ASAZGUA
Asociación de Azucareros de Guatemala

SUSTAINABLE WATER & ENERGY SOLUTIONS NETWORK

CASE STUDY:

Activities by the Guatemala Sugar Agroindustry supporting the implementation of the Sustainable Development Goal 13 (SDG 13) of the United Nations 2030 Agenda for Sustainable Development.

Asazgua: Association of Sugar Producers of Guatemala | 2023

The Guatemala Sugar Agroindustry has planted more than 6.7 million trees since 2011 as part of the annual reforestation program.

13

CLIMATE ACTION

TAKE URGENT ACTION TO COMBAT CLIMATE CHANGE AND ITS IMPACTS

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Asociación de Azucareros de Guatemala

SUSTAINABLE WATER & ENERGY SOLUTIONS NETWORK

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Take Urgent Action To Combat Climate Change And Its Impacts / Asazgua

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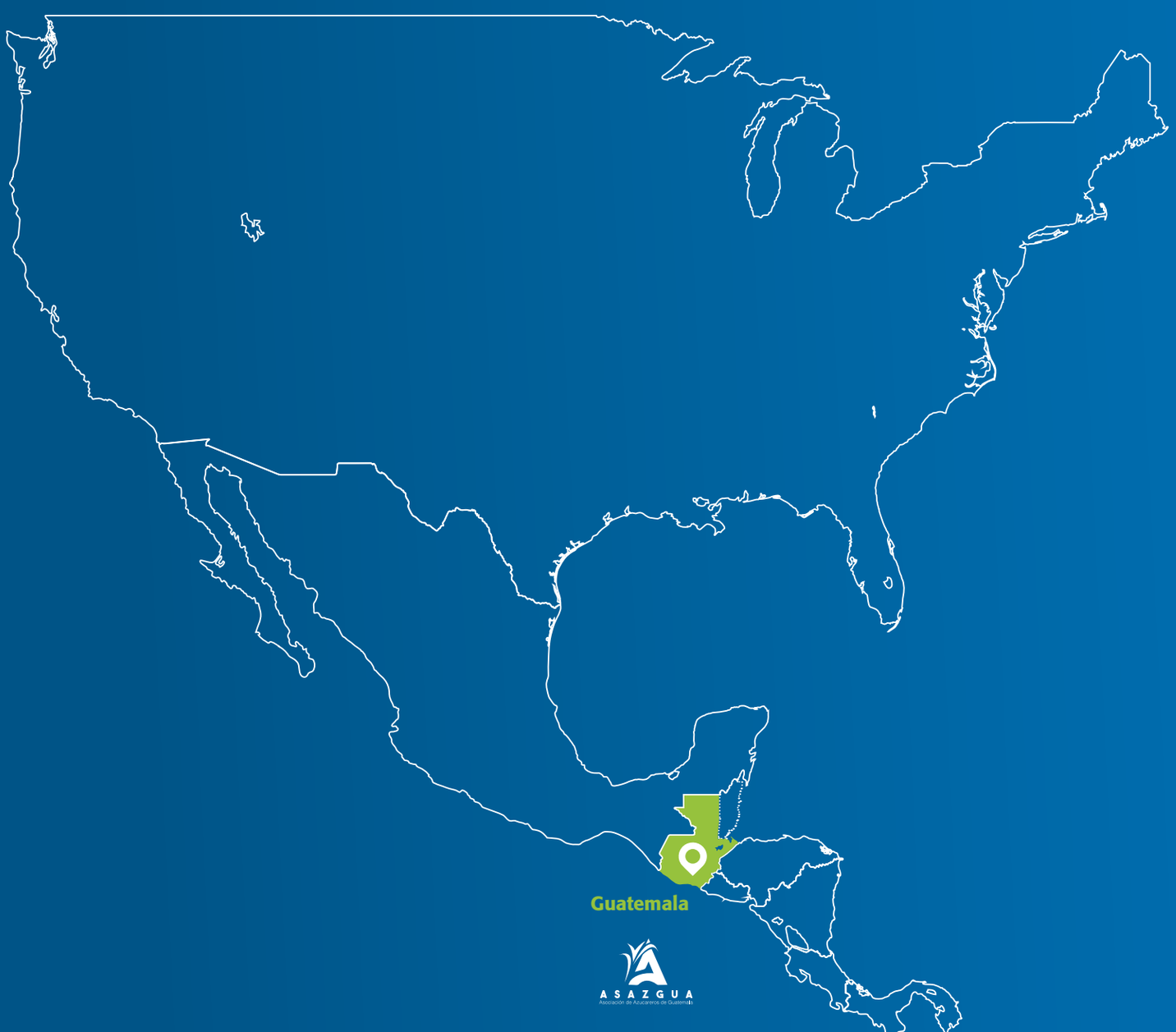

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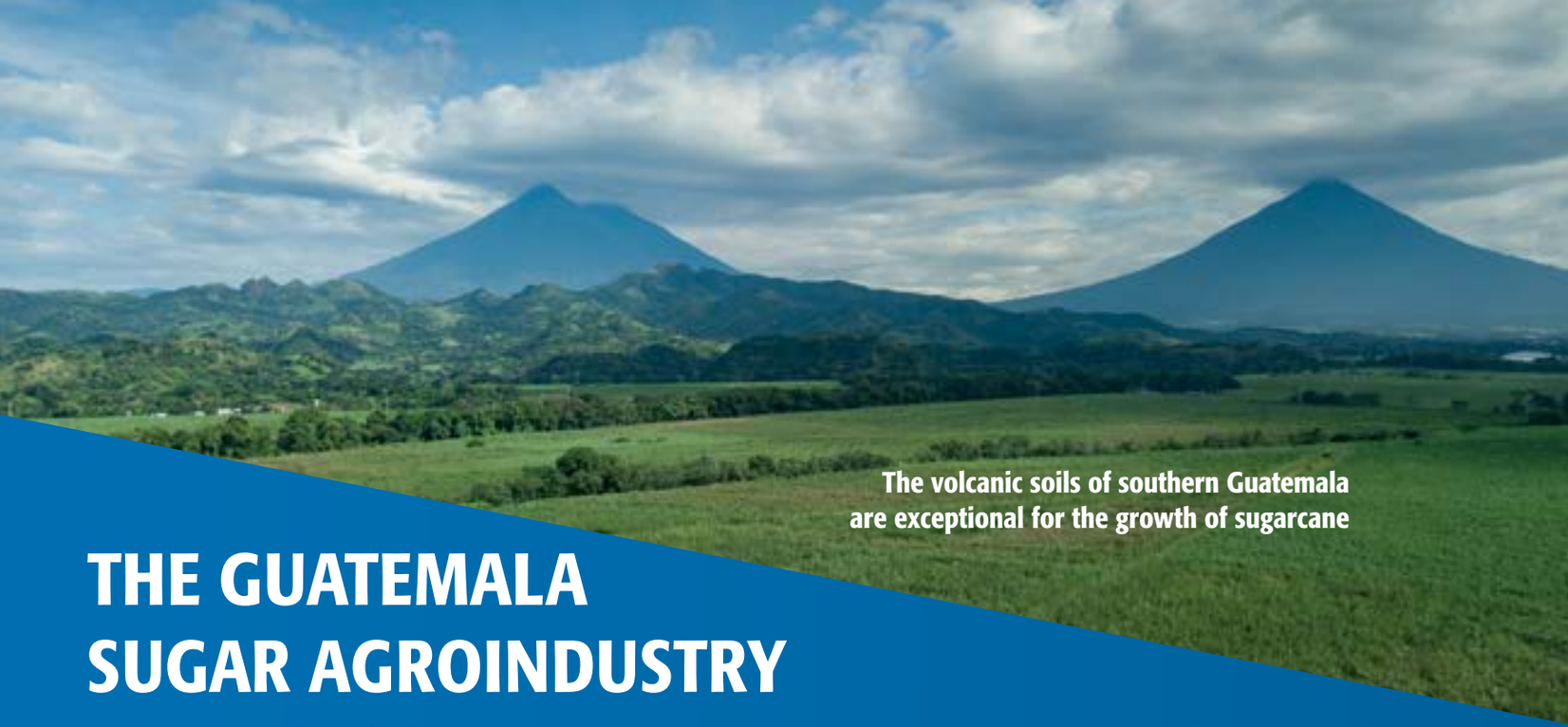
Target 13.3: Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

Target 13.a: Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible.

Target 13.b: Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities.

Source: United Nations, 2015



The volcanic soils of southern Guatemala are exceptional for the growth of sugarcane

THE GUATEMALA SUGAR AGROINDUSTRY

As of 2021, Guatemala was the third largest producer in Latin America and the sixth largest exporter of sugar in the world. Sugar is the second agroindustrial product most exported of Guatemala. The Guatemala Sugar Agroindustry generates almost US $700 million in foreign exchange annually and provides more than 55,000 direct jobs and 278,000 indirect jobs in the country. Besides, the sector receives products and services from more than 6,000 small, medium-sized and large enterprises, which also generate more employment. Only 2.97% of the cultivable land in Guatemala is used for sugarcane production. Asazgua, the Association of Sugar Producers of Guatemala, was created in 1957 to coordinate the activities of the Guatemala Sugar Agroindustry. It includes 11 sugar producers and five technical organizations specialized in research, climate change, sugar exportation and social responsibility (Asazgua, 2020). In addition, since 2022, it counts with an organization specialized in innovation. The sugar producers that are members of Asazgua include: Pantaleon, Concepción, Palo Gordo, Santa Ana, Magdalena, Santa Teresa, La Unión, Madre Tierra, Trinidad (San Diego), La Sonrisa and El Pilar.

The Guatemala Sugar Agroindustry is committed to generating opportunities and prosperity for the people of Guatemala that support the country's sustainable development. It promotes decent and valuable jobs for the wellbeing of the population, while at the same time promoting environmental protection and conservation.

The Guatemala Sugar Agroindustry follows sustainable development principles as reflected by its strategic objectives and integrated actions and programs, supporting social wellbeing, economic growth, industrialization, and environmental protection. The activities of the sugar industry in Guatemala are recognized as examples of "Good Practices" in the effective implementation of the United Nations 2030 Agenda for Sustainable Development and the Sustainable Development Goals.

Associated organizations supporting specific sustainable objectives of the Guatemala Sugar Agroindustry have been created in the last decades. In 1990 Fundazúcar was launched as the social branch for the development and implementation of programs and projects on health, education and development. In 1992 Cengicaña started research activities to develop new varieties of sugarcane, to have integrated pest management, to study land quality and to implement more efficient processes for the cultivation of sugarcane and for the production of sugar. In 1994 Expogranel, one of the most efficient boarding terminals for sugar export in the world, was launched to cover international markets in a more efficient and competitive manner. In 2010, the Private Institute for Climate Change Research (ICC) was created to perform research, activities and projects related to climate change. In 2022 the Innovation Hub was created to develop a program of innovative projects through the identification and optimization of products, activities, processes and business models of the Sugar Agroindustry.

At the international level, the Guatemala Sugar Agroindustry supports the work of ICC on climate change mitigation and adaptation with other countries of Central America. Also through Asazgua, it participates actively in the Global Network on Sustainable Water and Energy Solutions. This is an initiative led by the Division for Sustainable Development Goals of the United Nations Department of Economic and Social Affairs (UNDESA). The Network promotes integrated water and energy solutions that address climate change objectives worldwide.

SUSTAINABLE DEVELOPMENT STRATEGY

The Sustainable Development Strategy of the Guatemala Sugar Agroindustry is based on its vision, mission and objectives which promote a comprehensive and forward-looking transformative pathway to prosperity and peace for the people of Guatemala, at the same time supporting a healthy and sustainable planet. It follows an integrated approach based on transformation and adaptation to changes expected in the future due to new challenges. With its inclusive participation policy with multi-stakeholder partnerships, the Sugar Agroindustry, through Asazgua, is committed to coordinating the work of enterprises, governmental entities and civil society to achieve the final goal of prosperity and sustainable development for Guatemala. The Guatemala Sugar Agroindustry is a global example of efficiency and technological advance representing a very relevant factor for the economy of Guatemala with important positive impacts also on the social and environmental dimensions of sustainable development.

