Annex 25: Food security and water security baseline information in the seven participating countries

Food security

INTRODUCTION

According to FAO *et al.* (2019), in recent years, Latin America and the Caribbean have made significant progress against hunger, food insecurity and malnutrition in the region. However, the current economic models and climatic crisis put all the progress made at risk.

This document presents the current evolution and situation of the main elements that affect the dimensions of food security and nutrition (FSN). The countries studied were Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, located in Central America, and the Dominican Republic, located in the Caribbean. These countries as a whole have a population of 59 million people, of which more than 7 million are in a condition of undernourishment. In that sense, it is pertinent for countries to promote actions aimed at improving living conditions that allow them to strengthen themselves in order to achieve food and nutritional security, in a sustainable way, protecting their livelihoods.

The structure of the document provides an introduction to the conceptual aspect of food and nutrition security, moving on to an overview in view of the global challenge that countries have under the 2030 agenda, specifically the challenges for achieving the development objective 2 (SDG 2) “to end hunger, achieve food security and improve nutrition, and promote sustainable agriculture”

Subsequently, relevant indicators are provided for each dimension of the FSN, (physical availability, economic and physical access, food utilization and stability), the evolution in the last 10 or 15 years is shown. The stability dimension shows the possible effects of climate change on food and nutritional security.

The information provided will allow us to know the region from a food and nutritional security point of view, identifying the most vulnerable areas, necessary to strengthen the population's capacity to cope with the imminent impact of climate change and thus promote their own development.

Food Security and Nutrition and the Sustainable Development Goal #2

Food Security and Nutrition (FSN) is the center of growing discussions and efforts, from the local to the global level. The current state of food security and nutrition is the complex result of activities, processes and factors that operate from the domestic level to the macroeconomic and international level, and which together can constitute the food system. The main objective of this system, from a vision for sustainable and inclusive development, is to achieve food affordability, food consumption diversity, nutrition and health of the population, and environmental sustainability (ECLAC *et al.*, 2017).

According to “Necesidades nutricionales” (s.d.), food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. In fact, the Sustainable Development Goal (SDG) number 2 states that one of its targets is to end hunger and ensure access to a healthy, nutritious and sufficient food for all (FAO *et al.*, 2019).

From this definition, four main dimensions of food security can be identified (Gross et al., 2000):

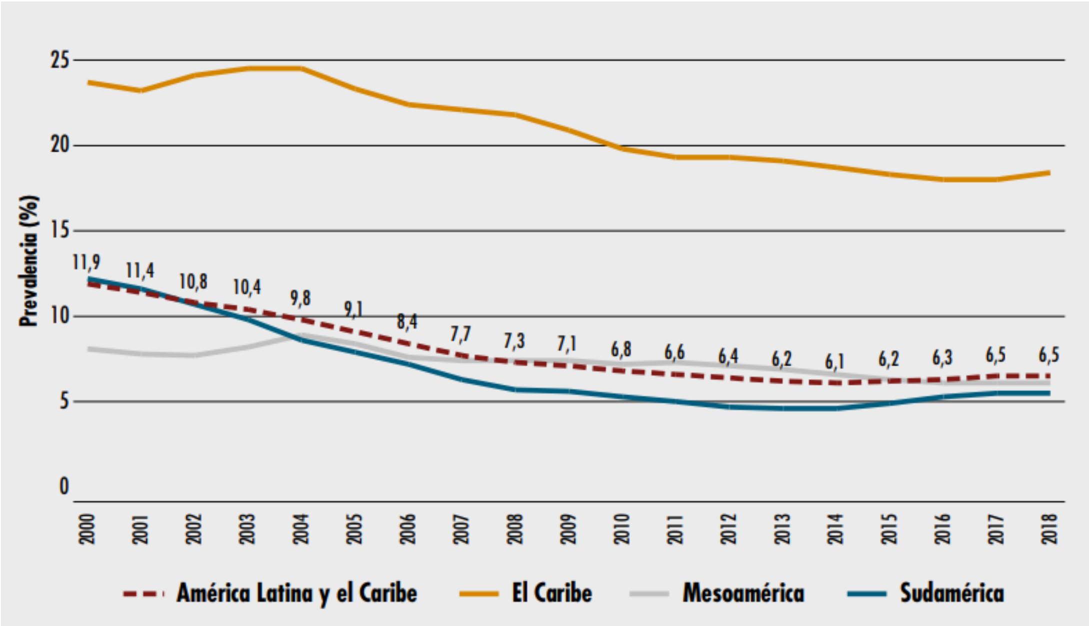
- Physical AVAILABILITY of food: Food availability addresses the “supply side” of food security and is determined by the level of food production, stock levels and net trade.
- Economic and physical ACCESS to food: An adequate supply of food at the national or international level does not in itself guarantee household level food security. Concerns about insufficient food access have resulted in a greater policy focus on incomes, expenditure, markets and prices in achieving food security objectives.
- Food UTILIZATION: Utilization is commonly understood as the way the body makes the most of various nutrients in the food. Sufficient energy and nutrient intake by individuals is the result of good care and feeding practices, food preparation, diversity of the diet and intra-household distribution of food. Combined with good biological utilization of food consumed, this determines the nutritional status of individuals.
- STABILITY of the other three dimensions over time Even if your food intake is adequate today, you are still considered to be food insecure if you have inadequate access to food on a periodic basis, risking a deterioration of your nutritional status. Adverse weather conditions, political instability, or economic factors (unemployment, rising food prices) may have an impact on your food security status (FAO, 2008)

All dimensions of food security and nutrition, including food availability, access, utilization and stability, are potentially affected even in the short term by climate variability and climate extremes. In 2018, critic food insecurity in Latin America and the Caribbean was linked to climatic phenomena (FAO *et al.*, 2019). Changes in climate are already undermining production of major crops (wheat, rice and maize) in tropical and temperate regions and, without adaptation, this is expected to worsen as temperatures increase and become more extreme (FAO, 2018a). Climate variability and extremes are a key driver behind the recent rises in global hunger and one of the leading causes of severe food crises, putting at risk achieving the above-mentioned SDG 2 by 2030 (“end hunger, achieve food security and improve nutrition, and promote sustainable agriculture”).

One of the indicators for monitoring SDG 2, Target 2.1 is the prevalence of undernourishment (SDG Indicator 2.1.1) which is an estimate of the proportion of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life (FAO, 2018b)

According to FAO *et al.* (2019), in general, undernourishment has declined in the region, as seen in Figure 1. Out of the six countries of the Central American dry corridor (Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panamá) and Dominican Republic, five managed to reduce the prevalence of undernourishment between 2000-02 and 2014-16 (FAO, 2018b). The most significant progress was made by Panama with 17% decrease in undernourishment, followed by Nicaragua (13.1%), Honduras (3.2%), Guatemala (2.3%) and Costa Rica (0.9%). El Salvador experimented an increase of 1% for this indicator. On the other hand, the Dominican Republic reduced the prevalence of undernourishment 16.7%. Despite the progress, there are still 6.3 million undernourished people in the Central American region (6 countries), added to 1.1 million people undernourished in Dominican Republic, 7,4 million people are undernourished (Table 1).

Figure 1 Evolution of undernourishment in Latin America and the Caribbean in %, 2000-2018



Source: FAO *et al.*, 2019

Table 2 Prevalence of undernourishment (%), number of undernourishment (millions) per country

Country	Prevalence of undernourishment (%)				Number of undernourished people (millions)			
	2000-02	2010-12	2014-16	2016-18	2000-02	2010-12	2014-16	2016-18
Costa Rica	5.3	5.2	5.4	4.8	0.2	0.2	0.3	0.2
El Salvador	9.3	12.5	10.6	9	0.6	0.8	0.7	0.6
Guatemala	18.1	15.8	16	15.2	2.2	2.4	2.5	2.6
Honduras	18.5	15.2	14.5	12.9	1.2	1.3	1.3	1.2
Nicaragua	29.3	20	17.2	17	1.5	1.2	1	1.1
Panama	26.2	11.8	9.6	10	0.8	0.4	0.4	0.4
Dominican Republic	27.1	14.6	12.1	9.5	2.4	1.5	1.3	1

Source: FAO *et al.*, 2019

The challenges that countries have faced to achieve FSN and SDG 2 are multicausal and multisectoral, with some determining differences between some countries, which marks the greater or lesser progress of their goals among them, as can be seen in each dimension of the FSN.

Achieving FSN is contributing to the realization of the Human Right to Adequate Food (HRAF), which for many people today in Central America and the Dominican Republic is not attainable. The realization of the Human Right to Adequate Food has direct effects on the well-being and development of people and societies, affects the development of human abilities, physical and cognitive skills, reduces the risk of disease and has an effect on well-being of the next generation (FAO, 2016).

The lack of adequate food has critical and acute manifestations in famines that periodically afflict various vulnerable populations, and in cumulative harmful effects of malnutrition in all its forms, prolonging the vicious circle of poverty, from generation to generation.

For this reason, actions aimed at improving FSN and HRAF directly contribute to improving the conditions of the population to combat the scourge of poverty.

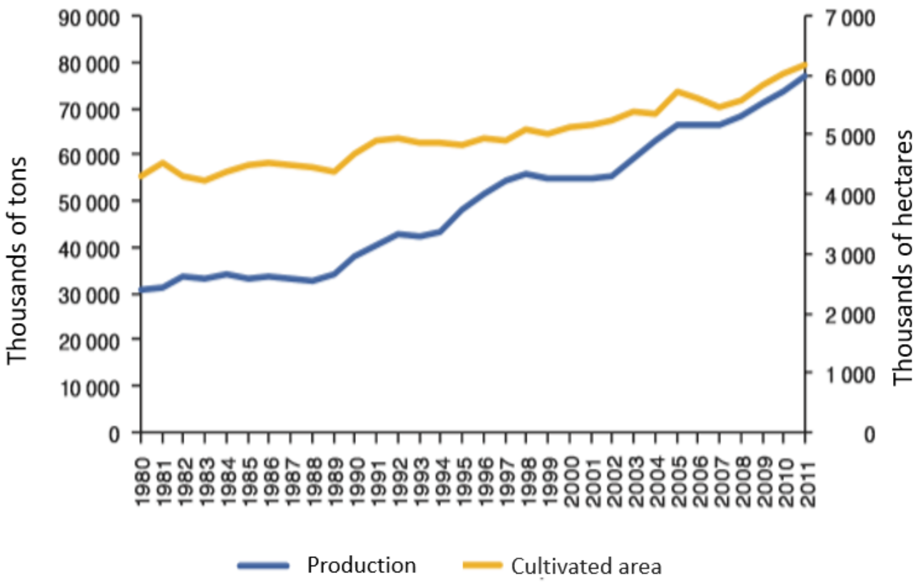
Physical AVAILABILITY of food

During the last decades, in the Latin American region and in the world, agricultural production has grown faster than the population. This has resulted in an increase in the availability of agricultural products per person. In Central America, this increase in production can be seen, accompanied by better yield and productivity, so that production growth has not been parallel with the expansion of sown area (Figure 2). This increase in productivity is due to the use of improved varieties, phytosanitary agricultural inputs, fertilizers and irrigation systems.

The main fastest growing primary products were sugarcane, banana, corn, melon, papaya, walnut, oil palm, pineapple and carrot, between 1980 and 2011 (ECLAC, 2013).

Figure 2 Production and harvested area of primary crops in Central America 1980 - 2011

(thousands of tons and thousands of hectares)

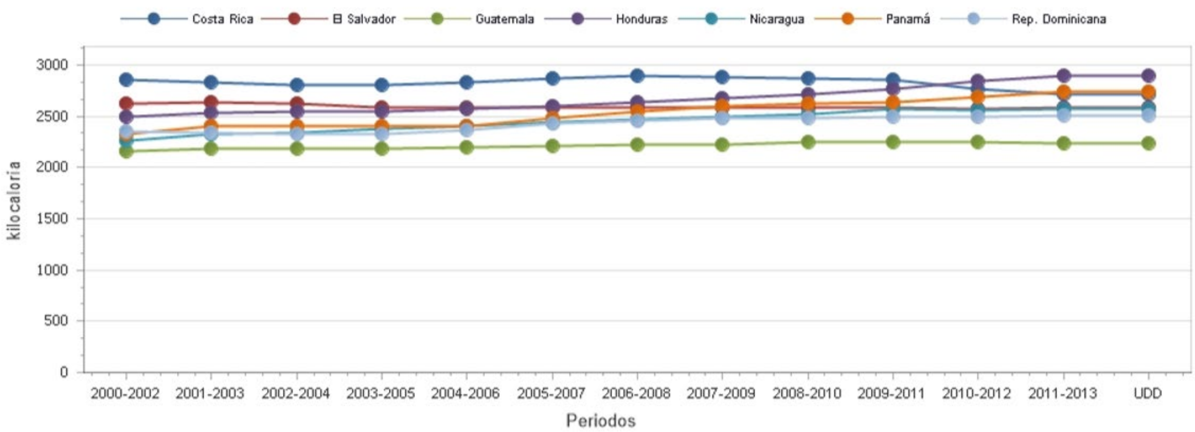


Source: FAO, 2013

According to ECLAC *et al.* (2016), all Latin American countries have enough food to meet the energy needs of their population, among which cereals stand out as the main source for human consumption. They estimate that for the triennium 2014-2016, Central America has a caloric availability of 2,964 calories per capita, representing an increase of 5% over the period 1990-1992 and in the Caribbean (including Dominican Republic), availability increased by 19% in the period, reaching a caloric availability of 2,758 daily calories per person in the last quarter of the 2014-2016 triennium. This caloric availability is sufficient if we consider the recommendations of FAO (1985), where it states that for women with moderate physical activity, it requires an amount of 1950 cal/day and men in equal conditions up to 2850 cal / day.

