PART V:
CLIMATE CHANGE RESPONSES, EQUITY AND SUSTAINABLE DEVELOPMENT

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Sustainable and Inclusive Adaptation to Climate Change and Public Policy Challenges in Central America*

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Abstract

Highly vulnerable, small developing countries have to develop public policy responses to climate change in the face of fiscal constraints, the current economic recession, excruciatingly slow international negotiations, and their immediate and long-term development challenges. This article presents findings regarding potential climate change impacts and policy response discussions in Central America. The separation between adaptation and mitigation, so prevalent in international negotiations and finance, is probably not appropriate for policymaking in small developing countries. An alternative is to prioritise adaptation that is both sustainable and inclusive. Measures to transition to economies that are more sustainable and low-carbon-oriented and that improve intra- and intergenerational equity would be integrated within this basic approach. Sector-specific knowledge and policies will have to be developed, while identifying intersectoral co-benefits and adverse effects, and aligning them with fundamental development challenges. Countries that are already increasingly exposed to extreme climate events could prioritise measures to reduce vulnerability to these events, given their higher profile on the political agenda, while ensuring that these

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measures serve as first steps along a sustainable and inclusive adaptation pathway.

A. Introduction

One of the great challenges of public policy development and governance for small, highly vulnerable developing countries is their response to climate change, given both immediate and long-term development challenges, the economic recession in developed economies with spill-over effects for their countries, and excruciatingly slow international negotiations aimed at a global agreement. This article explores this challenge in the light of findings from an initiative in Central America that aims to develop knowledge of potential impacts of climate change, to increase policymakers' awareness across multiple sectors, and to encourage knowledge-based dialogue and policymaking. The initiative addresses the following questions: Is the separation between adaptation and mitigation that is so prevalent in the international arena appropriate for policymaking in small developing countries with limited public budgets? How can knowledge of sector-specific potential impacts and responses, and their costs and benefits, be developed, while ensuring that the response of one sector does not undo efforts or have adverse effects on another? Can the response to the additional challenges generated by climate change be made in ways that bring about progress in fundamental development challenges?

B. Potential Climate Change Impacts in Central America

Central America is one of the regions of the world most exposed to the effects of climate change, although it produces a minimum part of greenhouse gas (GHG) emissions, viz. less than 0.8% of global gross emissions.[1] This narrow isthmus that serves as a land bridge between the two continents of the Americas and is surrounded by the Pacific and Atlantic Oceans is frequently

1 Equivalent to less than 0.3% of emissions without land-use change. Estimates based on national inventories for 2000 and global figures from IPCC (2007b) and the Climate Analysis Indicators Tool data base from the World Resources Institute (http://www.wri.org/tools/cait). It is important to note the high uncertainties around land-use change emissions and absorptions.

hit by droughts, cyclones and the El Niño Southern Oscillation. Over the past three decades there has been a trend of reduced rainfall, especially in the western part of the isthmus, and of temperature increases ranging from 0.7°C to 1°C. Given that diverse economic activities, such as agriculture and production of hydroelectricity, are climate dependent, climatic changes could increasingly affect the region's economic evolution over the course of the current century. In fiscal terms, climate change constitutes a contingent public liability that will have an increasingly detrimental effect on public finance.

At the same time, the region has valuable natural reserves that must be preserved for their contribution to the support and development of current and future generations. Ecosystems rich in biodiversity, including forests, coral reefs and mangroves, among others, all provide the population with multiple products and services, such as food, shelter, medicines, pollination and pest control, and regulation of local climate, water and humidity. These ecosystems are already suffering the ravages of unsustainable exploitation and will be further affected by climate change. The population of these countries should also be regarded as a treasure, given its youth and cultural, ethnic, linguistic and lifestyle diversities. This population requires not only investment in its development, but also a greater recognition of the value of the knowledge of its local communities and indigenous peoples. These assets could make important contributions to climate change responses, but they are also probably the most vulnerable to its effects and are already suffering from the consequences of increased extreme events such as hurricanes, intense rainfall, floods and drought.

The Global Climate Risk Index prepared by German Watch ranks over 180 countries according to the impact of events such as storms, floods and temperature extremes. In the cumulative ranking from 1992 to 2011, Honduras was placed first as the most affected country, Nicaragua third, Guatemala eleventh, El Salvador fifteenth and Belize twenty-sixth. In more recent years, these countries have often appeared in the first ten places: Guatemala was first and Honduras seventh in 2005, Nicaragua third in 2007, Belize ninth in 2008, El Salvador first in 2009, Guatemala second and Honduras fifth in 2010, and El Salvador fourth and Guatemala ninth in 2011.[2]

In its Fourth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) notes that the frequency of intense rainfall has increased over

2 Harmeling & Eckstein (2012:28).

most land masses, consistent with global warming and increases in water vapour. It reports that there is a medium certainty that anthropogenic influences have contributed to intensification of extreme precipitation on a global scale and of droughts in some areas, including Central America, due to rainfall reductions and/or increases in evapotranspiration. The report also warns that droughts and landslides can result from a set of accumulative events that individually are not considered as extreme.[3]

Just over 290 major climate-related extreme events have been registered for Central America in the Emergency Events Database, EM-DAT, between 1930 and 2011, with an estimated increase of 7% annually in the last three decades relative to levels recorded in the 1970s. The most frequently registered events are hydrological, with 86% associated with floods, storms, landslides and mudslides, and 9% with droughts. Many more such events have occurred on a lesser scale with cumulative effects that have yet to be assessed.

