Gross Added Value of Quito is marginal[38]. In terms of job provision in the city, the service sector contributes 48.3% of employment, within which 7% comes from lodging and food activities[39]. A small number of companies hold a large share of the market and turnover in the food processing industry. This is particularly true in the meat, bread, grain based and dairy sectors. For each of these sectors, no more than 5 large companies account for over 80% of the sales[40]. About the distribution of food processing industries, these are mainly located in the Tumbaco and Quitumbe sectors[41] in the northeast and south of the city, respectively. Finally, poor food preparation practices are relevant, since most offerings in public markets do not comply with food safety requirements.

DISTRIBUTION AND SALES

Food distribution and sales are of special importance to food security in relation to all main components of the four dimensions of food security. The greatest challenge is city access. Fifty-three percent of the food enters through the Panamericana Sur Expressway, and 24% enters through the north entrance of the city. These roads are highly vulnerable to a ranging set of threats, from political manifestations, to natural threats such as seismic, volcanic and landslides derived from climatic events.

On the other hand, food supply density is not proportional to population density. The Metropolitan District of Quito has a heterogeneously distributed population, and public and private responses manage to supply the local demand for food with different levels of quality and safety. However, the supplies of food to be distributed through food assistance programs (food bank or community kitchens) do not respond to the logic of vulnerable population distribution in the territory. The supply of processed and other foods with little nutritional value is distributed heterogeneously in the city creating food swamps[42] in highly populated areas, such as the surroundings of the Central University of Ecuador, the northern center of the city, or on Michelena Street, the core of informal commerce in the south of Quito.

