

CLIMATE-RELATED IMPACTS ON NATIONAL SECURITY IN MEXICO AND CENTRAL AMERICA

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Summary

Climate change will have profound impacts for Mexico and Central America, reshaping resource distribution, creating new dynamics of winners and losers, and making current challenges concerning poverty and governance more difficult to respond to. These changes will reshape the physical and political terrain, and could have far-reaching social, political and security repercussions.

The dynamics behind the current security issues in Mexico and Central America are complex, but this research explores how climate change can reinforce drivers of insecurity such as increasing poverty, weakened governance capacity, or greater social divisions and polarisation. Climate change does not necessarily have consequences for security; the impacts that climate change has on a society, including the security impacts, depend on the capacity of that society to cope with climate change.

At present the region is coping with existing challenges around food security, water availability and population movements. Even without additional stress from climate change, the region has multiple risk factors for instability including areas vulnerable to water stress, high population growth, crop decline, hunger, coastal risk from sea level rise, and a history of recent conflict. As climate change intensifies these dynamics, challenges will have to be handled in such a way as to avoid aggravating current tensions and contributing to a deteriorating security environment.

Adaptive Capacity

Social structures, institutions, economies, cultures and politics ultimately determine whether environmental pressures exacerbated by climate change can influence levels of insecurity, erosion of governance and conflict. How proactively societies create resilience through adaptation will determine the severity of climate impacts, including the potential for national security consequences.

Definition of 'Security'

The definition of 'security' used in this research process is 'social and political stability'. 'National

security issues' in Mexico and Central America are often synonymous with the issues of narcotics trafficking and serious organised crime (SOC). However this research takes a broader approach, and considers social and political stability to be the pillars that underpin national security.

Key Security Dynamics

- Extreme weather events will increase both the political and financial burden of disaster response as governments are expected to maintain the rule of law, protect citizens and ensure the secure delivery of aid supplies, while the community recovers.
- Climate change will lead to greater resource scarcity and is therefore likely to increase competition between social groups as well as dissatisfaction with government.
- Water management systems will come under increasing stress as climate change intensifies drought trends, leading to greater competition and tension between water users both domestically and transnationally.
- Food shortages in the region, exacerbated by climate change, will impact on health, education and social participation at the domestic level.
- Internationally, food shortages will increase competition between countries seeking to buy food on the world markets.
- Climate change could act as a driver of migration through its impacts on livelihoods. Depending on how migrants are received in destination areas, social tensions related to crime, unemployment and vulnerability to further climate change impacts could emerge.
- In an area where governance is stretched, resources are scarcer and livelihoods are under pressure, climate change could enable serious organised crime (SOC) to establish a stronger foothold.
- Climate change will increase the pressure on already-stretched security communities that will be expected to respond to the changing dynamics outlined above.

Introduction

Climate change is already being felt throughout Mexico and Central America. Public opinion gauged during the course of this research suggested a growing awareness of abnormal and less predictable weather. Moreover, scientific data and the physical evidence of climate change have become more pronounced. Out of season depressions, droughts, and extreme heat waves are noticeably more frequent over recent years.

This is the preliminary report from a project that runs until June 2010, examining climate-related impacts on national security and state stability in Mexico and Central America in the near term (2015) and medium-term (2030). These time frames were selected to reflect the lifespan of current policies and the policy generation cycle.

Project Methodology

The research methodology for this preliminary report comprised three stages:

- First, the core project partners¹ conducted literature reviews around climate change scenarios and the environment and security nexus for Mexico and Central America.
- Second, the Caribbean Community Climate Change Centre created climate impacts scenarios for the study region² in 2015 and 2030. The climate change impact analysis was summarised for different sectors including agriculture, energy, water resources and forestry. The impacts scenarios for 2030 were based on the Initial National Communications (INCs) from each of the countries in the study region, and the scenarios for 2015 were extrapolated from current trends in climate variability.
- Third, the project used the climate change impacts scenarios for 2015 and 2030 as a basis for scenario-building around potential social and political impacts.

Project leaders from the Royal United Services Institute (RUSI) in London held scenario-building workshops in Belize and Mexico City in August and October 2009, with representation from

several countries in the study region. Workshop participants included members of the security community, climate scientists, specialists in climate-sensitive sectors (water, migration, disaster response), representatives of environmental governance bodies, and security analysts with environment expertise. The scenario-building was structured around creating best, medium and worst-case scenarios for climate security impacts based on differing levels of resource availability and political stability and using the 'business as usual' (BAU) emissions scenario for climate impacts assessments.

Based on the outcomes of these scenario-building workshops and a series of expert interviews, as well as literature on climate change and security linkages, key dynamics were identified around the security implications of climate change for Mexico and Central America.

1. Climate Change Impacts in Mesoamerica

This chapter outlines the key impacts of climate change for Mexico and Central America at 5-year (2015) and 20-year (2030) horizons. These near-term and mid-term scenarios were used as the starting point for the project's analysis of the social, political and security implications of climate change.³

Part I: Geophysical Impacts in the Near Term (Five Year Horizon)

Climate Change – Current Impacts

There is a consensus that current levels of climate change, particularly the average rise in surface temperature, has less of an impact than climate variability associated with global warming.⁴ Climate variability is defined as out of season depressions, droughts, and extreme heat waves, which have been noticeably more frequent over the last few years.

Dry years in Mesoamerica are associated with El Niño - Southern Oscillation (ENSO) events. ENSO events produce intense rainfall that causes floods on the Atlantic coast of Mesoamerica. It is reasonable to expect that during the next 20 years the region will experience 3 to 5 ENSO events, which could cause a series of droughts and impact food supply.

The northern part of Central America, in particular the northern coast of Honduras and Belize, already displays a higher probability of experiencing direct impacts of storm conditions such as strong winds, intense rainfall and sea surges. During the last four decades the region experienced the impact of at least two major hurricanes simultaneously affecting two or three countries. Such events are expected to reoccur over the short and medium-term, as climate variability is influenced by El Niño events.

The Stern report shows an increase in the occurrence of extreme weather events leading to disasters this decade (Figure 1). During the period 2000 – 2005 (5-years period), 71% of climate-related disasters occurred, compared to 29% during the period from 1970 – 1999 (29 years). Three times as many disasters occurred in the recent five-year period than during the prior 29 years.

Greenhouse Gas (GHG) Emissions Trajectories and Extreme Climate Change

These projections of future climate impacts may be conservative. Climate change scenarios are based on climate models which use GHG emissions scenarios to calculate the impacts of different GHG concentrations in the atmosphere.

The projections used as a basis for this report use the 'business as usual' scenario for GHG emissions, which assumes that no reductions are made. However, actual emissions over the past years have been higher than the 'business as usual' scenario, leading to increased concentrations of GHGs in the atmosphere. In addition, observed climate impacts such as sea surface temperature rise and rates of glacial melt indicate that change is happening faster than anticipated. The latest research from the climate science community indicates that staying below 2°C warming (defined as 'dangerous climate change') would require emissions cuts that are unlikely to be achieved in time.⁵ Consequently, the impacts of climate change are likely to be more severe than the impacts outlined here.

Common Vulnerabilities and General Trends

Higher Temperatures

Observed temperatures have been on an upward trend. Higher temperatures increase the amount of water needed for agriculture and have a number of health impacts, including increased mortality closely associated with heat waves. GHG Emissions scenarios indicate:

- An average temperature rise of 0.3°C up to 2010
- Temperature rise ranging between 0.8°C and 1.3°C by 2050
- An average temperature rise of 3.4°C by 2100.



UN peacekeepers help Haitians cross a river after floods near Port-au-Prince, following the deaths of 500 people by Tropical Storm Hanna, September 2008. Photo courtesy of REUTERS/ Evens Felix.

More Intense Rainfalls

Total precipitation has not been increasing, but rainfall events are intensifying (meaning more rain is falling in a shorter amount of time). When rainfall is concentrated into heavier downpours and interspersed between longer dry periods, it can cause erosion as drier soil is less able to absorb moisture. Also, waterlogged land from heavy rains can impact agriculture, including export crops.

