Project: Climate Change, Vulnerability and Adaptation Assessment for USAID/Guatemala

USAID: United States Agency for International Development

Deliverable 4 (Final Report). Recommendations on Climate Change Adaptation responses for Guatemala

Consultants: Private Institute for Climate Change Research (ICC), part of the Guatemalan Sugar Association (Asociación de Azucareros de Guatemala); Global Climate Adaptation Partnership (GCAP); Grupo Laera

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Contents

Abbreviations and acronyms

AGAAI: Guatemalan Association of Indigenous Mayors and Authorities

ANACAFÉ: National Coffee Association

ANAM: National Association of Municipalities of Guatemala

ARNPG: Private Nature Reserves Association

ASOCUCH: Association of Organizations in the Cuchumatanes region

ASOREMA: National Association of Natural Resource and Environmental Non-governmental Organizations

CEMAT: Centre for Alternative Technology

CIV: Ministry of Communications, Infrastructure and Housing

COCODE: Community Development Council

CODEDE: Departmental Development Council

COE: Center of Emergency Operations

COMUDE: Municipal Development Council

CONAP: National Council of Protected Areas (by its Spanish acronym)

CONRED: National Coordinating Office for Disaster Reduction

COOPI: Italian Cooperation

DIPECHO: European Union Program for Disaster Preparedness

GCAP: Global Climate Adaptation Partnership

GHG: Greenhouse Gases

IAM: Impact-Action Matrix

ICC: Private Institute for Climate Change Research

ICTA: Agriculture Science and Technology Institute

INAB: National Forests Institute

INDE: National Electricity Institute

INFOM: Municipal Development Institute

INSIVUMEH: National Institute for Seismology, Volcanology, Meteorology and Hydrology

MAGA: Ministry of Agriculture, Livestock and Food (by its Spanish acronym)

MARN: Ministry of the Environment and Natural Resources (by its Spanish acronym)

MCD: Ministry of Culture and Sports

MEM: Energy and Mines Ministry

MINECO: Ministry of Economy (by its Spanish acronym)

MINEDUC: Ministry of Education

MSPAS: Ministry of Public Health and Social Assistance

UN: United Nations Organization

PDO: Pacific Decadal Oscillation

PES: Payments for ecosystem services

PINFOR: Forest Incentive Program

PINPEP: Program of Incentives for Small Owners of land with Forest and Agro-forestry Capacity

PFN: National Forestry Program

PRS/USAID: USAID Policy Regulation Support Project

PWS: Payments for watershed services

RA: Rainforest Alliance

REDD: Reduction of Emissions from Deforestation and Forest Degradation

SCAEI: Integrated Environment and Economics Accounting System

SEGEPLAN: Presidential Planning and Programming Office

SICA: Central American Integration System

SIGAP: Guatemalan System of Protected Areas

SIPECIF: National System of Forest Fire Prevention and Control

UNFCCC: United Nations Framework Convention on Climate Change

USAID: United States Agency for International Development

USAID/PRS: Policy Regulatory Support USAID project

WWF: World Wildlife Fund

ITCZ: Inter-Tropical Convergence Zone

1. Introduction

This report contains the final results of the study called Climate Change Vulnerability and Adaptation Assessment in Guatemala. It includes two of the three main objectives which involved developing a list of potential measures on climate change adaptation and recommendations to USAID/Guatemala regarding actions that should continue in order to support climate change adaptation in prioritized geographical areas. Its importance lies in the fact that Guatemala has been identified as one of the most vulnerable countries of the region and it needs to take measures to reduce impacts derived from current and future climate events and variability.

The report provides a brief theoretical framework that should allow the reader to obtain an overall picture on climate change adaptation in order to better understand what is presented throughout the document. The third section shows the list of potential adaptation measures that came out from the different project stages. This part includes one of the requirements of the purchase order, which consists in the assessment of adaptation measures in a final workshop with different stakeholders from Government, USAID/Guatemala partners and the geographical areas of interest (section 3.1). Among the numerous measures that emerged, several may not be considered as climate change adaptation measures but it is definitely advisable to take them into account to diminish climate derived impacts.

The fourth section addresses two subjects that were explicitly requested in the purchase order and that are essential to tackle climate change adaptation. These are local governance and gender equity. Both subjects highlight aspects that need to be considered and they also provide recommendations that emerged from both workshops and consultations, as well as from the consultants responsible for the study.

In the fifth section one of the most important elements of the report is presented: key messages and recommendations to USAID/Guatemala. Ten messages and recommendations derived from the whole study, and particularly from a discussion carried out by the foreign and national consultants after the final workshop, are provided.

Although the report as such is a tool that will support USAID/Guatemala, it is recommended to take into consideration information contained in the first three documents produced during the study. Even though the identified measures in the different stages of the study are summarized in this document, the other reports contain additional information that could be useful.

2. Adaptation to Climate Change: important theoretical aspects

The term adaptation has been used as the process to establish changes in a system's behavior and characteristics to increase its ability to withstand external pressures (Brooks, 2003). In terms of climate change, adaptation has been defined as the implementation of adjustments in the ecological, social or economic systems in response to expected or observed changes in climate and their effects to reduce adverse impact of such changes, or to take advantage of new opportunities (IPCC, 2007; Adger et al., 2005).

For two decades, towards the end of the 20th century, the adaptation issue was widely neglected because there were concerns that focusing on it would imply reducing attention to climate change mitigation (Pielke et al., 2007). However, climate change adaptation has gained importance and it is considered an alternative or complementary strategy to mitigation (Pielke et al., 2007; Smit et al., 2000). It is important to be aware of this because it explains, to some extent, the greater progress in the climate change mitigation agenda compared to the adaptation one. For the latter, there are no well-defined protocols or financial mechanisms that support the implementation of actions. The Adaptation Fund that emerged from negotiations of the United Nations Framework Convention on Climate Change (UNFCCC) is the first step, but its definition and structure have been developed in recent years and it has been functioning for two. The (relative) underdevelopment in climate change adaptation is not only reflected in international negotiations but also in theory, methodologies and mechanisms to guide actions nationally and locally. Nevertheless, considerable importance is given to the subject at all levels, which will facilitate without a doubt moving forward.

The definitions of adaptation have in common that they refer to changes in a system in response to climatic stimuli, though they also present differences. These are particularly related to application and context. Some refer to climate *change* while others focus on climate *variability*. There are variations related to who and what has to adapt as they could be social and economic sectors, ecological systems with or without management, or practices, processes or structures. The impacts of changes in climate are different according to sectors or systems. For instance, increases in heat waves have a deep effect on the elderly, and thus, adaptation measures must focus on that part of society. The implementation timing of adaptation measures also influence approaches that can be used, thus, there is preventive and reactive adaptation. Although adaptation measures are usually assumed to be or should be preventive, in reality it is common to take measures in a reactive way (Smit et al., 2000). Another factor to consider is the participation level of the country or the sector that must adapt and the assistance that will be provided by other stakeholders, that is adaptation can be passive or active.