Figure 3 shows the change in energy supply from 2000 to 2013, in the Central American countries and the Dominican Republic. It is appreciated that in all countries there are variations in the energy supply throughout the period (2000 - 2013). Guatemala, shows the lowest energy supply with 2240 calories per person per day for 2013, while Honduras has the highest contribution with 2890 calories per person per day, the rest of the countries oscillate between the values of those two countries. In all cases, energy sufficiency is appreciated for the population of all countries.

Figure 3 Food Energy Supply (SEA) for countries of Central America and the Dominican Republic from 2000 to 2013

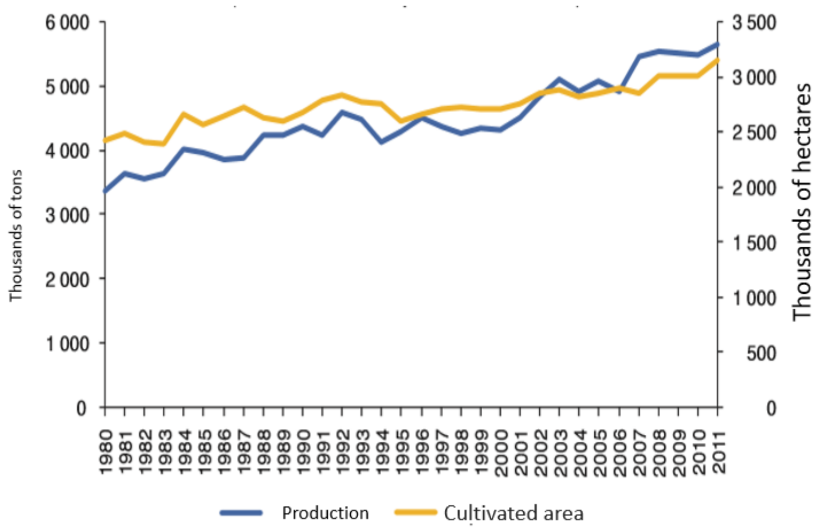


The increase in the production of basic grains in Central America has contributed to the increase in caloric availability. The main source of food energy in Central America and the Dominican Republic are basic grains, led by corn, beans, and rice and on a smaller scale wheat and sorghum. These are traditional foods for mass consumption, they have an important weight in the expenditure and caloric intake of the lower income groups. Likewise, its production represents an important part of the production, food and income of small farmers in proportions that vary from country to country (ECLAC *et al.*, 2017).

According to FAO *et al.* (2019), when studying the indirect effect of food and diet in mortality, it has been found that 11 million adults older than 24 years died because of causes associated to an inadequate diet. More than half of those deaths were associated with risk factors such as a low consumption of grains and fruits, and a high consumption of sodium. For this reason, analyzing the patterns of grain production is important both for food security as for health reasons.

ECLAC (2013) shows that in the period from 1980 to 2011 the production of basic grains grew by approximately one million tons. It should be noted that in this region much of the production of basic grains is in the hands of small producers. As can be seen in Figure 4, an increase in productivity is shown, due to the use of improved varieties and agrochemicals, especially by large producers.

Figure 4 Production and harvested area of basic grains 1980 – 2011 (thousands of tons and thousands of hectares)

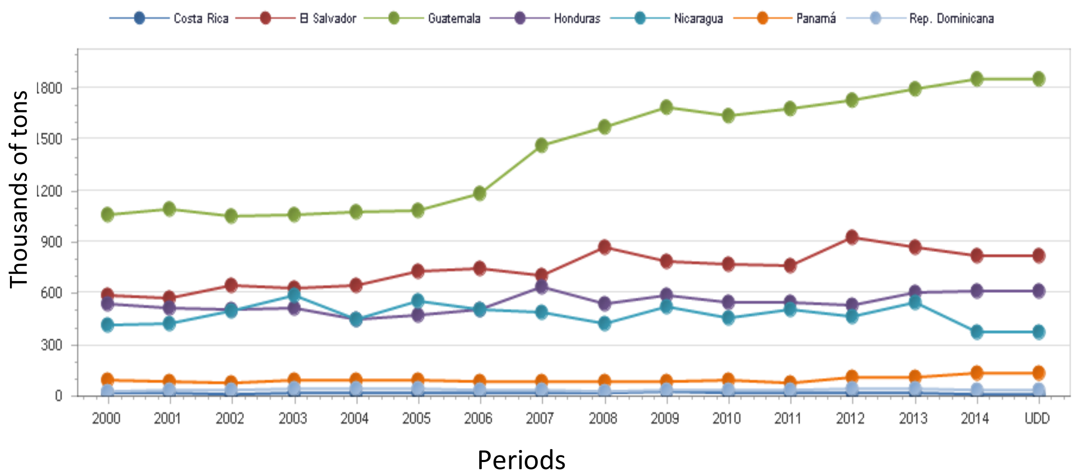


Source: CEPALSTAT, 2013

Includes: maize, beans, wheat, sorghum

In Central America, cereals (maize, rice, wheat, sorghum) represent 43% of the calories available (ECLAC *et al.*, 2016) and in the Caribbean, 33% (reference to the Dominican Republic), so they become the staple to support the food security of the population. Grain production by country is very diverse, according to information gathered from the information system of the Integrated Statistical Information System of the Central American Integration System (SICA). As can be seen in Figure 5, in the northern region of Central America are the countries with highest maize production. The big producer is Guatemala with almost two million tons for the year 2014, showing a significant increase since 2000. El Salvador in second place for 2014 had a production of 819.3 thousand tons, also with a significant increase since the beginning of the 2000s. Honduras in third place with a modest increase in its production from 533 thousand tons in the year 2000 to 609 thousand by the year 2014. On the other hand Nicaragua, Panama, Dominican Republic and Costa Rica, produce less than 400 thousand tons each, showing slight increases in production in the Dominican Republic and Panama and decrease in the case of Costa Rica and Nicaragua.

Figure 5 Evolution in maize production in Central America and the Dominican Republic 2000 - 2014. SICA



In the case of beans, production is dominated by Guatemala (235 thousand tons), Nicaragua (183.6 thousand tons), El Salvador (120.8 thousand tons) and Honduras (105.8 thousand tons), (Figure 6). On the other hand, rice production is concentrated in the Dominican Republic (863 thousand tons) followed by Nicaragua (335 thousand tons), Panama (290 thousand tons) and Costa Rica with 203 thousand tons (Figure 7).

Figure 6 Evolution in the production of beans in Central America and the Dominican Republic 2000 - 2014. SICA

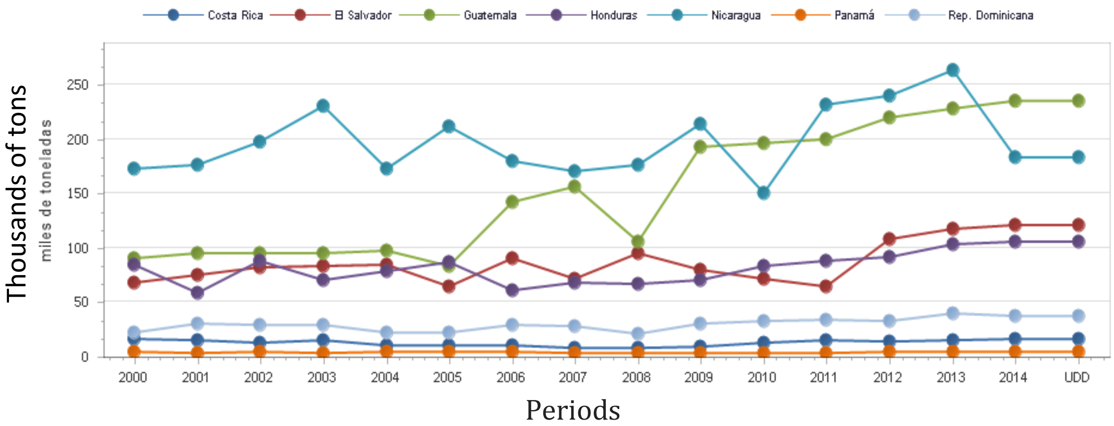
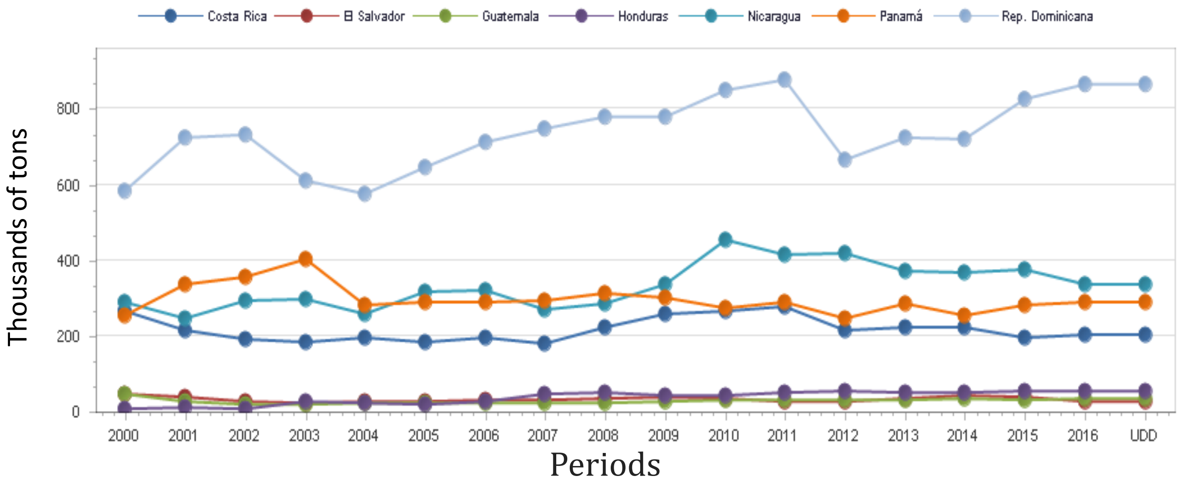
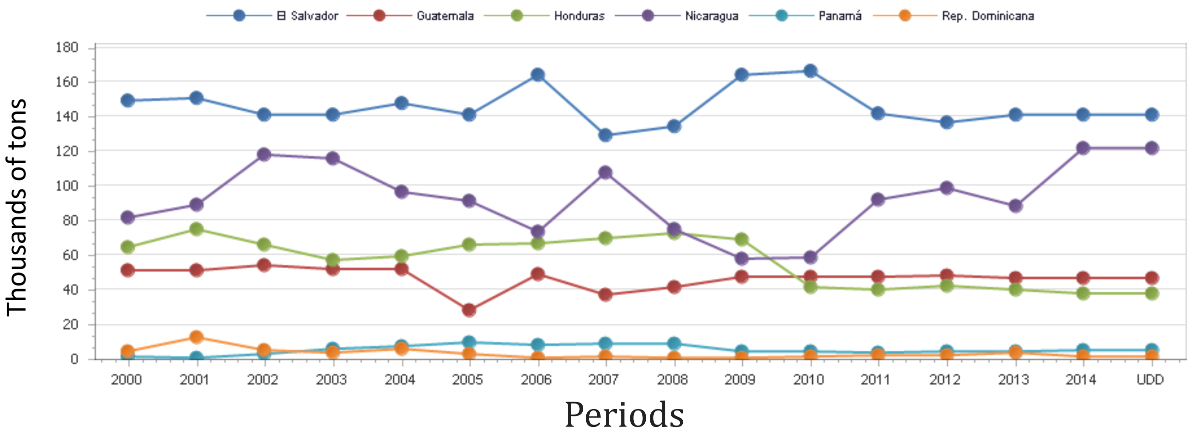


Figure 7 Evolution in rice production in Central America and the Dominican Republic 2000 - 2016. SICA



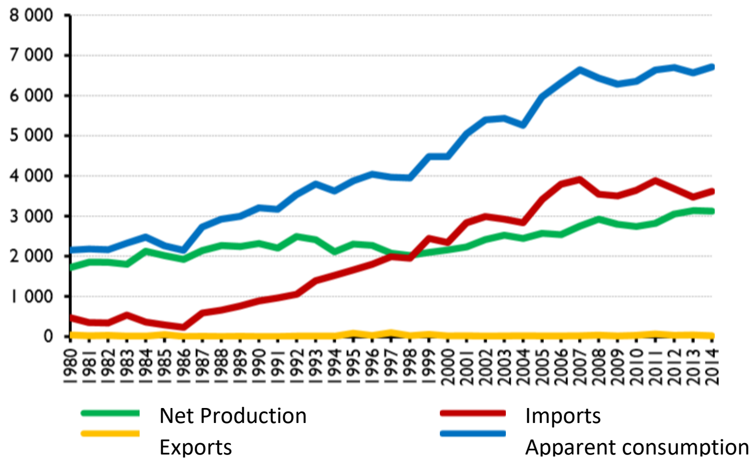
The main sorghum producers in Central America are El Salvador (140 thousand tons) and Nicaragua with 121 thousand tons, for the last data available in 2014, representing 74% of the region's production volume, including the Dominican Republic (Figure 8).

Figure 8 Evolution in sorghum production in Central America and the Dominican Republic 2000 - 2014. SICA



Grain production has not been sufficient to cover domestic demand, so countries depend on imports to meet the demand of their population. For three basic grains studied: maize, beans and rice, increased production in Central America and the Dominican Republic, apparent consumption exceeds net production. Understanding apparent consumption as the sum of production minus exports plus imports (ECLAC *et al.*, 2017). Figure 9 shows the evolution of maize from 1980 to 2014. Net productions are estimating a 20% loss.