Water Resources

The pattern of water availability and water stress varies across Mesoamerica. Some areas will face

increasing pressures due to higher competing demands for water, including irrigation for export crops. In general, the Atlantic side of Central America displays low vulnerability to water stress due to high water supply levels and low demand. Southern Mexico has higher water availability than northern Mexico.

Agriculture and Food Security

In the near term, the agricultural predictions from the models are for decreases in yields due to shorter growing seasons and lower rainfall. Variations in the climate produce somewhat similar results,

Rainfall in Central America: North and South

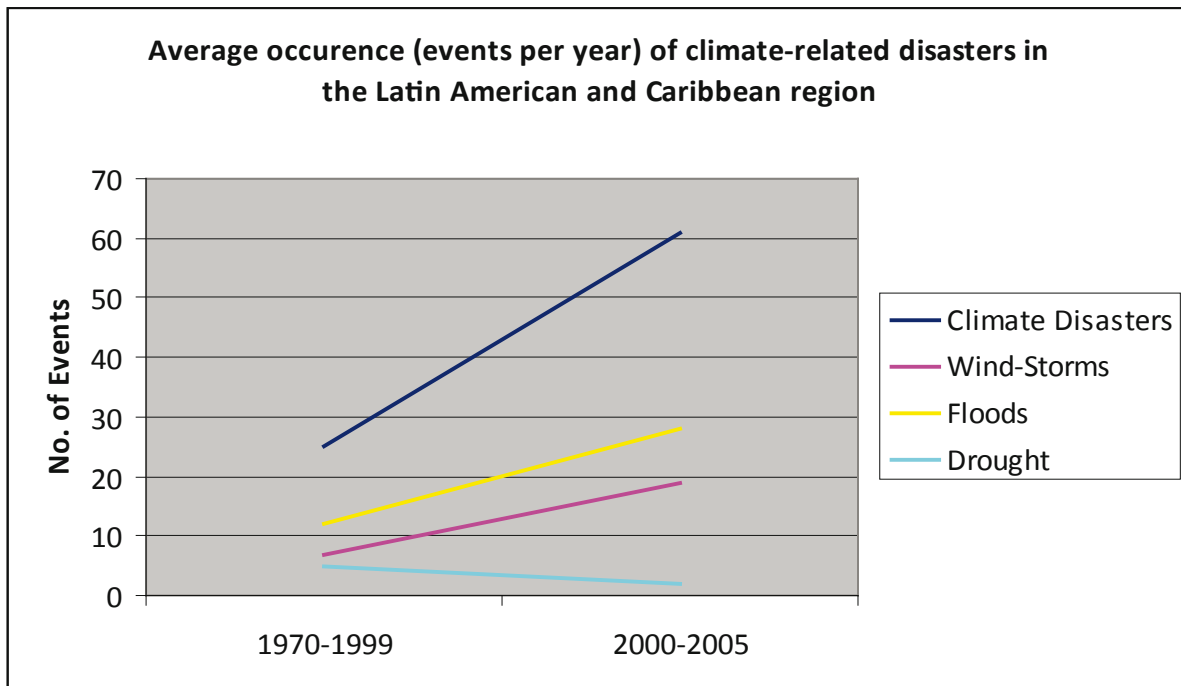
The projected changes in annual rainfall patterns are different between the northern and the southern parts of Central America, with a drier north and wetter south.

In the northern sector (including Belize, Guatemala and Honduras, with the transition zone across Costa Rica), short-term projections

indicate rainfall will decrease by up to 5.5% between now and 2020. A further decrease of up to around 20% is expected by 2100. These changes in precipitation can be expected for most months of the year.

In the southern sector (Nicaragua, Costa Rica, Panama) rainfall is actually expected to increase by as much as 10% for seven of the twelve months.

Figure 1: Average Occurrence (Events per Year) of Climate-related Disasters in the Latin American and Caribbean Region



Source: Stern, 2006.

except that in the case of unseasonal rainfall, crops were lost because the rain either damaged the crop by coming too early or reduced yield by coming too late. Farmers also tended to prepare the land and sow seeds (corn and beans) in anticipation of rain which sometimes did not materialise. Extended dry spells result in lack of water, slowing growth and production. Lower than expected yields of the staple crops mean that countries have to turn to neighbours for imports, if they have a surplus. The Central American region is small enough to expect that most if not all the countries would be having the same experiences.

Mexico currently imports around half of the food it consumes, despite being a major agricultural producer. With simultaneous trends of population growth and less stable domestic food production, Mexico is likely to rely on higher food imports in the future.

Disaster Vulnerability, Coastal Erosion and Flooding
Mesoamerica’s geography makes it highly vulnerable to the impacts of sea level rise. The coasts of the Gulf and the Caribbean Sea are low and sandy, with extensive adjacent wetlands and elevations of less than 1 metre above sea

level. Human settlements, economic activity and infrastructure are concentrated in coastal areas, and all of the countries in the region display high susceptibility to natural hazards in these zones.

These hazards include tropical cyclones (hurricanes) and the associated storm surge, and in some cases drought. This susceptibility is compounded as most key infrastructure (tourism, transport, and communications) and major economic activities are concentrated within the coastal zone and, in some cases, low-lying floodplains.

Sea Level Rise: Vulnerable Areas

Affected areas are likely to include Cancun on the Caribbean coast of Mexico, (the Yucatan Peninsula) and other coastal zones such as Veracruz, Ixtapa and Cozumel; San Pedro Ambergris Caye, Corozal Town, Belize City, Dangriga and Placencia among others in the coastal zone of Belize; Tela on the northern coast of Honduras; San Salvador on the Pacific coast of El Salvador, and Limon in Costa Rica, to name a few.

Corals

Corals are sensitive to ocean acidity and temperature rises – a temperature increase of 1 to 2° C can cause ‘bleaching’, which impacts on fish populations and food security for coastal populations.

Prior to 1979 mass bleaching events were unknown.⁶ The most significant mass bleaching events occurred in 1995 and 1998 when coral bleaching of between 52% and 90% was recorded in some areas of the Mesoamerican Reef. As ocean acidity and temperature increase further, this trend of mass bleaching is expected to continue.

Coral bleaching could have immediate negative economic impacts on the region due to lost tourism activity, and could lead to a detrimental loss of physical protection for the coast as reefs die. This

would increase the impacts of severe weather on the coast.

Population Growth

Population growth will add additional environmental stress, as it drives greater consumption of food, energy and natural resources.

Health

The health impacts of climate change include expanding vector-borne diseases such as malaria and dengue, increasing respiratory illnesses, diarrhoea associated with both drought and high precipitation, and reduced immune capacity due to malnutrition. In the near term, there is a possibility for lower investments in delivery of health services due to strain on state capacities, which could in turn create more vulnerability to health problems.



Hurricane Mitch approaching the Caribbean coast.

Table 1: Projected Total Population in Five Year Periods

Projected Total Population				
Country	2010	2015	2020	2025
Belize	306,000	335,000	363,000	389,000
Costa Rica	4,695,000	5,022,000	5,314,000	5,568,000
El Salvador	7,453,000	8,010,000	8,585,000	9,136,000
Guatemala	14,362,000	16,176,000	18,055,000	19,962,000
Honduras	7,614,000	8,353,000	9,079,000	9,772,000
Mexico	110,056,000	115,288,000	119,808,000	123,784,000
Nicaragua	5,825,000	6,192,000	6,538,000	6,855,000
Panama	3,497,000	3,752,000	3,995,000	4,220,000
Total	153,808,000	163,128,000	171,737,000	179,686,000

Source: Centro Latinoamericano y Caribeño de Demografía, División de Población, 2009.

