Final report

Food vulnerability in Guatemala: a static general equilibrium analysis

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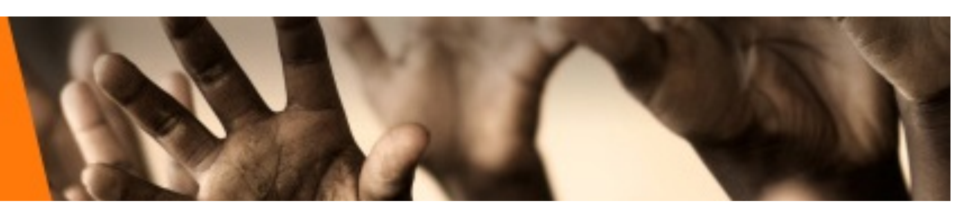

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Abstract

In this study, we used a Computable General Equilibrium model of the Guatemalan economy to conduct simulations for a) a reduction in productivity due to climate change; and b) the effects of drought in agriculture. The reduction in productivity due to climate change would mean an important drop in the value added of agriculture and animal production, as well as a slight drop in industrial food production and the service industry. Under this scenario we could expect a fall in real GDP of 1.2%. The reduction of productivity could mean a reduced fiscal space, and a reduction in government expenditure because of lower tax revenues. More importantly, due to higher prices and lower income of households, this scenario could mean that consumption of agricultural goods for each type of household would be reduced in a relevant manner with great impacts to the food security aspect of access. One of the findings in the effects of drought in agriculture is a decrease of the value added in 23%. As expected, this situation negatively affected the wages paid to unskilled workers, but also urban non-poor households would saw a reduction of their disposable income due to higher food prices. One of the most interesting results is that the demand for land would fall down by 38 per cent. This is because as water would become scarcer, there would be fewer incentives to engage in agricultural activities. However, due to the importance of agricultural production for ensuring food security, this results show that a proper water allocation system is needed.

JEL: R15, R22, Q12.

Keywords: Regional Economics Measurement, Computable General Equilibrium, Spatial Analysis, Natural Resource, Agricultural Employment, Farm Household, Farm Input Markets,

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List of acronyms

AIS	Secure Agricultural Income Program
BANGUAT	Central Bank of Guatemala
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
GDPFC	Gross Domestic Product at Factor Cost
GDPMP	Gross Domestic Product at Market Prices
GTAP	Global Trade Analysis Project
IAHS	International Association of Hydrological Sciences
IFPRI	International Food Policy Research Institute
INAB	National Forestry Institute of Guatemala
INE	National Institute of Statistics of Guatemala
LSMS	Living Standards Measurement Survey
MACEPES	Model of Exogenous Shocks and Economic and Social Protection
MAGA	Ministry of Agriculture, Livestock and Food of Guatemala
Mams	Maquette for simulation of the Millennium Development Goals
MDG	Millennium Development Goals
NDP	National Development Plan of Guatemala
NetIndTax	
PEP 1-1 model	Partnership for Economic Policy Standard Computable General Equilibrium Model Single-Country, Static Version
PFN	National Forestry Program of Guatemala
PROBOSQUE	Programme for promoting the establishment, recovery, restoration, management, production and protection of forests in Guatemala
SAM	Social Accounting Matrix
SEEA	System of Environmental and Economic Accounts
SEGEPLAN	Secretariat for Planning of the Presidency of Guatemala
SUT	Supply and Use Tables
TFP	Total factor productivity
UNESCO IHP	International Hydrological Programme of the United Nations Educational, Scientific and Cultural Organization
WMO	World Meteorological Organization

1 Introduction

1.1 Context of the study

After considerably reducing the size of planning agencies and their importance in the wake of structural reforms during the 1990s, Guatemala has recently resumed long term planning with the participative construction of the *National Development Plan K'atun: Our Guatemala 2032* (Conadur/Segeplan, 2014), NDP hereafter. The NDP has four broad components, one of which is related to environmental and food security aspects. Among the policy priorities identified for this component, the plan moves for the creation of incentives for agricultural output with cultural pertinence regarding age, ethnicity, and gender; along with the creation of value chains for that output and the development of infrastructure to improve agricultural trade.

According to the Living Standards Measurement Survey –LSMS 2011, in 2011, 33.5% of the employed population of 15 years old and over from Guatemala, was employed in the agricultural sector (43.6% of men and 16.1% of women). Of the total employed in agriculture, 78.5% lived in rural areas and 71.3% was below the poverty line. In addition, more than a third of those employed in this sector (37.1%) were of ages between 15 and 24, and 7 out of 10, and had incomplete primary education or less. For that same year, only 6.8% of those employed in agriculture were formally employed (at a national level, over 30% of the employed population were working in the formal sector).

It is not altogether clear which new concrete actions will be used to comply with the NDP, but the Secretariat for Planning of the Presidency –SEGEPLAN– has already instructed that existing policies be aligned to it and that new programs created under their umbrella strongly support NDP priorities.

One such policy is the forest policy and legal framework, which for fifteen years has underpinned the widespread National Forest Incentives Program which previously focused on increasing forest cover for commercial purposes and targeted large landowners. Recent modifications to the legal framework (under the name PROBOSQUE) allow smaller landowners with less certain property regimes to access the program not only for supporting their commercial purposes, but also for ensuring their food security and employment (INAB/PFN, 2013). One of the biggest changes is the introduction of new incentive purposes such as mixed agro-forest systems (for the simultaneous production of crops with forests to improve food security) and for energetic uses (fuel wood). Given the wide reach of this program, it could prove useful to assess how this program will affect land use, and how it might influence crop and forest output.

Another policy with far reaching actions within the agricultural sector is the National Irrigation Policy (MAGA, 2013), which identifies areas in need of irrigation; introduces micro-irrigation systems at the plot level for small and micro-farmers, develops infrastructure for water provision (regulation, storage, and transport); and promotes integrated systems of irrigated animal forage and agricultural output. This will put 60 thousand hectares under irrigation in the period 2013-2017. This is certainly a measure that has both economic and widespread environmental implications.

While there might be an improvement in food security with these actions, an increase of the industry's contribution to GDP might become more difficult in the presence of low price imports. With these types of incentives, there is the possibility that investments in the agricultural sector prove too big for large owners to diversify into finance or industry (Amsden, 2001). Furthermore, environmental impacts, and their effect on populations, might multiply in an economy already vulnerable to effects of climate change.

Even if some agricultural incentive programs in Central America have been assessed through a traditional impact evaluation approach (e.g. Iarna-URL/FAUSAC, 2013), it is believed that the direct and indirect effects of these programs on the entire economy and the environment should be evaluated by an environmentally extended general equilibrium approach, in order to overcome endogeneity issues (Khandker, et al., 2010).

In fact, water resources are facing several stresses in terms of quantity and quality. These pressures are related to human interventions like agriculture and land use change. According to Llop & Ponce (2012), CGE and water analysis at national scale had studied a broad type of issues like water pricing policy, water allocation, water markets and climate change impacts. Under different approaches and scope of analysis, any shock in water availability would have great implications on agricultural production and on inequality as we will see in the results section.

The agricultural sector is key to food security and it is important to understand the linkages between the economy and its various components in a systemic manner. A focus on agricultural and food security aspects of the System of Environmental and Economic Accounts of Guatemala (SEEA) shows key insights into these linkages. For example, it is interesting to notice that maize production in Guatemala depends entirely on rain water for its growth (INE, 2011). This exposes the production of this crop to considerable risk in terms of climate variability, which contrasts with the fact that after sugar cane and bananas, maize is one of the main products in terms of volume.

A similar argument can be made of beans, which also depend entirely on rain water (INE, 2011). Beans cover a relevant portion of the Guatemalan diet, and it is interesting to see how canned legumes are increasingly used by households. This form of consumption of beans is ever more present in urban kitchens and it might represent a cultural shift that might increase the importance of industrial food processing in the food chain.

It is also important to note the sheer amount of land used by maize and beans; the staple crops of Guatemala. Even if there are no land quality considerations in the data (INE, 2011), the low yields of the lands used for these crops, coupled with lower levels of technical development and no irrigation provide an explanation to the considerable amounts of land used for their production.

We must recognize the share used by manufacturing industries at the national level. For example, in the case of maize, only 20% of all used volume had a final destination in manufacturing. This is consistent with the 80% (adjusted to extract the negative stock variation) that was consumed by households. It contrasts with the 99% of the supply of unprocessed rice and wheat that were used almost exclusively by the food processing industries (INE, 2011). This does not mean that households did not consume such products. It only means that they got them in their processed versions, such as precooked white rice and dehydrated breakfast gruel. For this very reason, the totality of sugar cane was used by the food processing industry (INE, 2011).