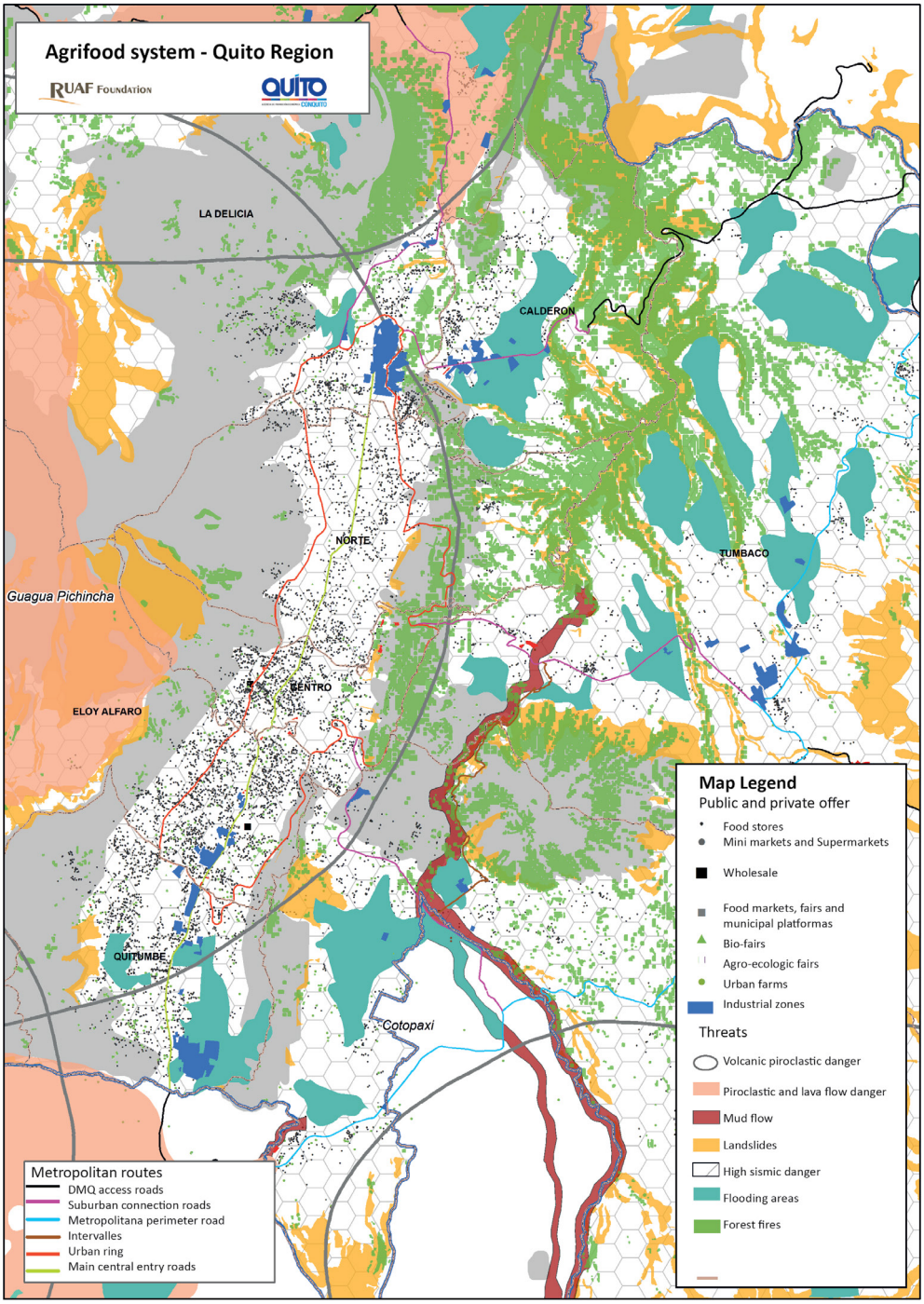

Figure 8: Public and private food offer are distributed in a multi-threat territory. The type of offer does vary considerably in the area. (Credits: María Cristina Cruz – RUAF Foundation)

Figure 9: Around 63% of children under 5 years old present problems of malnutrition in Quito. (Photo credits: Municipality of Quito)

CONSUMPTION

The consumption link of the chain has an important influence over the following factors of food security dimensions:

1.1 food is not economically accessible,
1.2 food is not physically accessible,
2.2 food donation failure,
3.1 food is not religiously/culturally/socially appropriate,
3.2 food is not adequately used, and,
4.2 socio-environmental risks.

Food accessibility is linked to the difficulty of people / households to access food that satisfies basic needs and contributes to a quality diet. Problems with food accessibility are associated with problems of per capita income. The incidence of poverty, meaning the inability to procure adequate basic needs, for the study area was 29.7% in ring 1 and 33.5% within ring 2. The fact that the basic food basket cost exceeds the minimum wage means that 1.5 million people live with food insecurity. Supply chains with high levels of intermediation affects

food prices and hinders affordability. Oddly, poor eating habits, especially the consumption of highly processed food, have produced a rapid increase of overweight and obesity in coexistence with high rates of delay in size and micronutrient deficiency[43]. In this sense, the approach that addresses only the provision of food and neglects access to sustainable and balanced diets for all must be reformed. The quality of urban infrastructure also makes it difficult to access food. Finally, there are areas in the city, such as Calderón in the northeast, that grow at an accelerated rate and have a large population, where its inhabitants must travel up to 2km or more to access food outlets in extreme weather conditions, without adequate physical conditions and / or public transportation.

FOOD WASTE

Finally, this analysis showed even though food waste currently does not have a highly relevant contribution to food security in the city, it might require the development of an integral food waste management strategy. In 2015, the Metropolitan District of Quito produced an average of 2,037 tons per day, of which 57% was organic waste. Part of this waste is contributed by 54 municipal markets and fairs, which produce approximately 70 tons of waste per day. Coverage in terms of waste collection is provided to 96.5% of the population. At the same time, approximately 930 metric tons of food per week is lost due to lack of adequate storage in the wholesale market, where most goes to landfills, degrading the soil and emitting greenhouse gases.

Nevertheless, the Quito's Food Bank recovers and redistributes an average of 5,000 kilos per week (vegetables: 78%, fruits: 6%, meat: 11%, flours, dry grains: 5%) of food still fit for human consumption for the most vulnerable population of the city. The program supports 485 families and a total of 9,637 beneficiaries.

To complement the municipal efforts to mitigate these negative impacts, a strategy based on the concept of the circular economy is needed.

STRATEGIES

Food production is one of the most important drivers of change on the planet[44]. The problem of food waste is doubly damaging in two dimensions: environmental and socioeconomic. An important number of authorized reports have requested fundamental changes in the agrifood systems[45], with the aim to develop a more sustainable and more equitable food systems. In this sense, the development and implementation of systemic strategies, involving institutional, social, ecosystem, environmental, financial and technical capacity components[46] to deal with these changes is critical to achieve proper functionality of the sys-

Figure 10: Farmers of the Metropolitan District of Quito. (Photo credits: AGRUPAR)

tem, making sure that it also responds properly to catastrophic events, in general, and as a way to adapt to climate change, in particular.

Although there are different frameworks and approaches, a general tendency is to study the following aspects: urban vulnerability[47], rural community[48], vulnerability of rural farmers[49] and vulnerability by economic sectors[50]. Efforts in these areas could have dramatic impacts on the resilience of the global food system, with important contributions to local agri-food systems.

For the city of Quito and its Eco-Agrifood System the task in the coming years is to feed a mostly urban population of almost 3.5 million by 2040 and to achieve the four dimensions of food security[51]. The system needs to provide healthy foods, transforming the system for the benefit of the planet and the future of its inhabitants, and to do so in such a way that interactions between rural and urban economies, communities and landscapes[52] are constructed. And we must do this in such a manner that efforts are not compromised by external events that may affect these systems.