Objectives

1. Increase productivity through development and improvements in the field and in sugar refineries
2. Provide technical training and capacity building for human resources
3. Develop projects and programs that increase the capacity of the production systems in the field and in sugar refineries, in distribution and commercialization of products, and of the export boarding systems.

Vision

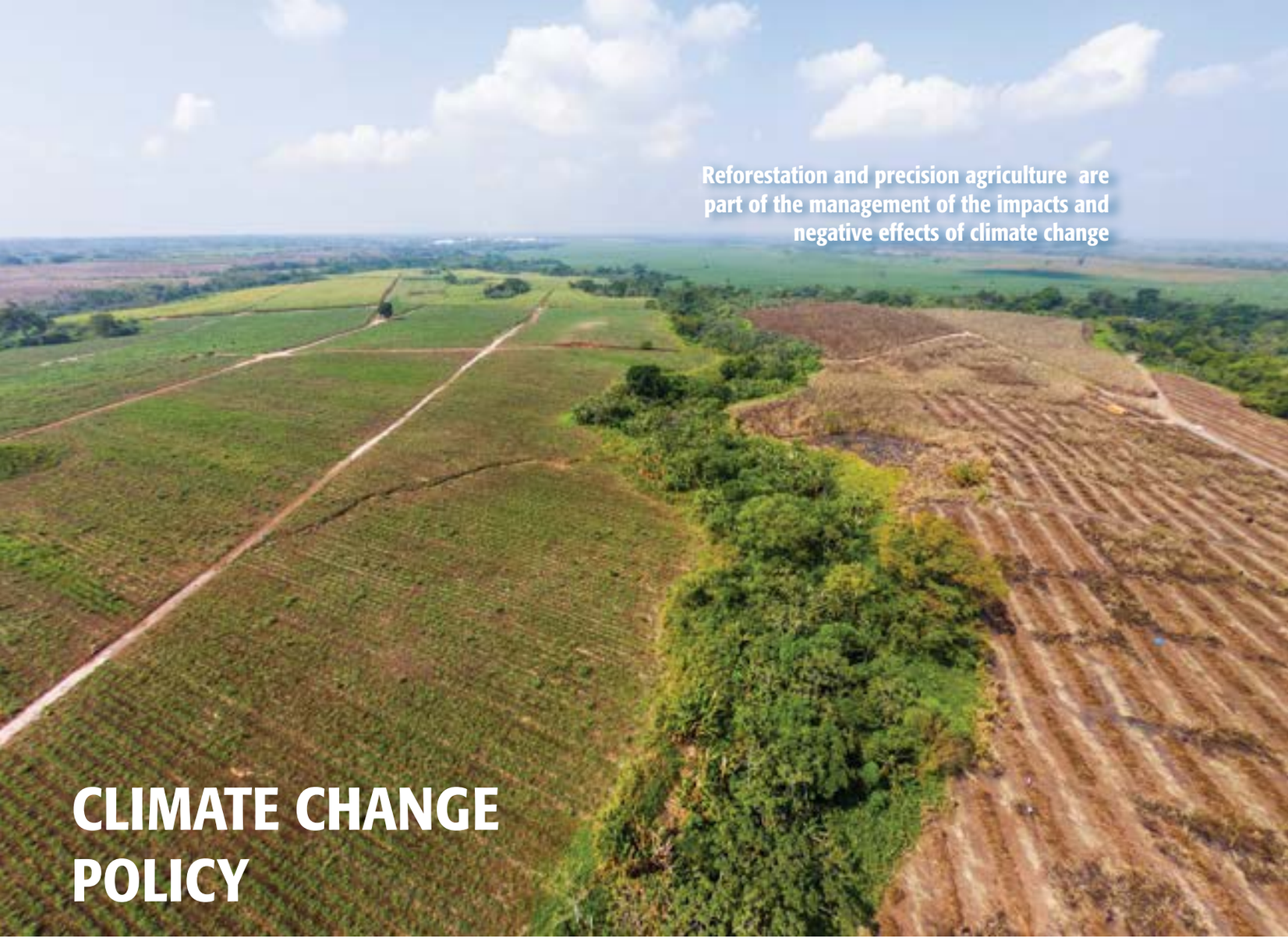
Before 2025 the Guatemala Sugar Agroindustry will be the most respected productive sector of the country due to diversification, competitive efficiency, generation of dignified jobs, and respect for the environment, suppliers and communities with whom it relates.

Given its policy of unified action, proactive attitude and strong socioeconomic support, the Sugar Agroindustry leads as a positive agent of change for integral development, boosting the progress of its members and the country.

One of the objetives of the Guatemala Sugar Agroindustry is to Increase productivity through development and improvements in the field and in sugar refineries.

Mission

The Guatemala Sugar Agroindustry mission includes the following: to act in united manner to cultivate and process sugarcane to produce sugar, electricity, ethanol and other products; to undertake other activities to increase the value of the associated enterprises with a positive impact on the integrated development of the country; to innovate constantly improving competitive efficiency; to facilitate national and international commercialization of sugar; and to ensure sustainability while building trust responsibly.



Reforestation and precision agriculture are part of the management of the impacts and negative effects of climate change

CLIMATE CHANGE POLICY

The general objective of the Climate Change Policy of the Guatemala Sugar Agroindustry is to provide scientific knowledge, appropriate practices, and mechanisms for the precautionary and preventive management of the impacts and negative effects of climate change. These impacts and negative effects are associated with the risks, hazards and vulnerabilities that climate change poses to the natural, cultural and built assets. The goal is to contribute to the sustainability of the Sugar Agroindustry and its role as an agent of change for the integral development and progress of its members and of Guatemala (Asazgua/ICC, 2018).

The Climate Change Policy includes four major specific objectives:

Objective 1: (Science) To improve and contribute to scientific knowledge about climate change in the area of influence of the Guatemala Sugar Agroindustry and to contribute to the climate change scientific knowledge at the national level.

Objective 2: (Adaptation) To apply the best practices and measures of adaptation in order to reduce the negative impacts, risks and hazards that climate change poses to the assets of the Guatemala Sugar Agroindustry and its area of influence.

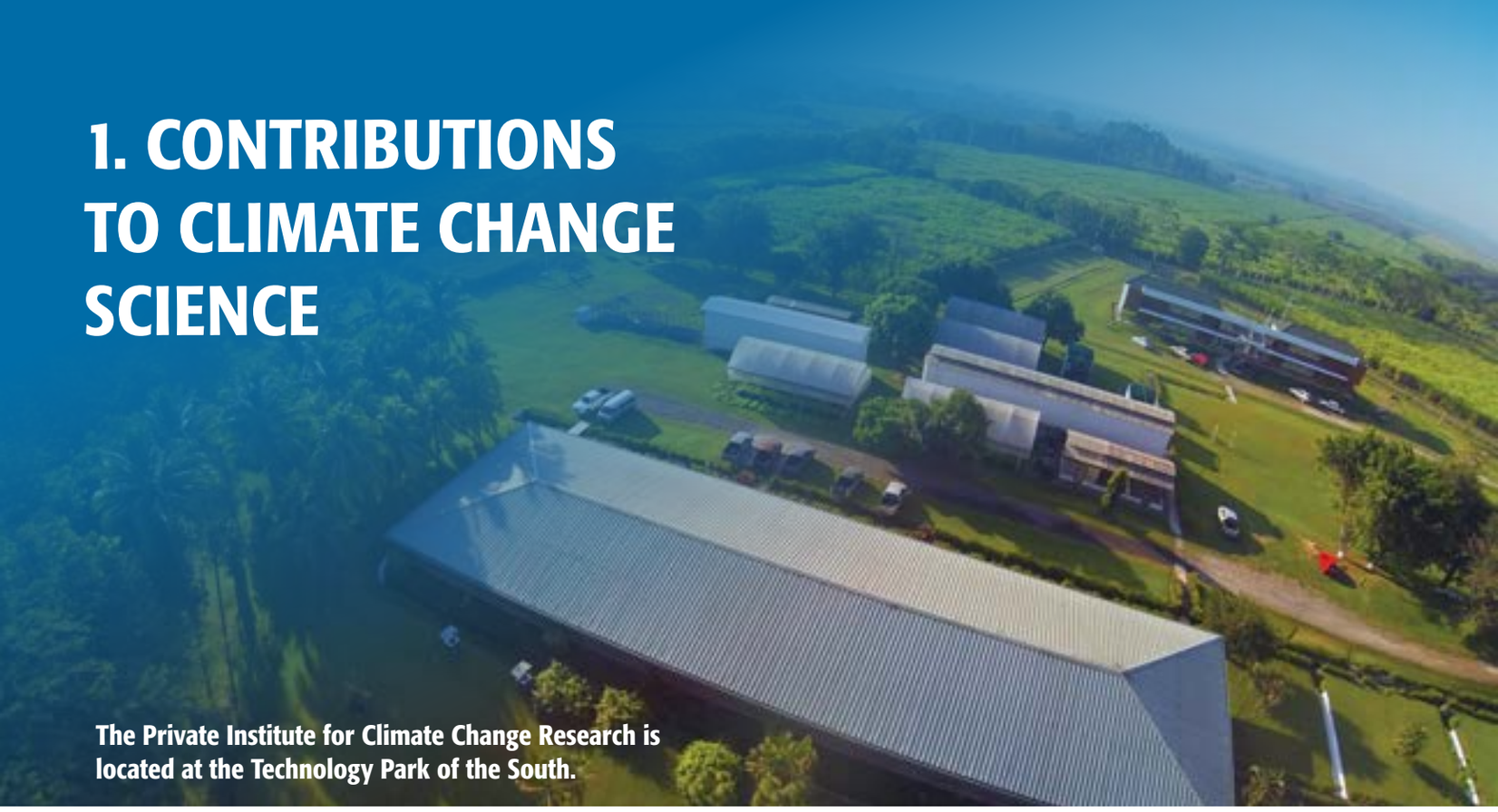
Objective 3: (Mitigation) To reduce greenhouse gas (GHG) emissions and to increase carbon fixation in the operations and area of influence of the Guatemala Sugar Agroindustry.

Objective 4: (Capacity building) To develop capacities for research, public awareness and information and early warning systems to reduce vulnerability and risks for the Guatemala Sugar Agroindustry and its area of influence and for the people of Guatemala.

CLIMATE ACTION

The Guatemalan Sugar Agroindustry is committed with conducting the activity in the most Sustainable way. We compete against ourselves, but we, of course, are open to new ideas and to learn from others. Measuring the impact of our activity, in the communities and to the environment, has been key, as we are aware that there is always space for improvement. We are eager to showcase some of the actions we have taken and programs we have implemented to ensure we continue to operate responsibly."

1. CONTRIBUTIONS TO CLIMATE CHANGE SCIENCE



The Private Institute for Climate Change Research is located at the Technology Park of the South.

The Guatemala Sugar Agroindustry is committed to improving scientific knowledge through applied research in its area of influence. This commitment includes the development and implementation of actions and good practices in adaptation, mitigation, technology transfer, capacity building and public awareness. These activities need to be validated with trusted, independent and certified information, particularly in relation to data that could reveal trends and scenarios on risks, hazards, vulnerabilities and negative impacts on the assets and services of the Guatemala Sugar Agroindustry (ICC/Asazgua, 2012).

One of the first main strategies by the Guatemala Sugar Agroindustry related to improving scientific knowledge was the creation of the Private Institute for Climate Change Research (ICC). This decision shows the long-term commitment by this Agroindustry to combat climate change and to collect the necessary data and information for the development of predictive models and scenarios that could diminish possible negative impacts on life, investments and natural resources. The Institute was created as a non-profit, autonomous organization open for other companies and sectors to become members. By 2020, the Association of Independent Banana Producers (APIB), Ingenio Tululá (a rum and sugar producer), Palo Blanco (a banana, plantain and avocado producer) and Grupo CASSA (the biggest sugar producer in El Salvador) had joined the ICC.