Aside from these exceptions, households did consume large volumes of cultivated products directly, which is consistent with the traditional market culture still present in most of the country. For example, they used 95% of beans, 88% of potatoes, 97% of other roots and tubers, 99% of fresh culinary herbs, 91% of other vegetables and 67% of all fruits, among others (INE, 2011).

These facts frame our simulations appropriately and they allow us to provide an intuition for the increases and decreases of the results.

1.2 Research questions and objectives

Because rural population has serious social disadvantages in terms of poverty and malnutrition, one on the main challenges of the economic policy is the creation of jobs in rural areas. With a long history of strong reliance of the Guatemalan economy in the agricultural sector and lack of creation of quality jobs, the policy questions are:

- What are the impacts of climate variability on food security, growth and employment?
- What can we expect from the share of contribution to GDP of the Agricultural industry given this variability?
- Will climate variability have an effect on water use according to the current base line?

2 Literature review

2.1 CGE models for food security analysis

According to a comprehensive report conducted in Guatemala by IARNA-URL, IICA, & McGill University (2015), food security issues are essentially multidimensional problem, where various elements carrying different impacts on food availability, access, and the ability to utilize and benefit from food. In that regard, computable general equilibrium models allow for the simultaneous evaluation of various aspects of the food security problem, such as food prices, income and expenditure, as well as economy-wide implications of food policies.

We understand food security as convened at the World Summit on Food Security (2009): "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The four pillars of food security are availability, access, utili[z]ation and stability. The nutritional dimension is integral to the concept of food security."

In a review, Saravia-Matus, Gomez, & Mary (2012) explain that the main economic problems regarding food security seem to be the under-nourishment of people in rural areas of low-income countries, due to lack of access to food, resources, and technology, on the one hand, and the volatility of food markets that threatens high-income countries, on the other. They explain that the scientific literature that addresses these problems from an economic perspective can be divided into studies that deal with increasing agricultural productivity by various means; those that discuss the macroeconomic analysis of price volatility, trade and market stability; and a cluster of studies that deal with the effects of demand for biofuels, farmland acquisition, and the food price crisis on small-scale farmers.

Food availability, thus, is only one piece of the puzzle. In the seminal work of Sen (1998) and follow up studies (Tomlinson 2011; and Smith et al., 2000), it is clear that the ability of people to buy food is the most relevant factor regarding the lack of food security, even in countries where food availability is not an issue.

Besides, any shock in water availability will have great implications for agricultural production and for food security, specially for countries with like Guatemala where production of some crops are heavily dependent on rainfall and water resources are facing several stresses in terms of quantity and quality. These pressures are related to human interventions like agriculture and land use change (Ponce et. Al., 2012). According to Ponce, et al (2012) CGE and water analysis at national scale had studied a broad type of issues like water pricing policy, water allocation, water markets and climate change impacts. Under different approach and scope of analysis, any shock in water availability will have great implications for agricultural production and for food security.

Despite food security is a big concern for Guatemala, local researchers had not used CGE models to analyze this situation. Most of the applications of CGE models for Guatemala have been few. Vasquez (2008) applied an integrated macro-micro model to analyze Millennium Development Goals -MDG[1] and Cabrera, et. Al (2010) implemented the Model of Exogenous Shocks and Economic and Social Protection - MACEPES-[2] to analyze impact of external shocks in poverty and inequality[3].

2.2 Regarding food security and agriculture

Low and middle-income countries have been under the spotlight due to the prevalence of food insecurity. As a result, there has been a global effort to reduce malnourishment as expressed by the MDG that were set to be achieved in 2015. By the end of that year, the United Nations Organization acknowledged that "the proportion of undernourished people in the developing regions has fallen by almost half since 1990, from 23.3 per cent in 1990–1992 to 12.9 per cent in 2014–2016" (United Nations, 2015).

However, the results differ widely by region and country. For instance, Latin America is one of the regions that reached the target of halving the proportion of people who suffer from hunger. Among the region, Nicaragua and Peru showed the greatest improvement, while Guatemala was the only country to show no progress on eradicating hunger (FAO, 2015). By 2015, Guatemala still had 15.6 per cent of its population living below minimum dietary levels (in 1991, this rate was 14.9 per cent according to the United Nations, 2016). Therefore, efforts to reduce hunger must continue.

There are several factors that are making Guatemala fall behind globally. For example, maize and beans, the staple crops behind the Guatemalan diet have shown low agricultural yields and absolutely no use of artificial irrigation (INE, 2011), influenced not only by the lack of technology among the small-scale farmers, but also because of adverse climate conditions[4]. At the same time, the country depends on the import of agricultural goods[5] which means that the country has recently experienced rising food import prices and exports that cannot keep up. For those reasons, Yu, You, & Fan (2010) consider it to be a low food-secure country.

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[1] The macro-micro model called MAMS (Maquette for simulation of the Millennium Development Goals -MDG-, described in detail in Lofgren et al., 2013). This study was developed under the Project "Políticas públicas para el desarrollo humano: ¿Cómo lograr los objetivos de desarrollo del milenio en América latina y el Caribe?" of UNDP, UN/DESA, The World Bank and UN/ECLAC, developed in 18 countries in Latin America.

[2] Thi study was developed under the Project "Implicaciones de la Política Macroeconómica, los Choques Externos, y los Sistemas de Protección Social en la Pobreza, la Desigualdad y la Vulnerabilidad en América Latina y el Caribe", coordinated by ECLAC and UN/DESA.

[3] Using a Macro-Micro approach, see Vos et al. (2010).

[4] Guatemala occupies the tenth position in the Global Climate Risk Index 2016, which means that it is one of the countries that has suffered the most from extreme weather events between 1995 and 2014 (Kreft, Eckstein, Dorsch, & Fischer, 2015).

[5] In 2010, the supply of wheat, rice and maize came from import flows (99.7%, 69.5% and 21.3% of total offer, respectively).

More recently, it has been argued that the most food-insecure countries "frequently have higher political stability risk and corruption levels, alongside weaker institutions that fail to provide appropriate government regulation and oversight" (Economist Intelligence Unit, 2014). Guatemala is one of the countries that falls into this description and this may undermine the capabilities to reach its food policies' objectives.

2.3 Food security under climate change and more dependence on technology

Conforti (2011) identifies some of main long term drivers of change in food systems that are relevant for the analysis of the Guatemalan case:

The demand of agricultural products will grow steadily: according to Alexandratos & Bruinsma (2012), the global demand for agricultural products is expected to grow at an annual rate of 1.1 per cent between 2005 and 2050. This growth is influenced by the increase of the global population, improvements of *per capita* income, and diet changes that include more livestock products. Altogether, these factors are expected to create pressure on natural resources, and according to the IFPRI IMPACT model, prices for maize, rice, and wheat would increase by 104, 79, and 88 per cent, respectively by 2050 (Rosegrant, et al., 2014).

A price increase on these vital products will impact countries like Guatemala, as the import shares of these products are high. In fact, from past events, Torero & Robles (2010) have estimated that a 10 per cent rise in food prices would increase the national poverty rate in 0.9 percentual points, affecting mainly urban households.

Climate change is expected to influence food security:

Scientists have largely explored the impact that climate change has on agriculture because "water-related hazards account for 90% of all natural hazards and their frequency and intensity is generally rising" (UNESCO, 2013). This means that spatial and temporal patterns of precipitation and water availability have been changing, and it implies more dry spells, droughts or floods across the world. Either of these events could have the following effects:

- Economic effects: the increasingly erratic rainfall and high temperatures, among other factors, can significantly reduce food availability in low-latitude countries (Porter, et al., 2014). In fact, Cline (2007) expects that agricultural productivity in Latin America will decrease between 13 to 24 per cent by the 2080s. Therefore, this implies, at a local level, that poor households that usually depend on agriculture would be more prone to lose a larger fraction of their assets and income. At a national level, countries in this region would progressively need to import food from other markets to meet their demand.

  In specific for Guatemala, under certain climate conditions forecasted by the Intergovernmental Panel on Climate Change, in 2030, the maize yields could vary between -6.7 and -3.8 per cent, those of the bean could vary from -6.9 to 1.5 per cent, and the rice yields could vary between -10.4 and -7.5 per cent (Comisión Económica para América Latina y El Caribe, 2013).

  Aditionally, Antle & Capalbo (2010) urge everyone to look beyond agriculture. They mention that the economic impact of climate change will not only affect agriculture but other economic activities as well. However, these potential impacts remain higly unexplored. They list potential issues related to "the effects of sea level rise on transportation infrastructure, changes in the design and location of storage facilities, …, the effects of regulatory policies on adaptive capacity of the food system", among others. As a result, strategies to cope with climate change should have a broader scope.

- Biological effects: according to FAO (2008) and Tirado, et al. (2010), some foodborne and waterborne pathogens and diseases (like cholera, mycotoxins and phycotoxins) are related to extreme weather events. This means that the variation of humidity, precipitation and temperature can have a real effect on food safety and human health. In specific, Hallegatte, et al. (2016) have highlighted that poor people and children are more likely to suffer diseases related to the influence of climate change on food quality.

