

The logo for EFD (Economics and Environment for Development) features the letters 'E', 'f', and 'D' in a bold, green, sans-serif font. The 'E' and 'D' are significantly larger than the 'f'. The logo is framed by two thick black horizontal bars, one above and one below the text.

Solutions for environment and development
Soluciones para el ambiente y desarrollo

Strategic Research Agenda on Environment for Development

Policy Research Review

Economics and Environment for Development Research Program

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Abbreviations and acronyms

BCIE	Central American Bank for Economic Integration (<i>Banco Centroamericano de Integración Económica</i>)
CAC	Central American Agricultural Council (<i>Consejo Agropecuario Centroamericano</i>)
CBDWO	Community-based drinking water organizations
CC	Climate Change
CCAD	Central American Commission on Environment and Development (<i>Comisión Centroamericana de Ambiente y Desarrollo</i>)
CEPAL	Economic Commission for Latin America and the Caribbean (<i>Comisión Económica para América Latina y el Caribe</i>)
CEPRENAC	Coordination Center for the Prevention of Natural Disasters in Central America (<i>Centro de Coordinación para la Prevención de los Desastres Naturales en América Central</i>)
CO ₂	Carbon dioxide
EbA	Ecosystem-based Adaptation
EEfD	Economics and Environment for Development Research Program
EfD	Environment for Development Initiative
ES	Ecosystem Service
GAM	Great Metropolitan Area (<i>Gran Área Metropolitana</i>)
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	German Federal Enterprise for International Cooperation (<i>Gesellschaft für Internationale Zusammenarbeit</i>)
GWP	Global Water Partnership
IDB	Inter-American Development Bank
IMN	National Meteorological Institute (<i>Instituto Meteorológico Nacional</i>)
INDC	Intended Nationally Determined Contribution
INS	National Insurance Institute (<i>Instituto Nacional de Seguros</i>)
IPCC	Intergovernmental Panel on Climate Change
MAG	Ministry of Agriculture and Livestock (<i>Ministerio de Agricultura y Ganadería</i>)

MPA	Marine Protected Area
MIDEPLAN	Ministry of National Planning and Economic Policy (<i>Ministerio de Planificación Nacional y Política Económica</i>)
MINAE	Ministry of Environment and Energy (<i>Ministerio de Ambiente y Energía</i>)
NAMA	Nationally Appropriate Mitigation Action
NGO	Non-Governmental Organization
OSPESCA	Central America Fisheries and Aquaculture Organization (<i>Organización del Sector Pesquero y Acuícola del Istmo Centroamericano</i>)
PAPCA	Support Plan for Fishing in Central America (<i>Plan de Apoyo a la Pesca en Centroamérica</i>)
PES	Payment for Ecosystem Services
REDD	Reducing Emissions from Deforestation and Forest Degradation
SEPSA	Executive Secretariat of Agricultural Sectoral Planning (<i>Secretaría Ejecutiva de Planificación Sectorial Agropecuaria</i>)
SICA	Central American Integration System (<i>Sistema de Integración Centroamericana</i>)
SINAC	National Conservation Areas System (<i>Sistema Nacional de Áreas de Conservación</i>)
SRA	Strategic Research Agenda
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
USD	United States Dollar
WAVES	Wealth Accounting and the Valuation of Ecosystem Services
WHO	World Health Organization

1. Introduction

The EfD in Central America is an integral part of the thematic Research Program in Economics and Environment for Development (EEfD) of the Tropical Agricultural Research and Higher Education Center (CATIE, by its Spanish acronym)¹. EEfD fosters the encouragement of environmental and economic conditions in the Central American region by improving policy design and increasing the impact of research activities through their alignment with national and regional policy needs. To achieve these regional objectives, the present Strategic Research Agenda on Environment for Development identifies the environmental policy areas that might benefit the most from EEfD research activities² and more generally from research conducted by partners in the region.

1.1 Purpose

This Strategic Research Agenda on Environment for Development seeks to assess the relevance of past and current EfD research on the policy discussions in Central America. This document also identifies areas where the center will direct its research efforts in the future in order to contribute to the policy debate and increase its impact in issues related to development and environment. Finally, this Strategic Research Agenda is also a call for collaboration and partnership with other researchers in the Central American region.

1.2 Identification and definition of prioritized sectors and research topics

Through a strategic literature review of regional and national reports of environmental and development matters, priorities of the Central American policy discussions were identified. In EEfD workshops, priorities were summed up into seven main sectors: climate change; water; land, ecosystems and biodiversity; pollution and transportation; agriculture; renewable energies; and coastal areas.

In addition, interviews were carried out with each of the researchers to identify past, current and future research areas and interests³. These findings were used to assess the policy relevance of EEfD work in Central American policy discussions, as well as how the center can move on to further contribute to the improvement of environmental and economic conditions in the region.

Finally, the Agenda will be discussed with key partners in Costa Rica and Central America, in order to incorporate their perception of urgent research and bring them on board as key players in the knowledge generation sector.

2. Development of the Strategic Research Agenda

The SRA was developed in four main steps. First, a strategic literature review of Central American technical and policy reports was carried out to define prioritized sectors. Second, interviews with each of the EEfD researchers were developed to find out their past, current and future research areas and interests. Afterwards, topics from the interviews were linked to topics from the

¹ For further information on CATIE, go to <https://www.catie.ac.cr/en/>

² For further information on EEfD, visit <http://www.efdinitiative.org/central-america/firstpage>

³ To find out more about the researchers at EEfD and their work, go to <http://www.efdinitiative.org/central-america/people>

prioritized sectors resulting from the strategic literature review. Lastly, past, current and future EEfD research was aligned with national and regional policy needs to see how the center has and still can contribute to policy discussions in Central America. Each of these steps will be next explained in more detail.

First of all, the strategic literature review was limited to a regional and national⁴ assessment of environmental and development reports (see Annex 1 for more detail on the documentation reviewed). These documents had two different natures: they consisted on either technical documents (mostly elaborated by NGOs, and regional and international organizations) or policy documents (mainly written by ministries, and regional and government agencies). As Table 1 shows, a total of 16 policy documents and 17 technical reports were reviewed.

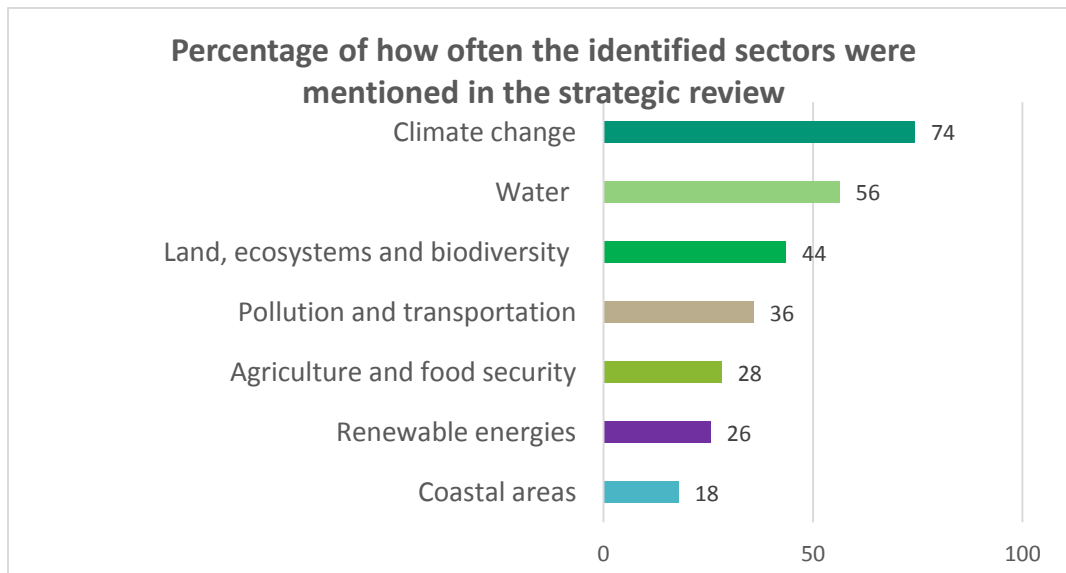
Table 1

Amount of resorted sources		
Type of document	Regional report	National report
Policy documents	6	10
Technical documents	10	7

The information provided by this strategic literature review was systematized into general areas, which were then summed up in seven prioritized sectors through EEfD team workshops. These priorities are broken down according to their relevance (frequency of mention) in Figure 1. The topics of climate change and water represent the main regional concerns, as they are discussed in more than 50% of the documents reviewed. The subjects following in relevance are land, ecosystems and biodiversity (44%), pollution and transportation (36%), agriculture and food security (28%), renewable energies (26%) and coastal areas (18%).