Part II: Geophysical Impacts in the Medium Term (Twenty Year Horizon - 2030)

By 2030 Mesoamerica should expect to experience more severe impacts directly attributable to climate change. These impacts will be compounded by the indirect effects of global change such as developmental constraints on the quality and availability of water and uncertain food security. Population growth will add further stress as it drives greater consumption of food, energy and natural resources, as well as demand for space and clean environments. These changes could have a pronounced impact on the security dynamics of the study region.

The projections for these scenarios follow the 'business as usual' emissions scenario, despite the ongoing negotiations around international climate change agreements. In recent years, industrial growth has generally continued at the same or faster pace than the 'business as usual' scenario, resulting in increasing concentrations of GHGs in the atmosphere. The impacts of climate change may therefore be much more severe than was originally projected by the Intergovernmental Panel on Climate Change's most recent Assessment Report (2007).

Common Vulnerabilities and General Trends

Temperature Rise

By 2030, temperatures may have increased by about 1.3°C to 1.8°C (above pre-industrial temperatures). This would indicate a significant amount of warming above current levels, with correspondingly serious impacts in other sectors.

Water Availability

The increase in demand and the potential reduction of supply due to climatic change, together with the role of extreme climatic events and the poor quality of water in most Mesoamerican countries puts the region in a state of high vulnerability.

Key Impacts for 2030

- Changing rainfall patterns
- Changes in the amount of arable land suitable for growing staple crops without irrigation
- 10% - 40% reduction in the production of rice, black beans and corn
- Destruction of coastal infrastructure and an increase of coastal inundations in flood-prone areas
- Coastal erosion and loss of sandy beaches

Right page: A woman prepares food in front of her house flooded by the Mearim river in Trizidela do Vale, in the northeastern state of Maranhao, May 2009. *Photo courtesy of REUTERS/Paulo Whitaker.*



According to the climate change scenarios, there is likely to be a decrease in rainfall in northern Mexico which could lead to an increase in pressure on water resources. In Central America, most of the water capital is located along the Caribbean basins. In Mexico, most of the water capital is located in the south. In Central America, much of the available water resources are shared among countries, even forming international borders. At present there are limited formal mechanisms for water resource management in Central America, which would need to be adapted for future conditions of regional water capital.

Agriculture and Food Security

One of the most significant impacts of climate change will be on food production. In 2009 the World Bank stated that the sector which would suffer the most from gradual changes in temperature and precipitation was agriculture.⁷ Declining food production capacity will have severe socio-economic impacts in the Mesoamerican region.

The demand for water to meet irrigation needs is critical for maintaining important crops in the study region. In Central America, water supply will be crucial for food security since 70% of the region's population lives and depends on agricultural production taking place along the Pacific seaboard, which is increasingly prone to droughts.

Models highlight increases in areas of land unsuitable for agriculture, with climate change significantly decreasing crop yields for staple foods such as corn, beans and rice. This will require subsistence agriculture to adapt to new meteorological cycles, and take measures to guarantee agricultural

production such as irrigation, crop diversification, and agro-forestry practices that protect soil.

In El Salvador, projections describe a 30% drop in food production, rendering the country totally dependent on imports, unless local production substitutes are found for basic grains. Across the region, crops for domestic consumption (grains) as well as export crops (banana, sugarcane, coffee, watermelon, pineapple, etc) will be affected.

Increasing temperatures lead to exponentially increasing crop losses. The climate models predict that 1°C increase in temperature, with no change in precipitation, reduces maize crop yields by 5%, but 2°C temperature increase and decline in precipitation reduces yields by 20%. As noted earlier, by 2030 the projected temperature rise in the study region is expected to range between 1.3°C and 1.8°C.

Coastal Flooding and Erosion

Areas in the study region are vulnerable to storm surges and high tides within the 20-year horizon, as well as the longer-term impacts of sea level rise. Mexico's Tabasco delta complex displays the highest level of vulnerability.

Corals

Countries in the region that depend on tourism and fisheries are faced with the potential loss of these habitats and sources of revenue due to bleaching. Local studies do not make any projections for 2030 about the extent of future coral bleaching events. However, the models used by the *Indicators of Reef Health and Social Wellbeing* report predict that the warming trend will continue and bleaching events are expected to become increasingly frequent over the next 100 years.

Population Growth

Population dynamics add an additional challenge to sustainable resource management, and the growth curves for Mesoamerica indicate significant additional pressure by 2030.

Health Impacts

Reduced precipitation will indirectly affect health due to poor hygiene conditions, causing

Impacts in Coastal Zones

- Increase in floods
- Erosion of the coastline
- Salinisation of aquifers
- Increase in flooded coastal zones
- Increase in erosion from tidal surges in bays and tributaries
- Destruction of coastal infrastructure

increases in incidents of diarrhoea, parasites, and skin infections.

Increased exposures to wider ranges of heat and cold, floods and droughts, will exacerbate some health hazards. Indirect impacts will favour an increase of vector-borne diseases, infectious diseases, respiratory infections, stomach infections, malnutrition, skin diseases and dehydration.

Livestock and Fisheries

Floods affect livestock and fisheries through loss of pasture and habitat. The scenarios project significant losses by 2025 if erosion, sedimentation and runoff control practices are not promoted.

Health Impacts of Climate Change

- Changes in the ranges of malaria and dengue (increasing in some areas, decreasing in others)
- Increase in respiratory illnesses due to temperature variations
- Increase in incidences of illnesses linked to water contamination.

Droughts and floods would cause losses in livestock production (due to reduction in pastures) ranging between 25% and 100% depending on the

Country Assessments of Water Supply Impacts – 2030

Guatemala

Decreases in precipitation in Guatemala will reduce stream flow, causing sedimentation and accelerated siltation. This will affect the Gross Domestic Product (GDP) through losses in agro-production and subsequent loss of agro-exports. Temperature increases and diminished precipitation will reduce water supply for human and animal consumption and irrigation.

Increased precipitation in southern Guatemala would cause losses in vegetable, fruits and grain production in the upper basins. Sugarcane and coffee production in the coastal zone will decline with resulting negative implications for the economy.

Honduras

Projected changes in the water cycle will exacerbate flood and drought situations. There will be serious implications for irrigation systems and electrical energy generation for this predominantly agricultural country.

Costa Rica

The change in the water cycle would impact erosion, sedimentation, flooding, and use of water for hydropower generation, irrigation and sewer systems.

Panama

Panama appears particularly vulnerable to changes in water resources, as a large proportion of economic activity depends on this sector.

Projected climate change impacts for Panama include:

- increased demand for hydroelectricity
- increased domestic use of water
- increased costs for transit through the Panama Canal and maintenance of related infrastructure
- increase in agricultural costs due to need for water storage and irrigation
- over-extraction of water and increased contamination due to reduced stream flow
- increased food prices
- increased erosion and sedimentation due to loss of vegetation cover
- increased human and animal competition for water
- reduced trade and revenue due to restrictions on the use of the Panama Canal
- decline in the quality of maritime services associated with the Panama Canal.

depth and duration of the floods, as well as the appearance of diseases in animals.

Forest Cover and Biological Diversity

Medium to long-term scenarios for Mexico predict changes in the temperate climates that would cause the displacement of conifer forests, the disappearance of grasslands and the northward migration of tropical forest.

Panama displays vulnerability to the other extreme in climate change. The worsening severity of droughts would increase wildfire incidents and result in significant degradation of the land. Associated losses to property and biodiversity will add further costs. With regards to the latter, most species can adapt or migrate, but some will disappear. Moreover, a number of plant species may not survive without assistance from humans or animals for seed dispersal. In the worst case scenario, deforestation will see unprotected or unmanaged forests disappear within 25 years.

Sea Level Rise Impacts

Belize

A 4 cm rise in sea level over the 25-year period would have relatively low impact, but a 50 cm rise would claim over half the existing beaches. 60% of the already inundated coastal areas would be transformed to lakes. Dry land adjacent to high tide levels could potentially form new wetlands. Projected sea level rise along with increased abstraction rates will lead to higher incidences of seawater intrusion and coastal agricultural lands may become salinated. Sea level rise may cause inland migration of more than 55% of the population.