Main activities being conducted for the improvement of scientific knowledge include:

1. Climate and hydrology information and research which includes weather variables, surface and groundwater.
2. Sugarcane adaptation practices.
3. GHG emissions and carbon footprint including inventory and footprint of various crops and electricity.
4. Flooding research in the Pacific watersheds of Guatemala, including mapping of flood-prone areas and flood dynamics.
5. Watershed knowledge which includes: water quality of rivers; flowrates of lower part of rivers; hydrological studies; studies of Sipacate-Naranjo mangrove conservation area; watershed biodiversity studies of Coyolate, Achiguate, Madre Vieja, Acomé and Nahualate; studies of tree species in the riverbank of the Acomé river; measurements in mangrove plots; data on growth rates of tree species in the south coast; carbon measurements in mangroves; and estimations of soil erosion in sugarcane cultivation areas. (ICC, 2019a)

1.1. The Private Institute for Climate Change Research (ICC): an instrument for climate action for the Guatemala Sugar Agroindustry

Objective and Description

The Private Institute for Climate Change Research (ICC) is an organization created in 2010 to conduct research, activities and projects related to climate change, with particular focus on the Pacific Slopes of Guatemala, from the volcanoes to the mangroves. The ICC team works in five different programs: Climate and Hydrology Research, Sustainability of Productive Systems, Integrated Watershed Management, Disaster Risk Management, and Capacity Building and Communications.

ICC is a non-profit organization created by the private sector for the benefit of society in Guatemala and the Mesoamerican region. The ICC follows a proactive and forward-looking approach as envisioned by its founders. The ICC works hand in hand with local stakeholders, mainly communities and producers (large and small) and in partnership with governmental organizations, especially municipalities and other local entities. It also works with universities, non-governmental organizations, and international cooperation agencies.

In its first 10 years of existence, the ICC has become a catalyst for climate action, setting an example in the region and globally. Its programs related to water management, reforestation, climate and hydrology research, GHG inventories and climate mitigation, risk management, adaptation and capacity building, among others, have allowed ICC to become a recognized leader at the local, national and regional levels. The ICC plays an important role, through its science-base and autonomy, in the search and implementation of solutions to local problems and challenges. ICC envisions science and scientists not only as information producers or providers but as active stakeholders in the fight against one of the biggest challenges to humanity – climate change (ICC, 2020b).

The ICC's vision is to be a leading private institution for research and project development to mitigate and adapt to climate change in communities, productive processes and the region's infrastructure. Its mission is to promote and implement actions that facilitate climate change mitigation and adaptation in the region, based on technical and scientific guidelines as well as economic feasibility. Its main areas of work include:

- Hydrometeorological Information
- Flood Research and Management
- Greenhouse Gases
- Environmental Management
- Protection and Restoration of Forests and Soil
- Integrated Water Management
- Adaptation Practices
- Capacity Building

One of the most important contributions of the ICC is data generation. ICC keeps records of weather variables from 36 automated stations of its network. Data are also collected and analyzed on river flows, tree growth rates, mangrove carbon content, flora and fauna species and soil erosion, among other topics. Based on the data, many studies have been carried out and there is potential for many more analyses. In 2018 great progress was made in the study of groundwater, especially in the conceptual model of one the most important aquifers: the alluvial fan of the volcanoes Fuego and Acatenango.

ICC keeps records of weather variables from 36 automated stations of its network.

ICC meteorological station network in Guatemala and El Salvador

The ICC conducts research and promotes activities related to climate change mitigation and adaptation in the highlands.
Photographer: Oscar Morales/ICC

The Guatemala Sugar Agroindustry has implemented precision agriculture to be sustainable

One of the main programs of ICC has the objective of contributing to the sustainability of productive systems which is a priority for the Guatemala Sugar Agroindustry. The main activities of this program include:

- Elaboration of the Environmental Policy of the Association of Sugar Producers Guatemala (Asazgua)
- Elaboration of the GHGs inventory of sugar production and electricity generation
- Identification and promotion of actions to adapt to climate change
- Advice on forestry activities of the sugar companies

In 2018 studies were initiated on the water footprint of sugar, sugarcane, and banana. This refers to the quantity of water used in production, including rainwater (green water footprint), both ground and surface water (blue water footprint), as well as wastewater (grey water footprint). Carbon footprint studies continue for those products and crops, adding to the analysis for the Mitigation Plan of these industries. This work has been possible by the support of the Low Emission Development Strategy (LEDS) Project funded by USAID (ICC, 2019b).

The ICC continues supporting and promoting forest protection and restoration. By 2020 more than 6.7 million trees of 55 different species were produced in tree nurseries supported by ICC, and 5,832 hectares of forests were protected mainly in the upper part of the watersheds. This work has been conducted with municipalities, many communities and various ICC member companies. In order to strengthen the reforestation mapping and monitoring work, activities with drones have been initiated. These activities are done in partnership with the National Forest Institute (INAB) and other organizations of the Pacific region of Guatemala.

The ICC work is possible through financial contributions from member companies and funds provided for specific projects by aid agencies and other international organizations. Resources and in-kind contributions from communities and other local organizations have been essential too.

Related Targets

The activities being conducted by the ICC provide strong and integrated support for the advancement of the three main targets of SDG 13 on climate change. Its activities on climate and hydrology research, and disaster risk management in Guatemala and in Central America are directly related to

Target 13.1 on strengthening resilience and adaptive capacity to climate-related hazards and natural disasters. All its work promotes the integration of climate change measures into national policies, strategies, and planning, which defines Target 13.2. Its activities related to research, capacity building, education and communications are also directly linked to Target 13.3 on improving education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

Challenges

During its first 10 years ICC has faced many challenges given the very large variety of activities that have been implemented in order to support progress towards important objectives related to climate change mitigation and adaptation. ICC has been able to expand its programs and its coverage thanks to the continuous support of the Guatemala Sugar Agroindustry and additional support from other national and international members including funding from international development organizations. Creating awareness about climate change at all levels and of the benefits that can be realized from mitigation and adaptation have been a challenging task throughout the years. Building the human resources with the appropriate technical skills and capacities for the implementation of many projects and programs has also been very challenging.

Lessons learned

Many lessons have been learned from the first 10 years of operation of ICC. It is clear that all the stakeholders in particular the local communities and municipalities need to work together to ensure the successful implementation of important climate change mitigation and adaptation strategies. An important issue is the need for everyone to work in a unified manner to tackle all problems in order to ensure the achievement of synergies and to diminish the negative impacts from climate change.

One important lesson is that institutions such as the ICC cannot and should not do the job of governmental organizations. Instead, they should work alongside and in support of them, which is often difficult because staff usually changes with new administrations or even when a minister is changed. In countries that present similar dynamics, an institution like the Climate Change Institute becomes key for continuity of processes.

The autonomy of the ICC that was lent by its members has been of huge importance for the credibility of its work. It has been key for collaborative work with the different stakeholders.

Working at the local level is critical for policies and science to make a difference in the lives of people and also for the companies. It allows institutions to understand the challenges and to gather inputs for discussions at the national and international level.

A focus on solutions is the best approach. Many organizations and academia tend to focus on the problems, which is important but should only be the starting point because solutions are what is needed. Focusing on problems divides people and sectors, focusing on solutions, unifies them.

Results

During its 10 years of existence, ICC has provided very valuable support to the people of Guatemala and the region for better understanding of climate change and its impacts, and for enhancing adaptation and mitigation strategies and policies for sustainable development ensuring a more prosperous future. ICC activities on risk management have been essential for public preparedness and for the development of contingency strategies necessary to confront catastrophic events. The work by ICC on data collection and analysis on climate change and other environmental issues is considered indispensable for planning processes and for decision makers in Guatemala. ICC also leads activities that have greatly increased the efficiency of productive systems contributing to sustainable economic development.

1.2. GHG Emissions and Carbon Footprint

Objective and Description

Reducing GHG emissions is a legal and international commitment of Guatemala. The decarbonization of the productive systems is an important goal for Guatemala and the Guatemala Sugar Agroindustry. The first step in this important process is the estimation of the direct and indirect GHG emissions associated with the production and transport of products in order to be able to develop an inventory of GHG emissions resulting from the activities of the Guatemala Sugar Agroindustry. A methodology being used worldwide to measure GHG emissions is the Carbon Footprint. The Carbon Footprint is the total GHG emissions caused by an individual, organization, service or product, expressed as CO2 equivalent (CO2eq).

ICC has estimated the GHG emissions of the sugarcane harvests beginning with the 2010-2011 harvest and is conducted annually. The inventory is based on the Life Cycle Analysis methodology taking into consideration the following categories: pre-harvest and post-harvest burning in the sugarcane fields, direct and indirect emissions from nitrogen fertilization, use of fuels for the different operations related to crop management and the energy produced from the fuels for the internal consumption of the factories (mills).

The direct GHG emissions reported in this inventory include CO2, methane and nitrous oxide according to international standards set by the Intergovernmental Panel on Climate Change (IPCC). The inventory includes data from the agricultural and production phases of the sugarcane as well as the industrial phase and the generation of electricity for internal consumption.

The inventory of emissions for the 2018-2019 harvest shows that the production of 2.97 million metric tons of sugar generated 770,088 tons of CO2eq. The activity that generates the most emissions is the use of fossil fuels for agricultural and transport activities (43%). This is followed by the use of nitrogen fertilizers that generates 25% of the total emissions and by the generation of electricity for internal consumption at 14% and the burning of biomass in the field, also at 14% (ICC, 2020a).

For the inventory of emissions, it is also necessary to take into consideration the factors that contribute to reduce or avoid emissions and to fixing and storing carbon. Carbon contained in the natural forests of the Sugar Agroindustry are estimated at 1.4 million tons of CO2eq. The carbon temporary stored in the sugar is about 2.8 million CO2eq.

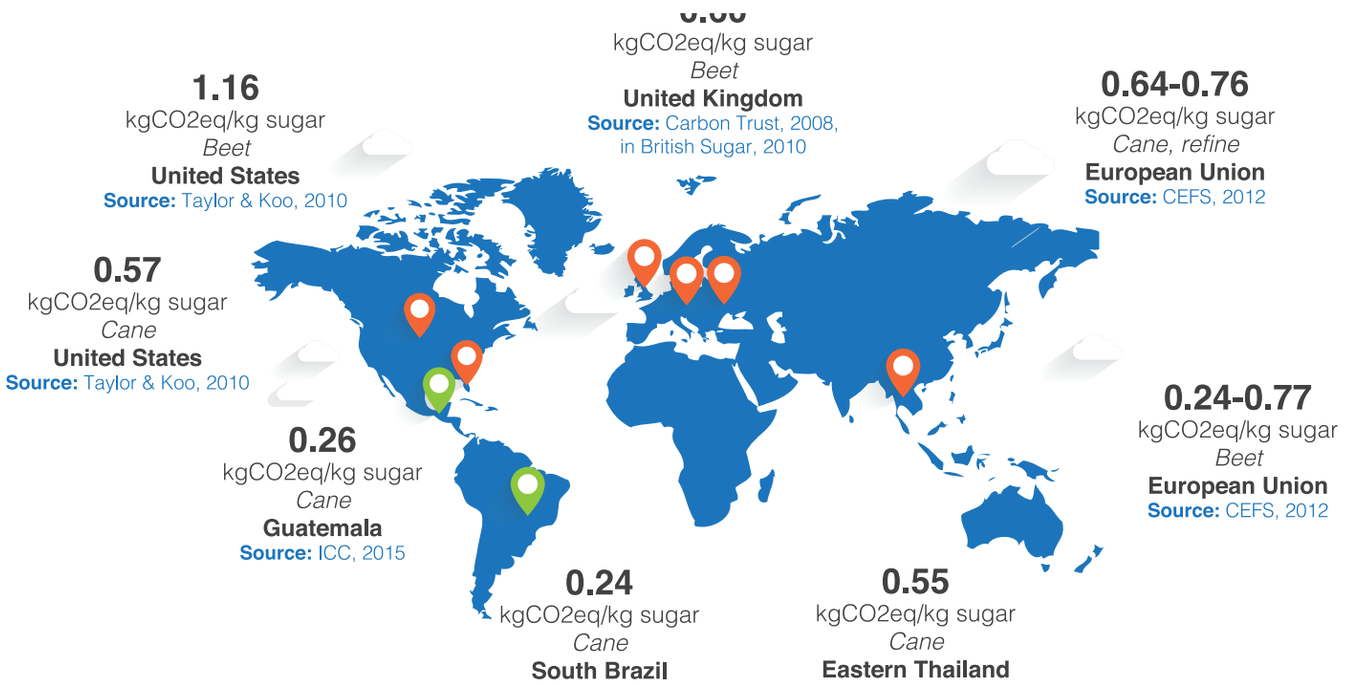
The activities of the Guatemala Sugar Agroindustry generate less than 3% of the total GHG emissions of the country.