Figure 1

⁴ National documentation was reviewed for the countries of Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica.



In parallel, interviews were held with each EEfD researcher to identify past, current and future research areas and interests. These inquiries were made taking into consideration the prioritized sectors resulting from the strategic literature review.

Then, the prioritized sectors were compared with the areas of work at EEfD. These findings were used to assess the current relevance of the work of EfD in Central American policy discussions, as well as how the center can move on to further contribute to the improvement of environmental and economic conditions in the region.

3. Prioritized sectors

This section summarizes the information provided by the strategic literature review on the seven main sectors of concern. However, many times, topics considered for one sector are intertwined with topics from another sector. The problem of water pollution, for instance, is considered in the sector of “Water”, but also in “Land, ecosystems and biodiversity” and “Pollution and transportation”. Although the approach of the topic varies according to the sector, it represents a concern in several domains and thus, it can be mentioned repeatedly.

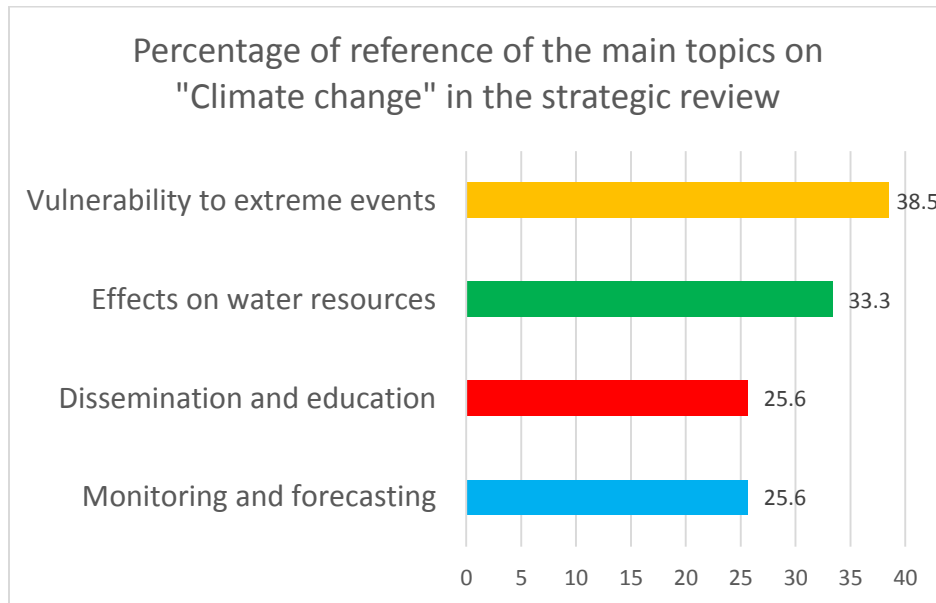
3.1 Climate change

This section describes the main topics covered on “Climate change”, which are: 1) vulnerability to extreme events, 2) effects of climate change on water resources, 3) importance of disseminating and educating the population about climate change, and 4) relevance of weather monitoring and forecasting.

Figure 2 shows the frequency in which these topics are treated in the strategic review. Vulnerability to extreme events represents the main concern, manifested in 39% of the documents reviewed, followed by the issue of the effects of climate change on water resources, raised as a problem in 33% of the reports checked. Dissemination and education of the population about

climate change, and weather monitoring and forecasting are considered regional concerns in 26% of the cases, each.

Figure 2



Vulnerability to extreme events

The main concern of climate change signaled in the literature review is the vulnerability to extreme events faced by livelihoods and other sectors. To put into context, of the 248 events occurred in Central America between 1930 and 2008, 85% corresponded to hydrometeorological events such as floods, tropical storms, mudslides and downpours. The remaining 15% referred to droughts (9%), forest fires (4%) and extreme temperatures (2%) (SICA, 2010).

The vulnerability of the region is also captured in the Global Climate Risk Index⁵, which ranks Honduras as the most vulnerable country in the world to extreme events from 1995 to 2014. Among the top 10 of most affected countries, Nicaragua and Guatemala are also to be found.

When looking at the direct victims of these events, poor and socially excluded households appear as the most vulnerable. Rural livelihoods face more danger, though urban areas are also exposed. Causes for this vulnerability identified in the literature are *the location of dwellings in high slope and flood risk areas, urban and rural environmental degradation, and structural bad practices and lack of controls in construction, productive specialization processes and countryside's land use change* (Programa Estado de la Nación, 2011, p. 389). Therefore, neighborhoods built in threatened zones have been relocated or, in the worst scenarios, have disappeared because of the occurrence of hydrometeorological events (IDB, 2006). The rise of social tensions for the use of the

⁵ This index is elaborated by the organization Germanwatch. It indicates the exposure and vulnerability to extreme events faced by the countries. This index should be understood as a preparation warning for more frequent and/or more severe events in the future.

resources, lack of rural governance, and massive migrations in search of refuge and better life conditions, usually to urban and peri-urban areas, are also named as direct consequences (Programa Estado de la Nación, 2011).

In addition, several sectors relevant for the economy of the region are affected because of this vulnerability to extreme events. The energy, agriculture and tourism sectors are signaled as the ones facing more risk because of the loss of (productive) infrastructure and crops, as well as landscape change (SICA, 2014; SICA, 2010).

The economic impact of eleven regional extreme climatic events has been assessed by the Economic Commission for Latin America and the Caribbean (CEPAL, 2011). According to the institution, these events led to economic losses estimated in \$13.6 billion⁶. Hurricane Mitch, in 1998, was the event that caused major losses (\$8000 million, equivalent to 58.2% of the total losses), followed by hurricane Joan in 1988 (\$1400 million, equivalent to 10.4% of the total losses) and tropical storm Stan in 2005 (\$1300 million, equivalent to 10.0% of the total losses). The most affected countries in terms of economic losses were Honduras (\$5600 million, equivalent to 41% of the total losses), Nicaragua (\$4500 million, equivalent to 33% of the total losses), and Guatemala (\$2200 million, equivalent to 16% of the total losses).

Vision of prevention and adaptation measures plays, thus, key roles to face extreme events (SICA, 2010). Recommended policies are the promotion of ecosystems' restoration, the development of sustainable landscapes, and the implementation of the approach of losses and harms associated to adverse climate effects in the policies (SICA, 2014).

Effects of climate change on water resources

Water is the channel through which most effects of climate change are evident. Therefore, although many natural resources and productive sectors are identified as victims of climate change, water resources are probably the most frequently mentioned. This section focuses on the concerns expressed related to the resource, such as water availability, and the consequences it implies, such as impacts on forests and agriculture.

Despite Central America being a privileged region in terms of water availability, water distribution between the countries, regions and Pacific and Atlantic watersheds is not homogenous (Programa Estado de la Nación, 2011). Under the context of climate change, with periods of high intensity rain and floods and periods of drought, the worry of unequal distribution is even more exacerbated (CEPAL, 2011). Temperature, evaporation and rainfall changes reduce streamflow and water availability, which creates water supply shortages. According to the IPCC (2014, p. 1521), *the Central American region shows a consistent future runoff reduction and future climate projections imply a reduction of 20% in inflows to major reservoirs*. The increase in the population, which rises water demand, and the vulnerability of water infrastructure to climate change also put at risk water availability (SICA, 2010). El Salvador, Honduras and Nicaragua are the countries in which water resources will be more harm (Programa Estado de la Nación, 2011).

⁶ Estimations are in values of 2008.

In addition, climate change detours water resources in an indirect way, as it affects ecosystems that process water such as forests, biodiversity and soils (SICA, UICN and GWP, 2002). Forest degradation, conversion of natural ecosystems and soil erosion enhance the already existing water stress (IPCC, 2014).

Regarding human life activities, the agricultural sector is recognized as the most affected by water problems, particularly because Central America is a very agricultural region and water is essential for crops' irrigation. According to the SICA, UICN and GWP (2002), the production of rice and beans, unmissable foods in the Central American diet, will decrease 27% and 66% in Guatemala, respectively. The loss of lands due to floods and mudslides is another consequence affecting this sector as well as others (SICA, UICN and GWP, 2002). Public health and the energy sector, mostly because of hydropower generation, will be also affected because of the reduction in water availability due to climate change (IPCC, 2014; SICA, UICN and GWP, 2002).

Identified solutions and adaptation measures include the implementation of a regional strategy for integrated management of water resources, such as joint watershed management (SICA, 2010). The promotion of good practices for the efficiency of water use and the management of water-supplier ecosystems also represent relevant measures. However, all of these strategies have to go hand in hand with constitutional and legal reforms, and coordination (IPCC, 2014).