Many societies, institutions and individuals have changed their behavior in response to climatic changes that have occurred in the past and others are considering adapting to future climatic alterations. A part of this adaptation is reactive because it responds to past or current events, but also preventive because it is based on assessments of future conditions. Adaptation is composed of individual, group and governmental actions. Among the factors that can drive adaptation are economic well-being protection and improvement of both individual and community security (Adger et al., 2005).

Authors like Adger et. al (2003) argue that populations in developing countries are not passive victims, but in the past they have shown stronger resilience to droughts, floods and other catastrophes. In that sense adaptation options may not be necessarily new to a place. The

analogous approach is to consider case studies of past responses to climate variability and extremes (temporary analogies). Current behavior in regions with similar climatic conditions to those that may develop in the region of interest (spatial analogies) can also be investigated (Adger et al., 2003). Most adaptation in developing countries will depend on past experiences on how to cope with climate related risks. So, a great part of the adaptation of farmers, fishermen, coast inhabitants and residents of great metropolis will be autonomous and facilitated by their own resources and social capital (Adger et al., 2003).

There are many approaches and types of adaptation measures. Some adaptation measures can be purely technological as in the adoption of water storage and irrigation technologies that would be recommended in order to decrease impacts of greater variability in water availability for some crops. Other adaptation measures can have an institutional nature like the creation of entities whose work contributes to the reduction of impacts from changes in climate. There are adaptation measures that are more related to behavioral changes. If, for example, food security is threatened by climate change due to the fact that it is fundamentally based on two vulnerable crops, a possible adaptation measure could be for people to change their diet, to be based on a greater variety of crops or on those less vulnerable to climate change. In many cases, although adaptation measures are identified, recommended actions entail tasks already carried out in a planned, effective and efficient way.

In the analyses of potential adaptation measures conducted, some of the resulting actions may not be seen as direct adaptation measures, but as conditions that help reduce climate change impacts. Still it is very important to identify how climate change and variability will affect specific sectors (biodiversity, agriculture, hazards, health etc). Deforestation for example, has multiple causes related more closely to social and economic processes than to climate. For adaptation, addressing deforestation is a key component because it will lead to more resilient ecosystems, reducing the loss of species and providing environmental goods and services for the population. Additionally, protecting forested areas and working on conservation, will reduce overall greenhouse gas emissions, thus linking adaptation to mitigation. One of the main causes driving deforestation is the increase in cropland demand, which is affected by the lack of land planning and lack of logging law enforcement. Measures considered, among others, that were discussed during this project to reduce deforestation include: 1) Promotion of sustainable uses of forests 2) Strengthening of authorities that are in charge of forests, 3) Dissemination of fire management, 4) Land planning, etc. These measures, however, would appear not to be directly climate change adaptation measures, but are in fact related to reducing current vulnerability, increasing resilience (both at forest level and within institutions) and increasing capacity to respond to environmental changes, including climate change and, would also reduce the extent of biodiversity loss. Additionally, it is important to note that deforestation can also lead to landslides, as hill slopes that are left without vegetation are much more likely to erode or form landslides during rain events, which may increase due to climate change. This is one of the reasons why adaptation measures should not be seen separately from project formulation or planning but they should be mainstreamed in them.

3. Climate change adaptation options identified for Guatemala

The project intended to provide an initial list of adaptation options that would then be analyzed through consultations with various stakeholders in order to produce a shorter list of most

recommended options per sectors and geographical areas. However, while some adaptation actions were identified as (overall) more feasible, each stage of the project added adaptation options to the initial list. Therefore, the project yielded a rather long list of adaptation options or measures that can help reduce climate impacts. A discussion of the most recommended options, based on the different analysis and assessments and on the climate potential impacts in the different geographical areas, is included first. Then we included those options that were analyzed at the final workshop with numerous stakeholders (see section 3.2), including a rank of the main options for each of the sectors studied. The complete list of adaptation options that resulted from the project is then presented (see Table 3).

3.1. Focus of the adaptation options in the geographical areas of interest for USAID/Guatemala

According to the Impact Action Matrix (IAM) carried out during the first workshop, impacts and potential adaptation responses were identified for forests, biodiversity, agriculture and the water sector, in the different regions of interest.

3.1.1. The Sierra de las Minas Biosphere Reserve

The Sierra de la Minas Biosphere Reserve has an exceptional value in terms of biodiversity. Adaptation options in that region should be prioritized around protecting that diversity. Furthermore, its adequate conservation and management is also crucial to sustain the livelihoods of hundreds of human settlements in its surroundings, particularly because most sources of water are found in it. Forest fires are a threat at present and its risk is very likely going to increase as a result of higher temperatures and reduced rainfall, as most future climate projections suggest. Fire could speed up the changes in those ecosystems as indicated by a recent study by IARNA (2011), where the most threatened ecosystem is the cloud forest, which could even disappear. Therefore, fire risk management, and particularly the prevention element, should be a priority. The results shown in the IAM indicated that an increase in forest fires is the factor that could have a high impact on forests and biodiversity.

In the case of the agricultural sector, the main impacts were pointed out as 1) loss of crops due to drought (in the southern part), as well as loss and degradation of soils; 2) a medium impact is expected through the loss of crops due to excess rainfall, and high humidity, as well as an increase in pests; 3) a low impact was believed in loss of crops due to floods, frosts, and (scarce) water availability.

The water sector expects a high impact through poorer water quality and water-related conflicts, due the reduced availability of water. Water quality becomes a growing concern as water availability reduces because there is less available water for the dilution of contaminants. A medium impact is expected through damage in infrastructure and variability in water availability for human settlements.

Actions aiming to reduce, prevent, and manage forest fires would be advisable in the Reserve, followed by ecosystem conservation initiatives. Soil management strategies and watershed management initiatives would reduce current and future agriculture vulnerability to climate change at the Reserve. For the water sector actions aiming to improve water quality, reduce

conflicts arising from the use of water and ensuring the resource could increase the sector's resilience to Climate Change.

3.1.2. The Maya Biosphere Reserve

The discussion on the Maya Biosphere Reserve generated several conclusions. Direct impacts of Climate Change on the Reserve's biodiversity can be linked to the plant and animal capacity to respond and adapt to changes in temperature and precipitation patterns. As ecosystems are formed by communities of species, the alteration of abundance and distribution of such species will definitively impact ecosystems structure, resilience and composition. If environmental conditions change, species and ecosystems can adapt to new conditions or migrate to areas with more suitable conditions. However, if there are geographical barriers, or the exact environmental conditions required for their reproduction and development are nonexistent, then the evolutionary process will prevail and species might disappear, other species will occupy their niches and it is possible that ecosystems change, as well as the services they provide. Overall there is very little scientific knowledge on species and ecosystems thresholds to the impacts of climate change. For example, basic knowledge on amphibians leads to the conclusion that drier conditions will add stress to the animals; there has also been laboratory research of their physiology and relation to humidity and temperature, but these are for few species and under controlled environments. It is possible that some of these species are in the limit of their thresholds and we do not know them, also conditions might be changing too fast for those species to adapt. Furthermore, most ecological models involving climate change impacts are still very simplistic and do not incorporate the other many environmental, ecological, and evolutionary variables that could be driving change on ecosystems, such as relief, waterways, prey-predator behavior, competition, or human pressures, to name a few.