The avoided emissions from the generation of electricity from biomass from sugarcane are about 4 million tons of CO2eq if coal is used for the generation of electricity for internal consumption and for sale to the Interconnected National System. Therefore, the use of the sugarcane biomass, as a byproduct of sugar production, allows the considerable reduction of the GHG emissions and the carbon footprint of the Guatemala Sugar Agroindustry and the whole country.

Based on the GHG estimates and the production of sugar, the carbon footprint of sugar from Guatemala for the harvest 2018-2019 is estimated at 0.26 kg CO2eq/kg produced sugar. The activities of the Guatemala Sugar Agroindustry generate less than 3% of the total GHG emissions of Guatemala although sugar provides the second largest profit from exports for the country.

The carbon footprint of sugar from Guatemala is one of the lowest in relation to others at the international level. Although this can be attributed to different methodologies used, type of inventories and other factors, they are mainly the result of improvements in the activities of the productive process such as the efficient use of fertilizers (reduction of nitrogen fertilizer use), the high yield rate of sugarcane per hectare, the use of sugarcane biomass for the generation of electricity and the reduction of fossil fuels for agricultural and transport activities by the Sugar Agroindustry.

Guatemala and South Brazil have the lowest CO2 emissions in the sugar producing countries according to ICC research.



Source: Report on the inventory of greenhouse gases and carbon footprint of the sugar in Guatemala, Harvest Season 2018-2019" ICC based upon IPCC(2006) metodology.

About 4 million tons of CO2eq are avoided annually through generating electricity from sugarcane bagasse

Related Targets

The work related to measuring GHG emissions, developing inventories of emissions, and defining the carbon footprint supports climate change policies, strategies, and plans. These are the objectives of Target 13.2. These activities are also related to human and institutional capacity building and awareness-raising on climate change mitigation which are part of the objectives of Target 13.3.

Challenges

The challenges of this activity are mainly related to the availability of data to be able to perform the estimates of GHG emissions as well as the importance of using the right, latest and internationally approved methodology. Comparing estimates and footprints for different harvests could be challenging due to these issues.

Lessons learned

It is important to allow for revisions of previous estimates if more accurate data and better methodologies are being developed for this purpose.

The estimates of the emissions inventories and carbon footprint are a powerful educational tool for managers and directors of the companies. Also, it has contributed substantially to inform the public, especially those whose opinion and perception was that the agroindustry was responsible for a high percentage of emissions in the country. The findings of the studies have helped illustrate the positive effects of the sugar sector, especially through avoided emissions from the use of sugarcane biomass for electricity generation.

Results

The Guatemala Sugar Agroindustry plays an important role in limiting the GHG emissions in Guatemala. About 4 million tons of CO2eq are avoided annually through generating electricity from sugarcane bagasse. The Sugar Agroindustry contributes to the reduction in the use of fossil fuels by generating electricity from sugarcane bagasse, replacing 316 million gallons of oil or about 1.54 million tons of coal during the 2018-2019 harvest. Furthermore, the carbon footprint of electricity generated by the sugar industry in Guatemala has been reduced from 2.3 kgCO2eq/kwh in 1998-1999 to 0.26 kgCO2eq/kwh in 2018-2019. Around 1,550 hectares of the sugarcane mills' natural forests store an additional 879,000 tons of CO2, and about 6,900 hectares of forests plantations absorb over 118,400 tons of CO2 during the year (Cengicaña, 2020), (ICC, 2020a).

At the general level, including increases and reductions of different sources of emissions, the GHG emissions of the Guatemala Sugar Agroindustry for the 2018-2019 harvest are estimated at 770,088 tons of CO2eq. This represents a reduction of 2.94% with respect to the 2017-2018 harvest.

River flow monitoring by the ICC of 58 rivers in southern Guatemala is essential for their sustainable management.

1.3. Climate and Hydrology Research

The ICC conducts the comprehensive program of Climate and Hydrology Research with support from the Guatemala Sugar Agroindustry.

Objective and Description

This program has two main objectives: (1) to generate meteorological data and information about water resources as this type of data, which has significant value for the use of natural resources, is scarce in the region; and (2) to analyze the data in order to create recommendations for actions and technical and scientific strategies.

The information for this program is generated through the Weather Station Network and the Hydrometric Station Network. The Weather Station Network includes 30 weather stations in Guatemala that generate data for seven variables every 15 minutes. The information is available in real time on the corresponding website platform. The Hydrometric Station Network includes a number of stations that are used to monitor the flow of rivers in the Pacific Slope in real time. This network in 2020 consists of five stations, but more stations are planned for the future.

Additional information is generated about the capacity of rivers in the dry season. This is the main information used to guide technical roundtables and committees regarding the use of water in a rational manner. Additionally, the flows of 58 rivers are monitored in southern Guatemala. The information generated has contributed to fulfilling the main objective of the local technical roundtables which is to ensure that water, which is a common good, arrives at the mouth of the river on a permanent basis.

Another critical area, in which information is collected, is in relation to the levels of community water wells. Groundwater is a strategic resource in southern Guatemala. Around 40% of the population in this region lacks running water at home and relies on wells to access groundwater. The ICC monitors 249 wells four times a year to follow changes in the water levels and to anticipate any problems that might occur in the region.

The analysis of information and generated data supports research in six main areas:

1. **Meteorology:** Analysis of meteorological data generated through the Weather Station Network; annual meteorological summary; standardization of rain gauges used in the area; analysis of temperature inversion; analysis of intensity of rainfall; determination of the water balance; monitoring of storms and weather events that could affect the country; and the creation of a bulletin related to El Niño.

2. **Agrometeorology:** Analysis of weather conditions and their influence on crops; development of a controlled-burn system for sugarcane; analysis of crop productivity and its relationship to climate; and development of studies for the projection of pests and the drift of areal applications based on the weather conditions.

3. **Climatology:** Statistical analysis of climatic variables; analysis of the beginning and end of the rainy season; characterization of the occurrence of the canícula (the mid-summer drought) in the south coast of Guatemala; characterization of meteorological droughts and wet periods (floods); and characterization of the wind's direction.

4. **Hydrology:** Analysis of hydrological processes; analysis of hydrometric information; and flood zoning on the south coast of Guatemala.

5. **Water management:** Generation of materials and recommendations for the management of water on the south coast; monitoring of and communication with users to support the coordination of water use; and generation of annual reports.

6. **Groundwater:** Generation of basic knowledge regarding the operation of groundwater systems in the region; maps of the piezometric levels; characterization of the subsoil using geophysical surveys; water quality analysis; numerical models; isotope analysis; hydrological balance; and saline intrusion studies.

Related Targets

The climate and hydrology research with its comprehensive approach to data collection and analysis in relevant meteorological, climatological, and hydrological areas is contributing to the objectives of Target 13.1 on strengthening resilience and adaptive capacity. It also supports the objectives of Target 13.2 by providing critical and valuable information that contributes to the integration of climate change measures into national policies, strategies, and planning.

Challenges

One of the main challenges related to this activity is the collection of data in very remote areas. There is also the need to expand the data collection coverage in the country and to increase the frequency of data collection and the number of parameters being monitored. Not only is the purchase of equipment needed but also constant maintenance and follow up, which is what the national system usually lacks. ICC has done it successfully, but the expansion is a challenge.

Communication of data and information to stakeholders and decision makers is always a challenge. Furthermore, they expect recommendations on actions to be taken, which can be a compromising task and it is not the responsibility of the ICC.

Lessons learned

The Guatemala Sugar Agroindustry understands the importance of working in partnership with governmental organizations, local stakeholders, academia, and other stakeholders to ensure the success of all these important activities.

Collaboration with universities, both national and foreign ones, is important. The main way to collaborate has been through interns or students doing their thesis at the ICC. They help through their time and intellectual contributions and also through supervision and resources from their respective universities.

It is important to combine scientific and technical information with knowledge from local people. This has been particularly important in the mapping of flood-prone areas.

Results

There are very positive results obtained in the last 10 years allowing an expanding database and analysis of critical meteorological and hydrological parameters. The research work has provided an important contribution in the effective management of water supplies and groundwater availability. Additionally, there is a much better understanding of climate variability and the occurrence of storms and other weather events.

2. CLIMATE CHANGE ADAPTATION AND VULNERABILITY REDUCTION

A major objective of the climate change policy of the Guatemala Sugar Agroindustry is the implementation of the best and most efficient practices of adaptation.

Guatemala is placed among the ten most environmentally vulnerable countries of the planet (COP14, 2009). This vulnerability is to a great extent due to its geographic location (between the Pacific and Atlantic Oceans). In addition, Guatemala is situated in a zone affected by three tectonic plates, causing the existence of three active volcanos and high seismic activity. There is also imminent climatic alteration and variation. However, these contrasting conditions have produced a country rich in biodiversity, with 10 physical regions, 7 biomes, 14 eco-regions, 66 ecosystems (41 natural and 25 affected by anthropogenic activities) and 14 ecoregions, according to the Holdridge system. The topography of the country has played an important role for the Pacific plains, since it has created an important area for agricultural development. The geophysical characteristics together with the socio-economic conditions determine high levels of vulnerability (SGCCC, 2019).

A major objective of the climate change policy of the Guatemala Sugar Agroindustry is the implementation of the best and most efficient practices of adaptation that allow the protection of natural, cultural and built assets and services of the Guatemala Sugar Agroindustry.

Some of the more important climate change adaptation activities include:

- Risk management of flooding and early warning including: flood emergency plans for Escuintla and other departments; early warning system for floods; mitigation works; flood zones in the south coast and community risk; and emergency attention for natural events
- Management of sugarcane crops according to climate conditions including: variety of sugarcane types adapted to climate; integrated pest management; and irrigation efficiency and technology change
- Support to communities and municipalities in the management of water and health including potable water systems (design and construction) through the Sugar Foundation (Fundazúcar)
- Efficiency, reuse and recycling of water including advances in efficiency and reuse of factory water, and advances in wastewater management
- Watershed management including forests in the high areas, biological corridors and reforestation
- Advances in river management including technical roundtables with multiple stakeholders to ensure an ecological flow in all the main rivers
- Soil conservation through adoption of practices for soil conservation in sugarcane plantations
- Water management including estimation of the water footprint in sugarcane crops (ICC, 2019a)

2.1 Disaster Risk Management

The Guatemala Sugar Agroindustry provides support for the comprehensive program of Disaster Risk Management and diverse activities on climate change adaptation being led by ICC.

Objective and description

This Disaster Risk Management Program supports disaster risk reduction by promoting actions based upon the analysis of natural and social factors. It identifies the main climatic hazards of the area contributing to the understanding and monitoring of potential risks. In the social scope, the program performs diverse analysis of the vulnerability of towns, their infrastructure and production systems allowing the identification of weak points and priority actions to reduce these risks.

Since 2011, ICC has been conducting research about the behavior of the flood hazards of the Pacific watersheds of Guatemala. The objective is to identify flood-prone areas and the impact on the lives of people in affected communities as well as infrastructure and production systems. These activities include: eight hydrological studies, nine studies of unidimensional and bidimensional hydraulic models, one study of precipitation intensity in five watersheds of the Pacific of Guatemala and 135 technicians trained from the public, private and academic sectors.