Dissemination and education

The need to disseminate and educate the inhabitants about climate change is manifested as a regional concern. The Climate Change Regional Strategy from SICA (2010) states it as a strategic priority in Central America, suggesting the introduction of the topic in elementary, high school and university educational programs. Other recommended measures are information dissemination in massive social media, and the elaboration of workshops to exchange experiences and elaborate joint regional proposals for adaptation and mitigation to climate change.

CEPAL (2015) also perceives education as a facilitator to foster an inclusive and sustainable adaptation to climate change, especially for the topic of disaster prevention. Awareness about the eventual risks of climate change involves community organization and education, local reaction and communities' relocation plans, creation of refuges and emergency deposits, and construction of safe dwellings.

Monitoring and forecasting

Strengthening weather monitoring and forecasting has been stressed as a need in regional reports. As in the case of education and dissemination about climate change, monitoring and forecasting have been described as relevant tasks to reduce risk vulnerability. According to CEPREDENAC (2011), these tools will help to comprehend risk and anticipate the magnitude and probability of natural threats. These actions will allow making better-informed decisions when formulating or evaluating investment projects.

The monitoring and forecasting can be also sector-oriented. For example, opportune forecasting allows farmers to be aware of changes in the productive cycles or the intensity of plagues in different seasons (CEPAL, 2011). In the case of water resources, research and monitoring of biophysical and social characteristics permits the elaboration of hydrological balances, which at its time serves a guidance to foresee water availability (SICA, UICN and GWP, 2002).

Box 1. Costa Rica's INDCs

The Intended Nationally Determined Contributions (INDCs) represent the effort each country is willing to commit to build a new climate regime past 2020, based on their capacity and reality. In the case of Costa Rica, its INDCs were presented under the United Nations Framework Convention for Climate Change and define the country's commitment to climate action from 2016 until the year 2030. The measures proposed can be differentiated into mitigation and adaptation measures, where experimentation will be a key component as the country "*is looking into becoming a laboratory for the world's economy de-carbonization process, working with civil society, the private sector, academia, and the international community in order to accomplish it*" (MINAE, 2015, p.2). The following segment hints at the main national concerns and describes how the country pretends to tackle them.

Mitigation

Costa Rica makes two main commitments to contribute to climate change mitigation. Firstly, the country aspires to become a Carbon Neutral economy by the year 2021, understood as having total net emissions equal to those in 2005. Then, it commits to *generate a maximum of 9,374,000 T CO_{2eq} net emissions by 2030, with proposed emissions per capita of 1.73 net tons by 2030, 1.19 Net Tons per Capita by 2050 and -0.27 Net Tons per Capita by 2100* (MINAE, 2015, p.3).

To accomplish these goals, Costa Rica's INDCs propose four broad policy options:

1. Reducing energy demand and GHG emissions
2. Decarbonizing energy supply (electricity, liquids, gases)
3. Fuel switching in end-uses (buildings, transport, industry)
4. Enhancing carbon sinks

The identified prioritized sectors are, thus, Transportation and Energy, followed by Agriculture and Solid Waste. Pilot actions, such as NAMAs and Low Carbon Sector Strategies, are proposed among the possible practices to reduce the emissions generated by the sectors previously mentioned. The implementation of a national REDD strategy is also considered.

Adaptation

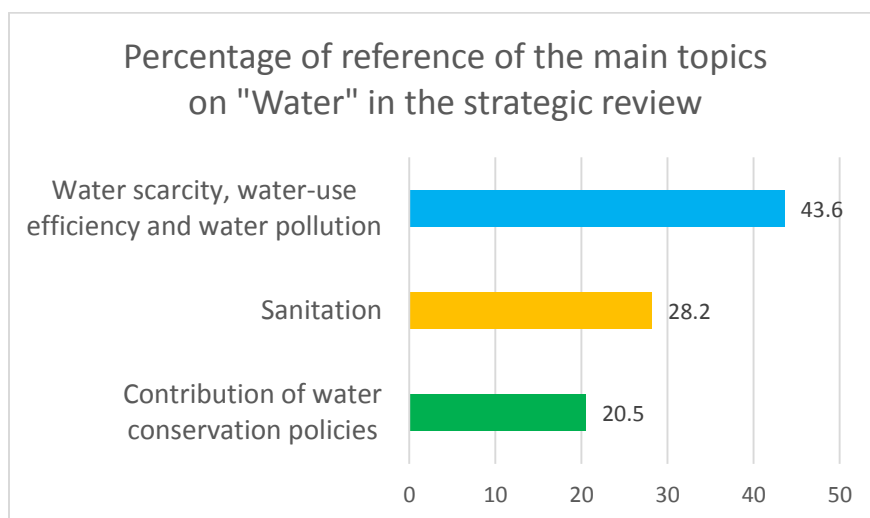
Costa Rica distinguishes two main sectors, where adaptation measures are needed: Water Resources and Agriculture. Actions for these sectors will be carried out with an Ecosystem-based Adaptation focus, for which a National Ecosystem-based Adaptation Strategy will be launched. Other relevant aspects considered are disaster risk reduction, local planning and management of territory, public infrastructure, environmental health, and capacity building and technology transfer.

A commitment made by the government in the INDCs is to conclude the National Adaptation Plan by 2018. This Plan will combine a sectoral and territorial focus, while giving priority to at least ten sectors (Biodiversity, Agriculture, Water, Coastline, Fishery, Health, Infrastructure, Energy, Tourism, and Cities). It also takes on the commitment to find sustainable financial sources to implement the proposed actions.

3.2 Water

This section points out the main topics covered on “Water”, which are: 1) water scarcity, water-use efficiency and water pollution, 2) sanitation, and 3) contribution of water conservation policies. Figure 3 shows the frequency in which these topics are treated in the strategic review. Water scarcity, water pollution and water-use efficiency are the main concerns, manifested in 44% of the documents reviewed, followed by the issues of sanitation (28%) and the contribution of water conservation policies (21%).

Figure 3



Concerns around water resources have been addressed from two main perspectives in the literature review. The first approach considers water in its broad spectrum and as a national sector of relevance, while the second one focuses on the resource under a climate change context. Therefore, although both perspectives address similar issues of the sector, such as water availability and the contribution of conservation policies, they tackle them from different perspectives. For example, water scarcity is analyzed as a consequence of water use inefficiency and water pollution, but also as a result of climate change.

Despite the difficulty of separating these two perspectives, the following section focuses on the first perspective, the one that considers water as an independent sector and the implications it has at national and regional levels. The section of “Climate change” addresses water resources under the context of climate change.

Water scarcity, water-use efficiency and water pollution

Water scarcity, water pollution and water use-efficiency represent concerns on the subject of water resources in Central America. These issues are interrelated, as the first can be a consequence of the two others. When water is polluted and it is not efficiently used, much of it turns unavailable, deriving in scarcity. Water scarcity and water pollution can have severe impacts on public health, economic activities and energy generation (CEPAL, 2011; Programa Estado de la Nación, 2011).

Although Central America is a privileged region in terms of water availability, its uneven distribution due to its latitudinal position and topographic variations along the territory makes water lack in many areas of the region (SICA, 2014; CEPAL, 2011). However, scarcity is not only a consequence of the Central American biophysical characteristics or climate change (mentioned in the previous section), but it is also a result of human activities. Land use changes, urban dynamics and riverbeds' alterations are examples of practices leading to unsustainable water uses (Programa Estado de la Nación, 2011; SICA, 2008).

Another main reason to explain the apparent water abundance-though relative scarcity in Central America, is the lack of water storage infrastructure (Programa Estado de la Nación, 2011). Investments in this department are necessary for sustainable water provision and consumption (UNEP, 2012). Currently, required investments in drinkable water and sanitation infrastructure are uneven between the Central American countries, with the IDB estimating a total amount of USD \$6.543 million in the region.

A regional strategy for integrated water resources management has been proposed as a way to promote a more sustainable water use (SICA, 2014). This measure will also help to battle the disparities in water availability between rural and urban areas (GWP, 2011). In Costa Rica, the Ecological Blue Flag is a successful program that has been taking care of environmental quality, where water is an important component (Programa Estado de la Nación, 2013).

The issue of water pollution is related to water scarcity, since pollution of the resource reduces its availability for consumption. Sewage mismanagement and poor regulations in productive activities, mostly agriculture, result in water pollution (Programa Estado de la Nación, 2011; SICA, 2008). In Costa Rica, for instance, water resources for human consumption have been found with insecticide's residues coming from pineapple plantations (Programa Estado de la Nación, 2013). Also, in 2012, the presence of arsenic in communal aqueducts affected at least 12,000 people in 23 Costa Rican communities. Prolonged exposure to this chemical has been proven to cause cancer and cutaneous injuries (Programa Estado de la Nación, 2014, 2013).