Hurricanes generate the greatest measured costs to date, with the Atlantic coast being most exposed. At the same time, hurricanes originating in the Caribbean force the Intertropical Convergence Zone northwards, provoking intense rainfall, landslides and mudslides over a far wider territory. This was the effect of Hurricane Mitch in 1998, which generated estimated costs of close to $8,000 million in five countries of the region. In the last few decades, storms and hurricanes originating in the Pacific have also started to make landfall in Central America, while previously they did so further north in Mexican territory.[4] In addition, tropical depressions and storms are being recorded with more intense rainfall and destruction, such as Tropical Depression 12E of 2011, which caused extensive damage and loss in El Salvador and parts of Guatemala, Honduras and Nicaragua. Although climatic events in Eastern Pacific have not been studied in similar detail, National Oceanic and Atmospheric Administration records for the Atlantic Ocean have provided evidence of an increased frequency of storms of short duration (less than two days), especially since the 1960s.[5]

The frequency of moderate duration storms has also increased since 1980, but has historically fluctuated in a cycle of about three decades. The relationship between frequency of these events and climate change may become clearer as we see if this oscillation changes its historic pattern in the coming

3 IPCC (2007b) and (2012).
4 MARN (2012).
5 ECLAC et al. (2010).

years. Regarding the relationship between intensity of these events and climate change, the evidence is stronger. It is estimated that the oceans have absorbed about 20 times more heat than the atmosphere during the last half century, causing higher temperatures in shallow and deep waters – which are factors contributing to the increased intensity of tropical cyclones. The surface temperatures of the Eastern Pacific Ocean and Caribbean Sea, whose waters affect the climate of Central America, have increased over the last hundred years: the time series indicates that the area of the Pacific Ocean associated with El Niño Southern Oscillation (20N–20S and 90W–120W) has experienced a temperature rise in this century and the Caribbean has suffered an acceleration of warming since the mid-nineties.[6] A review of the international literature suggests that the intensity of hurricanes could increase by between 5% and 10% during this century.[7]

Another line of analysis is based on the laws of thermodynamics, which suggest that elevated temperatures generate higher rates of evaporation, evapotranspiration and water vapour in the atmosphere and an acceleration or destabilisation of the water cycle. Stott of the Hadley Centre for Climate Prediction and Research has estimated that for every 1°C increase in temperature there should be an increase of 7% global average moisture in the atmosphere, which would cause more intense rainfall events.[8]

Historical climate databases indicate that Central America has seen a rise in average temperature of about 0.5°C over the past 50 years. The climate change scenarios for temperature and precipitation developed by the Economics of Climate Change in Central America (ECCCA) initiative used emissions scenarios and climate models recommended by the IPCC.[9] In an emissions scenario to 2100 that is lower than the current trend (IPCC scenario B2), temperature could climb between 2.2°C and 2.7°C, depending on the country, with a 2.5°C regional average increase over the 1980–2000 average. A continuation of the current trend of rising emissions (IPCC scenario A2) could result in temperatures rising between 3.6°C and 4.7°C, depending on the country, and a regional average of 4.2°C. With this scenario,

6 Jury (2011).
7 ECLAC et al. (2011).
8 Carey (2011).
9 The Intergovernmental Panel on Climate Change (IPCC) has developed four families of developmental and emissions scenarios. The ECCCA initiative primarily used scenarios A2 and B2 with four general circulation models, three of which were used for this reported average.

the temperature rise limit of 2°C could be reached by a number of Central American countries in the next 40 years.

The estimates for future precipitation levels involve even greater uncertainty. In the B2 emissions scenario, precipitation could fall by 3% in Panama, 7% in Guatemala, between 10% and 13% in Costa Rica, Belize, El Salvador and Honduras, and 17% in Nicaragua by 2100. The average reduction for the region could be 11% by that year. Using scenario A2, precipitation could be reduced in the order of 18% in Panama, 35% in Nicaragua and between 27% and 32% in Costa Rica, Belize, El Salvador, Guatemala and Honduras. On a region-wide basis, the decrease could average 28% by 2100.[10]

However, even with a lower reduction in precipitation under B2 scenario, rising temperatures will have their own effect on evapotranspiration, and result in reduced availability of water, especially in the second half of the century. In the more pessimistic scenario (A2), this multiplier effect would be greater. The ECCCA analysis of aridity patterns found that levels of temperature and precipitation for the period 1950-2000 generated an aridity index of 1.6 for Central America, varying between the Western Highlands of Guatemala with higher humidity (aridity index of 1.96) and parts of the Dry Corridor of Central America (index results between 0.91 and 1.25). This study estimated that by the end of the century the region could experience conditions associated with an aridity index of 1.4 in the least pessimistic scenario (B2) and 1.2 in the most pessimistic scenario (A2), with a general prevalence of conditions similar to those experienced by the driest part of the Dry Corridor in the period between 1950 and 2000.[11]

Central America is privileged in terms of the average availability of water in the region, but there is a very uneven distribution of this resource between countries and regions at the subnational level. This situation often leads to alternating periods of floods and of severe droughts. Population and economic growth alone could cause water demand to grow by almost 300% by 2050 and more than 1,600% by 2100 in a baseline scenario without climate change and without improvements in efficiency of water use. With climate change, demand may expand 20% more than in this baseline scenario in the case of B2 and 24% more with A2. The total availability of renewable water could fall 35% by 2100 compared to current levels under B2 and 63% with

10 ECLAC et al. (2011).
11 ECLAC et al. (2012a).

A2. In these scenarios, El Salvador would be the most affected, followed by Honduras and Nicaragua. The combination of changes in water demand and supply could result in a regional intensity of water use of 36% by 2100 in a scenario free of climate change, 140% with B2 and more than 370% with A2, if adaptation and efficiency measures are not adopted. These levels would be greater than the 20% threshold internationally accepted as critical for water stress, and are similar to current levels of intensity found in Egypt and some countries on the Arabian Peninsula.