ICC has developed a comprehensive flooding map for the flooding zones of the Pacific basin of Guatemala. Also, local maps have been developed for flooding zones requested by local municipalities and communities that incorporate local and scientific knowledge. The areas that have been studied include: Sipacate, San Jose Port, Antigua Guatemala, Escuintla, and Santa Lucia Cotzumalguapa. This activity includes a total of eleven watersheds with flood maps from El Naranjo river to Los Esclavos river encompassing all the Pacific watersheds except for the bordering ones (ICC, 2020b).

An example of this activity is the project on "Community resilience assessment to flood and drought events in the Coyolate Basin". The project was implemented during the 2014-2016 period by ICC in partnership with the Universidad de Tucuman, Argentina; the Universidad Javeriana, Bogota, Colombia; and the Universidad Mayor de San Andres, Bolivia. The objective was to understand how communities have faced floods and droughts and how the impacts on the livelihood of the people residing in the lower part of the Coyolate basin could be minimized. The more specific goals included: describing the socio-ecological system of the Coyolate and identifying variables and processes that control it; evaluating the resilience of the communities' livelihood in the lower basin of the Coyolate river against flood and droughts events; and generating a proposal for tools and mechanisms that increase resilience of the livelihood of the communities in the lower basin of the Coyolate River. The project was implemented in the areas of San Pedro Yepocapa, Chimaltenango and Nueva Concepcion, Escuintla. The project was funded by the Inter American Institute for Global Change Research and the National Academy of Sciences of the United States.

With the purpose of mitigating the impact from floods in the south coast specifically in communities, productive systems and infrastructure, longitudinal dikes are being implemented in vulnerable points of the banks of the rivers Coyolate and Achiguate. Since 2012, ICC has contributed to the execution of projects from private, public and NGO organizations with the objective of diminishing the vulnerability of floods and supporting the development of communities in the mid-term.

Due to the vulnerability of the Guatemalan territory to hydrometeorological phenomena, since 2011 ICC has monitored and has warned its members accordingly so they can make appropriate decisions in emergency situations. The ICC has contributed with the development of projects for the monitoring, evaluation and action in emergency situations that have resulted in financing from international corporations and the private sector. These actions have contributed to the creation of the Center of Emergency Response as a public private partnership where ICC acts as the link between the private and public sectors for the management of emergencies. The process was part of a project funded by

The Guatemala Sugar Agroindustry donated the land to build a hospital in the south of the country to take care of patients during COVID-19 Pandemic. The hospital will operate permanently for the benefit of the population in the region.

the European Commission. Due to the high frequency of disaster events in southern Guatemala, the plans have been put into operation three times from 2017 to 2020. All the sugar companies, Asazgua, and Fundazucar deploy staff and resources to help authorities and communities during the emergencies.

In 2019, the Guatemala Sugar Agrondustry donated to the Guatemalan Government 10 thousand square metters to build a hospital, and also US$1 million to buy equipment and furniture, to help people affected by COVID-19, after the pandemic, this new hospital will remain as one of the most important health centers in the south of the country.

The land was part of the Guatemalan Sugarcane Research and Training Center –Cengicaña- and is located at 92 kilometers from Guatemala City at the CA-2 highway in the jurisdiction of Santa Lucia Cotzumalguapa, Escuintla. The donation of US$1 million contributed to the purchase of more than 750 items necessary to equip the hospital, among which high technology stands out, such as respirators, equipment for clinical laboratory analysis, ultrasound and X-rays, cephalic cameras, incubator, anesthesia machine, cardiovascular imaging system, vital signs monitors; as well as furniture ranging from intensive care beds, washing machines and industrial dryers, among others.

ICC supported the provision of water to the hospital and the recent studies of groundwater by ICC provided the basis for the drilling of wells to supply the hospital with water. ICC proposed the development of a rainwater catchment system and, after the consent of authorities, it provided the design and calculations for the system. Initially conceived for the care of COVID-19 patients, now this hospital will be permanent to provide excellent medical care to the entire population of the South of Guatemala.

The hospital started operations in 2020. The ICC studies on groundwater were used to plan the water system of the hospital.

The Guatemala Sugar Agroindustry also donated US$1 million to buy medical equipment for the hospital.

Related Targets

Disaster Risk Management activities contribute to the objectives of Target 13.1 on strengthening resilience and adaptive capacity to climate-related hazards and natural disasters. It also supports the objectives of Target 13.2 contributing to the integration of climate change measures into national policies, strategies, and planning.

Challenges

Obtaining funding for the implementation of projects in disaster risk management and climate change adaptation represents an important challenge, especially considering the need to scale up. The ICC has been critical to the implementation of these projects and for the pursuit of funding from national and international organizations.

Throughout history, risk has been created by establishing human settlements in hazard-prone areas, especially flooding and landslides. Relocating would be the most effective way to save lives and houses but it is an extremely complex process. Therefore, any measures taken can only mitigate risk but cannot be totally effective.

Lessons learned

The participation of all stakeholders is essential to the successful implementation of projects in the realm of disaster risk management.

Research is essential to understand risks and it is the starting point for the analysis of mitigation options and planning. For information to be relevant not only does it need to be readily available, but scientists need to be close to the stakeholders explaining it and informing decisions.

There are actions for the short, mid, and long term. All of them should start immediately if impacts are expected to lessen. Even if all the information is not available or its quality is not the highest, inaction is usually the worst option.

Communication and coordination play a key role in the best use of existing resources during emergency response, which are always limited.

The private sector can make contributions in all stages of risk management, from the science through to the planning and implementation. Protecting their own value chain is important for society because of the generation of jobs.

In countries like Guatemala, an important component of climate adaptation and vulnerability reduction is disaster risk management. It is rather urgent because disasters have been part of life in the region and they seem to be increasing due to climate change (SGCCC, 2019).

Results

Much has been achieved in the last decade in relation to assessing disaster risks and in implementing adaptation programs to climate change impacts. The work of ICC with support from the Guatemala Sugar Agroindustry and its members has been key to the advances on emergency preparedness and contingency plans addressing potential disaster risks. The work supported by the Guatemala Sugar Agroindustry has enhanced the resilience of the country with respect to climate change impacts, particularly in the south.

Since 2016, the most important achievements related to disaster risk management include: the creation of fifteen local and one departmental coordination entities for the reduction of risk; sixteen plans for the response to emergencies; two major risk analysis reports at the departmental level in support of the Southern Association of Municipalities (Mancomunidad Sureña); two analysis of disaster risk perception in the Community of Las Palmas and the municipality of Sipacate; more than 250 people accredited and trained in disaster risk management from the coordination entities; five partnerships with the private sector and universities for the development of community projects; three international NGO's trained in the digitalization of community maps in the theme of risk; and fifteen evaluations of habitability of official shelters in the Escuintla Department.

The Sugar Agroindustry formulated and implemented a strategy for forest restoration in the south of Guatemala.

2.2 Protection and Restoration of Forest Ecosystems

Objective and Description

The Pacific lowlands of Guatemala have been the ideal location for sugarcane production. As the cultivation of sugarcane is of great importance to the country and particularly for the Pacific coast, the Sugar Agroindustry formulated and implemented a strategy for forest restoration as a contribution to the country on this issue and to increase the resilience of this sector to the possible impacts of climate change.

In 2011, the Guatemala Sugar Agroindustry, through the Private Institute for Climate Change Research (ICC), initiated a geospatial analysis of forest cover, land use, land use capacity and forest biodiversity. The analysis also included key stakeholder mechanisms and certification commitments that contribute to forest restoration of the main watersheds in the sugarcane cultivation areas of Guatemala, as well as related obligations of social and environmental responsibility. This analysis concluded with a strategy proposal for forest restoration as the first step towards biological corridors and forest connectivity in the Pacific lowlands. The strategy considers the key stakeholders and the different mechanisms of implementation associated with each of the three areas of the watersheds (high, medium and low). These mechanisms jointly serve as the basis to generate the national strategy for forest restoration of Guatemala.

In 2011, the ICC also initiated a process of gathering and analyzing information within the sugar refineries located in this region to better understand development issues in the subject of forestry, mainly the land area devoted to conservation and/or where it has been managed with restoration in view. In 2012 these actions concluded with a map that gathered together data on these areas. By the end of November of that year a total of 10,204 hectares had been quantified. In the following years, the ICC developed various studies to look for opportunities, actions, and key stakeholders on forest restoration, always with the focus on watersheds. These actions added up to the inter-institutional relations that the ICC has achieved in a short period of time and mechanisms of environmental certification adopted by partners, which jointly supported the creation and implementation of the strategy of forest restoration by the sugar sector.

The Reforestation Program has among its priorities the recovery and conservation of the watersheds of the rivers that flow into the Pacific Ocean. As part of the efforts of the technical groups for the use of water from rivers, in 2017 the reforestation of watersheds was initiated for the rivers Los Esclavos, Achíguate, Madre Vieja, Bolas and Peráz.

In 2012 ICC started actions with members and partners to increase forest cover in riverbanks of southern Guatemala

As a general objective, ICC planned to contribute to forest restoration of watersheds in the area of influence in the cultivation of sugarcane, and to increase the resilience of the communities and productive systems of the Pacific lowlands of Guatemala in the presence of climate change. To achieve this objective five strategic goals have been defined:

- Determination of potential areas for restoration and connectivity
- Implementation of mechanisms of forest restoration
- Establishment of tree nurseries
- Restoration of the mangrove ecosystem
- Research

Riparian Forests

In 2012 ICC started actions with members and partners to increase forest cover in riverbanks of the rivers of southern Guatemala. The first activity was to design tests to restore native species. In 2014 and 2015 these tests were evaluated, and a baseline was generated about the biodiversity of forests in the riverbanks. This includes tree species, birds, reptiles, butterflies, fish, amphibians and dung beetles. Also, research was conducted on the implementation, follow up and evaluation of the restoration zones. The ICC in partnership with enterprises, communities and governmental institutions has reforested with native species more than 86 kilometers of riverbanks in southern Guatemala between 2011 and 2020 covering about 410 hectares. These areas are constantly monitored in order to document their development and to allow improvements in the way these actions are conducted. Currently there are 40 plots for the monitoring of the restoration of these riverbank forests (ICC, 2020b).

Mangrove restoration

In 2012, with partners such as the Instituto Nacional de Bosques (INAB) and the Consejo Nacional de Áreas Protegidas (CONAP), tests were initiated for mangrove species in a nursery stage and for testing different restoration practices. The mangrove restoration plan for the Pacific slopes was developed in 2016 with strategies for conservation, restoration, and other complementary activities. The plan is a key tool supporting conservation and restoration of the mangrove ecosystem of the Pacific slopes of Guatemala. More than 81 hectares of mangroves have been recovered in the Guatemalan coast in partnership with communities, municipalities, enterprises and the CONAP and the INAB (ICC, 2020b).

Nurseries and Tree Production (seedlings)

The Guatemala Sugar Agroindustry through ICC has implemented since 2011, as one of its main actions, the establishment of forest nurseries to increase the forest cover of the Pacific slopes of Guatemala. This action contributes to mitigation through carbon fixation and also to adaptation to climate change. In 2012 a strategic partnership started with the INAB for the establishment of tree nurseries with native and exotic species of rapid growth and with diverse local uses including energy and construction and for forest restoration. In the last 10 years, 424 nurseries have been established for regions, communities, enterprises, municipalities and with participation of diverse stakeholders. From 2011 to 2020, a total of 6.7 million trees have been produced. This tree production has been possible by the strategic partnerships with regional stakeholders that had allowed the existence of tree nurseries in 87 municipalities of the Pacific slopes. The reproduction of 55 tree species have been achieved, of which 48 are native and seven are exotic.

The Sugar Agroindustry planted more than 6.7 million trees between 2011 and 2020.

Related Targets

These activities are related to Target 13.1 on strengthening resilience and adaptive capacity to risks related to climate and natural disasters in all countries. They also relate to Target 13.2 on the integration of climate change measures into national policies, strategies, and planning.