In addition, inefficient water use and low productivity among its different uses might also explain the resource's scarcity⁷ (Programa Estado de la Nación, 2011). According to UNEP (2012, p. 326), *"in areas where resources are heavily exploited, improved water-use efficiency is urgently needed through technological developments and by applying traditional and scientific knowledge. This fosters measures to adapt to climate change as well as reducing costs for water users"*. Measures to improve water-use efficiency can be the control of unaccounted water at the grid level;

⁷ According to the Programa Estado de la Nación (2011, p. 369), CEPAL estimates that *"only 40% of the water extracted for irrigation purposes goes to its final destination"*.

installation of water-saving appliances, reuse and recycling systems, rainwater harvesting and water-saving irrigation systems; groundwater recharge; and desalination (UNEP, 2012).

Sanitation

Sanitation is another concern at regional level, mainly related to health. The Guatemalan and Honduran poverty reduction strategies state that access to basic services, sanitation being one of them, *“would not only directly increase well-being, but it will also help reduce the incidence of diseases, such as diarrhea and, thus, contribute to reduce mortality and malnutrition”* (Gobierno de la República de Guatemala, 2001, p. 34).

In addition, sanitation is an important environmental concern, especially in urban areas, as it relates to the deposition of sewage and the management of domestic and industrial liquid residues (UNEP and CCAD, 2005). According to the Programa Estado de la Nación (2011) and based on estimations from the CEPAL, access to sanitation varies along Central America: 52% of the population has it in Nicaragua, 71% in Honduras, more than 80% in Guatemala and El Salvador, and 95% in Costa Rica. However, GWP states that 60% of the provision of water and sanitation services in the region is deficient (GWP, 2011).

Solutions consist on an increase in investment, which is described as being cost effective in terms of the ration between public cost and health benefits (UNEP, 2012). UNEP argues in its 5th Global Environmental Outlook report that the economic benefits from investing in sanitation can range from US\$3 to US\$34 for each US\$1 invested. *Household treatment, such as disinfecting water for drinking and food preparation, can pay back up to US\$60 for every US\$1 invested, while cutting the primary transmission route for diarrheal disease* (UNEP, 2012, p. 327).

Contribution of water conservation policies

The Programa Estado de la Nación (2011) states that two of the main risks faced by the water sector in Central America are the environment’s transformation and the high deforestation rates, caused mainly by agricultural activities, traffic of exotic timber and electricity generation. Therefore, policies encouraging conservation and restoration of water- supplying ecosystems, such as water-generating forests, aquifers, wetlands, mangroves and reefs, become crucial to deal with the issue (UNEP, 2012; SICA, UICN and GWP, 2002). SICA (2008) proposes the implementation conservation measures at different levels, such as watershed, plantation and farm levels. Other suggestions are the elaboration of National Water Plans and General Water Laws, where water conservation is taken into account (SICA, UICN and GWP, 2002).

In this regard, the biosphere reserve of the Minas’ mountain chain in Guatemala sets an example. This reserve was established with the aim of protecting ecosystems and water resources in the area. Downwards from the basin, water is an essential resource for different uses and sectors, such as domestic consumption, energy generation, the bottled water industry, agriculture, livestock, tourism, recreation and trade (UNEP and CCAD, 2005).

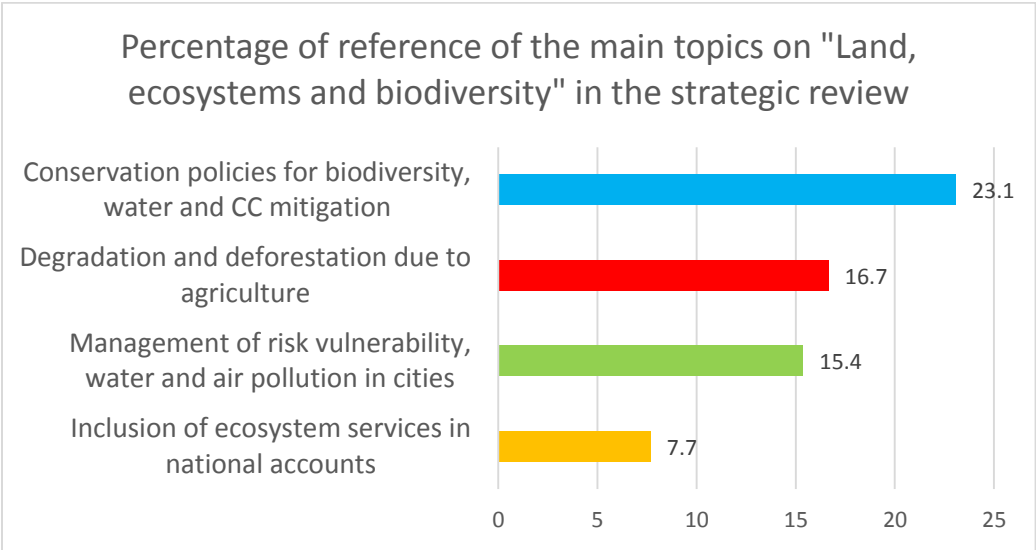
International watersheds represent a large proportion of the surface of Central American countries: they cover 75% of the area in Guatemala, while in El Salvador they do so for 59% of the land, in Nicaragua is 37%, in Costa Rica is 35%, and in Honduras is 22% (SICA, 2008). The highest parts of these catchment areas are very important for the countries, as they contain the main sources of drinkable, irrigation and groundwater in the region (SICA, 2008). Therefore, current implementation of joint watershed management plans becomes a positive step towards conservation of water resources (Programa Estado de la Nación, 2011).

3.3 Land, ecosystems and biodiversity

This section points out the main topics covered on “Land, ecosystems and biodiversity”, which are: 1) conservation policies for biodiversity, water and climate change mitigation, 2) degradation and deforestation due to agriculture, 3) management of risk vulnerability, water and air pollution within cities, and 4) inclusion of ecosystem services in national accounts.

Figure 4 shows the frequency in which these topics appeared within the documents reviewed. The topic of conservation policies as an instrument to protect biodiversity, water and climate change mitigation is discussed in 23% of the documents reviewed. It is followed by degradation and deforestation due to subsistence activities and high value crops, and risk vulnerability, water and air quality within cities, with 17% and 15%, respectively. These topics are mostly discussed at national levels in the countries of Guatemala, Honduras and Costa Rica. Lastly, the inclusion of ecosystem services in national accounts is a recent topic of discussion in Costa Rica, considered in 8% of the reports reviewed.

Figure 4



Conservation policies as an instrument to protect biodiversity, water and CC mitigation

Conservation policies for biodiversity and water protection are a relevant topic in the Central American literature (SICA, 2014, 2009 and 2008; UNEP, 2012; Programa Estado de la Nación, 2011), though these policies have been generally late implemented in these countries (UNEP and CCAD, 2005). However, according to the Programa Estado de la Nación (2011) there have been recent changes in the legislation that are stimulating protection actions, while hindering the expansion of the agricultural frontier.

A large part of the Central American conservation measures focuses on the subjects of protected areas and biological corridors as tools for biodiversity conservation. An example of this type of initiative is the creation of the Mesoamerican Biological Corridor in 1997, which includes the countries of Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Belize, Panama, and four states in the South- Southeast region of Mexico.

Nevertheless, according to UNEP (2012), there is a need to increase and expand protected areas, improve their management and create greater connectivity between them. Co-benefits of these measures besides the environmental improvements related to national gross domestic product (GDP) growth, equity improvement, poverty alleviation, and empowerment of women, communities and indigenous people.

Water scarcity is another issue that can be tackled through the implementation of conservation measures fostering forest protection and soils regeneration, as mentioned previously. Initiatives promoting technological innovation focused on sustainable water use and management may include soils management practices at different levels, such as watershed or farm levels (SICA, 2008).

Lastly, forests conservation has been often cited as a mechanism for climate change mitigation (SICA, 2014; Programa Estado de la Nación, 2011). In this regard, the implementation of Payment for Ecosystem Services (PES) programs has been discussed and used in the area, where Latin America has become a worldwide pioneer (UNEP, 2012; Programa Estado de la Nación, 2011). PES are said to generate co- benefits, such as biodiversity gain, poverty reduction, employment increase, and water provision and purification (UNEP, 2012).

Deforestation and land degradation due to agriculture

Deforestation and land degradation are concerns often mentioned in the Central American literature (SICA, 2014, 2009, 2008; Programa Estado de la Nación, 2011). Different causes have been identified to explain increases in their rates, such as urban development (IDB, 2006). However, the Honduran and Guatemalan poverty strategies have raised the issue as a direct consequence of subsistence activities related to farming, location of food crops, farming technologies (slash and burn, swidden), and fuelwood use for cooking (Gobierno de la República de Guatemala, 2001; República de Honduras, 2001).