These scenarios suggest greater risks and uncertainty for activities such as hydroelectricity production. The combined effect of the rise in temperature and precipitation changes would affect evapotranspiration in watersheds, river flows and evaporation in dam reservoirs. In a pilot study of two hydroelectricity plants (Chixoy of Guatemala and Cerron Grande of El Salvador), this chain of effects results in reductions in electricity generation of over 20% in the two plants for 2020 in the most pessimistic scenario (A2) relative to average generation during reference periods (1979–2008 for Chixoy and 1984–2009 for Cerron Grande). By 2050, the reductions would be above 40% in both plants, and would reach more than 80% for Chixoy and 70% for Cerron Grande at the end of this century. In the less pessimistic scenario (B2) there could be an increase between 4% and 6% in the plants for around 2020, but from then on production is reduced, with up to a 26% decrease in Chixoy and 17% in Cerron Grande by 2100. The study recommended making a more detailed analysis of possible changes in the next two decades and reviewing the operating models of the reservoirs.[12]

The agricultural sector is a driver of the region's economy. It represents 18% of total GDP when agro-industry is included, and it will be one of the sectors most affected by climate change. According to initial estimates, the regional agricultural index could register a reduction of approximately 9% under scenario A2 by 2100, if no adaptation measures are taken. Maize yields could grow in the near term with levels slightly greater than 2 tonnes per hectare, but would then begin to decline, possibly falling to as little as 1.4 tonnes per hectare around 2100. Average bean yields may decline from more than 0.7 to less than 0.1 tonnes per hectare by the end of the century. Rice production could fall from the historical average of 3.5 tonnes per hectare to between 2 and 1 tonnes per hectare.[13]

12 ECLAC et al. (2012c).
13 Ramirez et al. (2009).

The importance of these crops goes beyond their economic value, because they are staple food crops for large segments of the population. For example, bean production represents less than 4% of agricultural GDP but, combined with corn or rice, is an invaluable source of vegetable proteins and iron. With differences between the various countries and crops, low-income small-scale farmers produce a significant proportion of these staples. Climate change will have a significant impact on food security of these rural producers by reducing their production-based direct access to these staples and could cause shortages and price increases to urban consumers, depending upon import possibilities. Thus, the implications for food security and poverty are serious.

Central America is home to 7% of the planet's biodiversity and exhibits great geological, geographic, climatic and biotic diversity. In a business-as-usual scenario of land-use change (without climate change), one measure of biodiversity, the Potential Biodiversity Index (PBI),[14] could decrease by approximately 13% during the current century, especially in the period before 2050. With climate change, under scenarios B2 and A2, the PBI could decline by 33% and 58% respectively by 2100. Guatemala, Nicaragua, El Salvador and Honduras would be the countries hardest hit with PBI reductions ranging between 75% and 70% under scenario A2.[15] Another ECCCA study on forests used the Holdridge life zones (HLZ) classification. Under this approach, the surface of natural cover would decrease under a land-use change scenario without climate from approximately 28.5 million hectares to 16.3 in 2050 and 16.9 million hectares by 2100. However, the proportion of each of the six predominant HLZ forest types in Central America would not change significantly. If drivers of this land-use change scenario occurred with the B2 emissions scenario, it was estimated that the humid tropical forest could increase its cover from 44% in 2005 to just over 70% by 2100. In contrast, with scenario A2, the largest increase in surface would go to the dry tropical forest, rising from 11% to 39% of the total. Thus, both scenarios suggest changes, one to drier HLZ (in A2) and the other toward more humid ones (in B2). Both scenarios estimate initial increases in areas with conditions appropriate for humid forests up to 2020 and a reduction in the diversity

14 The Potential Biodiversity Index includes species and ecosystems and makes an inference about the probability of encountering greater diversity in function of a series of relevant variables. It does not necessarily coincide with the present-day recorded number of species and ecosystems.

15 ECLAC et al. (2011).

of HLZ as the century progresses. This study evaluates the conditions of temperature and precipitation associated with the various HLZ, but it remains to be analysed whether their ecosystems could successfully make these transitions, especially considering the speed of the projected changes in precipitation and temperature coupled with the pressures of land use changes. These results confirm that reducing deforestation and increasing protection and restoration of natural ecosystems is a development challenge in itself, and that climate change, especially in the more pessimistic scenario (A2), could bring greater loss of forests and their ecosystem services.[16]

Of the approximately 41 million people in America, two-thirds live in settlements that combine poverty with poor sanitation and health services.[17] These adverse conditions make the population vulnerable to climate change, because poverty-related diseases, such as malaria and dengue, are also associated with changes in climate.[18] In addition, these populations face direct and indirect effects of extreme events on health, including crop destruction and relocation in overcrowded and unsanitary spaces.[19] Central America has a mosaic of ecological niches favourable for the transmission of diseases associated with climate change, owing to its varied topography and proximity to two oceans. A recent ECCCA study has identified valuable efforts in the region to assess climate variability and its influence on health and the epidemiology of certain diseases. It proposes priorities for a future agenda on the relationship between temperature and precipitation and the incidence of disease, the potential climate change impacts on human health, and the design of adaptation measures.[20]

The analysis of the many direct and indirect impacts of climate change on the vulnerability of certain populations requires consideration of the multiple dimensions of the condition of poverty, such as that of "capabilities and opportunities".[21] This requires an analysis of the ability of people to adapt to climate change, not only in terms of the availability of financial and natural resources, education and health, but also their ability to use these assets. The IPCC states that the causes, problems and solutions related to climate change are laden with equity issues, since the countries that contribute least to

16 ECLAC et al. (2012b).
17 FAO & ETEA (2008).
18 Hotez et al. (2008).
19 Noji & Toole (1997).
20 ECLAC et al. (2012e).
21 Sen (1999).