Challenges

Challenges related to these activities include the difficulty in the access to areas that need reforestation or restoration, invasion of exotic grasses, illegal entry of people, cattle entry, and soil compaction. The presence of invasive alien species, pest attacks, forest fires, encroachment invasions, clandestine dumps and extreme weather affect restoration activities and create negative impacts on the growth of trees. There is a need for constant conflict management and for ensuring the active participation of local communities.

Scaling up is a challenge, particularly in areas where the land's use capacity is agriculture and where it is used for different crops.

Lessons learned

Through these experiences the Guatemala Sugar Agroindustry and ICC have learned about the importance of adopting new restoration techniques using fast-growing plants with good canopy cover during the first phase and then enrichment with other species, which in many cases happens naturally because of seed dispersion by birds and bats. Adequate selection of species allows the rapid formation of the forest canopy and a more efficient control of invasive species. The monitoring of the reforestation efforts should continue even after the work has been completed to verify the success of the interventions.

People are more likely to value a restoration project and look after it if they are involved as partners providing some labor and other in-kind components instead of being given everything. In cases where restoration actions took place on land owned by sugar companies, involving local communities from the outset increases the chances of success significantly.

Results

Guatemala is following international trends in terms of forestry and environmental certification. The private sector is identified as a key player in forest restoration of the countryside. The Guatemala Sugar Agroindustry has set a precedent in the investment, implementation of research and actions in forest restoration as a strategy of environmental responsibility and productivity in the Pacific lowlands of Guatemala.

The Guatemala Sugar Agroindustry has excellent results from these activities providing global benefits in relation to climate change mitigation and adaptation. Through the ICC and with contributions from other enterprises and in-kind contributions from local stakeholders, the Sugar Agroindustry planted more than 6.7 million trees between 2011 and 2020.

2.3 Integrated Watershed Management

The Guatemala Sugar Agroindustry contributes to the Integrated Watershed Management program being implemented by the ICC. The program includes planning and execution of socio-environmental actions carried out at the watershed level with a strong participatory component of local stakeholders.

Objective and Description

The main objective of the Integrated Watershed Management program is to promote and implement actions that maintain the integrity of the natural resources in the relevant watersheds considering the socio-cultural context. To achieve this objective, the following main work areas have been established:

- Generation of primary data on the watersheds and to establish a baseline
- Promotion and follow up on social organization processes to manage watersheds
- Effective management and protection of forests
- Integrated water resource management
- Soil protection

Activities have been conducted to support the conservation and protection of the natural resources of the sub watershed of the Ixtacapa and Mazá rivers covering over 950 hectares. Mangrove restoration activities have also been conducted in the communities of Blanca Cecilia, Iztapa and Escuintla as well as in the Suchitepéquez Department. These mangrove restoration activities were evaluated in 2018 (ICC, 2019b). ICC has supported the conservation of 5,832 hectares of forest in the upper part of the watersheds (ICC, 2020b).

In 2018 a plan was prepared and implemented for the production of plants and reforestation of the watersheds of Sis-Icán and Villalobos, where the CBC (Central America Bottling Corporation) manufacturing plants are located. About 202,700 plants were produced with funds from CBC through municipalities, communities, private universities and the governmental sector.

The ICC has also developed an Intersectoral Model for the integrated management of watersheds in the Southern region of Guatemala. This effort represents a case of improved water governance where the private sector plays an active role.

Related Targets

Activities on Integrated Watershed Management are directly linked and are fully supportive of the objectives of Target 13.1 which calls for strengthening resilience and adaptive capacity to climate-related hazards and natural disasters.

Challenges

Creating awareness of the long-term benefits of an ecosystem service approach that includes climate change strategies and the integrated management of water and terrestrial ecosystems is a major challenge.

In Guatemala, except for the main lakes, there are no designated authorities for the watersheds of the water bodies (rivers). Such authorities are the ones who should lead the construction and implementation of integrated watershed management plans. The lack of them is a key challenge. All the work supported by the Guatemala Sugar Agroindustry and promoted by the ICC can contribute to watershed management but its impact is limited because of the lack of official institutions and plans, thus, having less participation from most of the relevant stakeholders in each watershed.

Lessons learned

The program depends on alliances and partnerships between private and governmental organizations as well as local communities. Therefore, major efforts are necessary to ensure the active and constant participation and support of relevant stakeholders for the success of integrated watershed management programs.

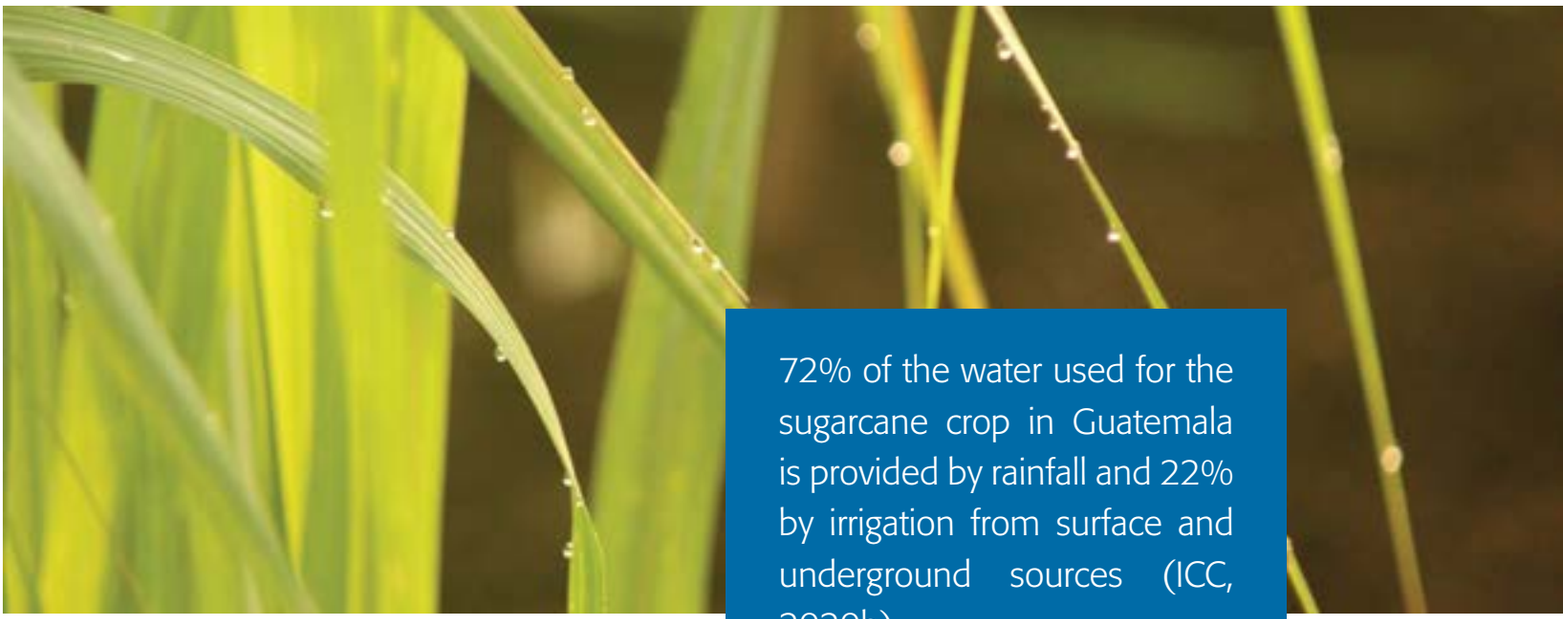
Local stakeholders can start planning and implementing actions toward the protection of natural resources as part of the Integrated Watershed Management program.

Even without a legal mandate and institutions for watershed management, local stakeholders can start planning and implementing actions toward the protection of natural resources, namely, water, soil and forests in their corresponding watersheds.

The private sector can be an active stakeholder, implementing actions within their production systems, and supporting actions outside them working in collaboration with other stakeholders.

Results

The program has implemented successful projects in important watersheds of the region. The success of these activities and the benefits obtained support the planning and implementation of future projects that will translate into further sustainable local development. In addition to the environmental benefits, the program has enhanced social and economic inclusion in the region and is promoting a cultural change in the relationship between people and nature and in the relationship among people in the participating communities.



72% of the water used for the sugarcane crop in Guatemala is provided by rainfall and 22% by irrigation from surface and underground sources (ICC, 2020b).

2.4. Other Adaptation Practices

Water Usage by the Sugar Agroindustry

Guatemala faces considerable challenges in terms of water resources management. Several parts of the country suffer from water scarcity despite a relative natural abundance. Public investment in water infrastructure and services is often low. However, there has been significant progress in the sugarcane growing regions. Several roundtable multi-stakeholder consultations have been organized by local governments to facilitate dialogue on water needs and water use between local communities, agro-export companies, governmental organizations, and municipalities.

The average water footprint of sugarcane cultivation in Guatemala is estimated at some 129 m3 of water per ton of sugarcane, which is 38% below the world average. Some 72% of the water used for the sugarcane crop in Guatemala is provided by rainfall and 22% by irrigation from surface and underground sources (ICC, 2020b). Sugarcane cultivation in Guatemala covers around 260,000 hectares, and 80% of this land is irrigated, leading to concerns about the impact of the industry on water resources. However, sugarcane plantations and sugar mills have been taking many initiatives over the past 20 years to increase the efficiency of irrigation. This includes research, investment, and installation of efficient irrigation technology. There have also been many efforts to reduce the water footprint in the sugarcane mills through improvement of efficiency, water re-use, and the elimination of washing of sugarcane.

The sugar agroindustry has implemented procedures and practices for the significant reduction and rational use of water in the production and processing of sugarcane. This is in response to impacts from climate change and natural phenomena such as "El Niño" which create droughts.

The use of water in agricultural processes has been reduced through the implementation of more efficient irrigation systems and new technologies and processes such as the dry cleaning of sugarcane. The reutilization of water has allowed sugar refineries to reduce water consumption up to 99%. Industrial waste waters from sugar production go through a treatment process allowing them to be charged with nutrients for use in systems of ferti-irrigation. Water used in fields for irrigation has been reduced by 16% in 2020 as compared to 2015. Also, the most efficient sugarcane variety has been developed in Guatemala which allows the reduction by 14% of the use of water per ton of sugar produced (Cordon, 2020).

Another way to face the challenges from climate change is the use of diverse types of sugarcane which adapt better to new regional conditions allowing to be more resistant to pests, diseases and requiring less water. Cengicaña has promoted the research and implementation of 31 more resilient types of sugarcane, increasing the productivity in 33% of cultivable areas. Scientific research is key to productivity and sustainability in the farming of sugarcane and the production of sugar. The development of more efficient processes and sustainable practices has allowed a very competitive sugar agroindustry.

Fish farming at the community level

The tilapia farming project provides another food source with high protein, profits from the sales of this fish, and diversification of a lifestyle, and community adaptation to climate change. It started as a pilot project in El Paredón, Buena Vista and El Naranjo (Sipacate, Escuintla) under the REGATTA project sponsored by the UN Environment. REGATTA is the Regional Gateway for Technology Transfer and Climate Change Action in Latin America and the Caribbean. The sugar companies funded the expansion of the project to other communities in southern Guatemala. In 2020 there were ongoing projects in seven municipalities. In order to reduce costs of concentrate to feed the fish, a native alga (Lemna minor L.) was reproduced (ICC, 2020b). Not only is it a great option because of its high protein content, but it also grows rapidly (doubles its size on a daily basis) and fish readily eat it.

Ecosystem based Adaptation project

During the 2014-2015 period, the project "Adaptation to climate change through strengthening livelihoods associated with mangrove ecosystems and cloud forest in the Pacific Slopes of Guatemala" was implemented by ICC with funding from the REGATTA initiative. The main goal was to promote the ability of communities to adapt to climate change, based upon the ecosystems in which they were located, such as cloud forests and mangroves in the Pacific Slopes of Guatemala. More specific goals included: the analysis of vulnerabilities, hazards, and adaptation measures; the development of plans to adapt to climate change; and the implementation of demonstration actions for the primary livelihoods. The project was implemented in La Soledad Village, Acatenango, Chimaltenango and El Paredon Buena Vista Village, Sipacate, Escuintla. Matching funds equivalent to fifty percent of the total cost of the project were provided by the sugar companies through the ICC.