In Costa Rica, high value crops such as pineapple or African palm are the origin of this environmental problem (MIDEPLAN, 2015). Some characteristics of these crops are that they are

monocultures and demand the application of a high level of agrochemicals (Programa Estado de la Nación, 2011).

As a result of the current deforestation and land degradation rates in Central America, the vulnerability of the region to climate change increases (SICA, 2014, 2009; Programa Estado de la Nación, 2011). This situation fosters biodiversity loss and is detrimental to agricultural productivity (SICA, 2008). Therefore, and many times as part of the initiatives to battle climate change, Central American countries are implementing strategies such as REDD (WAVES, 2015; SICA, 2008).

Management of risk vulnerability, water and air pollution in cities

The problems of risk vulnerability, and water and air quality within cities have been highlighted in the regional literature, particularly emphasized in the Costa Rican reports. Regional vulnerability to natural threats is said to have increased in the last two decades (IDB, 2006). Events, such as the Mitch hurricane in 1998, have led to the loss of millions of lives. Most at risk people are the poorest population, inhabiting peri-urban areas (Programa Estado de la Nación, 2011). Identified causes are fast population growth and the occupation of unsuitable areas for urban development, generated by an increase in the migration to urban zones and the consecutive infrastructure endowment in these areas (Programa Estado de la Nación, 2011). Thus, regional authorities are working on the introduction of integrated risk management practices. Changes in policies and urban development strategies seek to avoid the construction of dwellings in unsafe places (CEPRENAC, 2011).

The loss of water and air quality in the cities also represents a regional concern. On the one hand, poor water quality in urban spaces has caused health problems and an increase in household's expenditures, which have to look for other drinkable water sources. This problem is directly associated with the growing deforestation and forest degradation rates around water sources, linked with unplanned development in urban areas (SICA, 2009). The Programa Estado de la Nación (2011) highlights the problem as a matter of urgency calling for regional joint action. A positive example in this regard is the current implementation of an integrated management plan for joint watersheds in the region.

The relationship between risk vulnerability and poor water quality within cities has also been stated in some Costa Rican reports. There, land use change caused by the increase in the number of dwellings, many times in unsuitable areas, has derived in the deterioration and depletion of natural resources such as water (MIDEPLAN, 2015). In addition, the sewage system has not been able to keep up with the cities' population growth, resulting in public health problems (Programa Estado de la Nación, 2011). To face these challenges, the Costa Rican government has reconsidered the elaboration of a management plan for the Great Metropolitan Area, in which risk management is a matter of key relevance (INVU, 2013).

On the other hand, the quantity and variety of air pollutants have accentuated in the last decade in Central America. Respiratory and cardiovascular health problems have been signaled as consequences, deriving in mortality sometimes (IDB, 2006). The biggest responsible for this situation is the transportation sector, not only because of the main source of fuel used (oil), but

also because of the growing and aging fleet. Industries, waste burning and the use of polluting fuels in households also increase the problem (IDB, 2006).

Inclusion of ecosystem services in national accounts

The relevance of ecosystem services (ES) and the need to include them in the system of national accounts are two topics brought up in the Central American literature (SICA, 2008). It is only in the cases of Costa Rica and Guatemala however, and as a part of the WAVES⁸ framework, that the issue is being implemented.

Water, soils, forests and biodiversity are natural assets that generate numerous environmental, economic and social benefits such as clean air and timber (WAVES, 2015). The idea of including and standardizing these values in the system of national accounts is to produce comparable international statistics that reflect the relationship between environment and economy (Programa Estado de la Nación, 2014).

In Costa Rica, national accounts on water and forests have been defined as priority policy areas for environmental accounting support. On the one hand, degradation of watersheds, mostly due to pollution, and unsustainable use of water resources are being highlighted as main concerns in the country (WAVES, 2015). The water account pretends to organize the hydrological and economic information, such as stocks and flows of water resources. The final goal is to contribute to the creation of the National Plan for Integrated Management of Water Resources.

On the other hand, there is a national need of recognizing the value and importance of forests to other sectors of the economy, even though forests have the highest coverage of land use in Costa Rica. This account pretends thus to estimate the generated externalities, such as protection of biodiversity and provision of water for human consumption (Estado de la Nación, 2013).

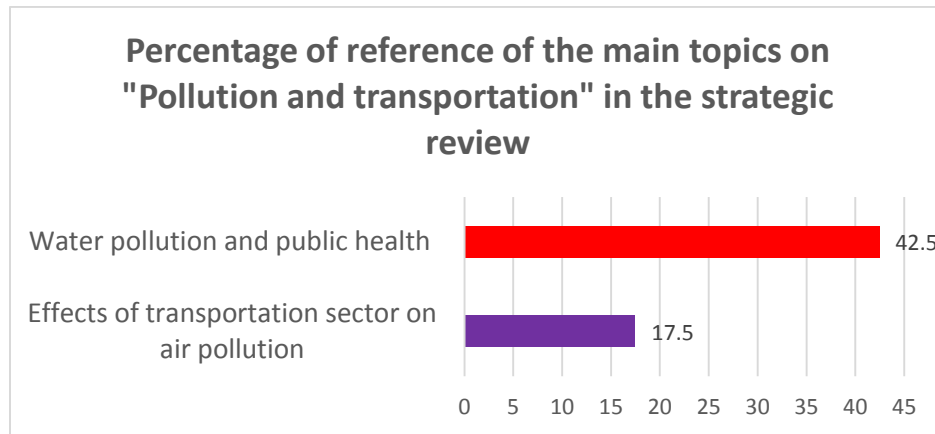
3.4 Pollution and transportation

This section points out the main topics covered on “Pollution and transportation”, which are: 1) effects of the use of agrochemicals and liquid and solid waste disposal on water pollution and public health, and 2) effects of the transportation sector on air pollution.

Figure 5 shows the frequency in which these topics are treated in the strategic review. The topic of water pollution and public health is discussed in 43% of the documents reviewed. Its relevance is regional, though it represents a particular concern in Costa Rica, Honduras and Nicaragua. This topic is followed by the problem of effects of the transportation sector on air pollution, considered in 18% of the reports.

⁸ WAVES is a World Bank-led global partnership that aims to promote sustainable development by ensuring that natural resources are mainstreamed in development planning and national economic accounts. Currently, the initiative counts on eight core implementing country partners (one of them being Costa Rica), which have begun implementing natural capital accounting (WAVES, 2015).

Figure 5



Water pollution and public health

The intensive and mismanaged use of agrochemicals in agriculture and the poor disposal of liquid and solid waste are affecting water sources, public health and marine biodiversity in Central America (SICA, 2008). According to GWP (2011), the increase in the population is generating high pressure on water sources and resulting in untreated or inadequately treated wastewater, affecting the quality of the water bodies in Central America. The lack of efficacy of the prevalent norms and institutions, as well as the intensive use of fertilizers and pesticides in the agricultural sector are also affecting air, water and soil quality in Central America (SICA, 2009). In this regard, UNEP and CCAD (2005) identified “drinkable water and sanitation”, as well as “health and environment” as areas of main concern in the region.

- Pollution of point and diffuse water sources

The concern of pollution of point water sources as a result of poor disposal of liquid and solid waste is manifested at a regional scale (Programa Estado de la Nación, 2011). This problem is mainly attributed to the industrial and residential sectors. According to the Central American Integration System, less than 25% of the domestic and industrial liquid residues in the region receive treatment. As a consequence, 75% of the superficial water sources are in a vulnerable state (SICA, 2009).

This problem is also raised at national levels. Nicaragua’s poverty strategy, for instance, mentions the issue of water pollution very briefly (Gobierno de Nicaragua, 2011). The Honduran poverty strategy addresses the subject more in depth. In this case, authorities declare that water resources are the main recipient of the country’s environmental problem, as a result of an increasing population migrating to urban centers, the lack of territorial planning and management, and poor sanitation infrastructure (República de Honduras, 2001).

Costa Rica is not exempt from this problem (MIDEPLAN, 2015; INVU, 2013). According to GWP (2011), this country treats only 30% of its sewage, while the rest is disposed in the water bodies without any treatment. Therefore, superficial water bodies are generally polluted (Programa Estado de la Nación, 2014). This inadequate disposal of sewage has caused a fall in the country’s

ranking in the Environmental Performance Index created by the Yale University, going from being at the 5th place to the 54th (Programa Estado de la Nación, 2015). The lack or low investment made on public infrastructure, such as sanitation and wastewater treatment systems, may explain the prevalence of this issue in Costa Rica (GIZ, 2015). However, a national goal for 2030, which is in line with the Sustainable Development Goals, is to reduce by half the proportion of untreated wastewater (MIDEPLAN, 2015).