Honduras

By 1995, Honduras' northern coast had been devastated by 3 hurricanes and 8 tropical storms during the century. Thousands of lives were lost along with extensive damage to infrastructure and property. Extensive deforestation intensified the effect of the hurricanes, resulting in more disastrous flooding incidents in the valleys.

Costa Rica

Sea level rise in Costa Rica will cause a recession of most of the 1300 km of coastline, and widen the area subject to inundation. In Puntarenas, a 0.3 m increase in sea level would result in flooding affecting 60% of the residential area in this suburb. The increase in sea level will result in a setback of most of the coastline. The worst-case scenario projects sea level rise of 1 m by 2100, which would inundate 90% of the residential sector.

Panama

Panama displays the same vulnerabilities and risks as the other countries with extensive coastal areas at sea level: increased flooding, loss of shoreline, decline in replenishment of aquifers, increased salt water intrusion, increased erosion, expansion of permanently flooded areas and increased wave action in bays and tributaries. Social and economic impacts could be experienced due to loss of investments in infrastructure, or the increased costs of maintenance.

*In the 20 year timeframe,
the severity of the
impacts of climate
change depends on
adaptive capacity*

Chapter Summary

The impacts of climate change outlined here, in combination with other human-driven environmental degradation, could be devastating for Mexico and Central America. The severity of the impacts of climate change depends on the adaptive capacity of societies.

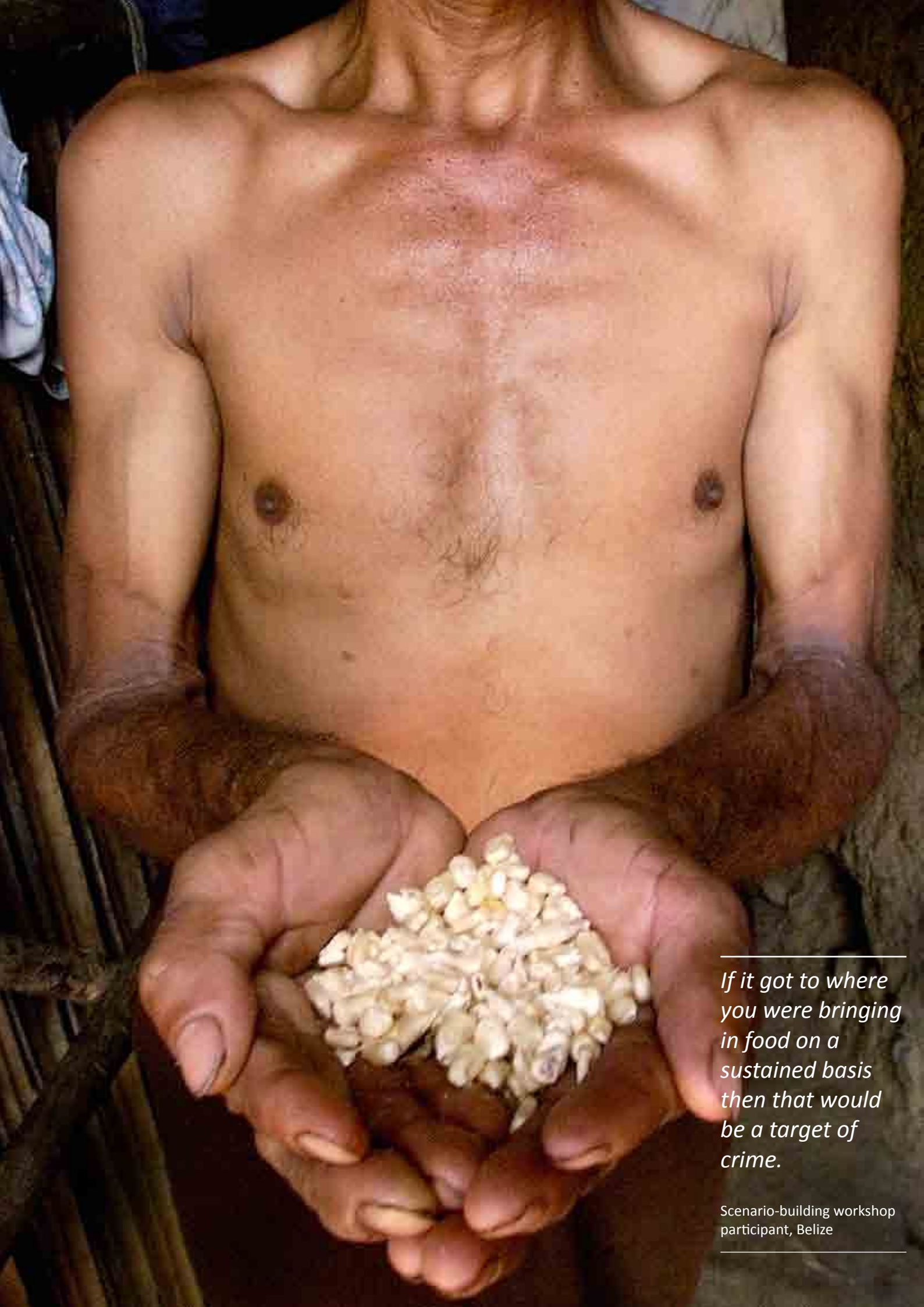
Within the five-year horizon it is possible that climatic changes will have knock-on effects for the social and political stability that underpins security in the region.

Climate will be one driver of change influencing Mesoamerica by 2030, alongside population growth, increasing resource stress and development constraints. These changes could have a pronounced impact on the security dynamics of the study region.

Key Climate Impact Facts

- No significant variations in precipitation amounts, but fewer days of rain (with higher concentration of precipitation)
- More rain on the Caribbean side, corresponding to higher sea surface temperatures
- Longer periods of rain correspond to higher Atlantic temperatures
- Increase in the intensity of rains (more rain falling in a shorter period of time)
- Every 3-5 years there is a period of drought. In a 20-year scenario between 4-7 droughts could be expected
- Every 1-3 years an extreme climatic event occurs (hurricane, tropical storm). Between 10-20 destructive events could be expected within a 20-year timeframe, with 10 being highly destructive
- Vulnerability to water scarcity is highest in cities





If it got to where you were bringing in food on a sustained basis then that would be a target of crime.

Scenario-building workshop participant, Belize

2. Social and Political Implications of Climate Change

Climate-driven environmental changes will have profound repercussions for social and political systems. Climate change will bring large-scale changes in resource distribution, which will create economic pressures and impact the ability to meet basic needs. These shifts in resource availability will not affect everyone equally, as vulnerability to climate impacts depends on adaptive capacity. These impacts have the potential to create social and political turbulence, as the ways in which the geophysical and economic impacts of climate change are distributed can aggravate social inequalities.

Meeting Basic Needs

Climate change will make meeting basic needs more difficult. Livelihoods that depend on sectors that are sensitive to climate change such as agriculture and fishing are particularly vulnerable. As fish populations and agricultural yields decline, communities which rely on these resources for subsistence will be put under pressure. As the traditional means of livelihoods are stretched, there is a potential for a number of responses:

- to turn to practices that are more environmentally destructive which may leave populations more vulnerable to climate change impacts, such as deforestation or over-fishing
- to seek alternative livelihoods in the informal sector, which could potentially include illicit economic activity.

Social Tensions

Social and community stability can also be affected by climate impacts, particularly where access to resources is concerned. Within communities, tensions may emerge between those with access to resources and those without – or perceptions about who has access and who does not.

There is a potential for the growing exclusion of the most vulnerable groups from adaptation measures, which could be dominated by more powerful

You are trusting in your government that they will provide that security and they will facilitate good living conditions. But if you start to lose it, then you've got to start taking that responsibility back into your own hands, to protect yourself, to provide for yourself, even if that means stealing, or killing another person to get it.