greenhouse gas emissions are the most vulnerable and have less capacity to adapt.[22] The Stern Report[23] states that "climate change is a great threat to the developing world and a major obstacle to continued poverty reduction across its many dimensions". Therefore, there is a need to integrate adaptation strategies with those being taken to reduce poverty and inequality.[24]

About half of the population of Central America lives in poverty, and about a third in extreme poverty, especially in rural areas. There are still high levels of socioeconomic, ethnic and gender inequalities, as reflected in several indicators, including the relatively high Gini index (0.53 in 2010), and high rates of child mortality and morbidity, maternal mortality, and malnutrition, and well as limited access to food, clean water, health services, education, social security, capital and productive credit. A significant part of this population, especially in rural areas, depends directly on the environment for access to water, food, shelter, medicines and energy, among other needs. The lack of capital and livelihood options has sometimes led to overexploitation of the environment by these populations. The general pattern of unsustainable and inequitable development and weak risk management has created a vicious circle of human impoverishment and environmental degradation, which further complicates the response to climate change.

Another part of the population living in poverty inhabits marginal urban areas, is often dependent on the informal urban economy and accesses most of its goods and services through the market. These communities will face the economic instabilities that climate change could cause with serious handicaps. The reduction and instability of water availability and crop yields can affect labour markets, the supply and price of commodities, and the migration to urban areas.

The already existing challenges of social investment are related to the prevalence of informal work and the limited coverage and quality of education and social protection in most countries. Only those who are employed in the formal sector have access to this coverage, including pensions, unemployment insurance and health services. Low per capita social spending, although relatively higher in Panama and Costa Rica, also limits resilience and adaptive capacity. Recent decades have seen the implementation of conditional cash transfer programmes for poor families in several countries to supplement income and encourage the use of basic health and education

22 IPCC (2007a).
23 Stern (2007).
24 ECLAC (2009) and (2010); IPCC (2007a); UNDP (2007); AfDB et al. (2007).

services. These programmes have the advantage of focusing on poor households with children, adolescents, and female heads of households and the unemployed and economically inactive population.[25] Cecchini and Madriaga state:[26]

> In some countries they facilitate access to social services for the population in greatest need. However, one should not lose sight that these programs do not replace the functions meant to be provided for by other policy instruments and their effectiveness depends largely on the presence of strong health systems and universal education.

Strengthening the supply of these services remains a priority need in the region and it would be advisable to consider that climate change may worsen the intergenerational cycle of impoverishment and that such measures should be made sooner rather than later.

Participation and political representation are important and will be key to successful climate change adaption. Although the countries of the region have democratic electoral systems, there is still a way to go to for marginalised groups, such as women, small-scale farmers, indigenous peoples and communities of African origin to achieve effective participation.

An initial estimate prepared by the ECCCA initiative of the measurable accumulative cost to 2100 for the impact on agriculture, water resources, biodiversity and the intensity of hurricanes, storms and floods under scenario A2 could be equivalent to about 54% of the regional GDP of 2008 at net present value (NPV) with a discount rate of 0.5%. With a discount rate of approximately 4%, the equivalent value is 9% of the 2008 regional GDP at NPV, underscoring the importance of the rate applied. The measurable accumulative cost to 2100 of the same sectors under scenario B2 could be equivalent to about 32% of the regional gross domestic product (GDP) of 2008 at NPV with a discount rate of 0.5%. With a 4% discount rate the equivalent value is 6% of regional GDP of 2008 at NPV. The current dollar cost under B2 is equivalent to 60% of the same cost under A2. It is important to note that the greatest increase in costs could occur during the second half of the century, and in general costs will be extremely high at the end of the

25 ECLAC (2012).
26 Cecchini & Madriaga (2011).

century in a scenario of inaction.[27] There is considerable uncertainty involved in such long-term scenarios and in the integration of various analytical *layers*, such as climate and macroeconomic scenarios with impact studies for different sectors and their economic valuation. In addition, there are notable methodological challenges in the various sectors and areas of concern. In this sense, these results should be regarded as an indication of relative trends and magnitudes, not as exact figures. In the future, it will be necessary to explore how changes in one sector influence what may occur in other sectors.

In conclusion, a scenario of rising emissions such as IPCC A2 will bring significant and growing impacts and costs to Central America, with a certain degree of variation between countries. This result confirms the asymmetrical nature of climate change with the most polluting developed countries probably experiencing the least effects and having a greater ability to adapt, while the countries that have contributed least to the problem will suffer greater impacts and have less resilience. It lends weight to the concern that the costs of climate change in a scenario of global inaction, particularly on the part of major emitting countries, would be higher than those in a scenario with an equitable and inclusive international agreement that significantly lowers emissions with shared yet differentiated responsibilities between countries. This second scenario would need to ensure adequate support for the most

27 The initiative first defined various baseline or business-as-usual scenarios for the macroeconomy, demographics, land use and energy consumption without climate change, against which the phenomenon's impacts and costs were measured. A bottom-up analysis was used to analyse impact in key sectors and areas of concern such as agriculture, water resources, extreme events and biodiversity services, and then an economic valuation of these impacts was generated in relation to the projected GDP baseline. Analysis and policy-oriented discussions were held regarding both adaptation and low-carbon economies. The initiative developed long-term future impact and cost scenarios to 2100, with cut-offs at 2020, 2030, 2050 and 2070 so as to uncover potential risks that could grow over time, particularly in the second half of the current century. On the other hand, mitigation scenarios were made only to 2030 owing to uncertainty surrounding technological changes, with cut-offs at 2010 and 2020. Lastly, a common focus was agreed upon for the treatment of discount rates for the economic valuation. The costs described are initial estimates and relate to the impacts analysed for the agricultural sector, water resources (availability and municipal and agricultural demand), biodiversity (direct costs registered in economic statistics and indirect impact on agriculture), and the increasing intensity of hurricanes, storms and floods (not including their increased frequency nor the costs of other extreme events). Thus, these results represent a conservative and initial estimate of the costs of economic impact.

exposed and vulnerable countries, such as those of Central America, to adopt adaptation and mitigation measures in the context of sustainable and inclusive development.