Adaptation in corn and bean crops project

During the 2012-2013 period, the project "Towards a production of Corn and Beans adapted to climate change" was implemented by the ICC. The main objective was the development of a mechanism to transfer technology to producers of corn and beans in four locations of the Pacific Slopes of Guatemala. The more specific goals included the creation of a knowledgebase of practices to adapt to climate change for the agricultural sector, and the facilitation of the transfer of technology and capacity building for the adaptation to climate change. The project included participation of 320 producers of corn and beans in the locations of Chimaltenango, Nahuala, La Maquina and Nueva Concepcion. The project was funded by the Climate Change Resilient Development of the USAID, Washington, DC.

Other research, actions and projects related to community adaptation to climate change include: exploratory studies about four crops that could tolerate floods; socio ecological resilience in the Pacific slopes of Guatemala particularly with respect to floods and droughts; and rainwater and fog harvesting.

3. CLIMATE CHANGE MITIGATION

One of the mitigation actions of the Guatemala Sugar Agroindustry has been increasing energy efficiency in the whole production system.

The Guatemala Sugar Agroindustry supports a comprehensive program of activities designed to support climate change mitigation. The Sugar Agroindustry through the ICC were part of the team that prepared the Low Emissions Development Strategies (LEDS) of Guatemala and of the commission that defined the intended Nationally-Determined Contributions (NDCs) for Guatemala in fulfillment to the commitment to the UN Framework Convention on Climate Change (ICC, 2020b).

The main activities related to climate change mitigation include:

- Identification of opportunities for reduction of GHG emissions.
- Electricity generation from biomass and methane including the plan for the reduction of GHG emissions by the Sugar Agroindustry.
- Energy efficiency including reaching higher levels of efficiency share while avoiding GHG emissions.
- Efficiency of nitrogen fertilization through research on fertilization efficiency.
- Carbon fixation including: carbon storage in natural forests of the Sugar Agroindustry; carbon fixation in planted forests of the Sugar Agroindustry; and carbon fixation from ICC reforestation program.
- Reduction of burning through the reduction of sugarcane burning and avoidance of GHG emissions (ICC, 2019a)

3.1 Strategy for the reduction of GHG emissions in the production of sugar in Guatemala

The strategy of the Guatemala Sugar Agroindustry was initiated in 2018 with support from the Low Emissions Development Strategies Project financed by USAID. The Strategy considers activities in cogeneration, energy efficiency, use of nitrogen fertilizers and the use of fossil fuels for transport and agriculture activities. The analysis provided evidence of the advances so far of the Sugar Agroindustry towards more efficient and sustainable processes as well as the reductions in GHG emissions in the last 20 years. As an example, the emissions from the use of nitrogen fertilizers were reduced from almost 0.008 tons CO2eq/ton sugarcane in the 1991-1992 harvest to 0.004 in the 2018-2019 harvest. Emissions related to irrigation activities were reduced from 0.0075 tons CO2eq/ ton sugarcane in the 2013-2014 harvest to 0.0045 in the 2018-2019 harvest. Emissions from the transport of sugarcane during the harvest were reduced from 0.0048 tons CO2eq/ ton sugarcane in the 1997-1998 harvest to 0.0032 in the 2018-2019 harvest.

The identified options considered for the reduction of GHG emission from the production of sugarcane included: reducing the burning of sugarcane; electricity co-generation and energy efficiency; efficient use of fertilizers and use of alternative sources; forest restoration strategy; and reduction in the use of fossil fuels. According to the analysis, the best opportunity for the reduction of GHG emission for the Guatemala Sugar Agroindustry is the use of electric pumps for irrigation (ICC, 2020b).

According to analyses, the best opportunity for the reduction of GHG emission for the Guatemala Sugar Agroindustry is the use of electric pumps for irrigation

Electricity from the Sugar Agroindustry has covered up to 35% of the national electricity demand during the harvest season

3.2 Electricity generation from sugarcane biomass

Guatemala's economy increasingly depends on export-oriented agriculture with sugarcane and sugar production playing a leading role. Sugar refineries have used bagasse for power generation since the 1990s. Sugarcane is also the main agricultural base for ethanol / biofuel production. With growing domestic and international demand and competition for land, water, and energy, understanding their interlinkages and identifying opportunities for synergies and efficiency is of great importance in Guatemala. The Guatemala Sugar Agroindustry and the ICC have undertaken important research in this field. Asazgua's members operate 11 power plants that generate electricity and heat for both internal consumption and to feed the national grid (Guerra, 2019).

Electricity from sugarcane biomass (bagasse) in Guatemala is a significant component of the energy matrix. Sugar companies generate electricity from bagasse to meet their own needs and to sell to the grid. During the 2014-2018 period, the contribution of the sugar industry to annual power generation accounted for 10.7% to 18.1%. Power generation from bagasse is typically seasonal from November to April. It complements electricity generation from hydropower, which is typically low during the same period. Electricity from the Sugar Agroindustry has covered up to 35% of the national electricity demand during the harvest season (Cordon, 2020).

Total electricity generated from sugarcane biomass has increased substantially from around 400 GWh during the 1997-1998 harvest season to 2,500 GWh in the 2017-2018 harvest season. The current installed capacity for electricity is 1,020 MW. This increase has resulted from growth in cultivated area, higher yields per hectare, and from achieving higher efficiency in biomass-based power generation. Sugar companies in Guatemala use about 34% of the electricity they generate for their own industrial processes, especially sugar production. The remaining 66% is sold to the national grid (Guerra, 2019).

During the 2018-2019 harvest, the electricity sold to the national grid increased to 68%. According to Cengicaña from November 2018 through June 2019, 23.7% of the energy of the country was generated by sugarcane biomass from the sugar companies which represents valuable renewable energy. During the same harvest, sugarcane biomass allowed the generation of 80.7% of the total energy generated by the Sugar Agroindustry representing only 12% of the emissions from the energy generation process (ICC, 2020b).

The use of sugarcane biomass for the generation of electricity allows Guatemala to avoid 4 million tons of CO2eq that would have resulted if coal were used, considering that this is generated during the dry season. By using sugarcane biomass for electricity generation, the combustion of 316 million gallons of bunker (fuel

oil) or of 1.4 million tons of coal were avoided. This represents a major contribution in relation to climate change mitigation for Guatemala and at the world level. For the 2018-2019 harvest, the total GHG emissions from electricity generation corresponded to 924,079 tons of CO2eq, of which 87% were generated by the use of coal.

Asazgua's members have invested over $800 million in technologies and systems to electrify their processes and achieve greater efficiency and productivity in the last 25 years. The efficiency of the power plants has increased on average from 35 kwh/ton of processed sugarcane (1997/1998) to 106 kwh/ton (2018/2019). The electricity generated by the sugar agroindustry has contributed to 16% of the electricity exports from Guatemala to the Central American market and 7.8% of electricity exports to Mexico (Asazgua/Cengicaña, 2020).

The carbon footprint of electricity from sugarcane biomass is 0.26 CO2eq/kWh (2018-2019 harvest), whereas the overall national average for electricity is about 0.367 kg CO2eq/kWh as published by the Ministry of Energy and Mines of Guatemala in 2018.

The reduction in the emissions from electricity is one of the important elements that has contributed to the low carbon footprint of sugar in comparison with other countries. It is important to note that electricity generation in the internal process of sugar production represents only 15% of the total carbon footprint.

Ethanol from sugarcane can potentially make an important contribution to reduce national GHG emissions in Guatemala. The sugar agroindustry in Guatemala has the capacity to produce up to 65 million gallons of ethanol annually. According to the National Low Emission Development Strategy, a 10 per cent blend of domestically produced ethanol in gasoline may help to reduce emissions from motor vehicles, improve air quality in towns and cities, reduce gasoline imports, and help the country accomplish its commitments to the Paris Agreement. The reduction potential is estimated at some 233,333 tons CO2eq/year (Guerra, 2019).

The electricity generated by the sugar agroindustry has contributed to 16% of the electricity exports from Guatemala to the Central American market and 7.8% of electricity exports to Mexico.

The natural forest areas and tree plantations of the sugar companies cover an area of more than 12,000 hectares, which store approximately 1,415,638 tons of carbon

3.3 Carbon capture and storage through forest activities

The natural forest areas and tree plantations of the sugar companies cover an area of more than 12,000 hectares, which store approximately 1,415,638 tons of carbon (ICC, 2020a). Note that they are not annual figures, but the accumulated amount stored. The figure is dynamic because the plantations change as they are harvested and replanted. Therefore, the carbon stored in forest areas is an estimate.

An assessment of the forest conservation and reforestation programs and activities promoted and carried out by the ICC, was conducted in 2020. Not only did it help to find out the level of success and survival of forest projects, but it also allowed the estimation of the impacts in terms of carbon capture and storage. The 6.7 million trees planted cover an area of around 5,126 hectares considering 85% survival according to field assessment. The ICC kept track of a sample of forest and reforestation plots since 2011 in different types of projects, namely, community forestry projects, restoration of riparian forest, and natural forest in other areas. Annual measurements of tree growth and development provided the basis for the estimation of carbon capture, equivalent to 98,166 tons of carbon (ICC, 2020c). This figure is likely to increase rapidly given that most trees were planted (more than a million annually) in the period 2017-2020.

In addition to the numbers above, there are around 1,416,809 tons of carbon stored in 5,276 hectares of forest that the ICC has helped protect in the upper parts of several watersheds in collaboration with indigenous communities and municipalities (ICC, 2020c).

All the carbon figures cannot and should not be labelled as contributions of the sugar agroindustry because there are a few other companies, including banana and avocado producers, who are members and fund the ICC's work on forest projects. Furthermore, most of the projects, as mentioned throughout this document, have been done in collaboration with numerous local stakeholders. They too have provided in-kind contributions. In sum, they are the result of collaborative work, which makes them more valuable and provide more benefits besides carbon capture and storage such as biodiversity conservation, regulation of the water cycle, and soil protection, among others.

Related Targets

These activities are directly related to the Target 13.2 of SDG 13. They represent policies, strategies and planning measures by the Guatemala Sugar Agroindustry related to an integrated approach to renewable energy and climate change that reduces emissions of GHG and avoids the consumption of fossil fuels, supporting global objectives in climate change.

Challenges

Increasing the efficiency of electricity generation from sugarcane bagasse has been a very challenging task. Nevertheless, through the years of applied research, experiences and lessons learned the Guatemala Sugar Agroindustry has been able to achieve significant increase in the efficiency of this process as reflected by the considerable increase in electricity generation per ton of bagasse.

Some options to reduce emissions in the sugar agroindustry are costly and present low potential. The extreme case is the reduction of emissions from pre-harvest burning of sugarcane. Its reduction potential is low (only 8,499 tons of CO2eq would be avoided annually even if all burning stopped) because the machines to harvest green sugarcane use diesel. If done only to reduce emissions, the cost per ton of CO2eq would be extremely high, more than US$2,000 (ICC, 2019c).

Lessons learned

A major lesson learned is the importance for organizations to work together toward common goals. Working together, many problems have been resolved and many innovative technologies and models have been successfully implemented. Furthermore, through research and hard work important efficiencies have been realized. Today, the Sugar Agroindustry of Guatemala is one of the world leaders in the efficient generation of electricity from sugarcane bagasse while at the same time ensuring one of the best water use efficiency.

Estimating emissions has been extremely important to find out where the agroindustry stands compared to other countries and what percentage of emissions it is responsible for in Guatemala. It has also helped find and communicate contributions over many years. Also important is to analyze opportunities of further reductions, some of them also entail lower costs of production.

Results

Through decades of work and innovation, the Sugar Agroindustry has been able to prove the extraordinary value of using bagasse for the generation of renewable electricity, allowing the reduction on GHG emissions, and avoiding the consumption of fossil fuels. Today, electricity generation from sugarcane bagasse represents the second most important source of electricity for Guatemala contributing to the social, economic, and environmental dimensions of sustainable development.