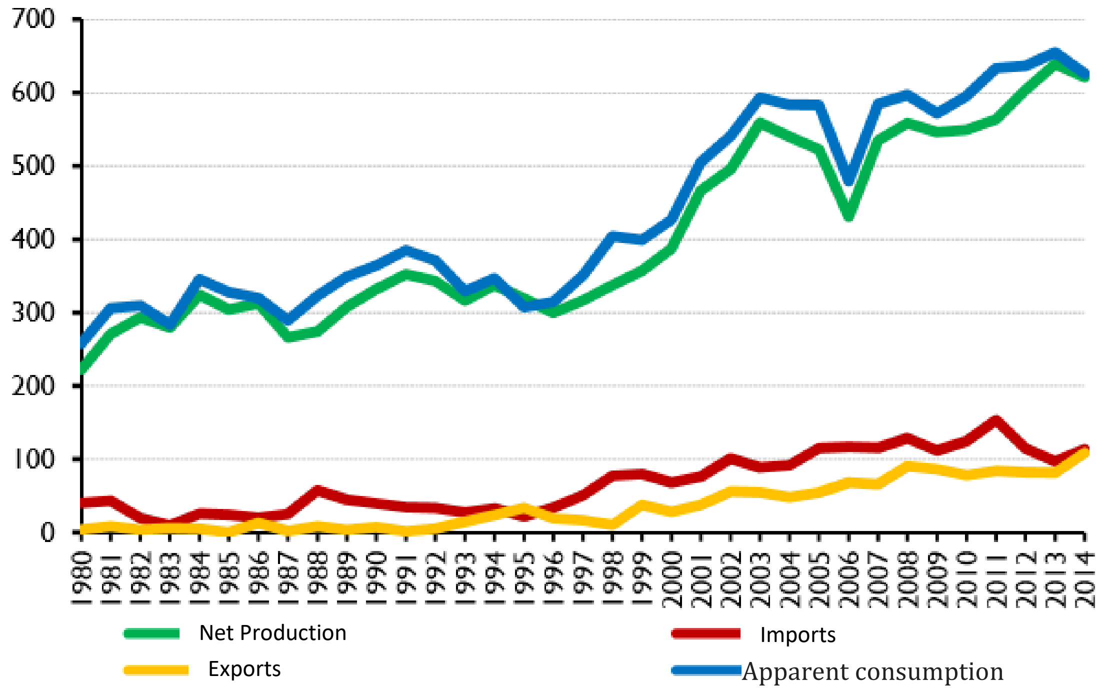
Figure 9 Central America and the Dominican Republic, net production, exports, imports and apparent consumption of corn - 1980-2014 (In thousands of tons)



- Taken from ECLAC *et al.* (2017). Data sources: SIAGRO-ECLAC; Belize data obtained from FAOSTAT. Trade SIAGRO-ECLAC with the exception of Belize and the Dominican Republic, which were updated with the base of UN-COMTRADE.
- *Note: these values also include data from Belize. However, these are not significant since Belize only represents 0.64% of the population of Central America and the Dominican Republic (383,071 inhabitants of 59,908,136 total inhabitants in the 8 countries).
- Maize imports include white and yellow maize. White maize is for human consumption and yellow maize is for agricultural use for feeding animals.

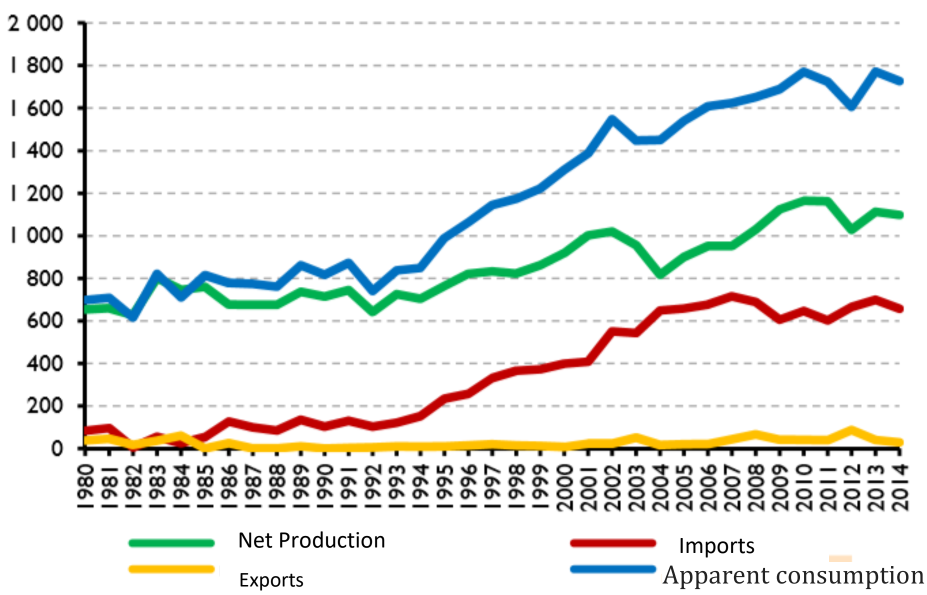
Figure 10 shows the evolution of net production, exports, imports and apparent consumption beans and Figure 11 shows the same for rice for the period 1980-2014. In both cases the increase in apparent consumption, production and imports can be seen. A slight increase in bean exports, and zero in the case of rice.

Figure 10 Central America and the Dominican Republic, net production, exports, imports and apparent consumption of beans - 1980-2014 (In thousands of tons)



- Taken from ECLAC *et al.* (2017). Data sources: SIAGRO-ECLAC; Belize data obtained from FAOSTAT. Trade SIAGRO-ECLAC with the exception of Belize and the Dominican Republic, which were updated with the base of UN-COMTRADE.
- *Note: these values also include data from Belize. However, these are not significant since Belize only represents 0.64% of the population of Central America and the Dominican Republic (383,071 inhabitants of 59,908,136 total inhabitants in the 8 countries).

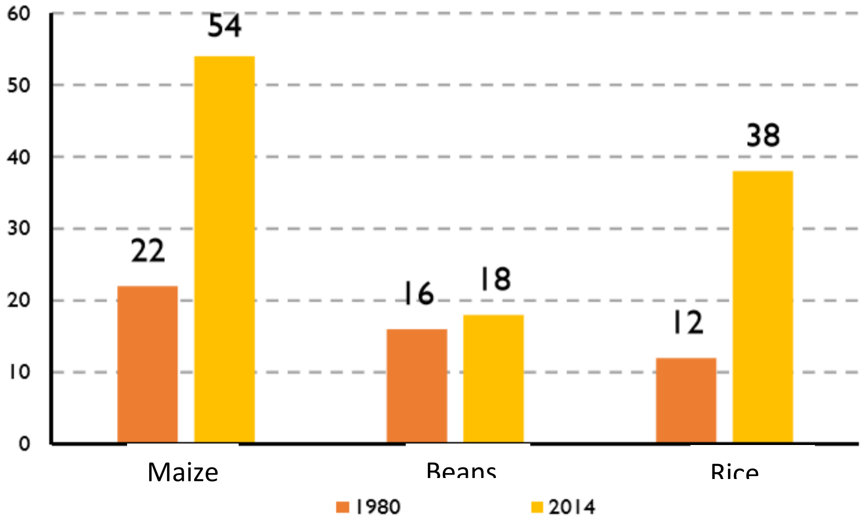
Figure 11 Central America and the Dominican Republic, net production, exports, imports and apparent consumption of rice - 1980-2014(In thousands of tons)



- Taken from ECLAC *et al.* (2017). Data sources: SIAGRO-ECLAC; Belize data obtained from FAOSTAT. Trade SIAGRO-ECLAC with the exception of Belize and the Dominican Republic, which were updated with the base of UN-COMTRADE.
- *Note: these values also include data from Belize. However, these are not significant since Belize only represents 0.64% of the population of Central America and the Dominican Republic (383,071 inhabitants of 59,908,136 total inhabitants in the 8 countries).

This disaggregated information allows to visualize the change in the dependency rate of the region (including Belize, although its contribution is not significant), with a marked upward trend in the three main grains studied. As shown in Figure 12, the product where the dependence grew most was maize (from 22% to 54%), followed by rice (from 12% to 38%). As mentioned, in the case of maize this figure includes yellow maize for agricultural consumption. Beans show a low degree of dependence (18%).

Figure 22 Evolution of the dependence rate of three main basic grains in Central America and the Dominican Republic 1980 - 2014 (percentages)

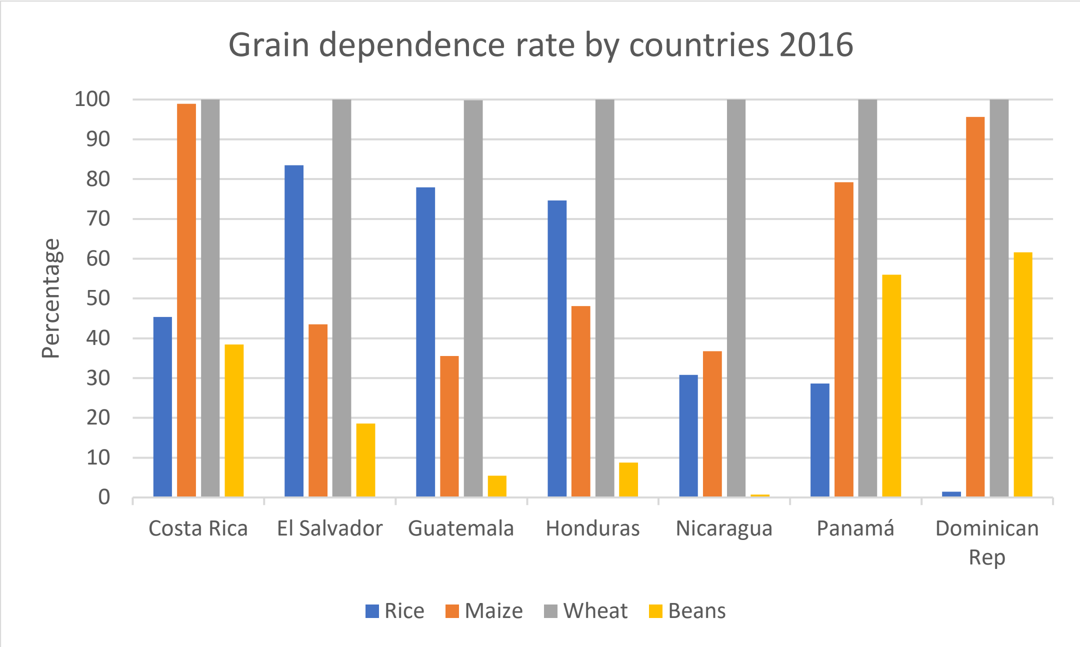


- Taken from ECLAC *et al.* (2017). Data sources: SIAGRO-ECLAC; Belize data obtained from FAOSTAT. Trade SIAGRO-ECLAC with the exception of Belize and the Dominican Republic, which were updated with the base of UN-COMTRADE.
- *Note: these values also include data from Belize. However, these are not significant since Belize only represents 0.64% of the population of Central America and the Dominican Republic (383,071 inhabitants of 59,908,136 total inhabitants in the 8 countries).

The information for each country can be seen in Figure 13, prepared based on the data of the SICA Information System for 2016.

Although the availability of food in the countries of study has been achieved, new information from the food balance sheets of the countries demonstrates the threat of reduced food availability and price increases in regions affected by the phenomenon of El Niño in 2015-16. This phenomenon resulted in large deviations and climatic anomalies compared to historical patterns, which were experienced in different ways and with varying degrees of intensity in different regions. In some areas, especially where low- and middle-income countries are located (as is the case in Central America and the Dominican Republic), severe drought conditions have occurred as a result of the El Niño phenomenon (FAO, 2018a).

Figure 13 Grain dependence rate for Central America and Dominican Republic 2016



Own elaboration, Prepared with information from the Information System of the Central American Integration System (SICA) 2016

Economic and physical ACCESS to food

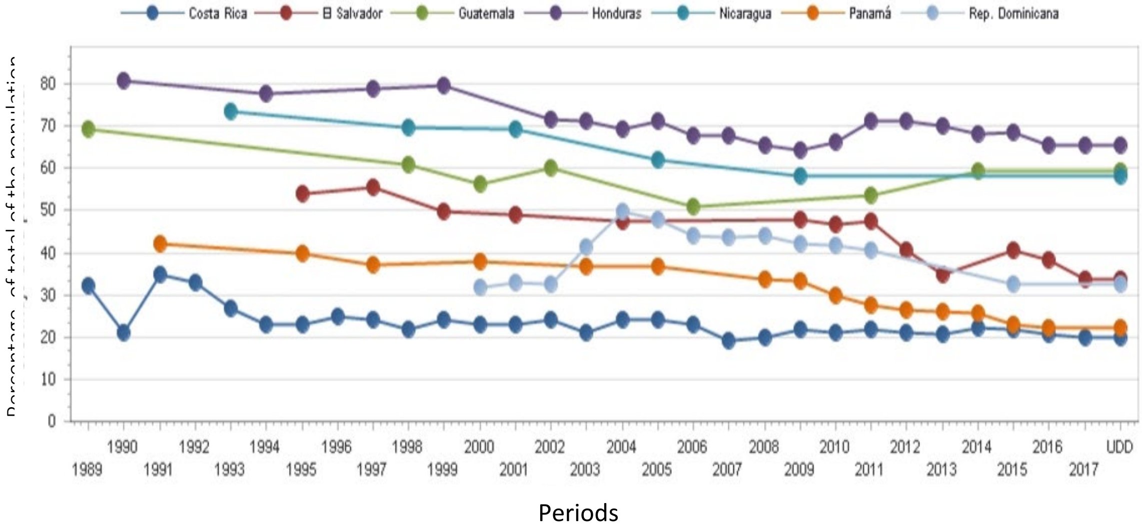
ECLAC *et al.* (2016) establish important premises, regarding access to food:

- The rise in food prices has a direct effect on food and nutritional security: it reduces purchasing power and the quantity and quality of food purchased by households. It directly affects and, to a greater extent, the poorest households because they spend a greater proportion of their income on food purchases. Families in better socioeconomic status can reduce their expenses in other areas to keep their food diet stable.
- The growth of economies, the increase in income, population growth and urbanization, among other factors, have imposed increasing production and consumption challenges in food systems. In this sense, it is imperative to reduce the negative effects of development on the environment and natural resources, as well as cope with climate change.