Understanding all the ecological and evolutionary processes occurring at the Maya Biosphere and how species and ecosystems at this particular site could be impacted by increased temperature and reduced water availability would be ideal. However, the reality is that it is not possible and reducing the other stressors might be the best alternative for species and ecosystems to adapt to climate variability and the changing conditions set by climate change.

David F. Whitacre in 1997 produced a report for USAID and CONAP in which he already identified potential variables that could affect the Reserve including climate and global change: atmospheric changes, potential increase in UV, increased concentration of CO2, acid rain and set a medium to high priority for monitoring such variables. The report states that there is a need of indicators at the habitat level to monitor the consequences of such processes. In particular the report states that trees and Anura (frogs) could be used as indicator species to detect and monitor atmospheric and climatic changes.

Local climate data, forest phenology, and tree growth and survival are suggested as indicators of climate change, but low and medium priority was given to them in the report mentioned above. Atmospheric changes are suggested to be monitored assessing amphibian population trends and trees growth and survival. High priority was given for amphibian population trends.

It is not possible within this project to assess the repercussion of such a report in CONAP and USAID projects in Guatemala, however, if the proposed monitoring system is in place it could be possible to use the data and assess changes over the past 15 years. The Team of this project was not aware of this report when doing the respective interviews. A scientific literature search

aiming to find more detailed information on climate change impacts on the Biodiversity of the Maya Biosphere Reserve resulted in no resources.

This project has identified the following direct impacts of climate change on forests and biodiversity: 1) biodiversity loss, including genetic material in crop and forest species, 2) Potential increase in forest fires, and 3) a potential decrease in ecosystem resilience. Deforestation, particularly due to land use change and illegal logging are further stressors that could increase the vulnerability of forests and ecosystems to climate change. It is thought that these two combined could have potentially more damaging consequences than the direct impacts themselves.

Further consideration is related to impacts of climate change on communities' livelihoods, agriculture, and water quality and availability, as well as other pressures on the systems outside the Reserve. If these conditions become worse, in close areas that are not protected or in areas within the region, it is possible that higher pressure on the Reserve resources might occur.

The experts who were consulted and who participated in the first workshop also agreed that medium and low impact was expected in the agriculture and water sectors. These included increase in pests, soil loss and degradation, poorer water quality (because of decreasing flow), and, possibly the start of water-related conflicts. Low impacts were expected in damage to infrastructure and water scarcity in human settlements, according to the informants.

3.1.3. The Western Highlands

Extremely high levels of poverty and food insecurity are found in the Western Highlands. Although the flood and drought maps by MAGA (2000) indicate that these hazards do not occur largely in the Western Highlands (except for some small localities), landslides, forest fires, and frosts are common to the region (DesInventar, 2012). The region's disaster vulnerability is high and any increase in climate-related hazards is bound to have a strong impact on the population. Because of the socio-economic conditions, the main areas of focus for climate adaptation should then be agriculture and water resources. However, the Western Highlands are home to numerous ecosystems due to their rugged topography and diverse microclimates, as described by Holdridge in his life zones system (MAGA, 2001). Protection and sustainable management of biological diversity should, then, be also encouraged and supported.

The IAM assessment identified the following direct impacts of climate change on forests and biodiversity in the region: 1) loss of diversity in the gene pool both for crops and forest species, 2) decrease in ecosystem resilience; and 3) Potential increase in forest fires. Forest degradation due to extraction of firewood and in a lesser degree deforestation, are further stressors that could increase the vulnerability of forests and ecosystems to climate change.

The main impacts identified for agriculture and livestock are: 1) loss of crops due to frosts, 2) loss of crops due to excess rainfall and high humidity, 3) Increase in pests, 4) (agricultural) drought, and 5) soil loss and degradation. On the other hand, a low impact is expected through loss of crops due to floods.

In the water sector the main impacts identified were: 1) damage to (public) infrastructure, 2) water scarcity in human settlements, 3) poorer water quality due to decreasing water flow, and 4) increase in water-related conflicts.

3.1.4. The Verapaces

Alta and Baja Verapaz show varying climatic conditions. Alta Verapaz and part of Baja Verapaz are some of the most humid areas in the country. Rainfall occurs all year round, intensifying from May to October. Some municipalities in the region also show some of the highest levels of poverty and food insecurity. According to the IAM, adaptation options, then, should give slightly more importance to the agricultural and the water sectors.

Part of Baja Verapaz lies in the dry corridor area. Given that dry conditions are likely to increase and cover a wider territory in that department (IARNA/URL, 2011), climate hazards related to dry conditions should then be analyzed to determine the appropriate adaption actions. They should take into account water resources, especially in their relation to provision to homes, and its use in agriculture.

The IAM showed that the highest impacts on forests and biodiversity were not directly related to the impacts of climate change but to other processes such as degradation due to extraction of firewood and to a lesser degree, illegal logging, which in turn could exacerbate system's climate change vulnerability.

Direct impacts identified included: biodiversity loss for crops, forests and other natural ecosystems, increase in forest fires (particularly in Baja Verapaz), and loss of ecosystem resilience.

The results for the agricultural sector were as follows, the highest impacts were expected through: 1) loss of crops due to excess rainfall and high humidity in the more humid regions, particularly during tropical storms, 2) increase in pests, and 3) soil loss and degradation. Medium impacts are expected through loss of crops due to floods and droughts, and variability in available water for crops. Impacts of frosts on crops were considered low.

High impacts are expected in the water sector through damages in infrastructure, deterioration of water quality due to decreasing water flow and a rise in water-related conflicts. Medium impacts are thought to happen through water scarcity in human settlements.

Table 1 summarizes the lines of actions identified during the IAM assessment to reduce the impacts of climate change in each of the regions of interest. Several other actions were discussed and this table is only presenting those that directly relate to climate change impacts.