Though water pollution in the region is a consequence of inadequate disposal of liquid and solid waste, the agricultural activity has also some participation in it. Presence of agrochemicals and fertilizers has been found in diffuse water sources in different countries (MIDEPLAN, 2015; Government of Honduras, 2001). For example, in the case of Costa Rica, rests of pesticides have been detected in aquifers, wells and springs near coffee, rice, sugar cane and African palm plantations (Programa Estado de la Nación, 2014).

- Public health

The use of agrochemicals and the poor disposal of liquid and solid waste also affect public health, mostly because of water pollution. For example, GWP (2011) states that gastrointestinal diseases represent one of the ten main death causes in El Salvador. Despite a direct causation has not been proved, this problem could be linked to the fact that nearly 80% of the main superficial water sources in the country do not fulfill the requirements for human consumption because of its pollution levels. Also, in Honduras and Nicaragua, diarrhea as a consequence of polluted water consumption, represent one of the main infant mortality and morbidity causes (UNEP and CCAD, 2005).

In a similar note, water pollution is representing a concern on public health in Costa Rica (Programa Estado de la Nación, 2011). 24% of the households consume water that has not been subjected to control programs, while pathologies associated with water pollution have increased within the last years (Programa Estado de la Nación, 2014). Cases of diarrhea actually represent the second disease of obligatory declaration in the country (Programa Estado de la Nación, 2014).

Similarly, intoxications due to insecticides in Costa Rica have risen from 300 annual cases in 1990 to 800 in 1996 (UNEP and CCAD, 2005), occurring mostly near banana plantations.

- Suggested solutions to be implemented

Since wastewater and solid waste treatment and the use of agrochemicals is considered a problem in Central America because of its effects on water pollution and public health, some regional and national entities have suggested possible measures to battle them.

From the wastewater and solid waste perspective, an integrated water management plan is proposed. This plan encompasses ecosystem protection and waste management (UNEP, 2012). Regional policies include the creation of the Regional Program for the Prevention and Control of Environmental Pollution and the regional strategy of Integrated Management of Solid Waste (SICA, 2009). Priority actions are the prevention, control and treatment of wastewater (with particular emphasis on the ones coming from touristic, residential, industrial, agricultural and mining activities), and the management, collection, transportation, treatment and disposal of domestic, industrial and hospital solid waste (UNEP and CCAD, 2005).

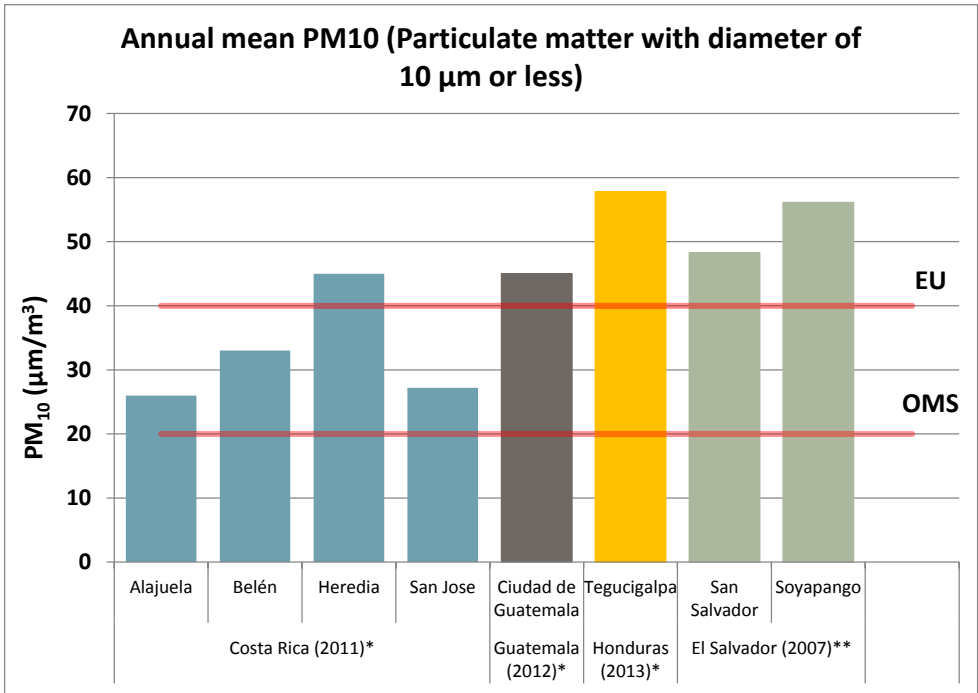
In regard with the use of agrochemicals, SICA (2008) suggests the implementation of technological improvements in order to rationalize, reduce and substitute the use of insecticides, as well as to avoid the use of persistent organic pollutants. Energy generation from solid waste, coming mainly from the agricultural sector, is also proposed.

At national scales, the governments of Nicaragua and El Salvador promote the collection and reuse of solid waste, while pointing out the relevance of the role played by municipalities in this part (Government of Nicaragua, 2011; Government of Honduras, 2001). In the case of Costa Rica, investments have been made in the areas of catchment, treatment and disposal of wastewater; however, the benefited population remains too small (Programa Estado de la Nación, 2015). In this regard, the idea of incorporating water resources in the national accounts can allow for a monetary calculation of the damages suffered by aquifers because of the use of agrochemicals, demographic and urban pressures, and poor sanitation (Estado de la Nación, 2014).

Effects of the transportation sector on air pollution

Concerns around the transportation sector are manifested at a regional scale, though they are mostly expressed in Costa Rican documents. At the Central American level, air pollution in urban areas has increased since the second half of the XXth century and it is partly attributed to the transportation sector, mainly because of the expansion of its infrastructure (UNEP and CCAD, 2005). Figure 6 shows the annual mean of PM₁₀ concentrations in main cities Costa Rica, Guatemala, Nicaragua and Honduras. This pollution is physical (noise, radiations), as well as chemical (emissions of chemical particles to the air and atmosphere) (UNEP and CCAD, 2005).

Figure 6



Source: *WHO (2014), **WHO (2011)

In the Costa Rican case, the vehicle fleet has experienced an accelerated increase (MIDEPLAN, 2015). This growth is very much due to the exponential increase in the number of private cars⁹, which at its time is a direct result of the lack of investments in public transport since the country's economic crisis of the 1980s (GIZ, 2015). Other characteristics of the Costa Rican vehicle fleet include its ageing (cars that are more than 15 years old) and a disintegrated public transportation system, which “forces” people to rely on their own transportation source (MIDEPLAN, 2015).

In addition, more than two thirds of the total energy consumed in the country comes from fossil fuels, 67% of which is used by the transport sector (MIDEPLAN, 2015). This sector becomes, thus, the largest emitting one, accounting for 80% of Costa Rica's GHG net emissions in 2010 (GIZ, 2015). Therefore, increases in the atmospheric and acoustic pollution, currently exceeding WHO targets, result as the main consequences in the Greater Metropolitan Area (GIZ, 2015; INVU, 2013).

Lastly, the high level of emissions coming from this sector represent a worry and a possible constraint for the country, as it has set the goal of becoming carbon neutral by 2021 (GIZ, 2015).

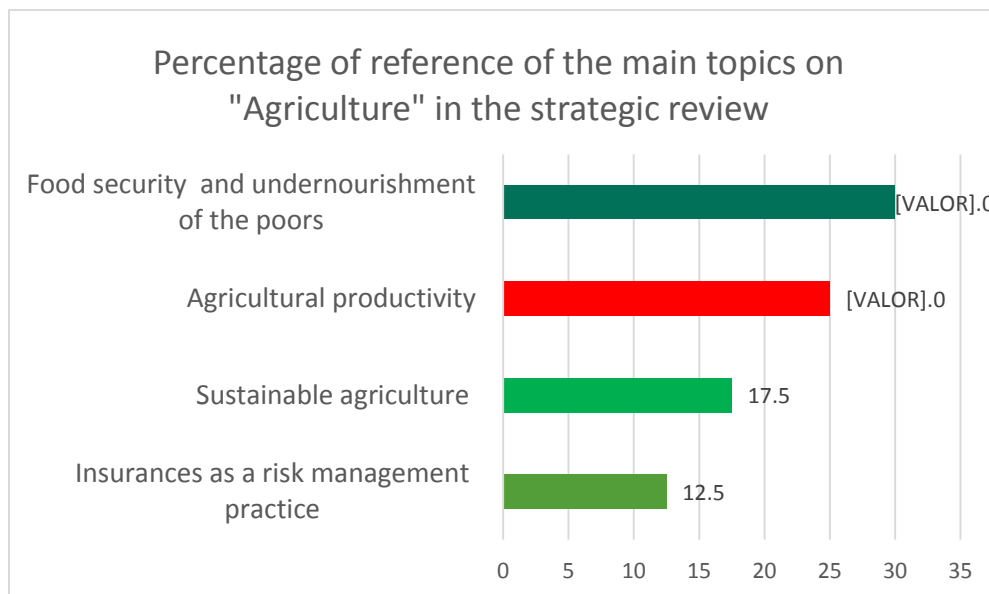
3.5 Agriculture

This section points out the main topics covered on “Agriculture” in the literature review, which are: 1) food security and undernourishment of the poor, 2) agricultural productivity, 3) sustainable agriculture, and 4) agricultural insurances as a risk management practice.