The limited progress against the scourge of hunger and malnutrition, despite the fact that governments have signed important declarations, persist and reflect the great inequities that the Central American and Dominican Republic region is going through. The socioeconomic situation varies from country to country, an important indicator such as poverty, shows that Costa Rica has 20% of its population below the poverty line (2017), reducing 12 points since 1989 (32%) being the country with the lowest poverty rate. On the other hand, Honduras with 66% poverty (2017) is the country with the highest rate for the region, it also held the highest number of people below the poverty line by the beginning of the nineties (81% of poverty, 1991)

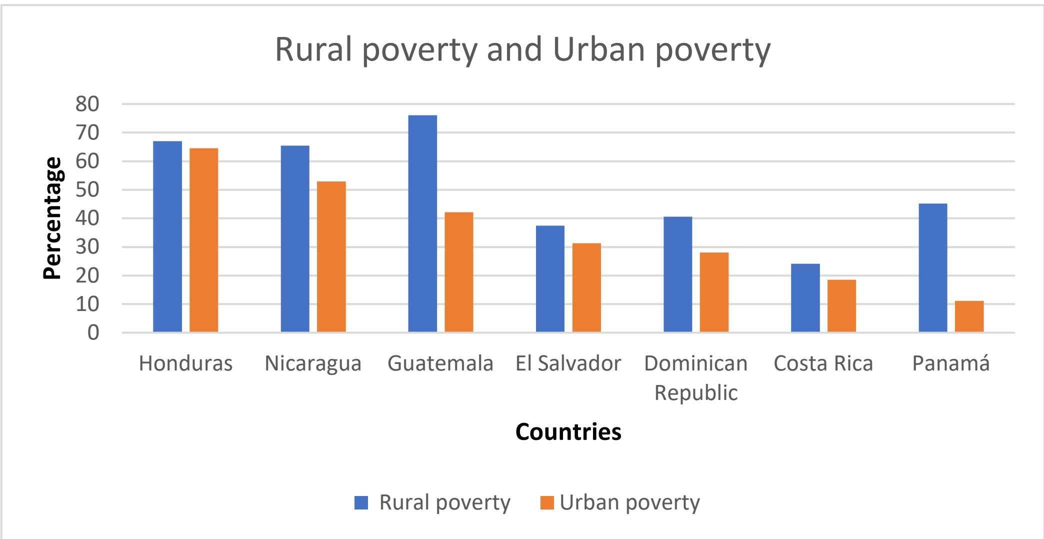
For the purposes of this study, the definition of poverty has been taken from ECLAC (2010b), which estimates the percentage of the population in poverty, corresponds to those who cannot acquire a specific basic food basket for each country. Extreme poverty, on the other hand, refers to people who cannot meet at least basic food needs. Figure 14 shows the values in percentages of people living in poverty in each country studied. The road to fight poverty has not been linear in the countries. While there have been periods of significant progress, situations such as catastrophes related to climate change (hurricanes, drought, flows, among others) rising food prices and limited incomes, socio-political crises, among others have slowed and even marked a setback in the progress of countries.

Figure 14 Population in poverty in countries of Central America and the Dominican Republic. SICA information system



In all the countries of interest there is a greater concentration of poverty in rural areas than in urban areas. Guatemala is the country with the highest percentage of poverty in the rural area with 76% followed by Honduras (67%) and Nicaragua (65%) as seen in Figure 15. It should be noted that Guatemala is also the country with the largest indigenous population in the entire region (41%) with a large population of these in rural areas.

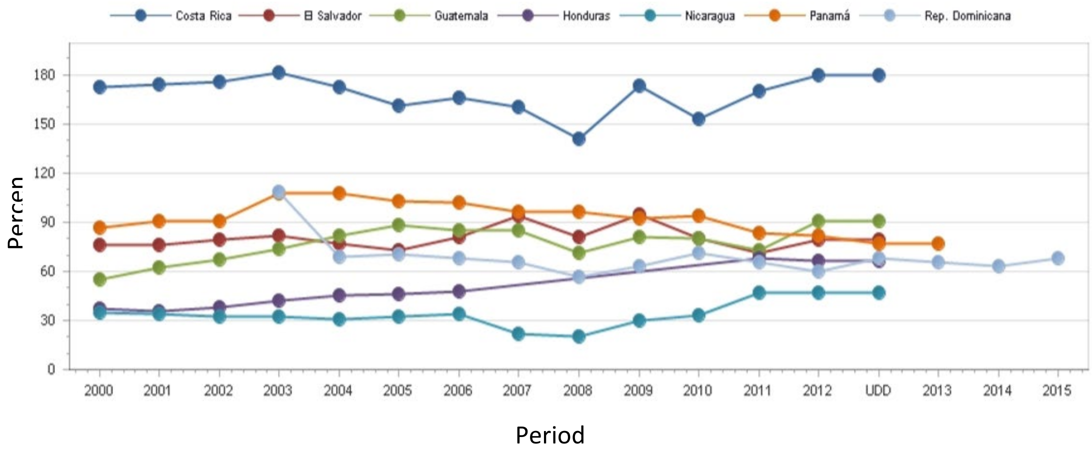
Figure 315 Distribution of poverty between urban and rural areas of the countries of Central America and the Dominican Republic



Own elaboration, Prepared with information from the Information System of the Central American Integration System (SICA) 2016.

FAO *et al.* (2019) states that the condition of rurality represents a greater risk of food and nutritional insecurity. One aspect that supports this claim is the food purchasing power of the minimum agricultural wage, this indicator understood as the percentage of the cost of the basic food basket that is covered by the minimum agricultural wage. As shown in Figure 16, only the minimum agricultural wage in Costa Rica can cover the basic food basket and other services. The rest of the countries reach 91% in the case of Guatemala, 79% in El Salvador and 77% in Panama. The Dominican Republic and Honduras reach about 65% of the cost of the basic food basket while in Nicaragua is covered only the 47%).

Figure 16 Food purchasing power of the minimum agricultural wage in countries of Central America and the Dominican Republic.



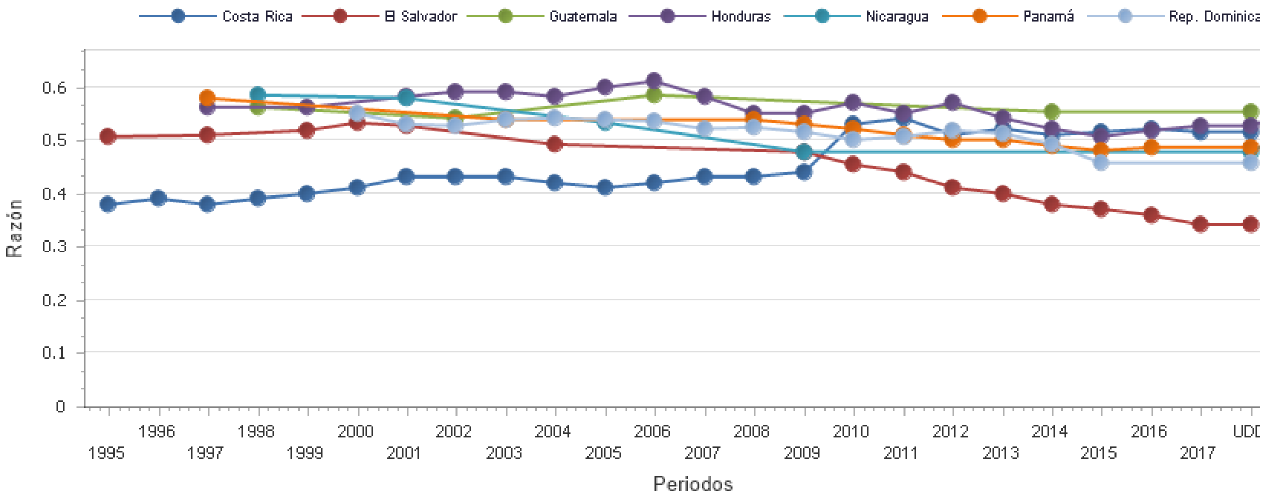
Another determining aspect in access to food is the distribution of income. A useful indicator to determine equality or inequality in income is the GINI coefficient, where the value of 1 corresponds to perfect inequality and the value zero corresponds to perfect equality. Figure 17 shows that of the 7 countries under study, 3 have a GINI coefficient above 0.5 Guatemala (0.55), Honduras (0.53) and Costa Rica (0.51), which indicates a high inequality in the region. It is closely followed by Panama with 0.49, Nicaragua 0.48 and Dominican Republic with 0.46 (SICA, 2019).

Inequality shows structural aspects, which strongly condition access to food and therefore food and nutritional security.

According to FAO *et al.* (2019), the high social and economic inequality in our region is reflected in the difficulties suffered by certain groups in a situation of vulnerability (including boys and girls, women and ethnic populations) to physically and economically access a healthy diet.

Furthermore, food environments have changed at an accelerated pace. Currently, Latin America and the The Caribbean is an eminently urban region, in which women are having a growing participation in the labor market. Nevertheless, in many cases, there is a lack of co-responsibility between men and women in domestic and unpaid work, which shapes food access conditions and realities (FAO *et al.*, 2019).

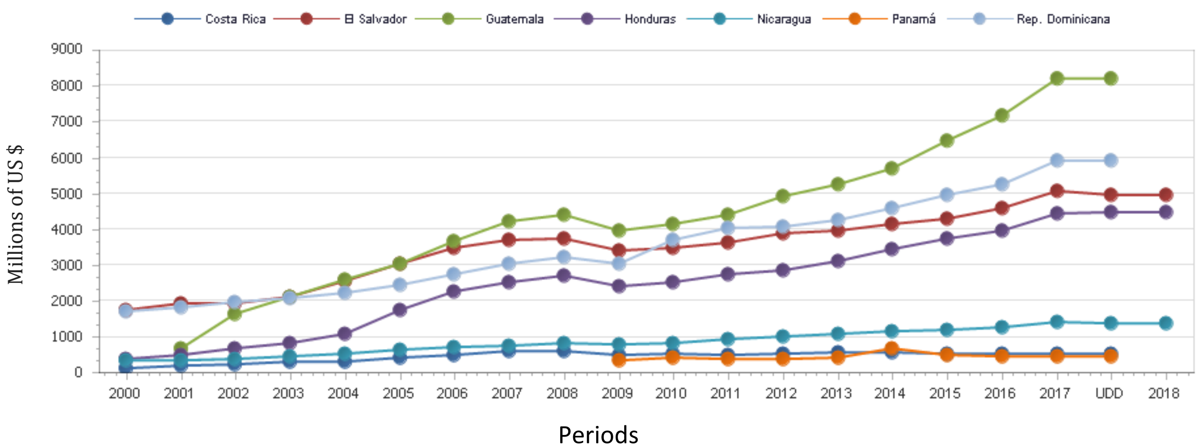
Figure 47 Gini coefficient for countries of Central America and Dominican Republic, SICA 2019



Under the above-mentioned conditions, it is quite common for the rural population to attempt to emigrate out of their territories, either towards urban centers in their own countries, or to emigrate to other countries. WFP (2014) demonstrated in a study in the dry corridor of Guatemala, El Salvador and Honduras, that there is a direct correlation between the peaks of emigration in this territory and the appearance of climatic crises such as droughts.

In that sense the population that is outside the national territory, becomes an important sustenance for the economy of the countries. So much so that remittances in some cases such as Honduras represent the item with the highest share of gross domestic product (SICA, 2019). Figure 18 shows the evolution of remittances in the last 18 years for the 7 countries. Honduras and Guatemala are the countries with the highest growth in the period 2000-2018 in this area, with more than one thousand percent in the mentioned period. Costa Rica and Nicaragua around 400% and the rest with lower values.