Scenario-building workshop participant, Belize

groups – for example if irrigation measures are directed toward the most influential agricultural producers rather than to subsistence farmers. Resolving disputes over access to resources will require facing a new set of challenges in a future affected by climate change.

Governance

Changing resource patterns and extreme weather impacts will also affect governance, as local, state and national governments face increasing demand for disaster response and recovery as well as implementing adaptation measures. The costs of responding to disasters is increasing, and the resource demand from rebuilding infrastructure after storms and providing food assistance or insurance payouts when crops fail will add additional challenges. These could give rise to tensions around allocations in national budgets.

If governments are unable or unwilling to meet the needs of their citizens, this could lead to increasing dissatisfaction and unrest. Changes in government usually function as an escape valve for frustration with current regimes. However, successive failures of government to adequately cope with the stresses of climate impacts can lead to higher levels of dissatisfaction, eroding confidence in government structures. This erosion

of confidence and overstretching of governance capacity could contribute to further instability.

Trends of industrialisation, large scale projects of natural resources extraction – especially mining – and large scale cropping for bio-fuels amongst others, can act as drivers for social and political instability. In this context and without clarity in development policies, Central American governments struggle to balance economic needs and social demands. This applies particularly to Guatemala, El Salvador, Honduras and Nicaragua, more so than to Costa Rica, Panama and Mexico which have more defined strategies for economic growth and financial sustainability.

Self-Reinforcing Climate Impacts

Furthermore, concurrent climate impacts can reinforce each other to generate ‘vicious cycles’ of increasing vulnerability that may be difficult to predict and could create exponentially escalating challenges.

For example:

- If governments are struggling with fiscal constraints due to falling revenues or costs of disaster response this may mean a decreased ability to implement adaptation measures, which in turn could make a country increasingly vulnerable to climate impacts.
- Social instability can create a cycle of reduced employment and investment, which can increase poverty and, in turn, increase the likelihood of further social conflicts.
- Temperature rises are linked to increases in forest fires and pests. As climate change stresses forests, ‘dieback’ may impact water quality and runoff patterns. This could have wide-reaching impacts including on fish stocks and the functioning of hydroelectric dams, due to problems of siltation. These in turn have impacts for the health and livelihoods of people dependent on fish, and occasionally interrupted electricity supplies have implications for economic productivity and security in urban areas.

The unexpected interactions between climate impacts indicate that concentrating on preventing

the impacts of climate change may be the most effective way to avoid knock-on effects, including potential security impacts.

Chapter Summary

Climate change will place pressure on the governance capacity of already overstretched municipalities, states and countries. Climate change will challenge the ability of governments to provide basic needs for their populations, placing further pressures on resource distribution and allocation capacity.

This will create ‘winners’ and ‘losers’ as resource access will disproportionately impact some more than others, which could lead to increased social and political unrest. Avoiding these impacts will require significant shifts in resources toward adaptation and mitigation. A failure to do so would be a failure to provide a secure future.

It's maybe not so much that [governments] have less ability [to implement measures to cope with climate stressors] but they have so many things they have to focus on that they are able to allocate fewer resources to each of them and they have to make compromises.

Scenario-building workshop participant, Belize

3. National Security Implications of Climate Change in Mexico and Central America

‘Security’ is a term with many different meanings. ‘National security issues’ in Mexico and Central America are often synonymous with narcotics trafficking and serious organised crime (SOC). However this research takes a broader approach, and considers social and political stability the pillars that underpin national security. Hence, the definition of ‘security’ used in this research process is ‘social and political stability’.

These pillars may be undermined by high population growth, competition for resources, governance and institutional challenges, and corruption.

Climate change can add additional stressors to the current security challenges identified in SICA’s ‘Security Strategy for Mexico and Central America’ which include Serious Organised Crime, narcotics (drugs) trafficking, unregulated population movements and human trafficking, and illicit weapons trafficking. The following section explores how climate change can influence the drivers of instability in the study region, incorporating outcomes from the scenario-building workshops in Mexico and Belize.

Extreme Weather Events

Storms and floods currently present major challenges for Mexico and Central America, including the financial burden of disaster response and reconstructing infrastructure. The economic effects of disasters include unemployment, destruction of harvests and plantations, and destruction of productive infrastructure.⁸

Risk management has been a priority for Central American and Mexican governments, and all countries have a national bureau for disaster prevention.⁹ However, none of Central American governments have special funds for disaster recovery, so when events occur governments must reallocate funds from other areas of their national budgets or ask for international cooperation. Once the emergency has passed, the rebuilding

Every day, we receive anecdotal evidence of a worrisome and increasing link between climate change, security and social stability.

In Guatemala, newspaper headlines inform us of clashes between rural communities for the control of water springs; of road blockades by indigenous movements opposing legislation on water or access to natural resources; of conflicts in our international borders because of illegal cross-border resource extraction...

Ecological refugees from drought-prone regions in the country are migrating to the Maya Biosphere in Petén, invading protected areas, clashing with police forces and park guards in violent confrontations, and forging alliances with local drug lords in order to obtain territorial control...

Guatemala is currently going through a serious food shortage because of droughts; on October 12th, peasants demanding food security and land clashed with the police, demanding food security and access to land and water; one person died in the protests...

These are not future scenarios; they are current threats to governance and social stability, which are never associated by the media with on-going impacts from climate change!

Marco Cerezo – Director, Fundación para el Ecodesarrollo y la Conservación (FUNDAECO), Guatemala

processes tend to be drawn out. The delay in funds allocation and the weakness of local governments and specific institutions who receive rebuilding responsibilities is a recurring challenge.

Security issues associated with these disasters include enforcing the rule of law immediately



Following devastating hurricanes and tropical storms in Salvador, some 500 peasants, made homeless by the flooding, protest at the Presidential House for economic assistance, October 1999. Photo courtesy of REUTERS/Luis Galdamez.

after a storm, protecting citizens in shelters and ensuring the secure delivery of aid supplies. The latter two impacts can contribute to a cycle of political instability, low development rates, and further potential for social and political instability.

There is a strong evidence base for a linkage between poor disaster response, social unrest and political change if:

- a government's response to the immediate disaster is inadequate (either through lack of will or lack of capacity)
- aid resources are misdirected (e.g. through corruption, or relief supply distribution shows favouritism on the basis of political parties)
- the recovery and rebuilding process emphasises inequalities (such as between tourist areas and other hard-hit regions)

These factors can contribute to a sense of grievance and disenfranchisement. If an opposition party or non-state actor can capitalise on that sense of dissatisfaction with the government it can

act as a catalyst for political change or political destabilisation.¹⁰

Limitations of Disaster Recovery

In a scenario where the hydrometeorological events will be more frequent and more extreme, how many times will we implement [the Mexican Army's natural disaster] Plan DN3? How many times are we going to rebuild Cancun, how many times are we going to rebuild the beach?

If the impacts are worst in the Caribbean, until what point will a government say 'This part – the residents, and the defence of the ecosystems, of the local government, of the community, the society, of the independent producers, how many times are they going to recover from the impacts of an event'?

Scenario-building workshop participant, Mexico City



A Honduran holds up a card that reads 'with this crisis we are not going to eat chicken' during a protest against the increase in prices of food and basic services in Tegucigalpa, August 2008. Photo courtesy of REUTERS/Edgard Garrido.

Increased Resource Competition

Climate change will alter the distribution of resources, which may increase competition between social groups as well as dissatisfaction with governments.