- Governance effects: UNESCO-IHP, WMO & IAHS (2016) highlight that water governance is one of the main concerns for economic growth and development. As water scarcity will continue, competition for water use will rise and countries need to build a platform for the discussion and resolution of water-related conflicts (water rights, privatization, water pricing, etcetera). Otherwise, these conflicts will frustrate the efforts towards poverty reduction and food security.

In short, the impact of climate change on agriculture has been largely explored, and it can be seen that the effects range from economic to biological and governance issues. Altogether, it is clear that a country-level assessment on climate change issues should be done in order to set mitigation and adaptation measures.

The adoption of technology will be key for agricultural productivity: at a global level, there is enough food for everyone to be nourished (World Food Programme, 2011), as a result of technological progress. In the following years, the agricultural activity is expected to become more dependent on technology adoption due to the challenges derived from climate change (IFPRI, 2016).

There are several technology choices for agriculture. Some of them, in spite of increasing agricultural productivity, might have further implications on the use of water, the quality of land and energy resources (for example, genetic modification, pesticides, and fertilizers). However, Rosegrant, et al. (2014) simulated the results in food and water supply, demand, trade and prices over forty years for eleven selected technologies. The authors conclude that the following technologies would have the strongest price-reduction and yield impacts, considering the future weather conditions. These results should be assessed for each country's reality.

Table 1 - Technologies that would have the largest global effect on a price reduction and yield increase in 2050, by crop

	Maize	Rice	Wheat
Price reduction	-Heat tolerant varieties -No-till	-Nitrogen-use efficiency -Precision agriculture	-No-till -Heat tolerant varieties -Precision agriculture

Adapted from Rosegrant, et al. 2014.

From a four-pillar perspective, efforts for fighting hunger should not only focus on increasing food availability, but also on reducing food waste, assuring market competitiveness, and assuring the safety and quality of food.

3 Model and data

This section describes the Computable General Equilibrium Model applied for this study, which is an extension of PEP 1-1 Model. In addition, a brief description of the construction of the Social Accounting Matrix prepared for this work is included, which is discussed in detail in the annex 7.1.

3.1 Model

In this study, we apply the PEP 1-1 Model with extensions made by Cicowiez and Banerjee (forthcoming) that include specification of closures, number of employees by economic activity, definition of simulations of shocks and policy scenarios, and the introduction of water as a resource. Closure specification includes option to specify mobile capital or sector specific; clearing variable in government closure could be endogenous government savings, endogenous government consumption, endogenous direct tax on households or endogenous indirect tax on commodities; closure of rest of the world could be by real exchange rate adjustment or foreign savings; and savings-investment closure could be using fixed or flexible investment. To take into consideration different remunerations of labor by economic activity, this extension includes the numbers of workers, to calculate a factor of wage differences across all industries. Also, in this version was included an excel file to simulate different shocks or policy scenarios, like increase in labor supply, changes in world price of exports and imports, change in capital stock, changes in government consumption, decrease in taxes, subsidies on capital, decrease in margins and changes in total factor productivity. Finally, this extension of the model includes water as an economic factor which price is zero if supply is greater than demand, but in the opposite scenario, the model estimates a price for this scarce natural resource, simulating the existence of market of water or internalizing the cost of provide water to economic activities.

It is important to explain what kind of macroeconomic closures we chose for this analysis. For exports demand, we assume that Guatemala is a small country or price taker in international markets, and the external sector closure we suppose that we have limits to international finance and the adjustment hast to be done via real exchange rate. We also assumed that capital is mobile. Government will adjust its consumption to maintain a level of savings, to incorporate costs of fiscal revenues reduction, in a scenario where it is very difficult to pass a tax reform. Finally, we assume that real investment is fixed and savings have to be adjusted to maintain the same level of real gross fixed capital formation.

Elasticities of consumption were estimated using micro-data of LSMS 2011. We use elasticities of production close to those provided by the model and for value added we use those for GTAP (Narayan, Badri, Aguiar & McDougall, 2012). Finally, for Armington and CET elasticities we use estimations for similar economies to Guatemala, like Ecuador, Mexico and Filipinas, that were compiled by Annabi, Cockburn & Decaluwé (2006).

3.2 Data

The SAM used in this study was constructed using three sources of information: SAM 2011 (Escobar, 2015), Supply and Use Tables (SUT) from the Central Bank of Guatemala (BANGUAT) for the year 2011, the relative structure of remunerations of capital and land found on the GTAP model, and the Life Standards Measurement Survey (Encovi in Spanish) from the year 2011 (INE, 2011).[6]

First, we compiled a Macro SAM, rearranging information from SAM 2011 into an aggregated format derived from an analytical perspective of the System of Environmental and Economic Accounts for Agriculture, Forestry, and Fisheries, which has a strong emphasis on food security issues. Second, we disaggregated the labor factor using information from the Household Survey. Next, we used data from GTAP to split the capital factor between capital and land. Since it was necessary to have a specific remuneration for the land factor, we used the relative structure from GTAP. Fourth, we rearranged the SUT information in order to disaggregate activities in SAM. Fifth, using household survey estimates we opened household information. Finally, we opened information for commodities.

The first step was to construct a Macro SAM using information from Escobar's SAM for 2011. Also, we identified accounts that could be disaggregated using supply and use tables from BANGUAT.

Table 2 - Macro SAM (in millions of Quetzales)

		L	K	AG	AG	AG	AG	AG	AG	AG	AG	J	I	OTH	OTH	TOTAL
		LAB	CAP	HH	GVT	ROW	TACT	TI	TM	TD	TFAC	A	C	INV	VSTK	
L	LAB					871						191,640				192,511
K	CAP					502						153,756				154,259
AG	HH	181,584	142,856		11,993	34,805										371,237
AG	GVT		50	2,721		2,200	2,261	20,829	2,524	13,199	10,846					54,630
AG	ROW	82	11,353	262	97								138,605			150,399
AG	TACT											2,261				2,261
AG	TI												20,829			20,829
AG	TM												2,524			2,524
AG	TD			13,199												13,199
AG	TFAC	10,846														10,846
J	A												594,170			594,170
I	C			316,528	37,803	98,783						246,512		54,910	1,592	756,129
OTH	INV			38,526	4,738	13,238										56,502
OTH	VSTK													1,592		1,592
TOTAL		192,511	154,259	371,237	54,630	150,399	2,261	20,829	2,524	13,199	10,846	594,170	756,129	56,502	1,592	

Source: own construction.

Then we disaggregated the labor factor between skilled (L-SKL) and unskilled (L-UNS)[7] labor. We applied the GTAP relative structure on remunerations for Capital, Land and Natural Resources[8]. Furthermore, we split gross operating surplus by activity[9]. Based on information from a processed SUT[10], we proceeded to divide remunerations of labor, production, and intermediate consumption by activity. Because we don't have disaggregation of transfers (non-tax) from activities to government and taxes on activities, we estimated those as a residual.

The SAM includes three types of agents, households, government and rest of the world. The PEP 1-1 model includes a set for "enterprises", but since we did not have access to information on transfers between enterprises and different type of households, we chose not to include them.

[6] See annex 7.1 for detail of the construction of the SAM.
[7] Skilled workers are those with 9 years of schooling or more.
[8] Narayanan, G., Badri, Angel Aguiar and Robert McDougall (2012)..
[9] See activities included in SAM in annex 7.1 table 13
[10] We collapsed activites from SUT from BANGUAT (2014) to create an Ad-hoc SUT.

Using the Living Standards Measurement Survey, we split the accounts to match our household structure. In this exercise we classified them in four types: rural poor, rural non-poor, urban poor, and urban non-poor. Poverty was determined using the official poverty line of 2011[11] and, using information from the household survey, we were able to estimate labor income, consumption and most transfers[12] according to each type of household.

Savings were estimated as a residual from factor income, as well as transfers from government and the rest of the world, minus transfers to Government, and transfers to the rest of the world and consumption. Using the processed SUT we included in the SAM all exports by commodity, intermediate consumption, supply, investment, and margins of trade and transport. To close the SAM, we estimated residually the change in inventories of two activities (beverages and other industries).

[11] See Living Standards Measurement Survey, INE (2011).
[12] Transfers from Government and Rest of the world

4 Application and results

4.1 Guatemala's economic structure

The Social Accounting Matrix allows us to describe how the Guatemalan economy is structured. We consider that this description is important to understand the impact of the various shocks that we have conducted in this study.

4.1.1 Main productive sectors

Services create more value added than other economic activities, with 65.1% of the total. Industry constitutes 20% of the remaining value added, out of which over 50% is related to the food processing industry. Agriculture activities, animal production, forestry and fishing account for 11.9% of the added value, of that percentage, the majority is represented by agriculture, with 8.7%. Activities under "other primary activities[13]" represent 3.0% of the total value added.