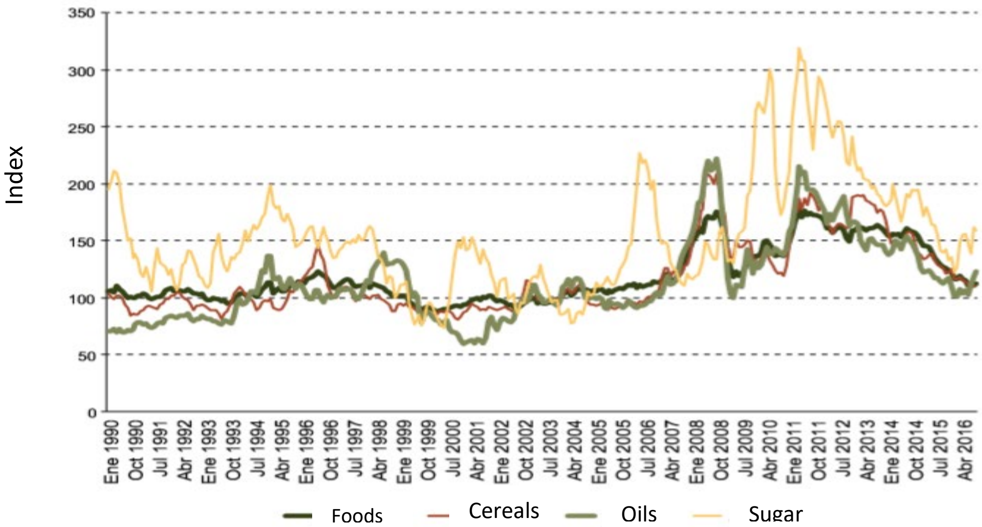
Figure 18 Evolution of remittances in countries of Central America and Dominican Republic



International factors can also condition access to food, such as the variation and volatility of food prices. According to ECLAC *et al.* (2016) the FAO food price index levels of maximum levels in mid-2008 and between fines of 2010 and September 2011; after having had a decreasing trend, especially as of March 2014, as a result of high levels of cereal and oilseed production and the consequent increase in stocks. The two maximum points of the index in the series mark moments of crisis in food prices, characterized by the increase in food insecurity, the social male and the acceleration of inflation, especially in the poorest countries, in which families allocate a large part of the income to food, such is the case of the countries of study.

The two crises of recent years were different in terms of the product groups that led the price increases (cereals in the first event and sugar in the second), however, in both cases a strong correlation was observed between the prices of the different food groups. Indeed, the prices of all food product groups tended to be located at those two moments above their average long-term price. Among the set of triggers of price increases, the effects of climate, biofuel production and export restrictions on food products markets are counted (ECLAC *et al.*, 2016) Figure 19.

Figure 19 FAO International Food Price Index, at constant values 1990 - 2016



Source ECLAC based of FAO data

ECLAC *et al.* (2016) mention the importance of promoting economic development policies aimed at the inclusion of the poor. An increase in income is necessary to improve access to food and its ability to cope with price volatility. The most vulnerable population is in rural areas and a large part is made up of the segment of small agricultural producers (net food buyers). Strengthening policies to promote family agricultural production would have a positive impact not only on the supply of local food, but also on the access that the most vulnerable population has to these foods.

Food UTILIZATION

Progress in reducing poverty and hunger has had a positive impact on the nutritional field, with a significant improvement in indicators of child malnutrition (ECLAC et al., 2016). However, all the aforementioned aspects mean that thousands of children still suffer from the scourge of malnutrition, which is due both to limited access to food, inadequate practices in food consumption and / or difficulties in food Nutrient absorption, with lack of safe water, parasites, diseases among others. Chronic malnutrition in particular has been a widely accepted indicator as a socioeconomic indicator, because its prevalence shows prolonged lack of access to food, but also to health, education, basic sanitation, safe water, economic development, among others. Tables 2 show progress in Central America and the Dominican Republic to ensure access to water and Table 3 to basic sanitation, both in urban and rural areas, which contributes to improving nutrient absorption in the most vulnerable groups.

Table 3 percentage of households with basic water service (has water in the home). countries of Central America and Dominican Republic

Countries	% of households with basic water service			
	Year	**Total**	**Urban**	**Rural**
Costa Rica	2017	95.2%	99.0%	85.2%
El Salvador	2017	88.3%	95.5%	76.4%
Guatemala	2014	75.0%	88.0%	61.0%
Nicaragua	2009	65.9%	89.8%	29.4%
Honduras	2017	85.3%	92.6%	78.0%
Panamá	2010	90.3%	98.4%	75.6%
Rep. Dominicana	2015	85.5%	88.9%	76.2%

Own elaboration, Prepared with information from the Information System of the Central American Integration System (SICA) 2016

Reference is made especially to Nicaragua whose values are considerably low, however, these values correspond to the year 2009, much earlier than those presented for other countries.

Table 4 Percentage of households with basic sanitation service countries of Central America and Dominican Republic

Countries	% de households with basic sanitation service			
	Year	**total**	**Urban**	**Rural**
Costa Rica	2017	99.9%	98.8%	99.3%
El Salvador	2017	97.9%	99.7%	94.9%
Guatemala	2014	95.0%	98.0%	91.0%
Nicaragua	2009	23.3%	36.3%	3.3%
Honduras	2017	90.1%	93.6%	85.5%
Panamá	2010	59.5%	78.6%	24.7%
Rep. Dominicana	2015	86.0%	88.7%	78.0%

Own elaboration, Prepared with information from the Information System of the Central American Integration System (SICA) 2019

ECLAC (2007) explains that child malnutrition deprives children of the necessary nutrients in their most important period of growth, generating both mental and physical sequelae that are irreversible and permanent. In addition to preventing the development of the full potential of these children, malnutrition also impacts economic progress and imposes additional costs on society, adding pressure on education and health systems.

FAO (n.d.) warns that climate change will worsen the living conditions of farmers, fishermen and those living in forests, populations already vulnerable and in conditions of food insecurity. They will increase hunger and malnutrition. Rural communities, especially those living in fragile environments, face an immediate and growing risk of loss of crops and livestock, as well as reduced product availability. This implies a direct affectation in those vulnerable groups such as children under five, pregnant and lactating women and older adults. The interruption of their energy and micronutrient supply poses an imminent risk to their already fragile nutritional food situation, with negative consequences for personal and community development.

Malnourished children begin life with a terrible impediment, most likely to die in the first days or weeks of those born with adequate weight and size. They are also more vulnerable to infections, which consequently reduce their appetite, prolong malnutrition and inhibit growth. The cognitive and behavioral development of these children is likely to be affected in the same way. If they reach school age, their poor brain development will limit their ability to learn and will not allow them to concentrate on studies that would eventually give them access to a good job (ECLAC, 2007). This unfortunate cycle is likely to be repeated in their children, perpetuating poverty generation after generation, if actions are not taken to avoid it.

This allows us to affirm without a doubt that, in addition to the ethical and social problems that child malnutrition entails, negative economic consequences are added. The highest cost comes in productivity. It is also possible to consider the losses generated by potential investments that do not materialize due to the lower human capital presented by the population that has suffered child malnutrition (ECLAC, 2007). Thus, in terms of economic cost, the main consequence is assumed by the productive sector of the countries through the loss of their human capital.

In Table 4 it can be seen that all countries have made progress in combating chronic malnutrition (using short stature for age as proxy). However, it is evident that Guatemala remains the great laggard in the fight against this scourge with almost 50% of its population under 5 years suffering from chronic deficiencies. It is followed by Honduras with almost a quarter of its population under 5 years old in this condition.

Table 5 Evolution in the prevalence of chronic malnutrition, according to height for age in children under 5 years. WHO Growth Pattern 2006

Country	First available data		Latest available data	
	Year	**%**	**Year**	**%**
Costa Rica	1967	28.0%	2009	5.6%
El Salvador	1967	56.7%	2014	14.0%
Guatemala	1967	63.5%	2014	46.5%
Nicaragua	1967	40.2%	2012	17.3%
Honduras	1967	51.4%	2012	22.7%
Panamá	1967	29.4%	1997	16.8%
Rep. Dominicana	1986	22.3%	2013	6.9%

Own elaboration, Prepared with information from the Information System of the Central American Integration System (SICA) 2019

Although deficit malnutrition has been reduced, overweight and obesity have increased, a situation that becomes a risk factor for chronic non-communicable diseases, such as diabetes, hypertension, cancer, among others. This is due to excess calorie consumption, sedentary lifestyle and changes in consumption patterns towards diets of lower nutritional quality. Overweight and obesity is determined through BMI, or body mass index, which allows people who are overweight to be identified in relation to their height. People with BMI between 25 and 29.9 are considered overweight and people with a BMI with 30 or over 30 are in obesity (PAHO, 2018).

STABILITY

Availability and access may be affected by variations in climatic, economic and political conditions, which may have an impact on people's food and nutritional security (FAO 2011). In Central America and the Dominican Republic there has been an increase in extreme weather events recorded in the EM-DAT base. Between the periods 1956-1965 and 2006-2015, the number of storms multiplied by eight, while floods multiplied by up to 39 (ECLAC and FAO, 2017). Based on the assessments made by governments, with the support of ECLAC and other international agencies, it is estimated that the cumulative cost of major events thus evaluated is $ 22.9 million, of which 49% corresponds to damages and losses in productive sectors, and within these, agriculture represents 66%; with the next sector with the greatest losses being infrastructure (ECLAC *et al.*, 2016).

Because the impact of climate shocks on income and food can be significant, it is crucial that those affected are able to cope with their losses and adapt their livelihoods to deal with changing climate variability and extremes. Identifying the effects of climate shocks on livelihoods and coping and adaptation strategies is key to addressing the impact on food security and nutrition (FAO, 2018a).

The hunger situation is significantly worse in countries whose agricultural systems are extremely sensitive to rainfall variability, temperature and severe droughts, and where the livelihoods of a high proportion of the population depend on farming. Of all the hazards, floods, droughts and tropical storms are the ones that most affect food production. Drought, in particular, causes more than 80% of the total damages and losses in agriculture, especially in the subsectors of livestock and crop production. In relation to extreme events, the fisheries subsector is the most affected by tsunamis and storms, while most of the economic repercussions on forestry are caused by floods and storms (FAO, 2018a).

Vulnerability plays an important role in addressing the effects of climate change. Vulnerability refers to the conditions that increase the probability that climate extremes will negatively affect food security. Although there are many other vulnerability factors, the below are selected due to their relative importance for food availability and access. Vulnerability related to climate-sensitive production and/or yields: countries with at least part of their national cereal production or yield variance explained by climate factors – i.e. there is a high and statistically significant association between production and climate or biophysical indicators such as temperature, rainfall and vegetation growth for production and see report cited below in source for yield (FAO, 2018a).

In Central America and the Dominican Republic, the occurrence of some natural phenomenon with a negative impact, from 2003 to 2017, can be seen in Table 5.

To dimension the impact of natural phenomena, we can consider the huge material losses and human lives, caused by such phenomena, such as: earthquakes, floods, tsunamis, landslides, deforestation, environmental pollution and others and the people affected, which to the population that requires immediate basic assistance, including food, water, shelter, sanitation and medical assistance in an emergency period caused by a natural disaster. Corresponds to the sum of the total number of injured, homeless and affected. Table 5 shows the number of people affected in each country for each year of available data, due to some natural phenomenon.

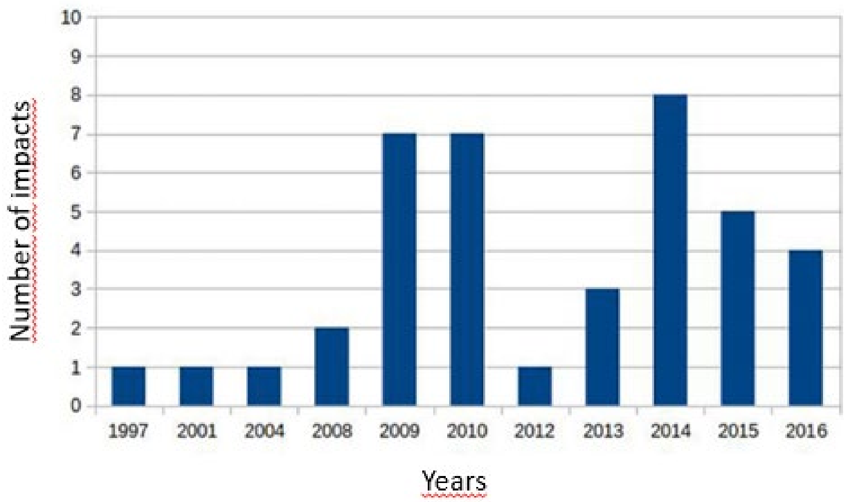
Table 6 Number of people affected by some natural phenomenon in each year. SICA 2019

Year	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panamá	Rep. Dominicana
2000	200	500	2'986	1'125	8'010	1'000	ND
2001	1'437	401'000	121'892	281'321	212'866	775	ND
2002	95'040	600	100'714	84'689	29'846	26'500	1'750
2003	2'500	ND	220	3'105	ND	'000	75'463
2004	3'056	ND	ND	137'500	5'969	22'748	24'261
2005	4'072	74'473	477'849	104'669	13'643	7'000	2'450
2006	ND	ND	ND	1'500	ND	7'866	ND

2007	24'500	3'300	6'001	35'000	212'726	129	162'763
2008	209'498	3'000	197'300	313'357	39'188	23'837	17'002
2009	ND	90'000	2'510'800	45'000	26'782	4'248	14'565
2010	3'106	12'020	454'108	29'685	75'860	32'941	47'200
2011	46'695	300'000	537'471	69'798	143'018	4'000	55'200
2012	9'523	ND	266'485	125'000	29'500	9'448	57'085
2013	ND	ND	ND	ND	14'149	ND	ND
2014	ND	ND	1'408'141	594'710	520'345	116	300
2015	9'666	720'000	66'248	ND	3'750	3'500	23'333
2016	50'000	ND	101	451'051	10'570	12'000	1'795'400
UDD	50'000	720'000	101	451'051	10'570	12'000	1'795'400

In recent years the impact of the drought has gained importance. The following figure 20 shows the number of events recorded, specifically in the Central American dry corridor, by year of occurrence.

Figure 20 Number of significant impacts due to drought in agriculture and livestock in the Central American dry corridor.