Table 1. Recommended actions for climate change adaptation in the regions of interest

Region	Proposed lines of action
Sierra de las Minas Reserve	Biodiversity protection and management
	Increase forest fire prevention, control and management
	Soil conservation and management
	Watershed management
	Efficient water management and harvesting to reduce conflicts among users

Maya Biosphere Reserve	Biodiversity conservation initiatives, including seed banks
	Increase fire prevention, control and management
	Soil conservation and management
	Pest management strategies
	Efficient water management and harvesting to reduce conflicts among users
The Western Highlands	Biodiversity conservation initiatives, including seed banks
	Increase fire prevention, control and management
	Crops management and diversification
	Soil conservation and management
	Pest management strategies
	Irrigation water management
	Infrastructure climate proofing
	Efficient water management and harvesting to reduce conflicts among users
The Verapaces	Detailed hazard assessment
	Biodiversity protection and management
	Increase fire prevention, control and management
	Pest management strategies
	Soil conservation and management
	Efficient water management and harvesting to reduce conflicts among users

3.2. Most recommended adaptation options according to the workshop with different stakeholders

The final list of adaptation options and the level of priority designated to them resulted from a workshop with various stakeholders (see the list of participants in annexes), though inputs from all stages of the project were taken into account. During the workshop the outcomes from the consultations, the initial workshop and interviews were presented to the attendants. They were split into groups according to three topics: forests and biodiversity, water resources and agriculture. They were asked to discuss the list of adaptation actions and consider including more according to their knowledge and experience. The instruction was to choose around 8

adaptation actions according to their effectiveness and feasibility. These actions were then used for a pair-wise exercise that would help further explore the most recommended actions.

The pair-wise exercise required the groups to compare each adaptation option against each of the other options and try to decide, in pairs of options, which was more feasible. They were asked to consider effectiveness, economic feasibility, technical feasibility, social/cultural feasibility, and institutional feasibility when deciding which of the two to select. In a matrix a letter that represented the chosen adaptation option was placed in a box intercepting the two options (see Annex 7.2). At the end this gave each adaptation option a frequency that helped build the rank of most recommended options (see Table 2). The resulting matrix for each sector is included in the annexes.

During the workshop, the participants stressed the fact that all adaptation options mentioned in the pair-wise exercise were very important. This made it difficult to select a short list of options to be analyzed. Although that implies that the adaptation options which were left out of the exercise should be taken into account, the discussions held allowed to identify priorities and to be practical when choosing adaptation options to be implemented on the ground. The results from tables 3 to 5 are summarized in the following table.

Table 2. Climate change adaptation options per sector in order of priority

Forests and biodiversity	Financial mechanisms for conservation
	Strengthening all types of protected areas and biological corridors
	Valuation and preservation of ancestral and traditional knowledge for climate adaptation
	Strengthening institutions on biodiversity matters, including the local level
	Strengthening local capabilities and citizens participation
	Research and monitoring
Agriculture and livestock	Soil conservation
	Irrigation and water storage
	Diversification of crops
	Harvest and seed storage
	Family gardens
	Integrated Pest Management
	Agroforestry systems
	Preservation of native species
	Fencing of livestock

	Use of meteorological information
Water sector	Use of information
	Protection of headwaters
	Organization of local stakeholders
	Water storage
	Improved water use efficiency
	Water infrastructure upgraded to withstand extreme events
	Water valuation
	Land planning

3.3. Recommended adaptation options according to all stages of the study

Table 3 shows the adaptation options that were mentioned throughout this assessment during workshops and consultations. There were a total of 81 options, which were then grouped in 58 options to avoid repetition.

The table lists the adaptation options in the first column and then information on the options is given in the three other columns. Each column presents:

- Adaptation options: Adaptation opportunities identified during the different consultation processes
- Source: Scenarios where consultations have occurred
- Criteria assessment: options that were considered in the feasibility assessment post workshop I
- Sectors of Interest: Options that where discussed considering biodiversity and forests, agriculture and food security and water.
- Regions of Interest: USAID areas of greater interest for those sectors in Guatemala

Table 3. Climate change adaptation options that resulted from all the stages of the study

Adaptation options	Source			Sector of interest			Regional Assessment			
	Workshop 1 (experts)	Feasibility Assessment (USAID partners and government officials)	Final workshop (stakeholders)	Forests & biodiversity	Agriculture	Water	Western Highlands	Verapaces	Sierra de las Minas	Maya Biosphere
Soil conservation	X	X	X	X	X	X	Δ	Δ	Δ	Δ
Food storage	X				X		Δ	Δ	Δ	
Collective intellectual property rights	X				X		Δ	Δ	Δ	
Increase capacity to produce, use and monitor information. Promote research on met data and baseline information that can lead to knowledge about how different systems (human and ecological) are impacted by climate change and their natural responses	X	X	X	X	X	X	Δ	Δ	Δ	Δ
Greenhouses for certain crops	X				X		Δ	Δ	Δ	
More resilient varieties of crops	X				X		Δ	Δ	Δ	
Integrated Pest Management	X		X		X		Δ	Δ	Δ	Δ
Early-warning systems	X				X	X	Δ	Δ	Δ	

Adaptation options	Source			Sector of interest			Region			
	Initial workshop (experts)	Feasibility Assessment (USAID partners and government officials)	Final workshop (stakeholders)	Forests & biodiversity	Agriculture	Water	Western Highlands	Verapaces	Sierra de las Minas	Maya Biosphere
New standards for water infrastructure	X					X	Δ	Δ	Δ	Δ
Promote systems for efficient water harvesting, storing and distribution	X	X	X		X	X	Δ	Δ	Δ	Δ
Monitoring of rivers	X			X	X	X	Δ	Δ	Δ	Δ
Payment for ecosystem services (PES) (including hydrological services)	X	X	X	X	X	X	Δ	Δ	Δ	Δ
Sewage water treatment	X			X	X	X	Δ	Δ	Δ	Δ
Industrial water treatment	X			X	X	X	Δ	Δ	Δ	Δ
Strengthening and supporting local governance, capabilities, coordination, planning and citizens participation	X	X	X	X	X	X	Δ	Δ	Δ	Δ
Crop and seed storage	X	X	X	X	X		Δ	Δ	Δ	Δ
Forest certification	X			X			Δ	Δ	Δ	Δ
Botanical gardens (conservation and ex-situ reproduction)	X			X			Δ	Δ	Δ	Δ
Protected areas including biological corridors	X		X	X		X	Δ	Δ	Δ	Δ

Adaptation options	Source			Sector of interest			Region			
	Initial workshop (experts)	Feasibility Assessment (USAID partners and government officials)	Final workshop (stakeholders)	Forests & biodiversity	Agriculture	Water	Western Highlands	Verapaces	Sierra de las Minas	Maya Biosphere
Improve capacity to prevent and control forest fires at the national and local level	X			X	X		Δ	Δ	Δ	Δ
Forestry training	X			X	X		Δ	Δ	Δ	Δ
Penalties for people that start forest fires	X			X	X		Δ	Δ	Δ	Δ
Efficient systems for sustainable wood consumption, forest-product substitutes, forest incentives and subsidies.	X			X			Δ	Δ	Δ	Δ
Penalties for illegal wood trade and collection	X			X			Δ	Δ	Δ	Δ
Raise the level of forest-related awareness and education	X			X			Δ	Δ	Δ	Δ
Forest management plans (e.g. municipal forest land).	X			X			Δ	Δ	Δ	Δ
Certified firewood forests	X			X			Δ	Δ	Δ	Δ
Enforce forestry regulation at the municipal level	X		X	X	X	X	Δ	Δ	Δ	Δ
Reintroduce the Integrated Environment and Economics Accounting System (SCAEI)	X			X			Δ	Δ	Δ	Δ