Table 3 - Added value per sector (millions of Quetzales and percentage)

Sectors	VA	%
Agriculture	29,906.3	8.7
Animal production	7,268.9	2.1
Forestry and fishing	3,831.4	1.1
Other primary activities	10,505.5	3.0
Food and beverage products	36,714.7	10.6
Other manufacturing industries	32,190.9	9.3
Services	224,979.1	65.1
Total	345,396.8	100.0

Source: Social Accounting Matrix for Guatemala, 2011.

4.1.2 Activities focused on the external sector

Most of the exports are food products (36.1%), other industries at 15.4%, and other forestry products with 9.9% of the exports. On the agricultural side, coffee and bananas are 9.2% and 3.7% of the exports, followed by vegetables at 3.8% and fruits at 1.8%. The export percentage column in Table 4 below shows that 68% of the coffee is exported, and that number is 40.2% for bananas, 79% for other animal products, 65.8% for prepared or preserved fish, 56% for preparation used in animal feeding, and 55.9% for food products.

On the imports side, the "Other Industries" category accounts for 80.2%, and "Other Services" accounts for 6.3%. Agricultural products account for less than 5%, with maize at 1.3%. Most of national consumption of cereals, at 67.8%, is imported. The "Other Industries" category shows 50.5% is imported, and 43.2% is imported for animal and vegetable oils and fats. Due to the importance of maize in the Guatemalan diet, it's important to emphasize that 15.2% of the national consumption is imported.

[13] Other primary activities include extractive industries like mining and oil extraction.

Table 4 - Exports and imports by commodity (in percentage)

Commodities	Exports	% Export production	Imports	% Imports
Coffee	9.2	68.0	0.0	0.0
Bananas	3.7	40.2	0.0	0.1
Maize	0.1	0.2	1.3	15.2
Beans	0.0	0.2	0.1	2.7
Cereal and legumes	0.0	0.2	1.2	67.8
Roots and tuberous vegetables	0.1	0.7	0.0	0.5
Other vegetables	3.8	8.1	0.0	0.3
Other fruits	1.8	16.0	0.3	6.5
Living plants	1.2	13.7	0.7	11.9
Milk	0.0	0.3	0.0	0.0
Eggs	0.0	0.7	0.0	1.1
Other animal products	3.4	79.0	0.0	0.0
Firewood	0.6	10.2	0.0	0.0
Other forestry and logging products	9.9	42.5	0.2	1.1
Fish and fishery products	0.4	23.1	0.1	10.9
Other minerals	0.3	4.8	0.7	23.5
Meat and meat products	0.8	3.7	0.7	5.5
Prepared or preserved fish	2.7	65.8	0.2	9.5
Prepared and preserved vegetables	0.3	11.7	0.6	31.9
Animal and vegetable oils and fats	0.3	4.3	1.9	43.2
Grain mill products	0.6	2.8	0.8	7.1
Preparation used in animal feeding	5.5	56.0	0.2	4.1
Bakery products	0.2	0.6	0.5	2.5
Sugar	0.1	1.0	0.0	0.1
Noodles and similar farinaceous products	2.1	43.5	0.1	2.6
Dairy products	0.9	6.9	0.8	11.8
Food products n.e.c.	36.1	55.9	2.2	6.6
Alcoholic and non-alcoholic beverages	0.2	4.0	0.3	8.7
Other industries	15.4	6.9	80.2	50.5
Water and electricity	0.0	0.0	0.4	3.9
Lodging	0.0	0.0	0.0	0.0
Other services	0.0	0.0	6.3	2.7

Source: Social Accounting Matrix for Guatemala, 2011.

4.1.3 Employment structure and earnings

Table 5 shows that 55.5% of the value added is allocated to labor (29.1% skilled and 26.4% unskilled), 41.9% to capital, 2% to land and 0.6% to natural resources. When looking at the details, over 58% of the participation across agriculture, animal products and forestry and fishing activities is unskilled labor, followed to a much smaller degree by capital and land. For other primary activities, the participation of capital represents 48.7% of added value, unskilled labor, 25.2%, natural resources, 19% and skilled labor, less than 10%.

On the food industry sector, the majority of the added value is allocated to skilled labor, at 37.4%, with capital following closely at 35.5%, and lastly by unskilled labor at 27%. On other services sector, capital is the largest percentage of the added value at 47%, followed by skilled labor at 33.7% and unskilled labor at 19.4%.

Table 5 - Factorial composition of value added (percentage)

Sectors	Labor		Capital	Land	Natural resources	Total
	Skilled	Unskilled				
Agriculture	6.8	61.7	14.9	16.6	0.0	100
Animal production	6.5	59.4	16.1	18.0	0.0	100
Forestry and fishing	6.8	58.9	16.2	18.2	0.0	100
Other primary activities	7.1	25.2	48.7	0.0	19.0	100
Food industry	37.4	27.0	35.5	0.0	0.0	100
Other manufacturing industries	23.4	30.8	45.8	0.0	0.0	100
Other services	33.7	19.4	47.0	0.0	0.0	100
Total	29.1	26.4	41.9	2.0	0.6	100

Source: Social Accounting Matrix for Guatemala, 2011.

4.1.4 Household income

Non-poor households in urban areas account for 71.1% of the total income, while non-poor households in rural areas account for 11.6%. The remaining 17.3% of the total income is accounted by poor households, 9.8% in rural areas and 7.5% in urban areas.

Table 6 shows the distribution of income for each household group. It is important to highlight that most of the labor income of skilled workers corresponds to non-poor households in urban areas (83.4%), and very little corresponds to non-poor rural households (9.0%). However, it can be seen that unskilled labor is distributed across all household groups, especially non-poor urban ones.

For the capital income category, 95.3% corresponds to non-poor urban households, 3.4% to poor urban households, and less than 2% to households in rural areas. More than 50% of land income corresponds to non-poor households, 48.3% to rural areas and 2.7% to urban areas, while the remaining 49% is distributed across poor households, in very similar proportion. For natural resources, 72.1% corresponds to non-poor households in urban areas and 13% to non-poor households in rural areas. Almost 15% of the remaining corresponds to poor households.

Table 6 - Distribution of income for each household group (percentage)

Household group	**Labor**		**Capital**	**Land**	**Natural resources**
	Skilled	**Unskilled**			
Urban poor	4.9	15.6	3.4	25.0	8.8
Rural poor	2.7	26.9	0.2	24.0	6.1
Urban non-poor	83.4	36.9	95.3	2.7	72.1
Rural non-poor	9.0	20.6	1.2	48.3	13.0
Total	100.0	100.0	100.0	100.0	100.0

Source: Social Accounting Matrix for Guatemala, 2011.

Table 7 shows income composition for each household group. For poor households in urban areas, 47.9% of their income corresponds to unskilled labor, followed in similar proportion by skilled labor (16.9%) and capital (16.2%). Transfers from the rest of the world accounted for 8.1% of their income.

For poor households in rural areas, unskilled labor income represents the highest proportion of their income (63.4%), followed by transfers from the rest of the world (15.8%) and government transfers (8.2%). For non-poor rural households, labor income accounted for 61% of revenues, 41% for unskilled and 20% for skilled labor. For this group of households, transfers from the rest of the world represent just under a quarter of their income.

For non-poor households living in urban areas, capital income represents almost half their income, and in less proportion, labor income accounts for 42.3%, as well as 30.3% for skilled labor and 12% for unskilled workers. Transfers from the rest of the world accounted for 6.3% of their income, and government transfers, for 2.5%.

It is important to note that although government transfers and transfers from the rest of the world represent a smaller proportion of the income of non-poor urban households, in absolute terms income is higher in this group of households.

Table 7 - Income composition for each household group (Percentage)

Household group	Labor		Capital	Land	Natural resources	Government transfers	Transfers RoW
	Skilled	Unskilled					
Urban poor	16.9	47.9	16.2	6.3	0.6	4.0	8.1
Rural poor	7.0	63.4	0.6	4.6	0.3	8.2	15.8
Urban non-poor	30.3	12.0	48.3	0.1	0.5	2.5	6.3
Rural non-poor	20.0	41.0	3.7	7.8	0.6	3.2	23.6

Source: Social Accounting Matrix for Guatemala, 2011.

4.1.5 Household consumption

Non-poor households from urban areas accounts for 59.5% of national consumption, and non-poor rural households, just under a fifth (18.1%). While consumption of poor households accounts for 22.4% of domestic consumption, 7.8% for households in urban areas and 14.6% in rural areas (see table 19 in annex 7.2).

It appears that for poor households, food accounts for the largest share of consumption, mainly for poor rural households, food accounts for 62.1% of its consumption. In the table we can see that for these poor rural households, beans and corn account for more than 10% of its consumption.