Source: Calvo et al., 2018

More precisely for the sowing period of basic grains that takes place between May and September (called locally “first sowing”), in the year 2019 for Guatemala, Honduras, El Salvador and Nicaragua, FEWSNET (2019) shows considerable losses, explained as follows:

- Some areas of Guatemala, Honduras and Nicaragua including the Dry Corridor registered below-average rainfall and above-average temperatures that affected basic grains crops during the Primera season (season from May/Jun to September).
- The poorest households in the Dry Corridor of Central America who will likely register significant losses (above 50 percent) of the first sowing harvests will not be able to replenish their bean and maize stocks. In consequence, they will keep purchasing in the market and engaging in negative coping strategies to access food.
- Labor opportunities will be reduced due to crops losses. Poor households will therefore engage in coping strategies to access food. Although, sowing for “second sowing” and the high labor demand season will help to relieve the situation.
- In Central America, the maize and bean market remain supplied by carryover stocks and imports. Maize prices remain above average and bean prices below average.

- Poor households whose livelihoods have deteriorated and have limited access to non-basic food needs will face Stress (Integrated Phases Classification, IPC, Phase 2) food security outcomes. However, the poorest households, who are engaging in negative coping strategies will face Crisis (IPC, Phase 3), particularly in some areas of the Dry Corridor in Guatemala.

In the Dominican Republic, WFP (2017) identifies floods, landslides and droughts as the main natural threats. Ishizawa Escudero and Van Der Borght (2015), cited by WFP (2017), state that between 1961 and 2014 the occurrence of events caused by nature in the country has concentrated on storms (50%) and floods (41%), followed by fires (5%,) drought (2%) and seismic activity (2%).

To estimate the potential impact of climate change on maize, bean and rice yields, this analysis used two GHG emission scenarios, one less pessimistic (B2) and one more pessimistic (A2), proposed by the Intergovernmental Panel on Climate Change (IPCC) (ECLAC, 2013).

Based on these circumstances and other elements considered, the two scenarios and their impact on the yield of basic grains in Central America have been developed. Tables 6, 7 and 8 show the evolution of maize, beans and rice yields for scenario B2 and A2 with cuts to 2100, clearly a reduction in yields can be seen, both in the less pessimistic scenario B2) and in the most pessimistic (A2), which represents the current trend of the last periods.

Table 7 Evolution of maize yields for scenario B2 and A2 with cuts at 2100 (projections)

	Yield average 2001 – 2009	2020	2030	2050	2070	2100
	(t/ha)			*(En porcentajes)*		
Costa Rica	3,3	-7,02	-11,91	-13,30	-17,96	-25,37
El Salvador	5,3	-6,81	-10,01	-13,64	-20,35	-26,20
Guatemala	2,6	-4,63	-7,46	-9,79	-15,48	-20,27
Honduras	2,3	-7,90	-11,92	-15,68	-23,98	-32,48
Nicaragua	2,2	-11,43	-18,78	-23,25	-32,71	-47,41
Panamá	1,8	-8,82	-16,50	-18,08	-24,97	-34,25
Centroamérica	2,9	-7,53	-11,88	-15,06	-22,41	-30,23
			Escenario A2			
Costa Rica	3,3	-10,01	-9,09	-19,85	-32,83	-39,98
El Salvador	5,3	-13,11	-12,05	-24,32	-36,21	-50,32
Guatemala	2,6	-9,33	-10,38	-19,27	-28,63	-41,71
Honduras	2,3	-11,60	-13,80	-24,37	-36,67	-49,92
Nicaragua	2,2	-15,94	-18,84	-33,60	-53,55	-68,84
Panamá	1,8	-6,07	-7,19	-12,07	-35,38	-48,89
Centroamérica	2,9	-11,07	-12,26	-22,60	-36,78	-50,25

Source: ECLAC

Table 8 Evolution of beans yields for scenario B2 and A2 with cuts at 2100 (projections)

	Yield average 2001 – 2009	2020	2030	2050	2070	2100
	(t/ha)			(En porcentajes)		
				Escenario B2		
Costa Rica	0,5	-7,71	-16,56	-9,61	-13,46	-28,37
El Salvador	0,9	-4,70	-7,36	-8,69	-13,72	-17,26
Guatemala	0,7	3,71	1,52	1,50	1,76	0,94
Honduras	0,7	-3,35	-6,68	-7,10	-12,70	-20,39
Nicaragua	0,7	-5,52	-12,01	-11,68	-15,95	-26,11
Panamá	0,3	-4,06	-22,08	-15,98	-28,09	-50,02
Centroamérica	0,7	-2,86	-7,88	-7,53	-12,26	-19,32
				Escenario A2		
Costa Rica	0,5	-15,65	-7,09	-20,16	-42,22	-47,64
El Salvador	0,9	-16,47	-13,19	-24,14	-35,00	-48,92
Guatemala	0,7	-6,99	-6,94	-8,79	-10,14	-17,44
Honduras	0,7	-11,77	-11,40	-19,00	-28,29	-42,04
Nicaragua	0,7	-14,45	-12,80	-22,74	-39,80	-54,39
Panamá	0,3	-1,03	-2,55	0,60	-43,00	-70,60
Centroamérica	0,7	-11,13	-10,20	-17,09	-29,99	-43,21

Source: ECLAC

Table 9 Evolution of rice yields for scenario B2 and A2 with cuts at 2100 (projections)

	Yield average 2001 – 2009	2020	2030	2050	2070	2100
	(t/ha)			(En porcentajes)		
Costa Rica	3,3	-7,02	-11,91	-13,30	-17,96	-25,37
El Salvador	5,3	-6,81	-10,01	-13,64	-20,35	-26,20
Guatemala	2,6	-4,63	-7,46	-9,79	-15,48	-20,27
Honduras	2,3	-7,90	-11,92	-15,68	-23,98	-32,48
Nicaragua	2,2	-11,43	-18,78	-23,25	-32,71	-47,41
Panamá	1,8	-8,82	-16,50	-18,08	-24,97	-34,25
Centroamérica	2,9	-7,53	-11,88	-15,06	-22,41	-30,23
				Escenario A2		
Costa Rica	3,3	-10,01	-9,09	-19,85	-32,83	-39,98
El Salvador	5,3	-13,11	-12,05	-24,32	-36,21	-50,32
Guatemala	2,6	-9,33	-10,38	-19,27	-28,63	-41,71
Honduras	2,3	-11,60	-13,80	-24,37	-36,67	-49,92
Nicaragua	2,2	-15,94	-18,84	-33,60	-53,55	-68,84
Panamá	1,8	-6,07	-7,19	-12,07	-35,38	-48,89
Centroamérica	2,9	-11,07	-12,26	-22,60	-36,78	-50,25

Source: ECLAC

Taking as reference the model developed by ECLAC for Central America, the information can be extrapolated, assuming that the conditions may be similar in the Dominican Republic.

Conclusions

The 7 countries of the study have made important progress towards the achievement of the objective of sustainable development 2 “zero hunger”, but despite the efforts still more than 7 million people are undernourished.

The availability of food is a dimension that the countries studied have managed to overcome through the increase in production yields of the main products on which the contribution of food energy from the countries of Central America and the Dominican Republic rests, mostly cereals (corn , rice, wheat and sorghum) and a legume (bean), added to the external dependence, in the case of the products of lower production within each country.

The dimension of physical and economic access to food is highly conditioned by poverty, which afflicts between 20% (Costa Rica) and 65% (Honduras) of the population in the countries, which in turn demonstrates a high inequality in the distribution of income in the population. This situation, adding to the variation and rise in food prices, low wages, crop losses due to the onslaught of climate change, shows a high level of food vulnerability especially for the poorest sectors.

Even malnutrition persists in and other forms of malnutrition in children under 5, a situation that makes them more vulnerable to climate change, as they belong to families with limited resources, who lose their livelihoods to cope with climate change, which condemns them to suffer hunger, with its consequences on nutritional deficiencies.

The projections in production of basic foods such as corn, beans and rice are not encouraging for the Central American region, in any possible scenario the losses in productivity are imminent, which demonstrates the level of vulnerability of the current and future countries.

Recommendations

It is necessary to redouble efforts, carrying out comprehensive actions to achieve the objective of sustainable development 2 by 2030.

Actions focused on taking climate change adaptation, strategies for grain production are urgent and necessary in the region to guarantee food and nutritional security, especially for the most vulnerable families.

In projects that seek to improve the conditions of families to face the effects of climate change, they must consider the importance of vulnerable groups by life cycle, such as children under five years of age, pregnant and lactating women, as well as older adults. Giving priority and attention to these groups, ensures that food and nutritional insecurity suffered in crisis situations does not have an immediate or long-term impact, causing irreparable damage to their development.

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Water security

GENERAL ASPECTS

Central American countries and Dominican Republic have been periodically affected by extreme hydro meteorological phenomena, including mainly the drought. It has been presented with greater emphasis in the areas of Dry Corridor of Central America and in the arid areas in the north east of the Dominican Republic, which has meant large crop losses and decreased livestock production, decreased crop yields, increase in poverty rates in rural areas, impact on food security and a reduction in water availability due to the decrease in rainfall expressed in reduction of aquifers and surface waters.

According to projections of climate change scenarios, the Central American region will experience temperature increases estimated at 1.5 ° C by mid-century and an increase in order to 3° C at the end of the century. In relation to the rain, it is considered that the Caribbean region of the southern zone of Central America could experience an increase in precipitation between + 5% and + 15% by the middle and end of the century, and the Dry Corridor area of Central America could experience estimated reductions between -20% and -30% for the same period (IPCC, 2013).

Regarding to Dominican Republic and according to the First National Communication (SEMARENA et al., 2004), and considering the scenario of IS92f emissions and HADCM2 model, there will be a gradual reduction in precipitation and temperature increase in 2010-2100 period, which is shown in the following table:

Table 1: Expected values of temperatures and precipitation for the years 2010-2100. Model HADM2 and emission scenario IS92f

Año	2010	2030	2050	2100
Temperatura ºC	26.2	26.9	27.7	29.6
Precipitación mm	1277.0	1137.0	976.0	543.0

Source: First National Communication

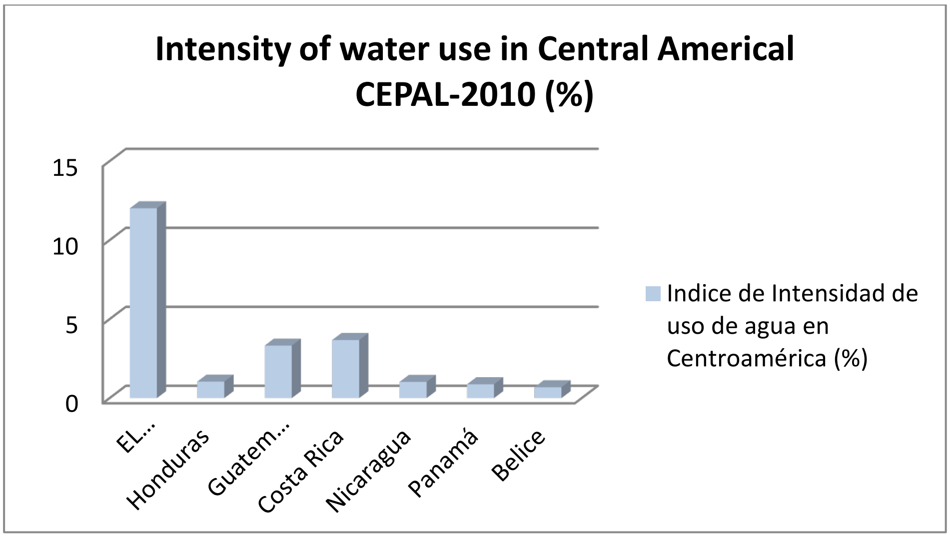
This reduction in precipitation and increase in temperature represents a strong impact on the country's water potential, both surface and underground, which would also cause the deterioration of the chemical and biological quality of the water.

According to the statistical analysis of the rainfall and temperature record of 12 weather stations monitored by ONAMET in the period (1984-2013), there is an average increase between 1°C–3°C in maximum temperatures (CATHALAC 2014).

In general, the impacts of climate change on water resources reflect a reduction in rainfall and an increase in temperature (greater evapotranspiration and loss of soil moisture) that will directly affect the availability of water resources for the coming years.
This climatic condition, together with anthropic processes of deforestation and increased surface runoff, loss of water recharge areas, urban development in sensitive areas, erosion and expansion of crop areas without soil conservation works, are aspects that contribute to increasing impacts of climate change in terms of further reduction of water availability.

Demand for water for different uses in the countries has been gradually increasing with demographic growth, expansion of the industrial, commercial and tourism sector, demand in power generation, greater extractions for irrigation of agricultural plantations and the expansion of urban centers. The intensity of water use, which is formulated through the percentage relationship between total demand and water availability, was estimated by ECLAC (2010) and is expressed in the following comparative chart 1 for Central American countries.

Figure 1 Comparatives Intensity of Water Use in CA



Taking this context into account, the adaptation measures aimed at the implementation of efficient water technologies, rainwater collection, reservoir dam implementation and small reservoirs are of great importance, with special emphasis on rural areas and prioritised municipalities of the countries as well as low consumption irrigation systems, community water treatment systems, among others.

The water resources availability, the offer and extraction water for all use according to references of the countries is submitted in the Chart 2.