Fish stocks are projected to decline as a result of increasing ocean temperatures and ocean acidification. This decline will impact coastal communities, as livelihoods and local economies based on fishing contract. It may also lead to localised or transboundary tensions as fishermen follow migrating stocks. Workshop participants cited recent examples of this along the Caribbean coast of Central America, as the Belize Coast Guard have deterred Guatemalan and Honduran fishing vessels from operating in their Exclusive Economic Zone (EEZ).¹¹

Participants from the Belize Coast Guard and Belize Defence Forces in one of this project's scenario-building workshops saw a connection between Belize's relatively intact natural resource base and increasing transboundary incursions to extract Belizean resources from neighbouring countries

with less effective conservation policies. In addition to the fishing vessels along the coast, they cited Guatemalan 'xateros' crossing into Belizean forests to cut *xate*, a palm plant exported for use in the floral industry. Ecosystem services on the Guatemalan side of the border are under pressure from much higher population density, and the indigenous populations in that region may have a different attitude towards national boundaries. In addition, the Belize/Guatemala 'adjacency zone' is a disputed border, and maintaining border security is a key focus of the Belize Defence Forces.

Resources - Perceptions and Tensions

An interview with a senior Belizean defence official cited recent problems with river siltation in Belize, which he identified as being connected with the *xateros'* forest exploitation upstream. While the illegal activities of the *xateros*, such as slashing and burning, do have an impact on the forests, project discussions identified forest dieback due to pests such as the pine bark beetle (which has a correlation with temperature increases/climate change and is likely to increase) as a much more likely cause for the siltation.

In an environment of increased tension between countries or population groups over access to natural resources, how the problem is perceived within a society may be more important than the impacts that an outside group has on the resource base. Regardless of whether the pine bark beetle or the *xateros* were more at fault for Belize's river siltation, if the dominant narrative is that the problem is related to illegal resource exploitation from a neighbour it can contribute to increased tensions. As climate change impacts alter the distribution of resources, the perception of who is at an advantage and disadvantage may increase social tensions, which in turn could have political impacts, for example heightened border security and stronger policies to prevent incursions into Belizean territory.

It is important to note that in this particular case, climate change is not the root cause of the tension – overexploitation of ecosystems in the Petén region of Guatemala and dynamics along the Belize/Guatemala border play much larger roles. However, climate change will impact the flow and quality of river systems, forest resources, and agricultural productivity – all of which could provide a context where difficulties around access to resources and livelihoods could assign blame, misdiagnose problems, and contribute to increasing social and political tensions.

Water Management in Mexico and Central America

Water System Governance

Water management systems in the study region are stretched coping with current supply and

infrastructure issues. In Mexico it is estimated that around 40% of potable water and 50% of water used in agriculture is lost due to infrastructure issues such as leakages and irrigation over long distances.¹² Challenges to integrated water management systems include institutional capacity, infrastructure construction and maintenance, and contamination, in addition to physical water scarcity.

Climate change will exacerbate these problems by intensifying drought trends and increasing the amount of water necessary for agriculture due to higher temperatures. This could lead to competition between water users, for example between industry, export agriculture and subsistence agriculture.

There are imbalances between water supply and demand across the region, with the majority of Mexico's agriculture located in the north, while the majority of its water capital is in the south. Similarly, two thirds of the population of Central America lives on the Pacific side, which has under one third of the region's available water resources.

Civil disturbances around the provision of water supplies are not uncommon in the region. Depending on how these are handled, confrontations could contribute to a sense of grievance and aggravate dissatisfaction with local authorities if the situation is not resolved, or if the authorities are heavy-handed in their response.

Water allocation in Mexico has sometimes been associated with political party favouritism, where politicians will provide water for their constituents based on party allegiance. According to one

Additional Driver - Global Economic Crisis

The economic crisis is having a tremendous impact on the fiscal situation of the region's governments.

Most governments have increasing fiscal deficits, and are returning to loans in order to finance their budgets.

If this situation continues, they will not have the fiscal resources necessary to maintain – much

less increase – their response capabilities to climatic events.

If contingency loans for disaster response were to be established and maintained by multilateral institutions, and could be rapidly provided to regional governments in such cases, this could contribute to avoiding collapses in services and increasing social instability.

workshop participant, this partially explains the existence of irrigation infrastructure in northern Mexico, because a number of previous presidents were from that region.

Transboundary Water Management

There are 23 shared river systems in Central America covering over a third of its territory. Many of the available water resources are shared between countries, even forming international borders. Integrated river basin management projects and negotiations on transboundary water management systems have taken place in the past, but no formal agreements have been implemented. As climate change contributes to increased water stress in some areas, and as dams are built for hydroelectric power, the water dynamics in the region will change. Without adequate agreements in place there is potential for increased tensions.

However, the importance of water management is recognised at national and regional levels, and institutional frameworks have been created to improve water service and supply. The creation of these structures are relevant considering that negotiations around transboundary water resources have to act in the field management level but also along the whole supply chain, including intermediaries between “water owners” and users.

Case study: El Salvador

El Salvador depends on one river, the Rio Lempa. The river originates in Guatemala and flows into Honduras before reaching El Salvador. There are four hydropower stations along its course.

El Salvador is on the Pacific side of Central America, which is more drought-prone than the Atlantic side. Due to these geographical factors, there is a high potential for water to become an important diplomatic issue for El Salvador in the future. Establishing regional water sharing agreements which take into account the projected impacts of climate change could help to avoid tensions.

Arable Land and Food Security

Food insecurity, hunger and malnutrition are already major problems in the study region. Guatemala is currently experiencing a food shortage responsible

Impunity and Corruption in Water Management

Maybe [impunity and corruption] will increase with climate change because of the pressure to access our natural resources or to stop migration. And if we have a tradition of informal ways to solve things I think that it will be quicker, because of the pressure that we are going to have in terms of all of these issues. If scarcity is going to happen on the macro level, I don't think that there would be democratic ways of distributing water, but 'Latin American' ways.

Mexico City workshop participant

Private Sector Management of Water and Other Resources

We might expect in 2030 either the government stays with managing [water] or it goes to the private sector, in which case they might have other problems around the accountability and transparency of the private sector ... Governance is more difficult with more political instability and polarisation.

Mexico City workshop participant

Indirect Impacts of Serious Organised Crime (SOC) on Water Resources

Transboundary rivers in northern Central America are being used for drug trafficking. In Guatemala three rivers are being used, the Sarstoon on the border with Belize, and the Usumacinta and Suchiate rivers on the border with Mexico. This fact is not translated into physical water scarcity but it can become a conflict issue if other water sources decrease and local inhabitants need to access rivers controlled by the local *narco*.

Predicting Other Potential Conflicts

Water flow reduction as a direct impact of climate variability can impact important sectors like energy – hydroelectric dams – and other industries that use high amounts of water. The objections to both industries by local communities and lack of understanding around climate change issues can generate new conflicts between industries and local communities and worsen already existing conflicts.

Likewise there are illegal water withdrawals taking place in some rural areas in Mexico, but the authorities are unable to police them or enforce water regulations because the water is used for SOC/drug activities.¹³



for several mortalities. Climate change is projected to have a major impact on staple crops. Most agriculture in Mexico and Central America is rain-fed subsistence agriculture, which is highly vulnerable to changing weather patterns including drought and more intense rainfall events. Beyond nutrition and health impacts, food insecurity has impacts on education and social participation. Food insecurity can place a strain on governments as they buy food on the world markets.

There is a widespread conception that if crop production is damaged beyond a certain point then there will be social unrest, but there are few studies on agricultural outputs and social stability in Mesoamerica. There have been public demonstrations around price spikes for basic grains.

Questions of food security in this region are partly centred on access to arable land. Access to land can be politicised and tied to historical social tensions.¹⁴

One dynamic identified in the project's field research was migration for productive land. In Mexico, most agriculture takes place in the north, which is projected to experience more intense droughts and higher temperatures. This in turn increases agricultural water demand. Although irrigation infrastructure is concentrated in the north, the land that will be more suitable for agriculture in the coming decades will be in southern Mexico. It has been reported by maize producing organisations in Chiapas that agricultural

Natural resources are overall in the centre and south. In 20 years ... it will be more costly to run agriculture, more costly to have industry that relies on natural resources affected by climate change, and that will affect experts. It is certain that agriculture will move south, for economic reasons. And only business people will be in the north. And that's already happening.