Adaptation options	Source			Sector of interest			Region			
	Initial workshop (experts)	Feasibility Assessment (USAID partners and government officials)	Final workshop (stakeholders)	Forests & biodiversity	Agriculture	Water	Western Highlands	Verapaces	Sierra de las Minas	Maya Biosphere
Market-based conservation mechanisms	X		X	X			Δ	Δ	Δ	Δ
Carbon sequestration		X		X						
Agro-forestry systems and livestock			X		X					
Economic activities diversification		X	X	X	X					
Improvement of subsistence crop management and family gardens		X	X		X					
Restoring native and endemic species		X	X	X	X					
Domestic fauna		X	X		X					
Promote efficient crop irrigation including infrastructure	X	X	X		X	X	Δ	Δ	Δ	
Fencing livestock			X	X	X					
Crop diversification		X	X		X					
Diet change (to one based on more resilient crops)		X			X					
Rural insurance			X		X					

Adaptation options	Source			Sector of interest			Region			
	Initial workshop (experts)	Feasibility Assessment (USAID partners and government officials)	Final workshop (stakeholders)	Forests & biodiversity	Agriculture	Water	Western Highlands	Verapaces	Sierra de las Minas	Maya Biosphere
Organic Fertilizers			X		X					
Promotion of infrastructure maintenance and upgrading to withstand extreme events and diminish habitat fragmentation (ensures greater ecosystem capacity to respond)			X	X	X	X				
Medicinal gardens			X		X					
Increase the capacity of project funding (private-public initiatives and micro-micro finances)			X	X			Δ	Δ	Δ	Δ
Forest fires prevention strategies	X		X	X						
Productive systems from forests (incorporating forest products into the economy)			X	X						
Strengthening local capacities and citizens participation			X	X						
Strengthening institutions on biodiversity matters at the local level		X	X	X						
Regional integration (SICA) and policies harmonization			X	X						

Adaptation options	Source		Sector of interest			Region			
	Initial workshop (experts)	Feasibility Assessment (USAID partners and government officials)	Final workshop (stakeholders)	Forests & biodiversity	Agriculture	Water	Western Highlands	Verapaces	Sierra de las Minas	Maya Biosphere
Restoration of ancestral practices that could potentially reduce the impact of climate change in rural areas			X	X						
Implementation of a national biodiversity strategy			X	X			Δ	Δ	Δ	Δ
Identification and reduction of impacts of multinationals on biodiversity			X	X						
Restoration of natural areas			X	X						
Ecosystems protection prioritization (mangroves, cloud forests)			X							
Land planning			X	X	X	X				

Table 4 presents a ranked list of high and medium priorities from the 58 proposed in table 3. All other options not listed in the table are low priority options according to this ranking.

Table 4. Final ranking of adaptation options throughout the study

Level of priority	Options
High	soils conservation and management
	Increase the capacity to generate, use and monitor information. Promote research on meteorology in order to understand the impacts on human and ecological systems.
	Promote Integrated Watershed Management, especially in areas of recharge
	Promote efficient systems to harvest, store and distribute water
	Payments for Environmental Services (PES), including hydrological ones
	Storage of harvest and seeds
Medium	Integrated Pest Management
	Early Warning Systems
	Strengthening and support to local governance, capacities, planning and citizens participation
	Strengthening all types of protected areas and biological corridors
	Enforce regulation at the municipal level
	Economic activities diversification
	Subsistence crop management and family gardens, including crops diversification
	Restoring native and endemic species
	Diet change
	Promoting infrastructure maintenance and upgrading resistant to extreme events (for enhancing communication between rural areas and cities) and diminish habitat fragmentation (ensures greater ecosystem capacity to respond)
	Increase Forest fires prevention strategies

In order to rank the adaptation options the following criteria were considered: workshop discussions, sectors that would benefit from such options (water, forest & biodiversity and agriculture) and relation of each option to climate change vulnerability reduction. For example,

improvement of information production and management was an issue discussed in all workshops, in all sectoral analysis, and a better understanding of the system by means of better baseline information could help reduce climate change vulnerability. Hence it was considered as high priority.

Early warning systems (EWS) were discussed in the expert workshop. They were options considered for the agriculture and water sectors, in the Highlands, the Verapaces and Sierra de las Minas. EWS are also key for reducing vulnerability to climate change.

Sewage water treatment relates to climate change because degradation in water quality may occur since climate change is predicted to reduce flows in some rivers, thus reducing dilution of sewage, but was discussed only at the expert workshop, related to all the sectors and regions but it is not directly related to the reduction of the impacts of climate change. This appears to be a low rank priority.

4. Cross-cutting topics to climate change adaptation

4.1. Local governance

Local authorities, such as municipal staff and community organizations will increasingly play a more central role in adaptation measures and their leadership role should be championed. Municipalities play a central role in local level governance across Guatemala, as do secondary groups such as the Municipal Development Councils (COMUDES), Community Development Councils (COCODES), and Local Emergency Committees (COE). While both knowledge and skills of members in these local governance entities vary considerably from place to place, both the definition and implementation of adaptation actions should be embedded in the relevant local institutions to guarantee uptake. In fact, many of the proposed adaptation actions would be best undertaken at local scales, taking advantage of the intimate experience and cultural knowledge available in municipalities and community organizations. There are several reasons for this:

- The development of local climate change strategies, including policies and actions related to them requires the involvement and participation of the affected communities. Communities and individuals are intimately aware of the challenges and opportunities they face from a changing climate, and can often draw on a rich portfolio of knowledge and experience when identifying actions to address climate risks.
- The solutions and proposals related to climate change will have greater legitimacy when decisions are reached in representative areas and through community participation. The need to work with existing knowledge and tools, placing special attention on approaches which have been tried in similar areas elsewhere, emerged as a priority during the second workshop. Indeed, it was clear that actions that have been tried before were more likely to succeed than those for which limited knowledge existed or were perceived to be too radical for the area.

Recognizing climate variability and change as a critical development challenge, decision makers have begun to shift the debate from one of high-level advocacy on the “need to act” on the

issue to defining appropriate responses on "how to" adapt (Schiermeier, 2007) and a growing number of local governments are beginning to explore ways in which to mainstream climate change adaptation into development objectives. The so-called mainstreaming process, aims to articulate the relationship between development and vulnerability by identifying the factors that create vulnerability and highlighting points in the development agenda where these factors can be addressed (Noble 2005, Klein et al. 2007). Mainstreaming adaptation to climate change into ongoing development efforts requires an understanding on how climate change may change the desired outcomes of a specific development activity. Under this approach, it is therefore critical to evaluate both current climate variability as well as future climate risks.