C. An Exploration of Climate Change Policy Options

From an economic standpoint, it is more cost effective to act now than to leave the matter to future generations. It is also more ethical to do so. The initial cost estimates of the ECCCA initiative suggest that climate change impacts will become progressively higher if ambitious and immediate emission reduction measures are not taken. The work also confirms that climate change is the greatest market failure to date for not having internalised the value of climate as a global public good and not properly registering its social impact and effects on environmental services. This failure implies the need to make ethical decisions that go beyond the realm of economics regarding the implicit inequalities within and between current and future generations.

Climate change could be considered a phenomenon that will only affect us in the distant future, not worthy of significant current investment given budget constraints deepened by the current global recession. But the growing impact of extreme events suggests that urgent action must be taken regarding climate resilience. In addition to the growing threat of major impacts and costs in the future, current risk reduction and reconstruction efforts need to be reoriented and strengthened by adopting more climate resilient infrastructure, housing and land use standards, more efficient water management, stepped-up protection of forests and watersheds, and natural coastal barriers such as mangroves. This investment should reduce vulnerability to upcoming extreme events and generate a greater ability to cope with the impacts of climate change.

The challenge of adaptation will be highly onerous for Central America because it demands a redoubling of efforts to reduce poverty, inequality and both socio-economic and environmental vulnerability, while heightening the resilience and adaptive capacity of these societies, especially high-risk populations and related ecosystems. There will be limits to what adaptation can achieve in the face of increasingly irreparable losses and damages, even if abundant financing were to be available, and especially in a business-as-usual, high-carbon scenario. This analysis demonstrates that the present value of the long-term costs of climate change impacts will prove to be too high if we do not take ambitious and immediate measures. Given that this is a

market failure, climate change cannot be treated as if it were the exclusive responsibility of environmental institutions, but instead must be recognised as a central and cross-cutting economic problem with serious fiscal implications.

Central American societies will need to avoid ad hoc strategies with a business-as-usual logic that might respond to emergencies, but only heighten risks. In such a logic, climate change might be regarded as important, but not a matter that could be fully addressed owing to existing budgetary restrictions exacerbated by the current global recession and the need to address urgent social and economic issues in a conventional manner.

We will have to address these challenges in a period in which the model of market self-regulation has demonstrated limitations. As Barcena has noted, we are experiencing a new era, which demands profound structural changes made necessary by climate change and other externalities caused by industrialisation and the hydrocarbon-based economy – changes on a scale equivalent to the industrial revolution.[28] Other elements to take into consideration are the significant population increase still to come before reaching its stabilisation point in the second half of this century, the demographic transition as the population ages, and the migration between countries and from the countryside to the city. The challenge of achieving inclusive development with better quality of life and opportunities is made greater when we consider our responsibility to future generations in the context of climate change. The globalisation of communications has promoted deregulation, self-regulation and increased information flows, which favour democracy. But it has also strengthened the role of market forces in the definition of identities. Reversing the consequences of market self-regulation and excessive dependence on hydrocarbons requires greater collective consciousness of global public goods. This will require transforming the processes and structures of global and national governance.[29]

National, regional and international agreements should be oriented towards sustainable and inclusive adaptation strategies that integrate vulnerability and poverty reduction with adaptation actions and measures for the transition to more sustainable and lower-carbon economies. This should include mitigation actions designed to generate adaptation co-benefits in a range of instruments directed at sustainable and equitable development. This

28 ECLAC (2010).
29 ECLAC (2010); ECLAC (2012).

requires a strategic vision to focus on inclusion and sustainability in its many dimensions and to maximise co-benefits and minimise costs across sectors and between adaptation and mitigation, and all within the development agenda. For example, improved protection and restoration of forests and energy efficiency are part of a sustainable development agenda, and, if well designed, co-benefits could result in better adaptation of these ecosystems, reduced emissions and improved wellbeing of populations living in these ecosystems, including indigenous peoples.

In this scenario, the global economic recession and climate change risks would be used as an opportunity to review thoroughly the current productive specialisation of these economies, including their linkages to regional and global markets, the ties between their energy patterns and negative externalities from conventional pollution and GHG, losses to public health and harvests, weaknesses in rural and urban infrastructure, degradation of ecosystems and loss of their services.

Public policies aimed at sustainable and inclusive adaptation could be designed to take into account intra- and inter-sectoral synergies in the following major policy clusters with explicit sectoral and territorial objectives:

- Inclusion and adaptation by human populations as part of policies aimed at the reduction of poverty and inequality, including food security, integrated management of water resources and reduction of extreme event impacts with strengthened land-use and territorial planning
- Transition to sustainable, low-carbon economies that are efficient in the use of natural resources, introducing structural and technological changes especially regarding energy security and efficiency, integrated water management and the curbing of deforestation and pollution
- Protection and restoring of natural ecosystems and rural landscapes, including forests, in order to improve their own adaptation and assure the long-term provision of ecosystem services, as a key policy area for both adaptation and a transition to more sustainable economies, including both effective use of economic incentives and ethical and cultural appreciations
- Far-sighted and proactive fiscal and investment policies as a cross-cutting policy area to establish climate resilient criteria for public investments and economic incentives for risk retention, reduction and transfer, technological innovation and adaptation, and the effective use of national and international resources, and

- Strengthening of the Central American integration process to take advantage of opportunities where regional responses offer added value for challenges such as managing common water resources, food and energy security, competitiveness, trade implications and international negotiations.