Forest conservation and reforestation projects contribute to carbon capture and storage apart from providing other benefits. The Guatemala Sugar Agroindustry has more than 12,000 hectares of forest lands where approximately 1.4 million tons of carbon are stored. Through the ICC and in collaboration with other companies, communities and municipalities, an additional 1,416,809 tons of carbon are stored through forest protection, and close to 100,000 tons have been captured through reforestation.

4. CAPACITY BUILDING ON CLIMATE CHANGE

The Capacity Building program of the ICC focuses on strengthening and developing the climate change adaptation capacities of the general population, of vulnerable groups, and of productive systems within the region.

4.1 Promotion and research of options for adaptation to climate change and variability and livelihood resilience for affected populations

Objective and Description

One of the main objectives in the climate change strategy of the Guatemala Sugar Agroindustry is the strengthening of applied research and the building of capacities for the development of the necessary knowledge and expertise on climate change mitigation and adaptation. The most important capacity building activities include:

- Research capacities which included the creation and financing of two research organizations by the Sugar Agroindustry (ICC and Cengicaña)
- Capacity building of the Sugar Agroindustry staff
- Public awareness and capacity building in climate change and related themes including: ICC certificate courses for teachers, journalists and government representatives; talks and events each year; graduates from communities financed by Asazgua; training events in climate change themes, disaster and risk management and other related themes (trainings within project frameworks)
- Early warning and information systems in partnership with universities and government entities
- Programs for the improvement of families, particularly for women. (ICC, 2019)

The Capacity Building program of the ICC focuses on strengthening and developing the climate change adaptation capacities of the general population, of vulnerable groups, and of productive systems within the region.

The capacity building program is considered to be a crosscutting component among its different programs and its actions in the field. In addition, the program responds to the legal mandates set forth in the National Climate Change Policy and the article 23 of the Framework Law to Regulate Reduction of Vulnerability, Mandatory Adaptation to the Effects of Climate Change, and the Mitigation of Greenhouse Gases in Guatemala. In the same way, the program responds to the 6th article of the United Nations Framework Convention on Climate Change (UNFCC), which calls for the development of efforts to improve access to information, outreach, education, training, participation, and cooperation in the face of climate change.

Up to 2019, 5,675 people from communities were trained through 45 certificate courses on community adaptation to climate change. Also, 1,078 teachers and students were trained through 31 certificate courses on climate change. They all received between 40 and 52 hours of training and complied with the conditions to participate (high attendance, homework, and tests). Additionally, 583 youngsters and teachers received a three-session course on climate change. Through 780 events including workshops, talks and

symposiums, 38,862 people received training on several topics related to climate change (ICC, 2020b). Research is conducted on the main livelihoods, such as agriculture, in relation to adaptation measures for climate change and variability. This allows the development or customization of new technologies that strengthen families' food security in the face of climate- or weather-related hazards, such as floods or droughts.

Adaptation initiatives and actions are established in the face of climate change and variability for those whose livelihoods depend on agriculture. In addition, it promotes the establishment of climate change adaptation demonstration plots, thus strengthening food security of families living in the Pacific Slopes of Guatemala.

Fieldwork is conducted related to socio-ecological resilience in the Pacific region of Guatemala, an emerging theme of relevance at a global level that is key to understanding the recovery of socio-ecological systems in the face of climate hazards.

Related Targets

The capacity building activities are particularly linked to Target 13.3 on improving education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.

Challenges

One important challenge is the continuous need for the development of professionals with the technical and pedagogical background to act as instructors, professors, trainers, and other key stakeholders leading capacity building activities.

Another important challenging objective is to ensure the implementation of fair selection processes that will allow participation of all stakeholders.

Unfortunately, staff at governmental organizations changes every four years when a new administration starts. In some cases, staff changes every year following removal of some ministers or directors of institutions. Therefore, capacity building is constantly needed in the public sector.

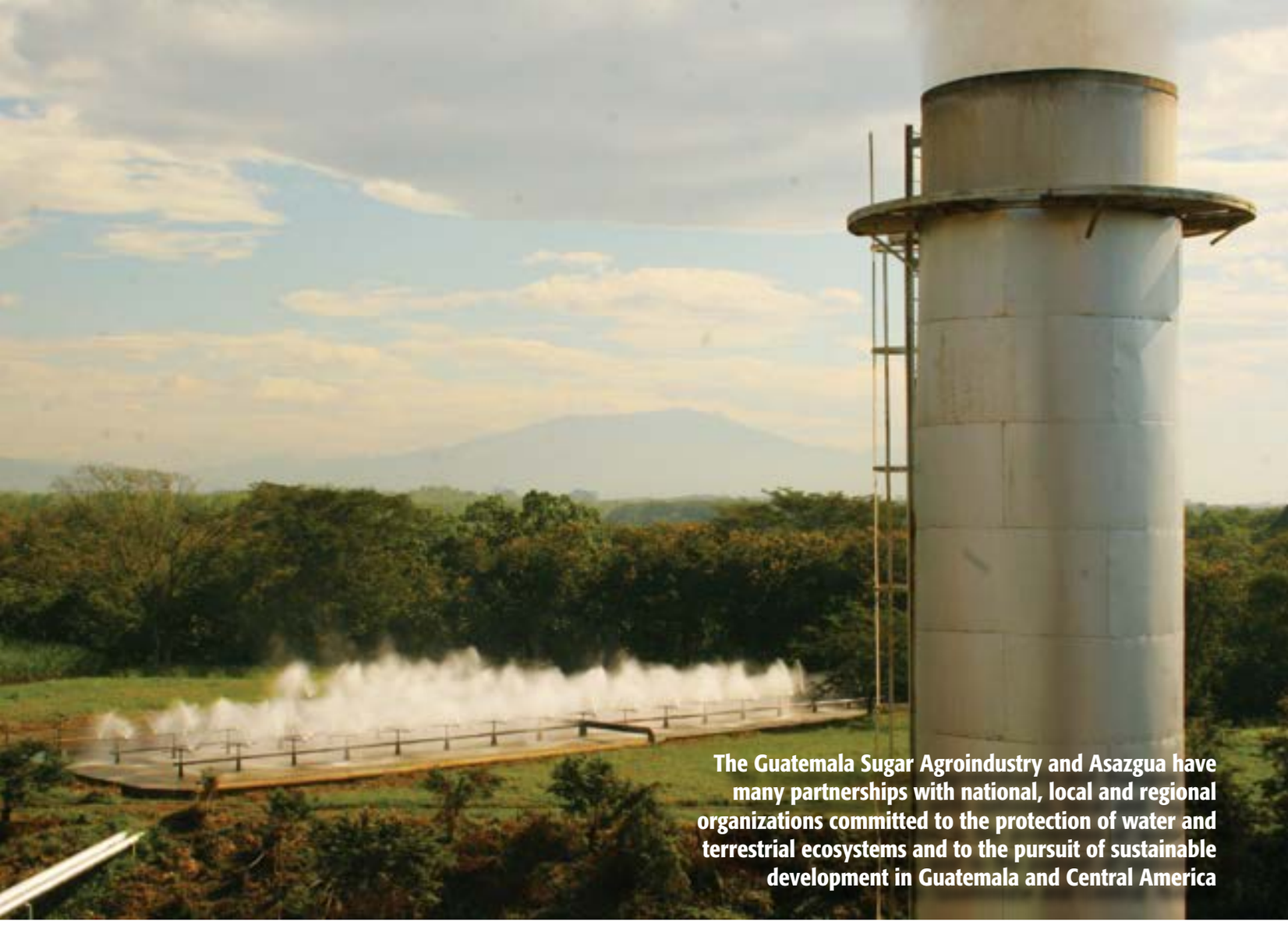
Lessons learned

Activities related to the building of capacities on climate change mitigation and adaptation need to be a permanent feature to ensure the transfer of knowledge to all relevant stakeholders and to future generations. These activities need to be inclusive and multi-disciplinary, ensuring that the social, economic, and environmental dimensions of sustainable development are covered. This is particularly important in light of the weaknesses of some governmental organizations as explained above.

Not all knowledge is needed or wanted by all stakeholders. In some cases, particularly at the community level, what they demand is practical and timely information to make decisions on a day to day basis. Information on the climate system, for example, is not a priority for them.

Results

The Capacity Building program of the ICC has been essential to developing capacities and creating awareness on different aspects related to climate change and to disseminating very valuable information in the region. Many seminars, courses, and programs have been conducted for community leaders, professionals, decision makers, producers, and practitioners. From 2011 to 2019, almost 49,000 people have been impacted through 891 capacity building events (ICC, 2020b).The ICC, Asazgua and partner organizations of the Guatemala Sugar Agroindustry are considered leaders in the successful dissemination of knowledge and in the implementation of climate change capacity building activities in Central America.



The Guatemala Sugar Agroindustry and Asazgua have many partnerships with national, local and regional organizations committed to the protection of water and terrestrial ecosystems and to the pursuit of sustainable development in Guatemala and Central America

INTERLINKAGES WITH OTHER SDGs

The interlinkages between climate change related activities (SDG 13) of the Guatemala Sugar Agroindustry and other SDGs are substantial. The strongest interlinkages are in relation to terrestrial ecosystems/forests (SDG 15) and water (SDG 6). The interlinkage with SDG 15 is evident by the effective and continuous effort to protect, restore and promote sustainable terrestrial ecosystems and by enhancing and supporting biodiversity. The interlinkage with SDG 6 is reflected by the clear commitment to keep increasing water use efficiency and by implementing an integrated management of water resources. There is also a strong interlinkage related to energy (SDG 7), given the fact that the Sugar Agroindustry is generating renewable energy in the form of electricity and ethanol with positive consequences in relation to climate change mitigation. Another strong interlinkage is with respect to partnerships (SDG17), given that the Guatemala Sugar Agroindustry and Asazgua have many partnerships with national, local and regional organizations committed to the protection of water and terrestrial ecosystems and to the pursuit of sustainable development in Guatemala and Central America. Additional important interlinkages relate to education and capacity building (SDG 4), sustainable cities (SDG 11) and sustainable consumption and production (SDG12).

CONCLUSIONS

The work being promoted and supported by the Guatemala Agroindustry to combat climate change and its impacts represents an outstanding case on effective climate action from the private sector.

The sustainable development strategy of the Guatemala Sugar Agroindustry and its comprehensive program of activities related to climate change, coupled with the generation of electricity from biomass, optimum integrated management of water resources, and protection of terrestrial and water ecosystems, represent an excellent example of the implementation in the field of the SDG13 on climate change and the UN 2030 Agenda for Sustainable Development. The support for the work of the Private Institute for Climate Change Research (ICC) provides evidence of the strong commitment of the Sugar Agroindustry to the goals and objectives of SDG 13.

The Guatemala Sugar Agroindustry has supported very valuable climate change activities including Climate and Hydrology Research, Disaster Risk Management and many climate change adaptation and mitigation activities. In addition, the ICC is implementing a comprehensive program on data collection, statistical analysis and parameter simulations that is allowing the assessment of current and future impacts resulting from climate change.

The Guatemala Sugar Agroindustry, its members and the ICC have been implementing an extensive program of reforestation and remediation in their areas of influence for decades including in important river watersheds that support climate change adaptation and mitigation objectives.

The ICC, Asazgua and partner organizations are considered leaders in the successful dissemination of knowledge and in the implementation of climate change capacity building activities in Central America.

The interconnection between climate change, energy, water and the reuse of waste is evident for the Guatemala Sugar Agroindustry, and the activities and policies related to climate change being led by the ICC are key to support efforts on climate change mitigation and adaptation inducing sustainable development and prosperity for the people of Guatemala. The Sugar Agroindustry has been able to generate clean and reliable electricity for decades, avoiding the use of fossil fuels and the emissions of millions of tons of GHGs to the atmosphere annually.

The work being promoted and supported by the Guatemala Sugar Agroindustry to combat climate change and its impacts represents an outstanding case on effective climate action from the private sector.

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