As a general rule it was decided that any effort must include: first, the perspectives of gender equity and social justice along the food chain, second, link

human nutrition policies to agricultural production policies, third, promote localized and well distributed networks of food points and waste management, fourth, increase the use of ecological processes rather than external inputs for crop production and food processing, where research, development and innovation play an important role, fifth, strengthen knowledge and awareness among the population on the importance of healthy eating, especially amongst children, encourage better eating habits and work on responsible consumption to improve the understanding of the advantages of preferring local, healthy, fair, fresh and diverse foods, sixth, redesign and implement strategies to avoid food waste and to recover and restore products, components, and materials to avoid the demands of new ones from nature, and, seventh, improve and retrofit road infrastructure and buildings, that must include participatory strategies with communities and relevant actors. Summing up, improving socio-ecological links and fostering adaptive capacity are essential to cope with short-term volatility and longer-term global change pressures[53].

Within a defined repertoire of strategies, the present delivery addresses two important challenges and presents suited solutions: the first is increasing and improving local production, and the second is establishing a system of provision, supply and stock of food to ensure proper functioning of the system in normal times, as in moments of catastrophic events.

The first solution, in the context of more sustainable practices in the social, economic and environmental dimensions, requires a higher yield and a general increase in food and agricultural production where the Metropolitan District of Quito has allotted land. The following strategies were identified:

1.) promote agricultural practices that improve food security, eradicates hunger and is economically viable while conserving land, water, plant and animal genetic resources, biodiversity and ecosystems

2.) guarantee safe and equitable access for women and men without any discrimination to natural resources, particularly land, water and biodiversity, as well as the sustainable use of them

3.) promote sustainable production chains that prefer cleaner production strategies, with a more inclusive commercialization and that shorten the gaps between the rural and urban sectors

4.) support national research systems, public universities and research institutes, as well as the promotion of technology transfer, the exchange of knowledge and practices, promote a significant increase in research and development in agriculture, especially for small food producers and other agents involved in the food value chain

5.) facilitate access to financial and risk management instruments, such as innovative insurance systems, as well as climate and financial risk management mechanisms
6.) integrating the food approach to waste management to reduce losses and waste.

For the second solution, the key is to understand the need to develop an efficient supply system to guarantee the quality of the distributed food in a timely effective way and at a reasonable cost for the buyer[54]. The idea is to create food hubs[55], or areas of food concentration, to solve the dysfunctions of local food distribution. The development of food hubs has emerged as a key strategy for the expansion of local and regional markets[56]. The main objective is to shortening distribution chains and take advantage of the wholesale, retail, and other means of food distribution, including those that offer to the most needed. This opportunity is also used to increase the presence of urban farmers within the city limits and advise everyone involved in the production and marketing of their products to improve their services[57].

The proposal establishes two levels of action, where the proper functioning of the first level ensures the short term provision of healthy foods and the ability to continue this provision, even during difficult times. The first level is made up of three subsystems. The first subsystem consists of wholesale and retail public markets, small local stores, agroecological fairs, and the distribution system of food to the most needed located in the consolidated urban area. This subsystem must increase its coverage and efficiency in the distribution of food, in addition to increasing its autonomy in terms of production, supply and food stock. This is important because, as mentioned, the city is highly dependent on a vulnerable road infrastructure to stock up on food. The second subsystem consists of urban farms, which has the objective of strengthening the production and existing local supply of organic products. This subsystem requires improvements in the legal frameworks of land regulation to encourage and increase agricultural production in the public and private urban areas. The third subsystem of urban food transport, seeks to serve the last mile and offer delivery service in the urban area, especially where there is not enough offer in proximity of healthy foods. The last subsystem made up of private markets, supermarkets, retailers and food services, such as restaurants, hotels, cafeterias, institutional and corporate canteens, as well as sometimes specialized retailers to supply companies, are regarded as a complement of the food offer, while offering and additional aid in difficult times.