Table 2 Water Resources availability in the countries

Country	Average precipitation annual (mm)	Precipitation (Km3)	Evaporation (Km3)	Water availability (Km3)	Consumptive Water use (Km3)	Intensity of use (%)
Costa Rica (1)	2926	170.3	51.4	118.9	3.6	3.1%
El Salvador(2)	1785	56.8	36.5	20.3	2.2	10.8%
Guatemala(3)	1996	217.3		127.1	3.4	2.7%
Honduras (4)	1880	211.9	124	87	1.9	2.2%
Nicaragua (5)	2280	297.2		63.5	1.6	2.5%
Panamá (6)	2928	220.8		137	3.6	2.6%
República Dominicana (7)	1500	73	51	22	8.2	37.3%

Source: (1) IMTA (2008), cited in GWP (2017)
(2) MARN (2017) included trans bordering basin
(3) GWP (2017), and FAO (2015)
(4) CEDEX (2003), cited in GWP (2017)
(5) CIRA/UNAN (2008), cited in GWP (2017), and FAO (2015)
(6) FAO (2015), and UNESCO (2008), cited in GWP (2017)
(7) FAO (2015)

AVAILABLE AND USE OF WATER RESOURCES ON TARGET AREAS AND WATER TECHNOLOGIES USE.

COSTA RICA

The last National Water Balance (IMTA, 2008, cited in GWP, 2017), determined the availability of water per year at 113.1 km3 (113,100 hm3), of which 38 km3 infiltrate producing the recharge of aquifers.
The total water demand for 2006 was estimated at 16,704.89 hm3 per year (14.77% of the supply), where of the surface extraction, 78.21% is for hydroelectric power production, 18.52% for other surface uses, 1.46% is extracted from the wells, and 1.78% from the springs. Taking these data into account, the consumptive demand for water is reduced since much of the water resource used for hydroelectric production is reusable downstream after power generation.

The total water concession in 2015 was 3,436,865.56 liters / second, where 93.2% corresponds to hydraulic force, 4.7% for irrigation and 2% for the rest of the uses including agribusiness, agriculture, industry and consumption human.

Regarding to the quality of water resources, between 2001 and 2009, about 50% of the pipe aqueducts presented some type of oil pollution, some type of pesticide and nutrients. The pollution by calcium, arsenic and aluminum arisen from geological and natural sources. (AyA, 2016, cited in GWP, 2017).

The particular area of interest for the project, the Province of Guanacaste, the Tempisque river basin, where the municipalities Liberia, Nicoya, Santa Cruz, Bagaces and Carrillo are located, constitutes one the main development areas of agricultural, agro-industrial and economic of the country.

In this region 24,000 ha of sugarcane is produced and 25% of the national rice. This region is the main melon producing area and is a zone for producing basic grains and raising livestock. This province is strongly affected by drought phenomena, affecting crops, water resources, supply systems for the population, as was the case of the drought in 2015.

Arenal Tempisque Irrigation District (DRAT) is located in this region, which supplies water to 1,017 producers of sugarcane, livestock, cotton, watermelon and fish farming, covering an area of 27,728.99 Ha, of which 86.7% is by gravity, 10.7% by pumping and 2.3% for fish farming.

The prioritised cantons are located in the northern Pacific of Costa Rica and it is an area characterized by the presence of wetlands, protected natural areas, conservation areas, national parks, wildlife refuges and ecosystems of great national and international importance. The most part of the territory has low slopes with high fertility soils where agricultural extensions and livestock predominate. It has elevations of 1000 masl in the areas of mountain ranges. Precipitation in the area varies between 1500 mm to 2500 mm.

It is an area of lower water wealth at the national level and present a significant reduction in flows in the dry season, which impacts on the productivity and supply of the population.

According to climatic reports of the National Meteorological Institute IMN (2018), the phenomenon of El Niño Southern Oscillation (ENSO), significantly affects the behavior of rainfall and the temperature of the region, generating decreases of 417 mm which is equivalent to 26% annual deficit and temperature increase of 1.2 ° C on the day. The Tempisque catchment one of the most affected areas. This basin has an area of 3382 km2 and has a maximum elevation of 1900 masl, an average of 169 meters above sea level and a minimum is practically at sea level. 90% of its territory has medium to low slopes. The water supply of the cathment is 8 km^3/year and the water withdrawal for all uses is 0.885 km^3/year (MINAET, 2011). The primary uses are:

- Agroindustry 16.78%
- Irrigation 77.90%
- Commercial 0.01%
- Human Consumption 0.13%
- Industrial 0.16%
- Tourist 0.47%
- Agricultural 0.99%
- Aqueduct 3.56%

Among the adaptation measures carried out in the region are sprinkler irrigation systems and reservoir construction.

Table 3 Reservoir construction for irrigation system implemented by the municipalities

Municipality	size (ha)	Families	Water source
Carrillo	40	46	Wells
Santa Cruz	13	38	Wells and stream
Liberia	11	22	stream
Bagaces	160	70	stream
Nicoya	8	6	wells

Source: Llanos del Cortes, Falconiana y Marañonal (2017)

EL SALVADOR

According to the National Integrated Water Resources Management Plan (PNGIRH) carried out in 2015 by the Ministry of Environment and Natural Resources (MARN, 2017), it determined an annual national availability of 20,338.8 Hm^3.

Total water withdrawal for all uses was calculated at 2,120.51 Hm^3 per year for the 2011-2012 hydrological year, corresponding to 10.4% of the annual availability, which 53.18% is for agricultural activities, 27.23% for human consumption, 11.89% thermoelectric sector, 3.68% industrial sector, 2.94% for the aquaculture sector, 0.99% livestock sector.

Río Grande de San Miguel basin is the hydrographic area where the prioritised municipalities of El Salvador are located. It occupies the third largest place nationwide, after the Lempa and Goascorán river basin, respectively (MARN, 2017), with a total area of 2,396.70 km^2. It has an average annual rainfall of 1689.91 mm and an average annual contribution considering surface and groundwater of 1,267.5 Hm3 (MARN, 2017).

The total annual demand in the San Miguel catchment estimated by the PNGIRH was 104.15 Hm^3, which 51.34% is due to agricultural activities, 44.51% for human consumption, 2.90% for energy sector, 1% for industrial activities and 0.25% for hotel sector.

Its population is approximately 505,600 (MINEC-DIGESTYC, 2018). It is important to establish that the actual availability of water varies in time and space, as it is conditioned by the rainy season (May - October) and by the dry season (November-April).

Río Grande de San Miguel basin is located in an area of high vulnerability to drought, which is characterized by experiencing recurring inter annual periods with more than 15 consecutive dry days. This situation has a direct impact on water resources, causing the groundwater levels of the wells to decrease and the average river flows to decrease significantly up to 60% less than the average flows in the dry season.

The prioritised municipalities of El Salvador that are immersed in this river basin are: Concepción Batres, Jucuarán, El Carmen, El Tránsito and San Miguel. They are located in the lower middle part of the hydrographic basin.

The local economy in all municipalities is fundamentally based on the rainy season for the crop of basic grains (corn and beans), and some vegetables such as chili and tomato in small agricultural plots.

There are some local irrigation systems in plots near the wetland areas. Small water reservoirs have been implemented for the cultivation of vegetables at the community level, which has been promoted by the Agricultural Ministry (MAG).
Similarly, the “Plantatón” government program has been carried out, which is a reforestation plan promoted within the strategy of Bonn challenges.

GUATEMALA

The situation of water resources in Guatemala, is established based on the national water balance of Guatemala in 2003, prepared by INSIVUMEH and IARNA 2012, It indicates that the total water availability of the country was 93,338 million m3, (GWP, 2017). According FAO 2015 the water availability is 127.1 Km^3. Guatemala does not have a detailed hydrogeological study to better classify the country's aquifers. However, different studies estimate the annual available volume of groundwater at around 30,000 million m3 (IARNA 2012, MARN 2011, cited in GWP, 2017).

Withdrawal water for all uses represents 22%, of which 37.5% are used by industry and agribusiness, while agricultural and silvopastoral activities use 31.9%, and 24.8% by generation hydroelectric It should be considered that in this case the use of water for hydroelectric generation is assumed as a consumptive use.

This resource is under heavy pressure. According to IARNA (2012, cited in GWP, 2017) and MARN (2011, cited in GWP, 2017) of the 38 river basins that the country has, 22 of which are transboundary, 14 have high physical, biological and toxic pollutant contamination. In 2015 there was a record of 547 entities that generate wastewater, of which 151 comply with the parameters of regulation 236-2006 of discharges to water bodies, while 286 do not comply, 15 are from municipalities with some degree of compliance and 95 They have not been monitored for different reasons. The lack of effective pollution controls by municipalities and other generating entities, leads to a decrease in availability, as well as an increase in health risks in the population, especially those that are most vulnerable. Conflicts over water scarcity, poor service quality or disputes over water sources are frequent in different areas of the country.

Climate change represents one of the primary factors in the impact on water resources. Drought and reduced levels in the aquifer have significantly affected crop production and drinking water services which depend on pumping systems. These systems are been impact for the increase in electricity consumption and the need to deepen wells in some cases, which has had an impact on the overexploitation of aquifers.

In 2015, Guatemala faced serious drought problems and in the months of October and November, there were significant floods that caused severe flooding on the South Coast, Izabal and Alta Verapaz.

The department of Quiché is the area of interest of the project. There are the Chixoy River and Negro River, which run through the municipalities of Uspantán, Canillá, San Andrés Sajcabajá, in the area of the Chixoy hydroelectric dam.

Quiché department is characterized by high levels of poverty, with 74.7% of the population in this condition and 41.8% in extreme poverty according to UNDP 2014 data. Agriculture is one of the main lines in the life of Its inhabitants, due to the variety of climates, combined with the large number of rivers that run through its territory, which allows the crop of basic grains and vegetables (potatoes, beans, peas), and other plantations such as sugar, cane, rice and tobacco.

In almost all municipalities there is livestock production, horses, sheep and goats. The region is also characterized by having diversity of tree species, shrubs and forests.

HONDURAS

The 2003 Water Balance of Honduras by the Center for Studies and Experimentation of Public Works (CEDEX), estimated a total supply for Honduras of 87,653 Hm^3. (GWP, 2017).

According FAO (2015), the withdrawal water for all uses is 1.9 Km^3. 52.40% is for the extraction of water for irrigation, human consumption (14.32%), hydroelectric power production (13.63%) and industrial production (5.18%). Mining consumes 0.01% and other uses 14.45%.

The demand for urban water has meant in many cases the overexploitation of aquifers and the deterioration of quality water due to domestic and industrial wastewater.

The withdrawal water for all uses is 2200 Hm^3/year, which includes all uses, where less than 10% is supplied with groundwater (excluding irrigation) and the rest with surface resources.
Regarding water quality, it is important to mention that the country does not have systematically a water bodies monitoring. However, the Choluteca, Chamelecón and Ulúa rivers are priority basins due to domestic and industrial pollution.

In Honduras, the National Climate Change Strategy was developed, seeks to increase the resilience and adaptability of human and natural systems. The strategy constitutes the frame of reference for the establishment of a national policy framework for climate change, both in terms of adaptation and mitigation.

Southern Honduras, which is the area of the Dry Corridor where the prioritised municipalities are located, constitutes the most vulnerable area to climate change, according to the projected scenarios. The affectation by less rains and the increases in temperatures, “could reach a disaster character if the necessary adaptation measures are not taken” (SERNA nd, cited in GWP, 2017).

The National Climate Change Strategy points out that climate variations threaten Honduran agricultural production in the poorest rural and urban populations. To cope with this situation, efficient irrigation, reservoirs and adequate drainage appear as the most important adaptation measures.

The investments projected from the State have been based on the “Vision of the Country” of Honduras 2010-2038 and the 2010-2022 Nation Plan, which are intended to increase to 400,000 hectares under irrigation, to ensure 100 percent of the national food requirements and help fight poverty. As of 2013, 140,000 hectares were reached under irrigation.

The drought of 2014 - 2015, affected 146 municipalities of which 81 had severe affectation (83,229 families of small producers), effects mainly related to the loss of crops and food insecurity of the population.

From this perspective, the prioritised municipalities of Choluteca (Apacilagua, Marcovia, Orocuina, Morolica and Duyure) are precisely immersed in this area of high vulnerability to drought, where one of the main risks is the interannual loss of agricultural production and livestock, as well as the reduction and scarcity of water for the supply of the population.

The physiography of region is mostly composed of high slopes greater than 15% in 60% of the territory. The plain areas constitute 8% of the territory and the areas of high slopes greater than 30% make up 32% of the territory. The soils are clayey texture, which favors surface and subsurface runoff.

It has altitudes between 55masl and 1300 masl considering 85% of the territory suitable for forest planting. The area is mainly dedicated to the cultivation of corn and beans.

Among the projects considered as adaptation measures to climate change considered by the municipalities, the construction of reservoirs for water supply to communities and fish production stands out. Its implementation is considered in catchments of the Choluteca River. On the other hand, the implementation of 12 drip irrigation systems for irrigation from 8 ha to 15 ha is considered.

NICARAGUA

According to GWP (2017), the country has a potential of 57,668.9 Mm3 of water per year, of which 50% is usable. 48,404 Mm3 per year drain on the Caribbean slope, while,on the Pacific side they drain 3,479.3 Mm3 per year. According FAO (2015), the water resource availability is 63.5 Km^3. The groundwater recharge level is 4,507.2 Mm3 per year in the Caribbean and 1,278.1 Mm3 per year in the Pacific. Most of the Pacific basins are fundamental to the country's food security and economy. However, they show high demand and insufficient capacity to meet the needs of the region.