Figure 7 shows the frequency in which these topics are treated in the strategic review. The topic of food security and undernourishment of the poor is discussed in 30% of the documents reviewed. This topic is followed by agricultural productivity, considered in 25% of the reports. The implementation of sustainable agricultural practices and of agricultural insurances as a risk management practice is also mentioned in 18% and 13% of the documents checked, respectively.

Figure 7

⁹ The German Federal Enterprise for International Cooperation cites a report from the World Bank, which states that between 2000 and 2011, the number of private cars in Costa Rica rose from 87 to 145 per 1,000 people. These data can be compared to 137 private cars per 1,000 inhabitants in Chile in 2011, and 102 in Panama and 38 in Guatemala (GIZ, 2015).



Concerns around agriculture are regional but also national, as the topic is mentioned in Guatemalan, Honduran, Nicaraguan and Costa Rican literature. Agriculture is considered a relevant economic activity and tool for development in the region, because of its contribution to the GDP and the generation of employment, among other reasons (SICA, 2008).

In addition, the topic of agriculture is approached in all of the national poverty reduction strategies¹⁰ (CAC, 2007). In the case of Guatemala, for instance, agriculture is the main source of employment of the poor, employing 57% of the labor force (Gobierno de la República Guatemala, 2001). In Honduras, dwellings where household heads are farmers, receive 30% less *per capita* income than those dwellings where household heads work in construction, transportation or the commercial sector (República de Honduras, 2001).

Lastly, the sector of agriculture has been addressed from two main perspectives in the literature review. The first approach considers agriculture in its broad spectrum and as a national sector of relevance, while the second one focuses on agriculture under a climate change context. Therefore, although both perspectives address similar issues of the sector, such as food security and economic dynamics of the activity, they tackle them from different perspectives. For example, food security is analyzed as a key component of the poverty reduction strategies, but also as an area of concern because of the impacts of climate change.

Despite the difficulty of separating these two perspectives, this section focuses on the first perspective, the one that considers agriculture as an independent sector and the implications it

¹⁰ The only poverty reduction strategy that does not directly contemplate farmers is the Costa Rican one. In this case, the document only refers to the population ““working on its own”, although it points out the relevance of employment and access to basic infrastructure for the poors (IMAS, 2015). One reason that might explain this is the fact that only 12% of the active labor force work in the primary sector (agriculture, livestock and fishing) in Costa Rica (MIDEPLAN, 2015), while 35% do so in Honduras, 29% in Nicaragua and 19% in El Salvador (CAC, 2007; República de Honduras, 2001).

has at national and regional levels. The section of “Climate change” briefly addresses agriculture under the context of extreme events.

Food security and undernourishment of the poor

Food and nutritional security represent a concern at regional and national scales, mainly because of its link to health, quality of life, employment, income generation, productivity and generation of competitive advantages (CAC, 2007). The issue is also associated with poverty reduction, especially in a region where large population groups are affected by undernourishment and chronic malnutrition (SICA, 2008). Thus, the Central American countries have elaborated joint strategies, such as the Central American Agriculture Policy in 2007 and the Regional Agro-environmental and Health Strategy in 2008. Both policies include the subject of food security as one of its main core ideas (SICA, 2008; CAC, 2007).

Policies concerning food and nutritional security have also been formulated at national levels. The topic, although defined differently in its specificities in the diverse national documents, shares a common base. Generally, food and nutritional security can be understood as *“the state in which all of the people inside a country have physical, economic and social access to quality and innocuous food, in a timely and permanent way. The biological use of this food guarantees a general state of well-being, which contributes to the achievement of an active and healthy life”* (SEPSA, 2015, p.23).

In the Costa Rican case, concerns arise because 6% of the population suffers from hunger, while the problems of “hidden hunger”¹¹, infant and young malnutrition, overweight and obesity prevail (SEPSA, 2015). Therefore, the current political agenda sets as goals to put an end to hunger, achieve food security and improve nutrition (MIDEPLAN, 2015). Some of the policies in this field include the State Policy of Food Security, which supports and favors national production of essentials in the food basic basket, such as beans, white corn, rice, potato, onion, milk, and pork and cow meat (SEPSA, 2014). This policy also aims to promote the implementation of the new National Law on Seeds and to encourage agricultural innovation, research and technological transfer through the articulation of joint work between private and public institutions (MAG, 2014; SEPSA, 2014). Another boost in this area is the creation of the Policies for the Agriculture and Livestock sectors and the Development of Rural Territories 2015-2018. This policy was elaborated in 2015 by the government and focuses on the relationship between food security and development in rural areas, mostly setting opportunities for the young population working on this field. In here, food and nutritional security are defined as complex, interdisciplinary and intersectoral concepts that overpass the problem of food supply and demand (SEPSA, 2015).

In Nicaragua, there is an association between food security and rural poverty. The government created, thus, a Productive Food Program, mostly known as Cero Hunger (Gobierno de Nicaragua, 2011; BCIE, 2010). *The priority set is to give access to the population, mostly the rural poors, to enough, nutritious, healthy and innocuous food through actions that support small farmers, such as access to goods, credits and technical assistance* (Gobierno de Nicaragua, 2011, p. 109).

¹¹ “Hidden hunger” refers to the consumption of poor quality and unhealthy food (SEPSA, 2015).

Guidelines are to encourage the development of household production for self-consumption (Gobierno de Nicaragua, 2011).

The government of Honduras also integrates the subject of food security as a component of its Poverty Reduction Strategy. In here, the goal is to guarantee a minimum food intake to rural families in the condition of extreme poverty. Support actions include the development of micro-projects and the strengthening of local organization (República de Honduras, 2001). However, although food security seems like a key topic to tackle poverty, the government only spent USD \$5.6 million between the 2000-2005 period. If one compares it to the USD \$17 million spent in the enhancement of agricultural productivity in the same years, food security does not seem as a priority.

The Guatemalan Poverty Reduction Strategy also acknowledges the relevance of agriculture and food security for the rural population. The former is described as the main economic activity and source of employment in rural areas, while the latter is associated with the prevalent high indexes of chronic undernourishment (Gobierno de la República de Guatemala, 2001). Actions thus center on the strengthening of the productive capacity of small farmers, through technical assistance, provision of fertilizers and improved seeds, and crops' diversification (Gobierno de la República de Guatemala, 2001). The government has also put a special focus on the infant population through the implementation of the programs *Guate Solidaria* and *Comedores solidarios*, which aim to diminish children's undernourishment and school desertion by providing breakfasts and lunch at school to children in risk of food insecurity (McCarthy and Salas, 2010).

Lastly, in the region, initiatives encouraging the use of biomass for energy generation are increasing, especially since the rise in the fuel's price in 2006. Although bioenergy represents an opportunity to generate new sources of income and employment in rural areas, concerns point out the danger that this activity might compete with food security (CAC, 2007).

Agricultural productivity

Agricultural productivity is a relevant regional concern because of many reasons. First, the topic goes very much in hand with food security and sovereignty. Second, as mentioned before, a large part of rural households in the region depend heavily on agriculture. Third, increases in agricultural productivity can be later translated into increases in food production for national and international consumption, and improvements in the agro-productive chains. These achievements can improve the living conditions of small and medium farmers in rural areas, which generally represent some of the poorest population in the region (SEPSA, 2015; MAG, 2014; SEPSA, 2014; Gobierno de la República de Guatemala, 2001).

Nevertheless, agricultural productivity in Central America is low, scoring an average annual growth rate of 0.4% (CAC, 2007). This situation might be explained by the low level of education of the labor force, limited public and private investments, lack of implementation of new and alternative technologies and of processes of technological transfer, and poor internal and external commercialization of the products (MAG, 2014; UNEP, 2012; CAC, 2007).