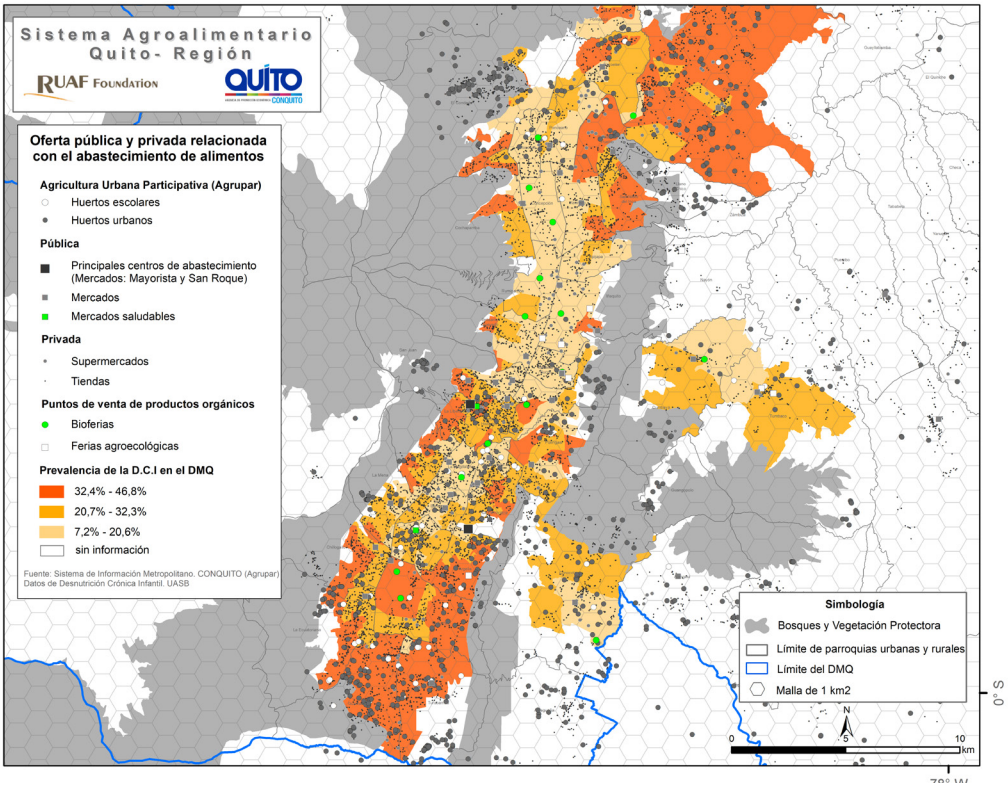

Figure 11: Proposed location of Food Hubs. Credits: Authors

The second level considers peri-urban and rural agriculture, which are dependent on the road infrastructure for the provision of food. This level benefits from the strategies established in the first solution. The second level should be ready to provide food when the first ceases to be able, in case the city is isolated.

Endnotes

1 Rockström et al, 2009
2 Rockström and Klum, 2015 in TEEB, 2018
3 TEEB, 2018, Vermeulen et al, 2012, Jägerskog, A. (Ed.), 2012 in Swinburn et al, 2019
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20 Sterman, 2000, Webster, 2014
21 Webster, 2014; Stave and Hopper, 2007
22 Frampton et al, 2005
23 Frampton et al, 2005
24 Behl and Ferreira, 2014
25 Ibid
26 Ibid
27 Frank, 2010
28 Davidz and Nightingale, 2008
29 Ibid
30 Biehl et al, 2017
31 Martin-Breen and Anderies, 2011
32 Does not include rice, wheat, fish or sugar
33 in Ecuador, transient crops use a greater amount of fertilizers and pesticides than permanent crops, 78.24% and 50.03 respectively (INEC, 2016)
34 DaMatta et al, 2010 in Magrin et al, 2014
35 Hertel et al. 2010 en Magrin et al, 2014
36 von Braun, 2007 in Magrin et al, 2014
37 MDMQ, 2015
38 Ibid
39 Ibid
40 Arrazola et al, 2016
41 MDMQ, 2015
42 communities flooded with unhealthy, highly processed, low-nutrient food combined with disproportionate advertising for unhealthy food
43 refined carbohydrates predominate, low consumption of fruits and vegetables, as well as legumes and fiber, high oil consumption palm, milk and whole cheese, all contribute to the consumption of saturated fats
44 Rockström and Klum, 2015 in TEEB, 2018
45 Hawkes, 2017, IPES-Food, 2017, HLPE, 2017, Haddad, 2016, Rockström et al, 2016, De Schutter et al, 2015, Fan and Rue, 2017, Ottersen et al, 2014, Whitmee et al, 2015 in Swinburn et al, 2019
46 see Chapter 14 in Magrin et al, 2014
47 for example, Hardoy and Pandiella, 2009, Heinrichs and Krellenberg, 2011
48 McSweeney and Coomes, 2011; Ravera et al., 2011
49 Oft, 2010
50 see Section 27.3 in Magrin et al, 2014
51 Pinstrup-Andersen, 1999
52 Forster and Escudero, 2014
53 Whalen and Zeuli, 2017
54 Severson & Schmit, 2015
55 see Stott, Lee & Nichols 2014
56 Anselm, 2013
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