For non-poor households, the proportion of food consumption is lower, specifically for non-poor households in urban areas, where it represents less than a third (31.1%) of total consumption. For this same group, services account for 44.8% of consumption. It is important to note that, although for non-poor households in urban areas the proportion of consumption in corn and beans is less than for poor rural households, 3% compared to 11.5%, in absolute terms, the consumption of corn and bean in non-poor households in urban areas is higher than in poor rural households.

4.2 Results from simulations

In this section we present the results from simulating a) a reduction in productivity due to climate change; and b) the effects of drought in agriculture.[14]

In second scenario, we take into consideration likely effects of climate change in grains. This effect could be caused by changes in mean temperature, variability of climate and extreme events, water availability, mean sea-level rise, pest and diseases (Gornall, et.al., 2010). There is no consensus about clear effects on agriculture on Guatemala, but we assume a negative scenario according to ECLAC, in one scenario of climate change, production of grains in year 2020 could be reduced around 8% in maize, beans and wheat. So, we estimate a scenario where total factor productivity of agriculture for food and agriculture for seed drops around 8%.

A specific scenario of environmental shock is when a drought occurred. Using information of water consumption by economic activity, we estimate likely effects of a drought that reduce in 25% the stock of water. Because information about total supply of water are not available in Guatemala, we assume that total demand is close to 90% of total supply. We also don't know what will be the exact or approximate change in price of water, because Guatemala does not have a market of this natural resource. However, the results give us an idea of likely effects of droughts in economic activity.

4.2.1 Reduction in productivity due to climate change

As we mentioned before, climate change could have negative effects in agriculture productivity. Under this scenario we estimate negative results in production, exports, wages and reduction of government spending and revenue. Besides negative effects of food security due to the diminished production and consumption of agricultural goods, our figures show that the effects of climate change could increase inequality, because the wages of unskilled labor would see a reduction as a result of an increase of capital income and skilled labor wages.

In this case, we registered an important drop in the value added of agriculture an animal production as well as a slight drop in that of industrial food production and the service industry. It is important to take into consideration that in this scenario we observed a fall in real GDP (1.2%), as can be seen in Table 8. Those products that are oriented to international markets saw a decrease, because goods like maize, bean, root and tuberous vegetables have a lower fall rate compared with coffee, bananas and fruits. This could be explained with the fact that lower productivity would translate into less competitiveness in international markets. Exports in real terms fell by 2.1%, but also we observed a decrease in imports of 1.5% in real terms. It is important to note that a depreciation of the real exchange rate contributed to the reduction of the negative impacts on external sectors. Another problem that we could see with reduction of productivity is that fiscal space was reduced. As an effect, government expenditure had to be reduced in view of lower tax revenues. There was also less income of households and less consumption.

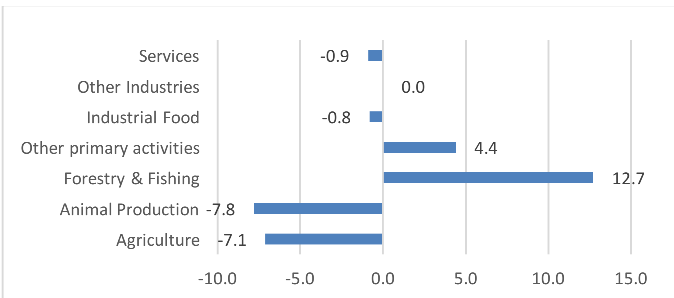
[14] The sensitivity results are included in annex 7.3.

Table 8 - GDP table (% change)

	Real	GDP share
Absorption	-1.1	0.2
Private Consumption	-1.4	0.2
Fixed Investment	0.0	0.8
Stock Change		2.1
Government Consumption	-0.5	-0.3
Exports	-2.1	0.5
Imports	-1.5	1.1
GDPMP	-1.2	0.0
NetIndTax		0.1
GDPFC	-1.2	0.0

Source: own calculations based on PEP 1-1 Model

Figure 1 - Aggregate output by industry in scenario of decrease of TFP (% change)



Source: own calculations based on PEP 1-1 Model

Due to higher prices and lower income of households, lower productivity translates into a drop in consumption of agricultural goods for each type of household. The exception was Maize, because its consumption only fell in rural areas. However, this result could affect food security of the most vulnerable population of Guatemala. Beans, which are also important for the Guatemalan diet, showed a decrease in consumption for all types of households. This behavior is not only the result of higher prices, but also of because of a decrease in household incomes for all categories; especially the urban non-poor (1.8%). This could be expected because a drop in productivity could affect wages negatively, and more so for skilled labor.

Table 9 - Agricultural goods: Price and consumption by household type (% change)

	Cofee	*Bananas*	*Maize*	*Beans*	*Cereals*	*Roots & Tubers*	*Vegetables*	*Fruits*	*Processed food*	*Others*
Price	4.0	9.2	5.4	6.3	7.3	5.2	3.3	4.6	0.7	-0.1
Consumption by type of household										
Urban Poor	-1.5	-2.1	0.0	-0.8	-1.5	-1.9	-1.9	-1.8	-1.2	-1.3
Rural Poor	-1.2	-1.8	-1.0	-1.1	-1.6	-1.9	-1.7	-1.5	-0.8	-1.1
Urban Non Poor	-2.0	-2.9	0.0	-1.1	-2.1	-2.7	-2.6	-2.6	-1.6	-1.8
Urban Poor	-0.9	-1.7	-0.7	-0.9	-0.9	-1.5	-1.2	-1.1	-0.2	-0.2

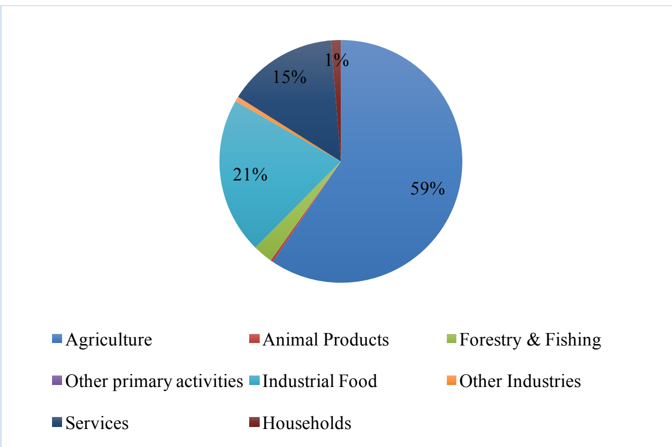
Source: own calculations based on PEP 1-1 Model

We observed a deterioration of the external sector. First, we identified a sharp drop in exports, especially in cereals, maize, fruits, vegetables, coffee and banana. Because local prices were higher, some of them were replaced by imports, like maize and banana. This situation, however, was moderated by a depreciation of the real exchange rate, in order to sustain the same level of deficit in the current account.

4.2.2 Effects of drought on agriculture

This version of PEP 1-1 Model contains an extension made by Cicowiez and Banerjee (forthcoming) to analyze effects of shortage of supply of water or drought. We analyze the effects on agricultural industries. In this scenario, agricultural sectors, which use this resource more intensely, were the most affected. Due to the fact that the use of water is concentrated in agriculture and forestry and fishing (see next figure), most negative effects are concentrated in these industries. In contrast, other economic activities that did not use water as an important input would not be affected. Another important effect was the climb in food prices, the reduction of wages of unskilled labor, and the reduction of income for rural households.

Figure 2 - Water use by industry (% total)



Source: own calculations based SEEA (INE, Banguat & Iarna-URL, 2013)
Note: includes use of registered and unregistered water.

There was a drop in private consumption, both in real as well as nominal terms in this scenario. This was closely linked to the reduction in disposable income of the urban non-poor households; a group responsible for more than 70% of total household consumption. And although labor income saw a reduction in all kinds of households, it fell only 5.3% for the urban non-poor, in contrast to more than 10% for the other categories.