The term, local governance, defines the ways in which local decision-making, particularly in the area of public goods and services, is carried out. It is in this area where key interfaces between local and climate change can be found, particularly with regards to:

- Local planning and regulation – largely in form of land use planning and zoning which aims to avoid development in high-risk areas (low-lying, flood prone, steep slopes) and to reduce negative impacts on ecosystem goods and services due to development activities. Strategic scenario planning could be used as a mechanism to examine the consequences of climate change and develop a suite of potential responses within municipal planning instruments.
- Delivering goods and services – that impact on vulnerable communities or that need to be climate resilient. For example, maintenance of transportation systems, lifeline utility systems such as water and electricity, and high potential loss facilities such as hospitals and schools. Environmental management, particularly related to forest conservation to reduce carbon emissions or forest management to guarantee necessary firewood stocks, are also the purview of local governance functions, as is the maintenance of healthy ecosystems to provide services for livelihoods and buffer against shocks.

The extent to which actors in local governance, in this case municipalities and community groups can address climate change risks is defined by the level of the available:

- Information base – an effective information base to support decision making should be transparent and available to the public, and provide an institutional memory to enable re-adjustments of priorities and actions as circumstances change.
- Institutions and staff – technically competent institutions and staff better assume the necessary tasks of coordination during emergencies and can provide incentives for improved planning mechanisms across relevant organisms.
- Infrastructure– infrastructure, including transport, energy and water provides the mechanism for delivering critical lifeline services to local populations. Infrastructural deficits need to be addressed as part of the development agenda and in many cases will supersede the adaptation deficits in importance.

Adaptation options should build on existing information, institutions and infrastructure base, by providing technical, capacity and planning support to address shortfalls in these areas within local governance. Some specific recommendations targeted to improve local governance include:

- Build capacity at local level– from the technical personnel in municipalities to individual families and households – to better understand and cope with climate risks – primarily risks they have already experienced – as well as the more important development implications of new investments and their coordinated operations.
- Prioritize efficient dissemination of knowledge among decision-makers and strengthen leadership at the level of implementation. The awareness of key stakeholders on the impacts of climate change on people, infrastructure and the economy is increasing. However, there is still a need to strengthen leadership at the level of implementation of adaptation, including the provision of ideas and practical approaches through which to integrate climate risks into existing plans and strategies.
- Increase the knowledge base and technical expertise of planning staff to risks brought about by climate variability and change will not only help to raise awareness of these issues but could also build champions within the municipal staff to include vulnerability and risk information into existing plans. It is clear that the funding for urban planning authorities also needs to be increased. In addition, raising the level of awareness of individual citizens and communities to risks will certainly increase mobilization of responses to climate change.
- Explore public-private funding opportunities for selected adaptation measures in partnership with the private sector. Their exposure and sensitivity to climate change risks makes the private sector a receptive partner in adaptation. There is an urgent need to include the private sector in the design and implementation of adaptation measures, including feasibility and cost-benefit analyses and options for investment programs, and in securing funding for adaptation options which may be too costly to implement with public funds alone.
- Provide policy makers and technical departments of the municipalities a set of guidelines, recommendations, and examples for the development and implementation of local climate change strategies. They should be encouraged to take into account the social, economic, cultural and environmental characteristics of their municipalities.
- Include solutions aimed at mitigating emissions of greenhouse gases (GHG) in strategic areas such as power generation, transportation and cooking. These bring local benefits and some are both climate change mitigation as well as an adaptation measures.
- Providing coordination and harmonization mechanisms to help municipalities work closely with the assistance of the Interagency Commission on Climate Change, of ministries and public entities, MARN, MAGA, MOH, MEM, INAB, CONAP, CONRED, MINECO, MCD, MOE, SEGEPLAN, ANAM-AGAAI INFOM, programs such as Zero Hunger and Rural Development, and other bodies such as the Environmental Commission of Congress and Attorney of Environmental Crimes.
- Build strategic alliances with social organizations. These include the Indigenous Bureau of Climate Change, National Climate Change Bureau, Bureau of Risk Reduction, Forestry Communities Alliance, Disaster Preparedness Program of the European Commission-DIPECHO-VIII-, Italian Cooperation –COOPI-, Action Against Hunger, CARE, OXFAM, the Red Cross, agencies of the United Nations, among others.

4.2. Gender and Adaptation to climate change

Gender has been one of the cross-cutting themes in the USAID/Guatemala mission. It is therefore important to identify how climate change will impact each of the initiatives, code of practice or projects involving women and development in the country.

Part of this assessment involved integrating gender issues into the adaptation agenda. Unfortunately despite the issue being brought up in both workshops, with the experts and with the relevant stakeholders, it was not possible to draw many conclusions. Since climate change and gender equity are extremely related with sustainable development, the general consensus was that equal opportunities exist for all the population, regardless of gender, to achieve adaptation in their lives and livelihoods.

Apart from this general perspective three aspects were mentioned on gender issues and climate change: 1) Girls attendance and permanence in schools in rural areas, 2) Timber and firewood collection by women and children, and 3) Women as leaders in cutting down wood consumption.

It was mentioned that in some areas of Guatemala, girls are in charge of cattle at small scale; hence they need to be in the fields. An idea was to promote strategies of animal fencing so that girls could go to school instead of looking after the animals. This topic was brought forward because education and awareness from school level is important for all individuals. Even if the education received is not directly related to climate change, education gives girls opportunities and tools to be more resilient. An educated community at all levels increases its resilience and reduces its vulnerability to environmental changes, conflict and other disturbances. Since women usually manage the homes and are in charge of looking after their children, their level of schooling has an impact on the families' resilience too. The fencing of animals also has positive environmental impacts, as observed in the case of IUCN-led micro-catchment projects in San Marcos. Natural regeneration is affected negatively by sheep or goats as they tend to eat the sprouts and young trees. Hence, fencing these animals favors natural regeneration, with positive effects on carbon sequestration and reduction of soil erosion.

With respect to timber and firewood collection, the discussions revolved around how firewood collectors are often women and children and how introducing measures and strategies to reduce the dependence on firewood as energy source (cooking mostly) could be beneficial both for forest protection and for women and children. Not only would this contribute to reducing the potential impacts from climate change on forests, but it decreases the amount of time women and children dedicate to collecting firewood and would allow them to focus on other activities like school or family care. It is also related to health improvement, as women and children are also the most impacted from firewood burning inside confined spaces. Related to this is the role of women as main users of the wood on the pressure on forests for wood and on the potential decrease of such pressure if more efficient stoves are introduced in the households.

Besides the above three general concerns there are other aspects that could be considered and have been considered in other countries in the region and worldwide regarding women's role in climate change. Such factors are presented next.

The first factor is household administration, including energy, water and natural resources consumption. In many areas men are the heads of the household and women are the administrators. In summary this means that men command and the women are the implementers. Women are aware of how much firewood is required for cooking, water, and resources for cooking, for example. Strategies directly involving women are key and more those strategies that could lead to making their activities more effective.

It is often seen that in community meetings or projects that have a component of community participation, it is men who attend such meetings. In those meetings projects could be discussing the importance of using energy efficient stoves, or the importance of adequate use of water in the household, or a change in land use activities to improve the community's livelihoods. It is important to include men and women in such meetings and not just men, as often. Women are the ones who have to deal with these situations in a day to day basis and often they are the ones that do not receive the training or awareness.