Scenario-building workshop participants, Mexico City

Dry earth in the Sonora desert, Mexico.
Photo courtesy of Tomas Castelazo.

interests from northern Mexico are buying arable land in the south.¹⁵ The demographic dynamics of this potential shift are of interest, as the south has a more predominant indigenous population and a recent history of armed confrontation.

Likewise, the Pacific side of Central America is projected to experience more intense droughts whereas the Atlantic side will be less drought-prone. A trend has been identified of land purchases on the Atlantic side of Nicaragua, because it is more suitable for agriculture. As with the north/south dynamic in Mexico, the Atlantic side of Central America is more rural and has a higher indigenous population.

This trend does not necessarily predict a future conflict in this area. What it does suggest is that present actions can aggravate latent tensions, and that future planning should incorporate the ways in which climate change may impact resource distribution and what the potential social and political repercussions of these changes might be, in order to implement measures that anticipate future tensions and prevent them from escalating into security problems.

Migration

Migration is often seen to be the most likely and most serious security consequence of climate change, with large numbers of people migrating long distances. This scenario is largely inaccurate – climate impacts can affect the drivers of migration, along with many other push and pull factors, but most migration is internal (rather than international) and not likely to be permanent.

The main ways that climate change could act as a driver of migration is by impacting livelihoods, especially for those dependent on agriculture. Also, seasonal migrants who participate in the coffee and sugar harvests could alter their patterns as those export crops are affected by climate change.

Migration can also be seen as an adaptation strategy for climate change, rather than a failure of adaptation.¹⁶ Diversifying incomes by seeking waged work elsewhere can be an efficient response to climate stressors. Migration can also function as a conflict avoidance mechanism, whereby rather than coming into conflict over scarce resources the preferable option is to seek economic opportunity elsewhere.



Every day Mexican trains are used by immigrants to cross the country, heading for the border between Mexico and the United States. Photo courtesy of REUTERS/Carlos Barria.

Migration itself is not a security problem, but depending on how migrants are received in destination areas, social tensions could emerge. If unemployment and hunger generate temporary or permanent migration, illegal migrants may accept lower salaries, as is currently the case in Costa Rica and Belize which are receiving migrants from neighbouring countries. This may produce social tensions between the incoming populations and locals over impacts on the labour market.

One of the migration trends that climate impacts are likely to reinforce is rural to urban migration. Mesoamerica is characterised by large capital cities with high populations. As livelihoods contract in the countryside, this trend is likely to become stronger as migrants seek paid work in urban areas. There are security issues associated with influxes of migrants into cities. Criminality and drug dealing could increase as a consequence of the growing precariousness of livelihoods and vulnerability in marginal settlements. Underemployment and the existence of the informal sector could be a better predictor than poverty or unemployment in causing criminality.

Migrants may also amplify their vulnerability to climate impacts and disasters, for example by accelerating the destruction of natural resources in the destination area, or building housing in precarious areas, e.g. steep hillsides and riverbanks. Informal settlements are often less well-served by water and sanitation services, increasing the potential spread of infectious disease.

An increase in the number of vulnerable migrants also exposes them to the activities of organised crime. In Mexico there has been an upsurge in kidnappings and migrants held for ransom, which generates revenue for criminal organisations. Migration flows into the US fluctuate depending on the economic necessity for more migrants in the US labour market. When the border is closed, there are greater demands on Mexican border cities, including health, schools, drug clinics, and other services. In the last twenty years there has been a steep increase in the size of the population settled along the border, which presently stands at 15 million.¹⁷ These economic conditions could increase

the number of people willing to be involved in illicit economic activity such as drug trafficking.

Contributing to an Environment that could Strengthen Serious Organised Crime (SOC)

This report does not assert that there is a direct linkage between climate change and serious organised crime (SOC). Its key message is that rapid, large-scale environmental change can contribute to a situation where governance is stretched, resources are scarcer and livelihoods are under pressure. These conditions, in which climate change is just one factor, could under some circumstances contribute to SOC gaining a stronger foothold.

Failing to acknowledge the complexity of this problem – and the various roles played by social, economic and environmental factors in increasing SOC – risks misdiagnosing the cause and effect, which in turn could make policy responses to the problem more off-target and ineffective. Oversimplifying this analysis could therefore have dangerous security implications if climate change is identified as the key problem rather than other more important drivers.

Governments' loss of territorial control could open up opportunities for SOC to operate. There is a pattern of organised crime purchasing land in border territories in Central America's northern triangle (Guatemala, Honduras, and El Salvador) and creating illegal border crossings controlled by SOC.¹⁸ As governments are stressed, maintaining their monopoly on the use of force may be weakened. In this environment criminal organizations may be able to expand their activities. Some areas of northern Guatemala are essentially ungoverned spaces controlled by 'narcotraffickers' who in some cases have established alternative state structures to provide basic services to people living in the region.

Another factor is economic contraction, where the alternatives to cooperating with SOC become less viable. There could be an increase in territorial control and popular support for narcotrafficking cartels, as a consequence of loss of harvests and unemployment in coastal zones and dry regions.



A Mexican marine stands guard outside a school used as a shelter in Puerto San Carlos, Mexico following Hurricane Jimena, September 2009. *Photo courtesy of REUTERS/Henry Romero.*