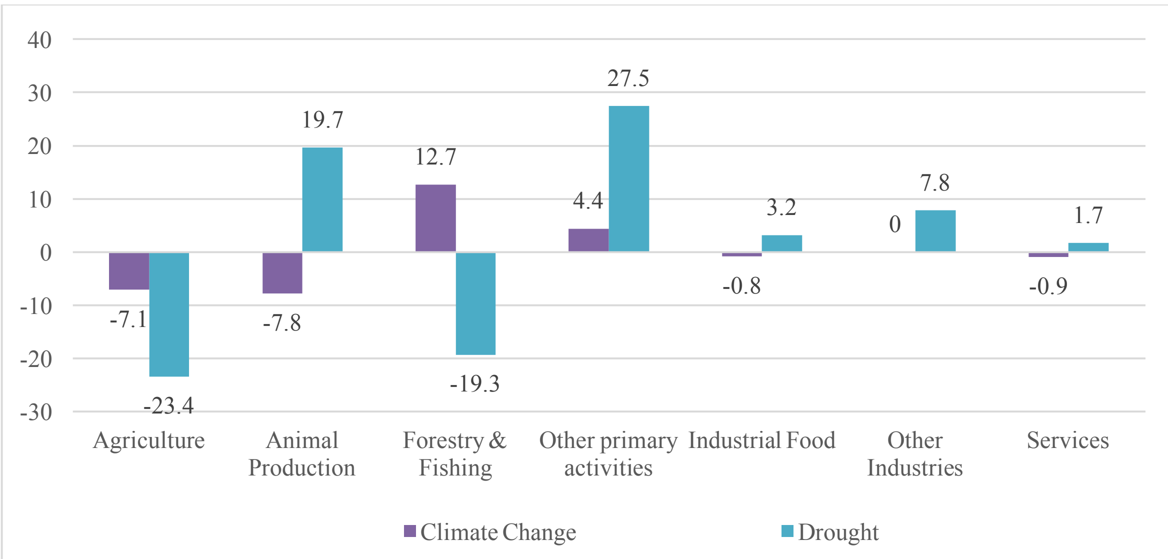
Table 10 - GDP table (% change)

	Real	*GDP share*
Absorption	0.5	0.4
Private Consumption	-0.2	0.9
Fixed Investment	0.0	-3.0
Stock Change	0.0	
Government Consumption	6.7	0.9
Exports	0.3	5.7
Imports	-0.2	5.3
GDPMP	0.6	0.0
NetIndTax	0.0	
GDPFC	1.2	-6.5

Source: own calculations based on PEP 1-1 Model.

Compared to previous scenarios, we observed larger effects of drought in agriculture and Forestry and fishing (see next figure). However, although water is an important input for agriculture, due to low intensity of use, drought could have been beneficial to this sector, because production from agriculture could migrate to these activities. Also, value added of forestry and fishing would have risen, because the use of water of this sector is lower than agriculture. This sector, however, is not important in total value added share and in total employment. Industries and services would not be affected by this shock.

Figure 3 - Change in value added by sector, by simulation scenario



Source: own calculations based on PEP 1-1 Model and extensions based on Cicowiez and Banerjee (forthcoming)

In drought scenario we would observe a sharp increase in prices of agriculture, especially for bananas, roots and tubers, and beans. This situation could happen because a small share of these products are imported and have a low degree of substitution between local and imported goods. In this scenario we observe an important increase in imports, GDP share increases from 37.4 to 39.3%. This is a result of higher prices of domestically produced goods and a sharp depreciation of real exchange rate (7.5%).

Depreciation of real exchange rate is the result of an important increase in the current account deficit, due to a displacement of purchases from local to imported goods. In this situation, depreciation helped contain increased demand for imports, and improved the performance of exports for products other than agriculture for seed and other agriculture (processed foods and services).

Table 11 - Exports and imports by product (% change)

	Coffee	Bananas	Maize	Beans	Cereals	Roots & Tubers	Vegetables	Fruits	Other agriculture products	Mining	Meat	Industrial foods	Other industrial products	Services
Import	24.6	52.6	54.7	13.7	8.8	32.1	6.7	22.8	10.8	3.0	3.5	3.3	1.6	3.5
Exports	-54.6	-48.8	-66.7	0.0	0.0	-66.7	-75.7	-75.3	-6.4	32.7	-4.3	12.3	13.7	12.1

Source: own calculations based on PEP 1-1 Model and extensions by Cicowiez and Banerjee (forthcoming)

5 Lessons learned, innovations and policy implications

Hitherto, there are various studies that have estimated the effects of climate change on the economy, and many of them show the aggregated results by geographical region. Therefore, we were particularly interested in explaining the impact within the Guatemalan economy. The timing of this report could not be better as the country is resuming its development planning actions in spite of the recent wave of political turmoil[15].

Even though the long term development plan was presented in 2014, policy makers need evidence-based research to fill the information gaps in order to implement it. For example, there is consensus that climate change is an imminent risk for the countries development, but there were few insights to anticipate the impact of these weather events.

Guatemala is one of the few countries in the world that has an updated System of Environmental and Economic Accounts. However, there are not so many studies that take advantage of this information to translate into policy recommendations. For that reason, this is one of the first studies to use this data – together with that from the System of National Accounts from the Central Bank– to inform policy actions towards the mitigation and adaptation to climate change.

As it is known, low latitude countries, like Guatemala, are prone to face warmer temperatures in the future decades. Several scientists have projected by how much temperature will rise and this translates into hotter and more frequent hot days in the countries located in those regions. However, rather than explaining how temperature will vary, policy makers need information to acknowledge the effects of dry spells.

As a result, we were willing to explore the impact that droughts –expressed by a reduction of water stocks– would have in growth, remunerations and food security. One of the findings refers to the decline on the value added created by agriculture (value added would decrease by 23%). As expected, this situation negatively affected the wages paid to unskilled workers, but also urban non-poor households would saw a reduction of their disposable income due to higher food prices. Thus, there is no segment of society that would not be affected.

Moreover, one of the most interesting results is that the demand for land would fall down by 38 per cent. This is because as water would become more scarce, there would be fewer incentives to engage in agricultural activities. However, due to the importance of agricultural production for ensuring food security, this results show that a proper water allocation system is needed.

Guatemala cannot postpone the creation of a legal framework to govern water resources. For that, we could consider the experience of Australia that have historically suffered megadroughts so this country has reformed its water allocation system. At first, an agreement between the federal and state governments was reached (National Water Initiative, 2004) to create a national water market. The idea behind this allocation system is that “water entitlements are expressed as a share of the available resource rather than as a specified quantity of water” (Peel & Choy, 2014).

In short, despite of the existence of an National Irrigation Policy in Guatemala, the framework is incomplete since there is not a water allocation system that prioritizes strategic economic activities to guarantee food security.

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The other simulation that was applied is also related to climate change, but we were more specific. We simulated a reduction in agricultural productivity, and one of the main results refer to the sharp drop in exports, especially in cereals, maize, fruits, vegetables, coffee and banana. This means that the country would be less competitive to sell agricultural products overseas. This would have large implications on pursuing an export-led growth strategy.

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7 Annex

7.1 Constructing of the Social Accounting Matrix for Guatemala

7.1.1 Sources of Information

The SAM was constructed using three sources of information: SAM 2011 (Escobar, 2015), Supply and Use Tables (SUT) from the Central Bank of Guatemala for the year 2011, the relative structure of remunerations of capital and land found on the GTAP model, and the Life Standards Measurement Survey (Encovi) from the year 2011 (INE, 2012). Since the SAM for year 2011 (Escobar, 2015 that we had as a starting point does not conform to the requirements of the PEP 1-1 model and also does not have the necessary degree of disaggregation of activities, commodities and households to analyze impacts of agricultural incentive policies on socioeconomic and environmental variables in Guatemala, the National Accounts' SUT for the year 2011 were used to disaggregate agricultural activities and commodities, as well as activities with high demand of water. In order to estimate the relative structure of factor remunerations by activity, transfers to households, and consumption by household, the household survey was used to derive standard coefficients.

7.1.2 Constructing the national social accounting matrix

Six steps were taken for the construction of a suitable SAM Guatemala 2011 for this study. First, we compiled a Macro SAM, rearranging information from SAM 2011 into an aggregated format derived from an analytical perspective of the System of Environmental and Economic Accounts for Agriculture, Forestry, and fisheries, which has a strong emphasis on food security issues. Second, we disaggregated the labor factor using information from the Household Survey. Next, we used data from GTAP to split the capital factor between capital and land. Since it was necessary to have a specific remuneration for the land factor, we used the relative structure from GTAP. Fourth, we rearranged the SUT information in order to disaggregate activities in SAM. Fifth, using household survey estimates we opened household information. Finally, we opened information for commodities.

The first step was to construct a Macro SAM using information from Escobar's SAM (2011). Also, we identified accounts that could be disaggregated using supply and use tables from the central bank of Guatemala (BANGUAT).

Table 12 - Macro SAM

		L	K	AG	AG	AG	AG	AG	AG	AG	AG	J	I	OTH	OTH	TOTAL
		LAB	CAP	HH	GVT	ROW	TACT	TI	TM	TD	TFAC	A	C	INV	VSTK	
L	LAB					871						191,640				192,511
K	CAP					502						153,756				154,259
AG	HH	181,584	142,856		11,993	34,805										371,237
AG	GVT		50	2,721		2,200	2,261	20,829	2,524	13,199	10,846					54,630
AG	ROW	82	11,353	262	97								138,605			150,399
AG	TACT											2,261				2,261
AG	TI												20,829			20,829
AG	TM												2,524			2,524
AG	TD			13,199												13,199
AG	TFAC	10,846														10,846
J	A												594,170			594,170
I	C			316,528	37,803	98,783						246,512		54,910	1,592	756,129
OTH	INV			38,526	4,738	13,238										56,502
OTH	VSTK													1,592		1,592
TOTAL		192,511	154,259	371,237	54,630	150,399	2,261	20,829	2,524	13,199	10,846	594,170	756,129	56,502	1,592	

Source: Own construction.