In rural areas, often men have to move from one region to another in search for income for the household and the women are left in charge of the entire household administration and wellbeing. International migration, in particular, has been increasing the number of women who are also been left in charge their crops. If women do not have adequate knowledge on how to manage the crops, part of their livelihood becomes more vulnerable. Therefore, proper training and adaptation options in the agricultural sector should be also available to women.

The inclusion of women in community activities or projects that aim to improve their livelihood or their adaptation to climate change, for example, has to be developed according to women's time availability. For example, meetings and workshops need to be organized at a moment that is suitable for them, so they can attend.

In line with the above, there is a need to empower women at the household level. It is common for all household values to be under the name of the head of the family, normally a man. He is part of the "finance" system, as all the assets (many or few) are under his name. It is very difficult for women to have bank accounts and even more difficult to have access to credits. Some microfinance institutions have favored women and as a result have generated more revenue, as women tend to be better at paying back their credits. This is important in a climate change situation because it is possible that the livelihoods of people change with changes in environmental conditions, and therefore there is a need to look for alternative sources of income. There is a need to create more resilient communities, with a more diverse economy. If both members of the household are able to apply to credits and to work and respond for them the chances for the household are greater for responding to changes on their social or environmental conditions.

Another issue that has been widely discussed in the (natural) disasters literature is the vulnerability of women during a disaster and after the immediate event. The vulnerability during the event is that women are the last ones to leave the households, making sure that everyone has left, and/or are the ones that return to the households to look for the children that are left behind. The vulnerability post-event is related to assaults and attacks from other members of the community (or not) that make the most of the emergency status.

It is important that all early warning systems include the training of women and consider the role of women in the household to avoid greater injuries or casualties. It is also required that in a post-event situation, women and children are protected and to maintain families together.

As new hazards triggered by climate change arise in certain areas such as new pests and diseases that affect households, information should be readily available for the population. Women should be seen as a key end user of such information so they can prevent or reduce impacts. If possible, efforts should be made to help them take actions, especially in rural settings, where people's mobilization and scarce resources could potentially exacerbate such impacts significantly.

5. Key messages and recommendations for USAID/Guatemala

Many analytical frameworks exist to assess vulnerability in light of climate variability and change and define strategic interventions.

We view these as instruments to clarify strategic choices rather than cookbook approaches, varying in their scales of applicability, treatment of decision spaces, stakeholders, risk and underlying definitions. Highly uncertain situations such as those related to climate adaptation require the application of frameworks that fit the needs of the intended scales analysis and questions posed, rather than prescribing a single analytic framework for all interventions.

Creating a shared knowledge space should begin by using existing stakeholder frameworks rather than seek to build a consensus framework as operational guidelines. The attempt to adopt existing frameworks forces stakeholders, including USAID, to ask crucial questions about the key vulnerability and risk drivers, and allows for an open, transparent and systematic discussion at the outset.

Climate variability is already significant in Guatemala and this variability already threatens vulnerable populations and sectors.

High inter-and intra-annual variability results from variations in the major driving forces of atmospheric circulation, topographic heterogeneity, El Niño/La Niña cycles, and intensification of the Inter-Tropical Convergence Zone (ITCZ) and Pacific Decadal Oscillation (PDO). The El Niño phenomenon magnifies vulnerability in the region, in particular, causing frequent severe droughts in the eastern portion of the country. Both maximum and minimum temperatures have increased across the country, at an average of 0.2° and 0.3° degrees per decade, respectively in the last 40 years. The number of hot days and nights has increased by 2.5 and 1.7% per decade, respectively. Conversely the number of cold days and nights has decreased by -2.2 and -2.4%. Rainfall and moisture changes over the last 40 years suggest a strengthening of the hydrological and climate cycles, with more intense rain events.

While a limited observational base makes it difficult to derive statistically significant trends on climate variability, local histories of climate and variability can be used to define appropriate response strategies. Collecting local histories is thus an important first step in understanding the impact of climate variability on vulnerable households, especially in the heterogeneous mountain areas. This is particularly relevant due to the existence of numerous microclimates in the country.

Guatemala's major economic sectors are already sensitive to climate variability and this is likely to be exacerbated by future changes in climate.

Agriculture, a mainstay of the Guatemalan economy, is one of the country's most vulnerable sectors, with implications for food security. Changes in rainfall patterns and increased temperatures can hinder crop productivity and often lead to crop failure in already marginal areas of production.

Managing priority risks, associated with current climate variability and extremes is a useful starting point towards taking anticipatory actions to address risks associated with longer-term

climate. Early response investments with cross-sectoral benefits, such as integrated soil conservation practices, should be pursued.

Guatemala's climate is already undergoing a process of change, but future predictability varies in confidence across variables, time scales and geographies.

High confidence projections, with significant implications for priority vulnerable sectors and populations estimate that by 2050: 1) temperatures will have increased by 1.5 to 4.5° Celsius, with the month of May being the hottest. The southern part of the country may have the most significant changes in temperature and 2) an intensification of heat waves and high temperature expansion into previously cooler mountainous areas. Future projections of rainfall are of low confidence. This is due to large model uncertainties, with multi-model averages suggesting a drying trend, and some individual models suggesting a more humid future. What is clear, however, is that the future will increase climate variability and extreme events.

In spite of these differences, projected temperature increases alone will place new stresses on existing resources. For example, it is likely that the incidence and distribution of crop pests and pathogens, previously unknown in high elevations may begin to appear, with attendant farm management implications. Changes in temperature also influence soil moisture availability; hence crop water use, actual evaporation and crop yield, irrigation demands, dryland agricultural practices (especially the beginning and end of growing periods), heat wave episodes and the frequency and severity of droughts. These are all dynamics which are likely to change across Guatemala.

Many entry points exist for incorporating climate adaptation into development initiatives across USAID

In practical terms, many entry points exist for incorporating climate adaptation at all levels of activities and governance of interest to USAID, including those implemented at the:

- **field level –** promoting the sharing of knowledge and experiences, especially those related to diversifying existing sources of income/production systems and changing livelihood strategies, and awareness raising on climate change issues to support adaptation as a "learning by doing" process rather than an end point to specific point forecast.
- **project level –** support the sharing information on improved infrastructure for small scale water capture, storage and use, and improved soil management practices;
- **institutional level –** support the collection and analysis of relevant information to support adaptation planning including local meteorological data in heterogeneous environments.
- **policy level –** facilitate communication exchange and proactive, fiscal responses that include strategic interventions for high probability impacts, strengthening existing policy frameworks**.**

The list of responses that resulted from the different consultations and workshops in this study provides a starting point of options that could be promoted at the levels mentioned above. Because of the points discussed in section 2, the responses could be incorporated not only in programs and projects directly related to climate change but also in other areas such as environment and economic development.