Central American societies need to become more audacious managers of their water resources, securing their sustainable and efficient use for the benefit of the population and production. In many ways, the key indicator of adaptation is related to more efficient use of this resource and its judicious distribution among multiple uses, including that needed by ecosystems. Forest conservation and restoration of rural landscapes are essential for the management of watersheds, for reducing erosion, landslides and floods, and for production of hydroelectricity. Extensive efforts are required to make more efficient use of water, reduce pollution and recycle it in domestic use, agriculture, industry and services. A much more effective institutional framework for managing water across sectors and between countries is needed, given that transnational watersheds cover 40% of the territory of Central America.

Protecting food security in the face of climate change, especially access to basic grains, and making the transition toward more sustainable agriculture is a major challenge in order to protect the poorest members of these societies, whether as small-scale producers or urban consumers. With a few notable exceptions, most countries have experienced lower levels of investment in rural areas in recent decades, and the dismantling of rural programmes in land titling, extension, post-harvest loss reduction, market access and capacity building. Much more effort is required for the protection and promotion of native varieties of crops and other local, indigenous and national technological know-how, which can make important contributions to climate resilience and adaptation.

The response to climate change in the agricultural sector will require close coordination with policies to reduce deforestation, protect biodiversity and manage water resources. It will also require recognising and expanding notable experiences in the region that have strengthened the welfare of rural and indigenous populations by establishing more sustainable production processes, such as agroforestry and other activities that combine farming with the protection of ecosystems and systems of payment for environmental services. The region's strategic agrobiodiversity is currently as unprotected as the small farmers and indigenous peoples that have developed it over

many generations. Increased access by rural populations to decentralised renewable energy sources, such as solar, wind and small-scale hydroelectric dams, can increase their resilience to climate change and reduce emissions at the same time. In general, rural areas, with their natural and productive resources, will be key to a successful response to climate change.

Active development of appropriate technologies is essential for adaptation and the transition to low-carbon economies, both in terms of using and adapting 'modern' technologies and the recovery of traditional and local knowledge and technologies, especially those of indigenous peoples and small-scale agriculturalists. The region has developed a serious dependence on contaminating and imported hydrocarbon energy sources. The transition to an energy matrix based as much as possible on local, renewable sources would bring multiple benefits, including improved energy security, foreign currency savings and reduced adverse effects of fossil fuels on human health, as well as lower GHG emissions.

Investments in waste management would generate multiple benefits such as reduced pollution, increased raw material for production, power generation by methane capture at landfills, and better drainage of water during extreme hydrometeorological events. There are opportunities to improve energy efficiency and reduce the intensity of GHG emissions and other pollutants with new rules and requirements for motor vehicles and industrial machinery and expansion of safe and efficient public transport systems. The expansion of hydropower, if designed with a focus on sustainability and inclusion, could expand access to electricity for low-income populations and contribute to sustainable production and social development of the surrounding areas.

The energy sector in Central America has designed its Sustainable Energy Strategy 2020,[30] which proposes expanding regional renewable energy sources, including hydro, wind and geothermal sources and importing natural gas. It is the first regional strategy that considered sectoral GHG emissions. It was adopted by the ministers of Energy and the Central American presidents and proposed the following measures:[31]

- Achieve at least 90% of electricity coverage in each country
- Achieve 10% reduction in wood fuel consumption for cooking by introducing more efficient stoves in a million rural households

30 ECLAC & SICA (2007).
31 (ibid.).

- Reduce electricity consumption by 12% in the residential, commercial, industrial sectors and for public lighting with more efficient lighting systems
- Reduce residential electricity use by 35% by replacing obsolete refrigerators for more efficient units in 2.7 million households
- Reduce electricity use in the industrial sector by 10% with more efficient engines
- Bring the level of losses in the electricity systems of the countries down to 12%
- Increase in the regional share of renewable electricity production by 11%, favouring the construction of hydropower plants
- Replace 15% of petroleum consumption with biofuels in public and private transport, and
- Reduce GHG emissions by 20% relative to the 2020 baseline scenario, maximising the use of emissions reduction certificates.

With greater access to technology and funding, Central America could advance further in implementing this regional strategy. The energy sector has shown its ability to carry out long-term coordinated investment projects, such as those conducted to develop the Central American Electrical Interconnection System. It is currently working on the harmonisation of fuel standards in the process of the Customs Union and the implementation of the Action Matrix for the development and integration of the sector in Central America.

Adaptation of societies to climate change is clearly linked to the adaptation of the ecosystems on which we depend. Meeting this challenge will require further assessment of the value and contribution of environmental services and taking non-market measures to create incentives and regulatory frameworks. It is necessary to use the precautionary principle and establish minimum standards of protection and restoration, considering the irreversibility of biological loss, risk and uncertainty.

Reducing deforestation and degradation and restoring rural landscapes will generate benefits in many aspects of the development agenda per se, even without considering climate change. The system of Protected Natural Areas (currently more than 550 in the region) needs strengthening, and biological corridors will have to cover larger-scale biogeographical areas and give greater scope to buffer areas and climate 'shelters'. These efforts could be complemented by programmes for expanding sustainable agriculture, agroforestry and protection of local and endemic varieties of crops and

wildlife. Other measures to facilitate the adaptation of forests and rural populations include programmes that involve these communities in the conservation and restoration of the ecosystems on which they depend. This includes adopting technologies for sustainable livelihoods; making full use of traditional knowledge and diversifying livelihoods; improving systems of forest management, such as control of deforestation and forest fires, afforestation and reforestation; and establishing regulations and certification of organic products and ecotourism.