Then we disaggregated the labor factor between skilled (L-SKL) and unskilled (L-UNS)[16] labor. Because Escobar's SAM has four different labor factors (wage skilled, non-wages skilled, wage unskilled, non-wag) we used the relative structure to estimate L-SKL and L-UNS.

We applied the G-TAP relative structure on remunerations for Capital, Land and Natural Resources[17]. Furthermore, we split gross operating surplus by activity. Based on information from a processed SUT[18], we proceeded to divide remunerations of labor, production, and intermediate consumption by activity. Because we don't have disaggregation of transfers (non-tax) from activities to government and taxes on activities, we estimated those as a residual.

The SAM includes three types of agents, households, government and rest of the world. The PEP 1-1 model includes a set for "enterprises", but since we did not have access to information on transfers between enterprises and different type of households, we chose not to include them.

Using the Life Standards Household Survey, we split the accounts to match our household structure. In this exercise we have four types of households: rural poor, rural non-poor, urban poor and urban non-poor. Poverty was determined using the official poverty line of 2011[19] and, using information from the household survey, we were able to estimate labor income, consumption and most transfers[20] according to type of household. Savings were estimated as a residual from factor income, as well as transfers from government and the rest of the world, minus transfers to Government, and transfers to the rest of the world and consumption.

Finally, using data from the household survey we created a split by commodity accounts. These accounts include consumption by household. Using the processed SUT we included in the SAM all exports by commodity, intermediate consumption, supply, investment, and margins of trade and transport. To close the SAM, we estimated residually the change in inventories from two activities (beverages and other industries).

7.1.3 Activities and Commodity aggregations of Supply and Use tables

In order to improve the analytical potential of the SAM, we turned to the recently drafted manual for the System of Environmental and Economic Accounts for Agriculture, Forestry, and Fisheries (FAO, n/d), which has a strong emphasis on food security issues. The logic behind the aggregation of economic sectors and commodities proposed by the manual implies that there are some crops that are used by some industries mainly for animal feed and other industries as seed. Some manufacturing industries then use agricultural products as inputs in the production of food for humans and animals. Some of these are used by food services, such as hotels, restaurants and bars as their own inputs, and other are consumed directly by households (or final demand in general). Hence, it seemed appropriate to aggregate our industries in categories which reflected that consumption process, because our study seeks to explore food security issues. It might seem unintuitive to group output activities according to their intermediate use of commodities, rather than their object of production, but in this manner the food security implications of policies are easier to track.

The table below describes the aggregation, which is detailed for 123 activities and 226 products, as well as transactions necessary in order to bring producer's prices to market prices. This re-aggregation

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[16] Skilled workers are those with 9 years of schooling or more.
[17] Narayanan, G., Badri, Angel Aguiar and Robert McDougall (2012).
[18] Using an R script we collapsed activites from SUT from Banguat (2014) to create an Ad-hoc SUT.
[19] See Living Standards Measurement Survey, INE (2011).
[20] Transfers from Government and Rest of the world

allowed for the creation of an ad-hoc supply and use table for this study, which is available upon request.

Table 13 – Commodity and Economic Activity Aggregation for the Micro SAM

Industries and Transactions	**Commodities**
T01A01 Agriculture	R01 Coffee
T01A02 Animal products	R02 Bananas
T01A03 Forestry and fishing	R03 Maize
T01A04 Other primary activities	R04 Beans
T01A05 Food industry	R05 Cereals and legumes
T01A06 Other manufacturing industries	R06 Roots and tubers
T01A07 Water distribution	R07 Vegetables
T01A08 Other services	R08 Fruits
T02A09 Imports of goods	R09 Other crops, live plants, flowers and their seeds
T03A09 Imports of services	R10 Milk
T04A09 CIF/FOB adjustment on imports	R11 Eggs
T05A09 VAT	R12 Other animal products including live animals
T06A09 Tariffs exc. VAT on imports	R13 Fuel wood
T07A09 Taxes on products, exc. VAT and Tariffs	R14 Other forestry products
T08A09 Subsidies on products	R15 Fish and other fisheries products
T09A09 Trade margins	R16 Minerals
T10A09 Transportation margins	R17 Meat products
T11A09 Electricity, gas, water	R18 Prepared or canned fish
T12A09 Exports of goods	R19 Canned legumes
T13A09 Exports of services	R20 Animal and vegetal oils and fats
T14A09 Household final consumption	R21 Mill products
T15A09 NFPI final consumption	R22 Animal foods
T16A09 Individual gov final consumption	R23 Bakery products
T17A09 Collective gov final consumption	R24 Sugars
T18A09 Gross capital formation	R25 Macaroons and noodles
T19A09 Stock variation	R26 Dairy products
T20A09 Valuable objects	R27 Other food products
	R28 Beverages
	R29 Other manufactured products
	R30 Electricity, gas, and water
	R31 Lodging, food service
	R32 Other wholesale, retail, and services

Source : Author with information from BANGUAT (2011).

7.1.4 Labor disaggregation

Labor disaggregation was developed with information from the Life Standards Measurement Survey (ENCOVI) from the year 2011. The labor factor is disaggregated in two categories, skilled and unskilled employees. Skilled workers are those with 9 years of schooling or more.

Labor income was calculated from the sum of the monetary and non-monetary earnings. Monetary income contains the entry of the first and second employment of a salaried worker (government employee, private employee, laborer or pawn and domestic employee) and those from independent workers (employer and self-employed).

Next table presents the relative structure of revenues by sector and level of qualifications. The sectors included in the table correspond to the activities of the SAM. In general, it can be seen that 52.8% of revenues correspond to skilled workers. However, by activity the proportions are different. For activities related to agricultural production, both for seed and for food, 90.1% of incomes corresponds to unskilled workers and 9.9% to skilled workers. For this outcome, it is important to note that over 90% of the population engaged in agricultural production, is unskilled.

Table 14 - Participation in activities income by skill level (percentage)

Activities	Skilled	Unskilled
Total	**52.8**	**47.2**
Agriculture	9.9	90.1
Animal products	9.9	90.1
Forestry and fishing	10.3	89.7
Other primary activities	21.9	78.1
Food industry	58.0	42.0
Other manufacturing industries	43.2	56.8
Water distribution	57.1	42.9
Other services	63.5	36.5

Source: with information from Encovi 2011.

For activities related to industry and services, the proportions of earnings for skilled and unskilled employees is different. For the food industry, 58% of income is for skilled employees, while for other industries the proportion of skilled income is less (43.2%). For service activities, is greater the proportion of income that corresponds to skilled labor.

Next table shows the detail of the sectors included in each of the activities of the SAM needed to estimate what proportion of income corresponds to skilled and unskilled labor. Because the activities in the survey are disaggregated only at two digits according to the ISIC rev 3 (International Standard Industrial Classification of All Economic activities, Rev. 3), it was necessary to include more than once the same activity of agriculture, hunting and related service for the agricultural production for food and seed.

Table 15 - Activities of the SAM according to the activities included in the survey

Activities	Activities in the survey according to the ISIC rev 3.
Agriculture	Agriculture, hunting and related service activities
	Grow Coffee
Animal production	Agriculture, hunting and related service activities
	Grow Coffee
	Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing
Forestry and fishing	Agriculture, hunting and related service activities
	Forestry, logging and related service activities
	Grow Coffee
Other primary activities	Mining and quarrying
Food industry	Manufacture of food products and beverages
Other manufacturing industries	Rest of manufacturing
Water distribution	Collection, purification and distribution of water
Other services	Rest of services

Source: with information from Encovi 2011 and ISIC rev 3.

7.1.5 Household disaggregation

For this exercise we disaggregated into four representative household groups, by poverty level and by urban/rural areas. Households that do not reach to cover the minimum cost necessary to meet the food and non-food needs are considered poor households, according to the official estimation of poverty for Guatemala. For the definition of urban areas, the survey uses the same of the latest census of population and housing of 2002. The table below shows the proportion of each group of household.

Table 16 - Share of each group of household (percentage)

Household group	Percentage
Urban poor	16.6
Rural poor	36.5
Urban non-poor	31.8
Rural non-poor	15.0

Source: with information from Encovi 2011.

- Household income

For each representative household group, income is disaggregated according to the source of income and the expenditure for each commodity. For all income components, the annual value is obtained by multiplying by 12 the income received on a monthly basis, and by four income received during the last three months. As already mentioned, the labor income includes labor income by skilled and unskilled worker. Skilled workers are those aged 15 or more, with 9 years of schooling or more.