The main users of the water resource are irrigation, livestock, industrial, domestic, commerce and ecological demand. The total national withdrawal water for 2011 reached 1.545 km3, highlighting the agricultural sector with an extraction of 1,185 km3, equivalent to 76% of the total extractions, of which 1.110 km3 correspond to irrigation and 0.075 km3 to the livestock sector.

In terms of water quality, it is greatly affected by a high consumption of pesticides, as well as by the inappropriate handling and disposal of solid waste, and of industrial waste without treatment. ENACAL in Managua develops a Program for the Control of Industrial Discharges and Wastewater Treatment Plants (WWTP) for Lake Managua or Xolotlán. With the start of operations of the WWTP in February 2009, an Evaluation and Monitoring Program of the water quality of the receiving body (Lake Xolotlán) is developed.

Like much of the Central American region, Nicaragua has been impacted by extreme events in recent years, from extreme rains such as the Tropical Depression 12 E event, to severe droughts in recent years. Regarding the impact of climate change on basic grain crops, in 2014 the Humboldt Center and Christian AID conducted the study of Impacts and alternatives of Basic Grains in Nicaragua in the face of Climate Change, 2014. The main objective is to assess the impacts of Change Climate in subsistence agriculture in the social, environmental and economic fields of the Nicaraguan families of the rural areas, especially in rice, beans and corn crops, in order to generate relevant information for the construction of public policies and agricultural practices contributing to the knowledge management in adaptation to climate change. This study indicates that in the Dry Corridor area of Nicaragua, basic grain crops are highly vulnerable to climate change, so it is necessary to take adaptation measures, generating conditions for irrigation, accompanied by a good seed program, technical assistance, technology for harvest and post-harvest, market, prices, incentives, subsidies, credits, access to other technologies, etc.

The implementation of efficient irrigation systems becomes a priority measure in the framework of public policies aimed at adapting climate change.

In relation to the municipalities of interest in the project, located in the upper basin of the Coco River, provinces of Madriz and Nueva Segovia, the municipalities of Somoto, Yalaguina, Palacaguina, Telpaneca and El Jícaro, are affected by severe droughts, but also by floods in torrential rains, associated with deforestation problems. The average annual rainfall in the prioritised municipalities is between 420 mm - 1410 mm. Most of the territory has high slopes (30% - 50%) which leads to erosion considered moderate to strong. In the flat part are the wells that supply water to a large part of the population.

According to the document Somoto Characterization (Alcaldia Municipal de Somoto, 2017), the strong reduction of forest areas, mainly gallery forests and the inappropriate use, management and practices of the lands, as well as climate change, have aggravated the meteorological and water drought. This situation every year causes more dry rivers and others with a reduction in flow with is a risk to availability and quality of water for the current and future municipal population. The entire Municipality is exposed and undergoes processes of accelerated soil erosion, due to poor land management, deforestation, agriculture without conservation works and overgrazing lands with steep slopes. The main activity in the Municipality of Somoto is the cultivation of basic grains (corn and beans). Henequen, sorghum and coffee are also produced in the region. The cultivation of vegetables is also practiced in 12% of the communities through small irrigation systems. This municipality presents a municipal strategy for adaptation to climate change with proposals for action lines and adaptation measures for prioritised sectors

The municipality of Yalagüina is characterized by being one of the poorest municipalities in the department of Madriz, with 51% of the families that depend on agricultural production, for self-consumption with predominant crops of basic grains of corn, beans and sorghum, as well as the municipalities of Palacagüina, Telpaneca and Jícaro.

A decrease in rainfall between 30% - 34% of rainfall is reported, which was carried out by analyzing 27 weather stations located in the north of the country with data between 1956 and 2009. There has been a decrease in flows and reduction of the water supply in the territory, which has generated crop loss, degradation of ecosystems and decrease of forests in areas of protection of water sources (Somoto Municipal Strategy 2011). Among the climate change adaptation strategies they propose:

Environmental planning plan for the territory and water resources management in the Inalí, Musunce, Tapacalí, Orocuina and Yarí river microbasins, which are cathments of the Coco River.

- Expand water harvesting systems such as small reservoirs and irrigation ponds with an average capacity of 20,000 mt3 to 40,000 mt3. Promotion of agricultural diversification and use of improved seeds resistant to drought.
- Promotion, expansion and management of energy forest for firewood and coal (250 Ha). 29% of Somoto homes do not have electricity and use wood and coal for food processing. A per capita consumption of wood of 510 kg has been established and a minimum annual consumption of 5000 tons is estimated.

- Expand the irrigation of vegetables that exist in the municipality through small systems of efficient micro irrigation in the riverine flat areas to the rivers. It is estimated that about 150 families Somoto are currently benefiting from parcel irrigation systems.

PANAMA

According to Panama's national water balance for 2008, the average annual runoff is 1764 mm, equivalent to 133,200 Mm3 (UNESCO 2008, cited in GWP, 2017).

The internal freshwater resources are 137,000 Mm3, of which the annual freshwater extraction is 1,000 Mm3, and of these 43% corresponds to the extraction of fresh water for agricultural use, while 56% is for domestic use and 1% for industrial use.

The main uses of water in Panama are: water for the lock in the Panamá Chanel, hydroelectric generation, sluice, agriculture, and tourism-recreation (not consumptive) and finally, domestic and industry (consumptive).

The main irrigation areas are located in the provinces of Herrera, Los Santos, Coclé, Veraguas and Chiriquí. There are 31,410 hectares with surface water irrigation and 730 hectares with groundwater, which require a water volume of 405.6 million m3.

In relation to the population supply, the volume of water distributed in 2014 was 733.2 Mm3 (IDAAN, 2014, cited in GWP, 2017) and according to PAHO, 97% of the urban population has access to improved water sources, and 80%, to improved sanitation facilities. Regarding the rural population, 87% have access to improved water sources, and 52%, to improved sanitation facilities (PAHO, 2014, cited in GWP, 2017). Improved water is not necessarily drinking water.

For 2014, Uncounted Water (ANC) reached 48.3%. It should be noted that Panama is the country with the highest daily water consumption per inhabitant (362 lt / inhabitant / day) in America (ADERASA, 2014).

The Management of Groundwater is weak, the exploitation has been isolated, empirical and disorderly, without previous or simultaneous studies of hydrogeological exploration and without the application of hydrogeological management tools that allow to guarantee the sustainability of the resource, in the face of threats such as pollution, overexploitation and saline intrusion.

The Ministry of Environment controls the country's water quality. According to the National Plan for Integrated Water Resources Management of the Republic of Panama 2010-2030 (PNGIRH) (ANAM, 2011), since 2002 the monitoring of rivers at the national level is carried out. The values of the Water Quality Index from 2005 to 2010, indicated a trend in the improvement of water quality, by decreasing the percentage of highly polluted and contaminated classification, while increasing the points classified as poorly contaminated and acceptable. In 2013, the largest wastewater treatment plant in Panama City and Panama Bay (PTAR) began operations, a state project to improve the sanitary and environmental conditions of 1.2 million inhabitants of the city from Panama, San Miguelito and its surroundings.

The demand for water for different productive uses and activities is constantly increasing, and although Panama has a high availability of the resource, there has been greater competition for the use of the resource and conflicts between various social sectors. These conflicts have been increasing over the past twenty years.

The Institute of National Aqueducts and Sewers of Panama (IDAAN), has drilled wells throughout the country, to provide water for human consumption. In the search for new aquifers, IDAAN drills more than 120 meters deep. This contributes to the reduction of pressure on overexploited groundwater aquifers, such as those existing in the Dry Arch, which are clearly in the process of reducing their production.

The IDAAN uses 87,937 cubic meters per day, 5.86% of the production of groundwater for human consumption. The Ministry of Agricultural Development and the Ministry of Health is another major user.

The prioritised municipalities in the Dry Arc region of Panama are Guararé, Macaracas, Pedasí, Pocrí and Tonosí. This area has a tropical savanna climate and moderate temperatures with an average annual rainfall of 1200 mm.

The main economic activities of the province are agriculture, livestock and forestry. 80% of the territory is arable land, predominantly arable crops of rainfed -cereal-, corn and rice. The area is highly influenced by the El Niño phenomenon, which has an impact on strong interannual droughts. 15% is used by livestock and less than 10% is forest cover. A large part is suitable for forestal explotation.

Rain in the region of prioritised municipalities is between 1000 mm - 1400 mm.
According to the hydrogeological map (Empresa de Transmisión Eléctrica, 1999) the rain was experienced between 1300 mm - 1500 mm. In the current times there has been a significant reduction estimating an average rainfall of 1000mm.

Its climate is tropical Savannah and presents a shortage of surface and underground water. The dry season extends for up to 7 months under the impact of the El Niño phenomenon. The municipalities are mainly located in the basins of the Tonosí and La Villa rivers, which has an area of 2,170 km2. The region experiences a low surface and subsurface runoff.

DOMINICAN REPUBLIC

Average annual rainfall of the Dominican Republic is 1,500 mm, which represents an annual volume of water throughout the territory of 73 km3. Of this total volume, about 70 percent is lost in evapotranspiration and direct evaporation of water bodies, so the remaining annual water resources are 21 km3. The total surface runoff is estimated at 19.5 km3 / year, with a base flow of 11.7 km3 / year. (UNDP, 2000, cited in PLENITUD et al., 2014).

The average temperatures in the cold months (December to February) are 20°C–25°C and in the hottest months (June to November), temperatures fluctuate between 25°C and 27°C.

According to the Ministry of Environment and Natural Resources, the Dominican Republic has 35 dams built with a reservoir capacity of 2,191.4 million cubic meters (m3), most of which have a multipurpose, such as electric power production, supply to aqueducts for human consumption, regulation flows and irrigation of agricultural areas. (PLENITUD et al., 2014). Groundwater has a potential of 1500 million m3 / year, but currently less than a third of this value is extracted. (PLENITUD et al., 2014).

Around 76% of the area of the Dominican Republic is dedicated to agriculture, 17% of which is irrigated agriculture. FAO (2015) indicates that, 270,000 ha are equipped for irrigation. The needs of the irrigation subsector are related to the improvement of efficiency, productivity and organizational aspects. According to FAO, solutions should be sought in the use of better technologies, the efficient operation of irrigation systems and the appropriate means of financial assistance. The lack of maintenance of the existing infrastructure and the irrational use of water are the causes of the low (global) efficiency of irrigation.

In the zoning of livelihoods for the Dominican Republic carried out by the World Food Program (WFP, 2017), the provinces of Santiago Rodríguez and Dajabón belong to Zone 4, corresponding to basic grains, minor fruits and border trade, whose Main productive activities are the trade of agricultural and agroindustrial products in the binational market. In this area, the production of basic grains (beans, guandules and corn) is the highest at the national level, informal employment in the commerce sector is important and the workforce of immigrants from Haiti stands out with a high proportion in the agricultural sector.

Integrated context index (ICA), which identifies the territories where long-term program strategies must be implemented that can help vulnerable and food insecure populations in ways that complement and protect the long-term development trajectory presents in each country, based on the analysis and interpretation of data on the recurrence of food insecurity, the location of risk records and / or exposure to climatic events; the provinces of Santiago Rodríguez and Dajabón, present a category 3 This category means that their municipalities have recurrent food insecurity, so they require the implementation of activities aimed at establishing or strengthening social protection networks. Although the risk of disasters due to natural hazards is low, the local context could benefit from early warning and emergency preparedness activities to reduce the impact of possible future events. Food insecurity in these areas is likely to be more affected by chronic poverty and deterioration of livelihoods. (WFP, 2017).

In relation to the prioritised municipalities in this project, the municipality of Villa Los Almácigos, has a high biodiversity richness, but with a high level of degradation and fragmentation of its ecosystems, so a process of restoration and recovery of the original vegetation is needed for restore the proper functioning of ecosystems and basic environmental services for communities. Regarding water resources, the importance of water production is highlighted, since there are numerous aquifers in the area that feed the Guayubin and Artibonito river basins, which supply water to the communities in the area. These water sources are threatened by the advance of the agricultural frontier, with the logging and burning of Rivera forest and other species of flora and fauna.

Among the crops that predominate in the municipality, are cassava, auyama, peanut, corn, beans, plantain, sugar cane, dry rice, coffee, on soils degraded by continuous tillage. There is an excessive use of agrochemicals, which have negative impacts on water resources in the area. The cattle ranch stands out, which has a great impact on the riparian forest, the secondary broadleaved forest and the grasslands. In this municipality, the main environmental problems are deforestation due to logging and burning, erosion, water pollution due to the use of pesticides and forest fires. Deforestation is almost over with the Creole pine forest for wood use. (Ministry of Environment and Natural Resources Vice Ministry of Protected Areas and Biodiversity, 2016).

In the municipality of Monción approximately 47.8% of the municipality is occupied by forest, of which 44.9% is dry forest and only 2.6% is coniferous forest located in the southwest part of the municipality towards the central mountain range. There is the coffee zone, which has 265 ha, 2% of the area of the municipality. In this municipality there is the Monción dam on the Mao river, which covers some 1,962 ha, 14.7%. 5.4% is covered by grass, to this area is added the surface of dry thickets with 15.3% that are land used for grazing animals. The economy of this municipality is based on the production of casabe, furniture factory, cassava production, livestock, cheese factory and livestock production (chicken farms, pigs, fishing).
In the municipality of El Pino, according to the 2002 Census (Oficina Nacional de Estadística, 2002), the main economic activities to which the population was engaged were: agriculture, livestock, hunting and forestry; with 14.9%, wholesale and retail trade 9.7%, industry and manufacturing 4.9%, other community service activities 4.0%, education 3.3%, private households with domestic service 4.5%; transport, storage and communications 2.3% and construction 2.1%.

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