Effective processes for prioritization of adaptation options engage a wide range of stakeholders, are transparent, and enable the review and adjustment of priorities as circumstances change

The process of prioritization employed can be an effective way to engage decision makers, identifying tradeoffs involved when evaluating strategic options. Results from the analyses conducted suggest that many adaptation options are desirable across sectors, while high priority ones depend on users, geographies and experience. As illustrated in this work, prioritization exercises can be used to effectively engage even the senior decision-makers in asking all the right questions when evaluating strategic options. The prioritization approaches applied suggest that these methods can be used to make useful judgments about the criteria used to identify feasibility and define critical constraints to their implementation. Furthermore, the true value of the prioritization exercise resides in the insight gained from a participative, collective effort than the specific actions themselves.

As climate variability and extreme weather events continue to impact Guatemala, decision makers will increasingly face new challenges about how to manage these risks

Guatemala's population already has experience with significant climate variability and in some areas a capacity to cope with these fluctuations. However, as climate variability and extreme weather events continue to impact the country, decision-makers will increasingly face new challenges about how to manage these risks. Furthermore, a large number of adaptation options have already been identified, and many of these are already being implemented across Guatemala.

Adaptation responses should capitalize on people's experience and knowledge - those living in marginal environments have a long history of adapting to climate variability. While traditional coping mechanisms may not be sufficiently robust in a changing climate, they can offer insights into effective strategies to address a changing climate and expand the available information base.

The need to improve partner communication and collaboration in the area of knowledge sharing will grow in importance under a changing climate

There are many initiatives and active organizations in climate change related issues and environmental action across Guatemala, however, weak institutional arrangements and lack of co-ordination between actors threaten the scalability of experiences and duplication of efforts. Furthermore, collaboration is often informal and linked to individuals rather to an institutional culture, requiring repeated awareness raising and training and making it difficult to move forward the dialogue on what to do about climate change.

USAID actions should continue to support a national dialogue around climate adaptation, and promote ownership of responses - Establishing an effective dialogue for collaborative problem-solving can provide for a shared understanding of concepts of risk, coupled with trust and credibility between the parties, whether they are internal to USAID or partner organizations. For example, the "producer's organization in the agriculture group" youth group

engages community members to actively promote soil conservation measures such as household compost, green compost, and tree planting.

Integrating adaptation with development priority and planning includes, gender, finance, and legal instruments of institutional reform

While climate may differentially impact certain population groups, such as women, it is important to consider gender within the context of vulnerability and responses, rather than separately. It is clear that many adaptation responses identified will help to relieve the pressures on women.

Efforts currently in place need to be increased and/or reinforced to continue with the successes observed to date. For example, the Climate Change and Resilient Development small grants program is now funding innovative ecosystem management practices and climate services partnerships at targeted scales, which can provide critical insights on models of adaptation implementation.

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7. Annexes

7.1. List of participants in the final workshop

Name	Institution
Haroldo Chiquín	CARE
Ana Vilma Pérez Sajoy	USAID
Glenda de Paz	USAID
Josefina Martínez	USAID
Teresa Robles	USAID
Jennifer Tikka	USAID
Sergio Vega	ICC consultant
Ricardo Roca	USAID
Janet Lawson	USAID
Carmen Lacambra	Consultora Grupo Laera
Julio Sandoval	Chac Mol S.A.
Fernanda Zermoglio	GCAP consultant
Oscar Murga	USAID
Thomas Downing	GCAP consultant
Jorge Cardona	The Nature Conservancy
Dany Vásquez	ASOCUCH
Elmer Ganeda	ASOCUCH
Rolando Gómez	FUNDAECO-Huehuetenango
Edwin Oliva	INAB-PFN
Víctor Hugo Villatoro	FUNDAECO-Huehuetenango
Oscar Núñez	Defensores de la Naturaleza
Ana María Palomo	National Climate Change Bureau
Claudia García	ARNPG
Juan de la Cruz	Climate Change Unit, Ministry of Finance
Flor de María Bolaños	UNDP
Rosa María Aguilar	ANACAFÉ
Edwin Rojas	Climate Change Unit, Ministry of Agriculture
Jorge Cabrera	ICC consultant
Vivian Lanuza	Fundación Solar
Luis Alberto Ferraté	ICC
Martin Keller	Association of Private Nature Reserves
Sergio Ajá	Counterpart International
Doris Martínez	Center for Environmental Studies, Universidad del Valle de Guatemala
Alejandra Sobenes	USAID/PRS
Aymé Sosa	USAID/PRS
Romeo Martínez	ANACAFÉ
Oscar Rojas	Defensores de la Naturaleza
Alejandro Santos	Rainforest Alliance
Patricia Orantes	USAID/PRS

Roberto Cáceres	CEMAT/ASOREMA
Amelia Coj	Ministry of Foreign Affairs
Alex Guerra	ICC

7.2. Pair-wise exercise results

Group 1: adaptation options for Forests and Biodiversity

A: Research and monitoring
B: Financial mechanisms for conservation
C: Valuation and preservation of ancestral and traditional knowledge for climate adaptation
D: Strengthening all types of protected areas and biological corridors
E: Strengthening local capabilities and citizens participation
F: Strengthening institutions on biodiversity matters, including the local level

Table 5. Pair-wise matrix for Forests and Biodiversity

Options	A	B	C	D	E	F	Option frequency
A		B	C	D	E	F	A= 0
B			B	B	B	F	B= 4
C				D	C	C	C= 3
D					D	D	D= 4
E						F	E= 1
F							F= 3

Group 2: adaptation options for Agriculture and Livestock

A: Soil Conservation
B: Agroforestry systems
C: Preservation of native species
D: Integrated Pest Management
E: Harvest and seed storage
F: Use of meteorological information
G: Family gardens
H: Fencing of livestock
I: Irrigation and water storage
J: Diversification of crops

Table 6. Pair-wise matrix for Agriculture and Livestock

Options	A	B	C	D	E	F	G	H	I	J	Option frequency
A		A	A	A	A	A	A	A	A	A	A= 9
B			B	D	E	B	G	B	I	J	B= 3
C				D	E	C	G	C	I	J	C= 2
D					E	D	G	D	I	J	D= 4
E						E	E	E	I	J	E= 6
F							G	H	I	J	F= 0
G								G	I	J	G= 5
H									I	J	H= 1
I										I	I= 8
J											J= 7

Group 3: adaptation options for the Water Sector

A: Land planning
B: Organization of local stakeholders
C: Water storage
D: Protection of headwaters
E: Improved water use efficiency
F: Use of information
G: Water infrastructure upgraded to withstand extreme events
H: Valuation of water

Table 7. Pair-wise matrix for the Water Sector

Options	A	B	C	D	E	F	G	H	Option frequency
A		B	A	D	E	F	G	H	A= 1
B			B	B	B	F	G	B	B= 5
C				D	C	F	C	C	C= 4
D					D	F	D	D	D= 6
E						F	E	E	E= 4

F							F	F	F= 8
G								G	G= 4
H									H= 2