Capital income include rental income of rooms, housing, machinery, land, etc., interest and stock dividends. It does not include imputed rent. Government transfers to households, include income from benefits welfare programs[21], the income on account of retirement or pension and the money received for scholarships and/or school transport subsidy.

The money received from remittances from people living abroad are the transfers received from the rest of the world. The income from the land was estimated from the sale or lease of land for agricultural use in the past twelve months. The following table shows the survey variables corresponding to each type of income.

Next table shows the relative structure of income, according to the source of income, for each household group. It can be seen that the largest share of skilled labor income corresponds to non-poor urban households, just as capital incomes. Importantly, government transfers are aimed primarily at non-poor urban households, because pensions and retirement income are included. Transfers from the rest of the world are mainly aimed to the non-poor, urban and rural households. The land income, corresponds most to the non-poor rural households.

Table 17 - Share of income for each household group

Percentage

Source of income	Urban poor	Rural poor	Urban non-poor	Rural non-poor
Labor income	9.9	14.1	61.5	14.4
Skilled	4.9	2.7	83.4	9.0
Non-skilled	15.6	26.9	36.9	20.6
Capital income	3.4	0.2	95.3	1.2
Government transfers	9.3	24.8	54.3	11.6
Transfers from the rest of the world	6.5	16.5	47.8	29.2
Land income	21.4	20.1	18.2	40.4

Source: with information of Encovi 2011.

- Household expenditure

Household expenditure on goods and services include the spending on food, spending on goods and services performed last week, last month and the last 12 months. Spending on energy sources used by the household and media. Also it's included the spending on transport and household services. Detailed expenditure on goods and services by household group is included in next table. It can be seen that in general the consumption of urban non-poor households is greater in most goods and services. The consumption of poor rural households is higher in some specific products such as corn, forestry and some baked goods. The consumption of urban poor households is low in most products, in part because they represent a smaller proportion, as well as non-poor rural households.

[21] The benefits of social assistance programs include the estimation of how much people would pay if they had to buy the benefit provided by an institution of the Government.

Table 18 - Household expenditure in good and services according to household groups (percentage)

No.	Commodities	Urban poor	Rural poor	Urban non-poor	Rural non-poor
Total		**10.0**	**19.2**	**52.3**	**18.4**
1	Bananas	10.5	21.4	49.4	18.7
2	Coffee	13.4	26.3	42.8	17.5
3	Maize	14.9	50.5	13.1	21.6
4	Beans	14.4	35.3	31.4	18.9
5	Cereals and legumes	13.4	25.8	41.8	19.0
6	Roots and tubers	12.6	24.9	41.8	20.7
7	Vegetables	11.5	22.3	46.6	19.5
8	Fruits	9.0	15.2	57.2	18.6
9	Living plants	3.1	2.0	82.7	12.1
10	Other animal products	11.6	19.3	51.3	17.8
11	Firewood	16.2	45.4	16.1	22.3
12	Fish and fishery products	6.6	16.5	53.6	23.3
13	Other minerals	11.7	23.8	47.2	17.3
14	Meat and meat products	11.2	17.6	52.7	18.6
15	Prepared or preserved fish	6.3	13.4	59.6	20.6
16	Prepared and preserved vegetables, legumes, etc.	6.7	10.6	61.9	20.7
17	Animals and vegetables oils and fats	12.4	22.5	45.9	19.2
18	Grain mill products	11.3	31.5	35.1	22.0
19	Preparation used in animal feeding	4.8	20.8	52.4	21.9
20	Bakery products	13.9	32.1	35.0	19.1
21	Sugar	14.2	32.8	33.7	19.3
22	Noodles and similar farinaceous products	13.3	25.1	42.3	19.2
23	Dairy products	8.5	10.0	64.2	17.4
24	Food products n.e.c.	10.4	16.5	53.4	19.7
25	Alcoholic and non-alcoholic beverage	7.9	12.3	61.9	17.9
26	Other industries	8.2	12.6	60.5	18.7
27	Water and electricity	10.5	12.2	61.9	15.5
28	Lodging	3.4	4.6	75.3	16.7
29	Other services	6.5	6.9	71.0	15.6

Source: with information from Encovi 2011.

7.2 Guatemala's economic structure tables

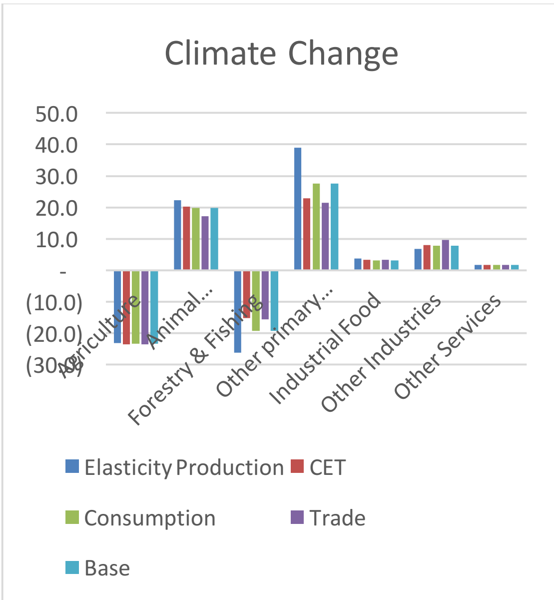
Table 19 - Consumption composition of each household group (percentage)

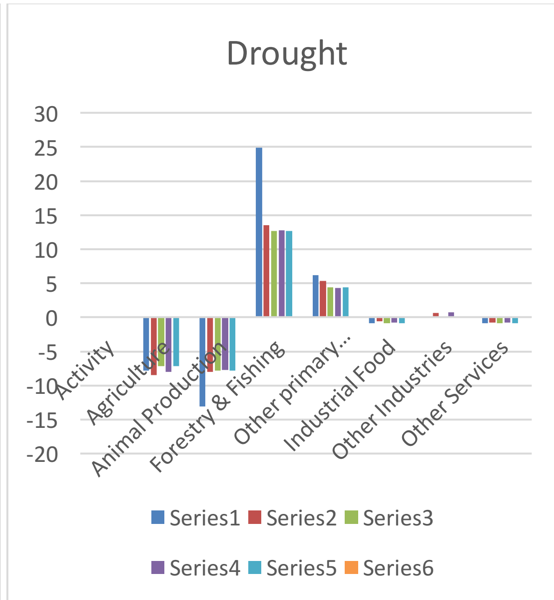
	Urban poor	Rural poor	Urban non-poor	Rural non-poor
Coffee	0.0	0.0	0.0	0.0
Bananas	1.4	1.5	0.6	0.8
Maize	4.3	4.7	2.6	3.3
Beans	3.8	6.8	0.4	2.4
Cereal and legumes	0.2	0.3	0.1	0.1
Roots and tubers	2.4	2.5	1.0	1.5
Vegetables	7.0	7.4	3.0	4.9
Fruits	1.7	1.7	0.9	1.2
Living plants	0.2	0.2	0.2	0.2
Milk	0.1	0.0	0.3	0.1
Eggs	1.1	0.6	1.3	1.0
Other animal products	0.0	0.0	0.0	0.0
Firewood	1.3	1.2	0.8	0.9
Other forestry and logging products	1.6	2.3	0.2	0.9
Fish and fishery products	0.5	0.7	0.1	0.3
Other minerals	0.1	0.1	0.1	0.1
Meat and meat products	6.0	6.5	3.2	3.8
Prepared or preserved fish	0.3	0.3	0.2	0.2
Prepared and preserved vegetables	0.4	0.5	0.5	0.6
Animal and vegetable oils and fats	0.8	0.7	1.0	1.1
Grain mill products	5.3	5.1	2.5	3.5
Preparation used in animal feeding	0.2	0.3	0.1	0.2
Bakery products	4.8	11.1	6.8	9.4
Sugar	3.1	3.8	1.0	1.8
Noodles and similar farinaceous products	0.8	1.0	0.3	0.5
Dairy products	4.0	4.0	1.7	2.5
Food products n.e.c.	2.4	1.5	2.4	2.2
Alcoholic and non-alcoholic beverages	1.5	1.2	1.0	1.2
Other industries	22.5	18.7	23.0	21.9
Water and electricity	1.0	0.8	1.0	1.0
Lodging	8.4	5.2	6.5	5.3
Other services	12.8	9.3	37.3	27.3
Total	**100.0**	**100.0**	**100.0**	**100.0**

Source: Social Accounting Matrix for Guatemala, 2011.

7.3 Sensitivity results

If we change elasticitis of production, consumption, CET, Trade, we observe that our model has more sensibility to elasticity of production, specially for agriculture, forestry and fishing, and other primary activites. In any case the sign of the effect changed from negative to positive.





Source: own calculations based on PEP 1-1 Model