Land-use planning is essential to achieve sustainable development and to improve the distribution of the population, its activities and infrastructure over the landscape in order to reduce damage and loss from extreme events and climate change. Natural ecosystems can reduce a population's vulnerability to extreme weather and serve as complements or substitutes for investment in 'grey' infrastructure, which may have higher costs. For example, forests and coastal mangroves provide protection against storms, floods, hurricanes and tsunamis.

It is advisable to expand and strengthen fiscal and financial policies that encourage a transition to higher energy and water efficiency, sustainable management of forests and the recognition of the economic value of environmental services, including water cycle regulation and carbon sinks. The region has developed programmes such as the National Forestry Financing Fund in Costa Rica, the Fund for the Conservation of Protected Areas in Belize, the Forestry Incentive Certificate in Panama, the Forestry Incentives Programme and the Programme of Incentives for Small Holders Forest Vocation Land and Agroforestry, both in Guatemala. Further assessments are needed of the benefits and costs of voluntary plans to reduce net deforestation at national and regional levels and options for funding with national and international resources, including a future expanded version of the Clean Development Mechanism, national, regional or international carbon markets, or payments for environmental services. National and regional goals for ecological conservation and sustainable use of ecosystems could be linked to those aimed at improving the quality of life of local populations.

Fiscal sustainability is already a serious concern in the region, and the impact of extreme events is putting further pressure on scarce public resources, even before the increasing effects of climate change and the need for an incentives framework for the transition to low-carbon economies are considered. Extreme climate events affect public finances in various ways: directly through increased emergency and reconstruction expenditures, often involving the need for lines of credit, but also by way of lost fiscal income

owing to economic losses and damages. Such events can also increase the demands for social services and the relocation of populations and economic activities. With little disaster insurance coverage in place, the cost of responding to the needs of affected populations usually falls on limited public financing or international aid. This incomplete list of climate change pressures on public finances suggests that the fiscal impact should be seen as a serious contingent liability, which in the long run will become far less contingent.

Despite the immediate challenges of the current economic crisis, the Ministries of Finance and Central Banks have begun to pay attention to climate change. These institutions have acquired experience in carrying out debt swaps for funding climate change programmes and creating a system to label expenditures on extreme events, and are now developing proposals for national climate change funds, domestic carbon markets, climate change planning requirements in sectoral public programmes and budgets, disaster contingency funds and investment in infrastructure adaptation.

Because climate change involves a market failure, it cannot be treated as the sole responsibility of environmental institutions, but should be seen as a central economic problem with serious fiscal implications. Climate change presents a complex series of multisectoral challenges that will need the proactive response of many stakeholders, including the public and private sectors, civil society organisations, academia, integration institutions and the international community.

D. Final Considerations

Central American countries are increasingly affected by the rising losses and damages of extreme climate events, and policymakers are more concerned about the rising costs of reconstruction and the need to reduce vulnerability. The effect on the frequency, intensity and patterns of extreme events that can be attributed to climate change is a subject of intense research and debate. Better methods of attribution and increasing evidence are regularly reported. In the region, there is clearly a need to strengthen climate monitoring and analysis in order to establish early warning systems, as well as to determine the additional impact of climate change on these events. From an adaptation point of view, it is becoming clearer that the many urgent steps needed to better protect the population, infrastructure and ecosystems from the ravages of current extreme events are also the first steps for climate change adapta-

tion. In the Central American region, these challenges include agricultural production losses due to droughts, intense rainfall and pest infestations, increased incidence of illnesses such as dengue and those related to pollution, location of dwellings and communities in high-risk areas, productive and social infrastructure badly designed for current climate variability, and increased public budget expenditures and debt to pay for post-disaster reconstruction.

Given that climate change affects multiple sectors and aspects of human activity, one of the challenges for public policy is to ensure that it becomes integrated into the agendas of sectoral ministries and other key actors, such as universities, NGOs and chambers of industry. In Central America, it became clear to many Ministers of the Environment that they rapidly had to change the perception about climate change so that it was no longer seen as a purely environmental issue under the remit of their Ministries, but a major economic and social threat with multisectoral and fiscal impacts and so necessarily involving Ministries of Treasury, Public Works, Health, Agriculture and Education, among others. This process has required developing sector-oriented analysis and arguments in the languages of these sectors, as well as a process of dialogue and consensus-building for new policies. Most countries are presently engaged in this process at the national level.

At the same time, it is becoming apparent that each government needs to develop a capacity to maintain an overarching and integrated coordination of response measures. This effort has been made more difficult as many Ministries of Planning have been downsized or closed in recent decades. Different strategies have emerged, such as leadership being taken up by the Environment Ministries or the Presidency or the signing of bilateral agreements between an Environment Ministry and the Ministries of key sectors such as Treasury, Public Works and Agriculture. Most countries have developed overall climate change strategies, which include proposals both for adaptation and mitigation, and have established national climate change committees. Some are constituted mostly within the national public sector, but others have a broader range of participating institutions – for example, in Honduras this committee has contributed to national public policies and encouraged initiatives by NGOs, academic centres and professional associations. Where sectoral ministries assigned technical staff to this committee, they then became focal points for interinstitutional work on different issues or policy drafts.

For many years, mitigation was the centre of concern in international negotiations and finance mechanisms. Less attention has been given to adap-

tation and vulnerability reduction. In addition, adaptation and mitigation are still largely treated as separate issues at the international level. While this approach may be necessary for negotiations and financial support based on the principle of shared but differentiated responsibilities, it is not clear that it is useful for public policies, especially for countries that are emission scenario 'takers' with demanding development agendas and limited budgets. Some sectors, such as agriculture and forestry, are usually identified as being a priority for adaptation and for emissions reductions or increased absorptions. Thus, one of the working hypotheses developed is that public policies should consider both aspects in an integrated manner.