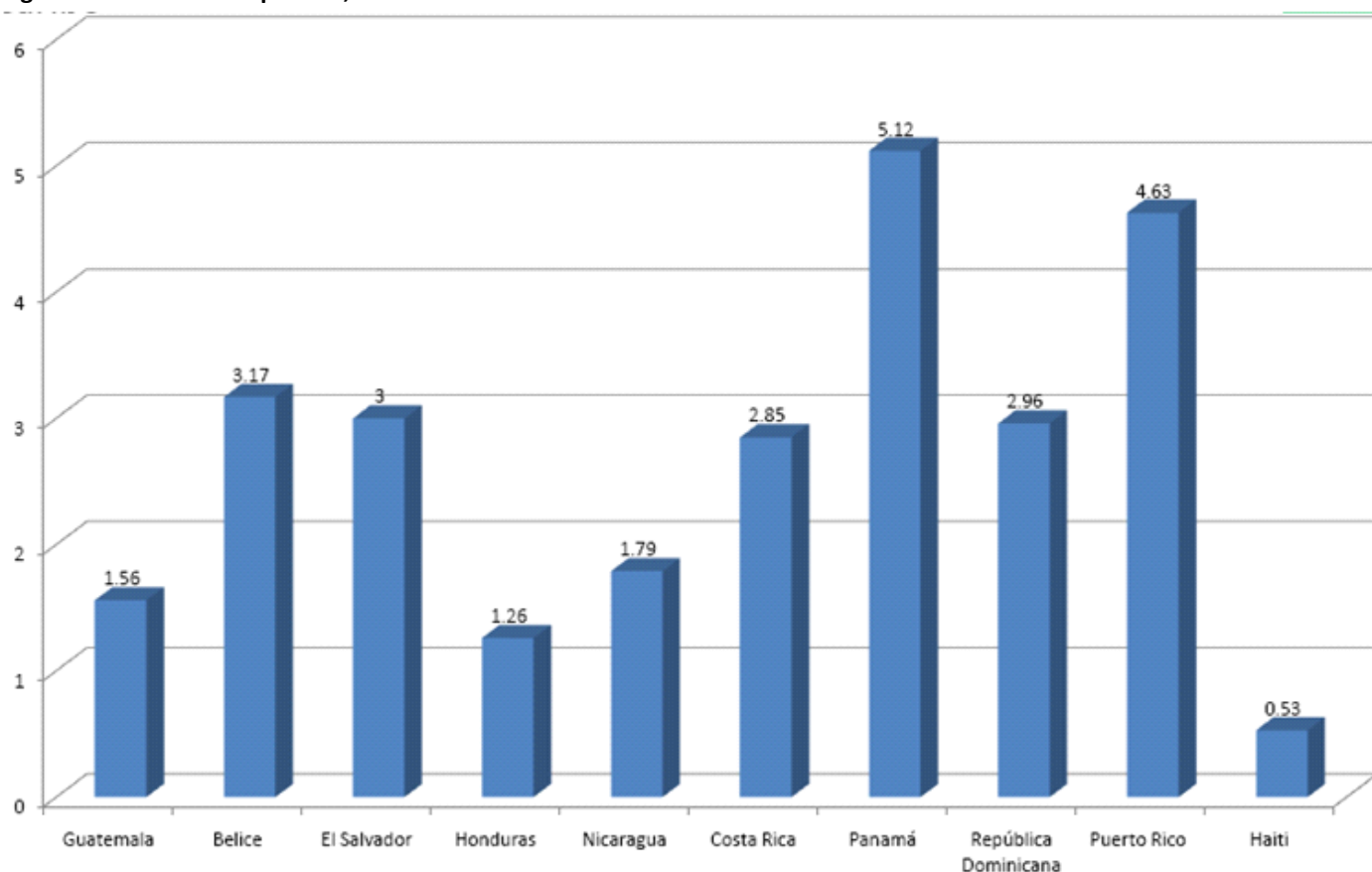
Impacts on Security Communities

Security communities, including police and defence forces, will have a particular role to play in responding to the changing dynamics. This may include an increase in the participation and involvement of armies in rescue operations, civil protection, patrolling and protecting natural resources, border patrols and security patrols in cases of increasing political and social instability, as well as in cases of increasing criminality.

In the wake of natural disasters, militaries work alongside humanitarian organisations to provide basic supplies and medical care, and military personnel also work to restore transportation and communication infrastructure and services. The Mexican military periodically offers disaster relief support to Central American countries, which focuses on disaster relief and response.

However, resource constraints are a constant challenge. Currently the security services in many countries are stretched to deal with existing challenges. Figure 2 illustrates the extent to which police services are already stretched in relation to their country's population size. This could indicate difficulties in responding to future security concerns due to lack of resourcing.

This data is particularly important in the zones that have both a high index of social vulnerabilities and high exposure to climate change impacts, i.e. both coastal zones of Guatemala, the Atlantic in Honduras and the Pacific in El Salvador. In these areas homicide rates are high, drug traffic occurs and communities in these areas have high risks of floods and are exposed to hurricanes and tropical storms. The combination of both drivers can contribute to more violent areas if the frequency and magnitude of events coincide with low local resilience capability.

Figure 2: Police officers per 100,000 inhabitants in Central America and the Caribbean

Source: Observatorio Centroamericano sobre Violencia OCAVI.

Conclusions

Climate change will have dramatic social and political consequences for Mesoamerica and its neighbours as the distribution of resources changes and current challenges become more difficult to cope with. Whether the countries in the study region have the capacity to manage these changes could influence whether climate change leads to a deteriorating security situation.

The security challenges currently facing Mexico and Central America are already significant (drug cartels, gangs, general criminal violence). Social issues are pressing (recurrent food shortages, lack of health services, malnutrition in children), and limited government response capabilities are already stretched. Yet the current situation, critical as it is, is still manageable within the existing capabilities and resiliency of the region. However, this capacity to absorb social and political pressures could be overwhelmed by the additional impacts of climate

change. The fragile equilibrium of governance in the region will undoubtedly be tested by the expected impacts of climate change.

Adaptation measures that limit climate change can also limit the knock-on effects for social and political stability. Adaptation, therefore, has security benefits as well as environmental and economic benefits. How well the security dimensions of adaptation are recognised and how adaptation agendas are prioritised could have a profound effect on the future security of Mexico and Central America.

Policy Recommendations

1. Integration of climate change impacts into national security policy
 - Integrate a specific chapter on Climate Change Impact on National/Regional Security into SICA's Regional Strategy on Climate Change; this chapter will be coordinated with the Central American Commission on Environment and Development (CCAD)
 - Develop and integrate a specific chapter on Climate Change Impact on National Security into National Security Strategies
 - Include climate change and security analysis in countries' National Communications to the IPCC
 - Construct a matrix of national/regional security drivers, how these drivers might be affected by climate change and/or climate variability; include measures at the national and regional levels with corresponding institutional liaisons or responsibilities for leading actions
 - Build scenarios of potential impacts of climate change on social stability and governance at the regional and national levels, and develop appropriate policy responses for future implementation.
2. Recognition of climate change adaptation as a security imperative
3. Recognition of greenhouse gas (GHG) mitigation as a priority with national security implications.



Pedro Aguilera looks over his ruined corn crop outside the village of La Concepcion in southern Honduras, August 2001. *Photo courtesy of REUTERS/Str Old.*

Endnotes

¹ The Royal United Services Institute (RUSI) in London, Fundación para el Ecodesarrollo y la Conservación (FUNDAECO) in Guatemala, Comisión Centroamericana de Ambiente y Desarrollo (CCAD) in El Salvador, and the Caribbean Community Climate Change Centre (CCCCC) in Belize.

² Scenario-building and other research for the remainder of this study awaits the submission of Second National Communications from Central American countries.

³ The scenarios were compiled by the Caribbean Community Climate Change Centre in Belize.

⁴ The vulnerability of the Central American countries was determined using combinations of global climate models. Examples included those based on temperatures scenarios such as CCC1TR, CSI2TR, ECH4TR, GISSTR, and HAD2TR. The analysts used other mathematical models based on precipitation such as CSI2TR, ECH3TR, ECH4TR, HAD2TR, and HAD3TR. Experience revealed that the HAD2TR was the better model in producing the projections based on the variables changed in the equations.

⁵ The conference '4degrees and Beyond' at the Environmental Change Institute at Oxford on 20-30 September 2009 offers a summary of the most recent climate science research. Audio files and presentations from the conference are available at the website: <http://www.eci.ox.ac.uk/4degrees/programme.php>.

⁶ Healthy Reef for Healthy People Initiative Project's *Guide to Indicators of Reef Health and Social Well-being in the Mesoamerican Reef (MAR) Region*, 2007. The Mesoamerican Reef region comprises the barrier reef extending from Mexico, Belize, Guatemala, and Honduras.

⁷ De la Torre et al (2009), *Low Carbon, High Growth – Latin American Responses to Climate Change*, World Bank Latin American and Caribbean Studies, Washington D.C.

⁸ The 2006 Stern Review on the Economics of Climate Change is the most comprehensive study on this topic, with a forthcoming in-depth study from Comisión Económica de América Latina CEPAL focusing specifically on the economic impacts of climate change for Mesoamerica to be released in early 2010.

⁹ CONRED in Guatemala, Dirección General de Protección Civil in El Salvador, COPECO in Honduras, SINAPRED in Nicaragua, CNE in Costa Rica, SINAPROC in Panama and CENAPRED in Mexico.

¹⁰ Renate Scubert et. al, 'World in Transition - Climate Change as a Security Risk', German Advisory Council on Global Change (WBGU), 2007.

¹¹ EEZ, defined as 200 nautical miles out from the coastline. The workshop participant was the Commander of the Belize Coast Guard.

¹² Scenario-building workshop participant, Mexican Institute of Water Technology, Mexico City 3 October 2009.

¹³ Climate-related impacts on state stability and national security in Mexico and Central America - Scenario-building workshop 2, Mexico City 3 October 2009.

¹⁴ Scubert et al, *op. cit.*

¹⁵ Dolores Rojas, Oxfam Mexico, Scenario-building workshop, Mexico City 2 October 2009.

¹⁶ Robert McLeman and Barry Smit, 'Migration as an adaptation to climate change', *Climatic Change* (Vol. 76, No.1-2, 2006).

¹⁷ Professor Ursula Oswald Spring, National University of Mexico, interview 10 September 2009.

¹⁸ Climate-related impacts on state stability and national security in Mexico and Central America - Scenario-building workshop 1, Belmopan, Belize, 20 & 21 August 2009.

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