In Central America, most countries started developing their climate change policy discussions prioritising adaptation and risk reduction, and there was an intense debate and different positions regarding mitigation. Currently all countries consider that they can at least do their part to reduce emissions on a voluntary basis. Taking a 'double perspective' has come about in different ways. In the case of Costa Rica, national climate change policy aims at both adaptation and mitigation, while the national development goal to achieve carbon neutrality by 2021 has given impetus to mitigation efforts with a focus on improved productivity. On the other hand, El Salvador first designed programmes focused on adaptation and then identified additional measures or co-benefits in emissions reductions. The country has proposed an 'adaptation-based mitigation' approach for its programme to restore forests and rural landscapes and make agriculture more sustainable.

For countries with limited financial resources, separate adaptation and mitigation policies would probably be fiscally onerous and inefficient in terms of both design and implementation efforts, especially considering the many sectors involved. A process that considers both adaptation and reducing GHG emissions could help to identify not only potential co-benefits, but also possible adverse impacts of a measure relative to another within and across sectors. In this regard, national development goals and sustainability, inclusion and protecting public goods would be important criteria. Potential areas for special attention include food security, energy efficiency and security, safe and efficient public transportation, and protection and restoration of forests, rural landscapes and watersheds.

A major concern for many developing countries is water availability and use. Water availability could be affected by a cascade of climate change impacts, including increased temperature and evapotranspiration, and possible declines in rainfall and in water regulation of ecosystems. Meanwhile

the efficient and just allocation of water is vital for adaptation of these same ecosystems, the population and its economic activities. Thus, reducing climate change is not just about low-carbon economies, but also about water-efficient economies. In the case of Central America, dependency on imported hydrocarbons and vulnerability to fluctuations in international supplies and prices could be reduced by increasing hydroelectric power capacity in the next decades. Nevertheless, designs, watershed management and operating procedures will have to take climate risks into account.

In addition, new hydroelectric projects will need to improve the track record for protecting the environment and benefiting local populations. Thus, the agenda for water is not only about water efficiency but also about ensuring equitable access to this resource for the population and creating effective social mechanisms for negotiating rights and needs between actors with different demands. The effective management of water resources now needs to include not only how to generate electricity, but how best to regulate water reserves in the face of fluctuating flows and extreme events; to protect local populations in the case of emergencies; to preserve ecosystems in the watershed; and to respond to the increased demand for agriculture and human consumption. This is one example of how complex decisions about options for climate change responses are becoming. This example also suggests that there is an opportunity to generate important advances for sustainable and inclusive development.

The essential nature of climate as a common public good has to be addressed by national policymakers and the international community. Although the principle of shared and differentiated responsibilities is established in the United Nations Framework Convention on Climate Change, those societies that are historically responsible for this externality have yet to assume its collective costs, while the negative impacts and costs have been borne by all, and suffered most by other populations that have not benefited to the same extent by its use. Those in the latter group do not necessarily wield the economic and political power needed to ensure that their needs are respected within countries and in the international arena. The cumulative and rising emissions of GHG have generated one of the greatest 'tragedies of the commons'. In economic terms, climate change is an externality whose costs are not fully accounted for in the current economy. Stern[32] considers it to be the greatest negative externality, or failure of market mechanisms,

32 Stern (2007).

that has ever existed. Thus, efforts to 'internalise' the value of climate as a global public good and register its social impact and effects on environmental services are important. In addition, climate change is riddled with complex equity dilemmas. Climate change is a phenomenon of flows and accumulated stocks of GHG over generations. Actions of the past and present generate impacts far into the future. For this reason, climate change has a negative impact on equity among the world´s current population and between it and future generations.

The equity issue and the failure of the market to value our climate as a common public good require ethical decisions far beyond the realm of economics. In the short term, a serious policy discussion is needed about the effectiveness and sustainability of current social security and poverty reduction mechanisms in the light of increased climate-related impacts on already strained fiscal budgets. There must be an explicit consideration of the value assigned to the needs of future generations and to ecosystems. These systems and their biodiversity provide us with multiple environmental services, which we are at an even higher risk of losing, as market signals of their decline will appear too late in the process.

Public sector institutions responsible for economic policy are essential partners in designing climate change responses, including Ministries of Treasury, Trade, Industry and Central Banks. Many of these institutions have a mandate to undertake analyses of longer-term risk and sustainability, although more traditionally in the fields of debt, exchange rates, international reserves, and trade negotiations. Adaptation not only implies responding adequately to the impacts of climate change, but also requires anticipating changes in the global economy, especially the transition to a low-carbon model. This transition could involve measures such as taxes on the carbon content of products and services and the establishment of barriers or tariffs on the carbon content of imports. Small developing countries may encounter both opportunities and threats in this transition. Identifying and taking advantage of the opportunities and counteracting the threats will take time. If left to the last minute, serious trade discontinuities could be encountered.

Finally, in Central America, one key incentive for public policy formulation was the establishment of climate-change-related mandates for national and regional institutions by the Presidents of these countries, leaders of the Central American Integration System (SICA). This agenda was clearly established during their summit on climate change held in May 2008, and then reiterated and broadened in summits in June 2010, November 2011 and June 2012. SICA has sectoral structures which bring together ministers of the

different portfolios, who have the responsibility of responding to the agenda set by their presidents and in which they can discuss strategies with a regional perspective. In some sectors, one or a few ministers have been able to champion climate change concerns and sensitise other colleagues. In addition, many of these structures have technical secretariats and work programmes with the academic community, NGOs, regional and international development agencies and donors. While a few years ago climate change was seen to be the responsibility of the Ministers of Environment and their sectoral integration secretariat, the Ministers of Health and Agriculture, among others, have now established regional programmes of work on potential impacts and policy measures. The Ministries of Environment and Treasury have a joint regional technical committee within the ECCCA Initiative which has provided a forum for developing common analyses and policy proposals.

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