The Central American Agricultural Council (CAC, its acronym in Spanish) proposes two main measures to enhance agricultural productivity. Firstly, investments in human capital and physical infrastructure (such as ports, airports, roads and telecommunications) need to increase and be better addressed. Improvements in human capital can be tackled through education and professional training (mainly in agricultural technical education), health and labor security in rural areas. Improvements in physical infrastructure can be obtained through the modernization and development of new infrastructure that gives access to producers to new markets and reduces transaction costs. Secondly, joint work between public, private and academic sectors remains crucial for improvements in agricultural research, innovation and technological transfer. The role of the private and academic sectors should be increase

In here, all of the steps of the food production chain (from primary production, to post-harvest management, to the product's industrialization) need to be considered (CAC, 2007).

The promotion of water-use efficiency in the sector is also of high relevance, especially when taking into account the vulnerability of the resource under the context of climate change. Experimentation with new irrigation systems might allow a more efficient use of the resource (SEPSA, 2014; UNEP, 2012). Also, alternative agricultural practices, such as crops' rotation and no tillage allowed, can increase the productivity (UNEP, 2012).

At national scales, the low productivity faced by the agricultural sector also represents a concern. In the Costa Rican case, improvements in the productivity, commercialization and generation of added value for agricultural basic consumption products represent the main objective of the Policies for the Agriculture and Livestock sectors and the Development of Rural Territories 2015-2018 (SEPSA, 2015). Costa Rica is even planning to double its agricultural productivity and the income of small farmers by 2030 (MIDEPLAN, 2015). To achieve this goal, the government plans to create synergies between different institutions to develop research, innovation and technological transfer (SEPSA, 2015). However, this task depends on financial support from the private and public sectors, with the latter currently facing a large deficit (SEPSA, 2014).

The Nicaraguan government also seeks to increase its agricultural efficiency and added value by improving its productivity (Gobierno de Nicaragua, 2011). The Central American Bank of Economic Integration (BCIE, its acronym in Spanish) plans to invest and give technical cooperation to the Nicaraguan government for the implementation of agricultural mechanization systems and productive infrastructure, such as irrigation systems and storage centers (BCIE, 2010).

The Honduran case is particular, as the country experiences the lowest agricultural productivity per farmer in the Central American region. Some of the reasons that might explain this situation are the scarce use of irrigation and the low mechanization in suitable lands for farming (República de Honduras, 2001). Therefore, improvements in agricultural productivity represent a relevant component of the country's Poverty Reduction Strategy. In here, USD \$17 million were destined for the development of appropriate and sustainable technological transfer and innovation. This is a large amount of money, if it is to be compared with the USD \$5.6 million executed in the rubric of Food Security (República de Honduras, 2001).

Lastly, in the case of Guatemala, concerns for agricultural productivity in Guatemala are exclusively oriented towards rural areas (McCarthy and Salas, 2010). The current low levels of

agricultural productivity are said to be due to low education levels (around 40% of the peasants and farmers are illiterate), poor quality of the rural infrastructure, low coverage of basic services (such as electricity), old and unproductive production techniques, and lack of quality control of the agricultural products (Gobierno de la República de Guatemala, 2001). In the country's Poverty Reduction Strategy, measures directed to agricultural productivity enhancement are based on infrastructure investments, such as the extension of rural roads and electricity networks, as well as to improve the water and sanitation provision systems (Gobierno de la República de Guatemala, 2001).

Sustainable agriculture

The implementation of better practices in agriculture is not only associated with increases in the productivity (CAC, 2007), but it is also considered a sustainable practice (UNEP, 2012). In sustainable agriculture, the use of components external to the ecosystems, such as insecticides, veterinary medications, additives and fertilizers, is diminished. The reduction of use of these elements fosters biodiversity and human health (SICA, 2008). Promoting sustainable agriculture can thus be seen as a way of promoting a "clean" agricultural production, which has become an interest in the region (SICA, 2008).

Therefore, Central American Agricultural Council (CAC, 2007) encourages the creation of regional networks of stakeholders related to agricultural production, as well as the institutional strengthening of the competent authorities. With the creation of these networks, knowledge around agricultural production can be more easily disseminated in the region through the fulfillment of bulletins and workshops (CAC, 2007).

At national levels, Nicaragua and Costa Rica have also manifested their interest on sustainable agriculture. On the one hand, the Nicaraguan government has set the compromise of avoiding monocrops and favoring organic production. They created the law 765, which fosters an agro-ecological and organic production (Gobierno de Nicaragua, 2011).

On the other hand, the Costa Rican government recognizes agricultural production as a poverty reduction strategy and an environmental-friendly practice (MAG, 2014; SEPSA, 2014). Currently, the country counts on 2,100 farmers who are producing organic food in a certified way in a total of 7,500 hectares. The goal is to increase the number of hectares up to 9,500 by 2018 (MAG, 2014). In the document *"Policies for the Agriculture and Livestock sectors and the Development of Rural Territories 2015-2018"*, the Costa Rican government seeks to establish policies, incentives and laws that stimulate organic production, as well as certifications, exportations of those products and their integration to local markets (SEPSA, 2015). To achieve these goals, the government will create strategies and coordinate alliances with producers' organizations, researchers, academic institutions, consumers' associations and certifiers (MAG, 2014). It will also seek advice from countries, which have experience in this field, through technical cooperation and assistance (SEPSA, 2015).

Agricultural insurances as a risk management practice

Farmers' crops are exposed to several environmental risks, such as tropical storms, floods and pests (SICA, 2010). Currently, in Central America, some measures have been taken in this regard, such as risk monitoring, and the implementation of forecast and early warning systems (CAC, 2007). However, the establishment of efficient agricultural insurances in the region has not been fully developed, although they could represent a potential and relevant financial risk management practice (SICA, 2008; CAC, 2007).

CAC has been open about the relevance of strengthening the regional market of agricultural insurances and other mechanisms of risk transfer. The implementation of these tools will give farmers and intermediaries more certainty, it will improve guarantees for the grant of credits, and it will make conditions for investments in agriculture more attractive (CAC, 2007). Therefore, some of the recommended tasks to be developed are: to improve the information system, to create an observatory specialized in agricultural insurances (that studies the different modalities or successful experiences), and to elaborate a legal and institutional framework that eases the development of an insurance market (CAC, 2007).

In addition, Nicaragua, Honduras and Costa Rica also acknowledge the relevance of these financial tools in some of their documents. In the case of Nicaragua, for instance, the government is willing to incorporate agricultural insurances as a part of its mechanisms to increase agricultural production and efficiency (Gobierno de Nicaragua, 2011).

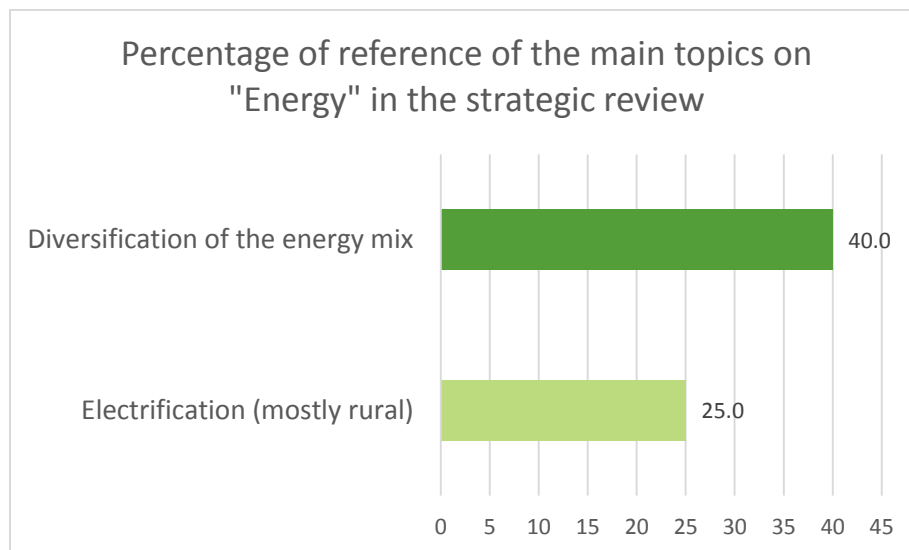
Honduras also addresses the issue of agricultural insurances in its Poverty Reduction Strategy, although it does not specifically integrate the concept in any of its policies. However, agricultural insurances are mentioned as important mechanisms to battle poverty in rural areas and are laid as a topic to consider for future agreements (República de Honduras, 2001).

Lastly, in the case of Costa Rica, current policies are considering the design and implementation of insurances for the agriculture and fishing sectors. However, joint actions from the two main related institutions, National Insurance Institute (INS, its acronym in Spanish) and National Meteorological Institute (IMN, its acronym in Spanish), are needed in order to develop programs of differentiated insurances according to the climatic indexes (SEPSA, 2015).

3.6 Renewable energies

This section points out the main topics covered on "Renewable energies", which are: 1) diversification of the energy mix, and 2) electrification (mostly rural). Figure 8 shows the frequency in which these topics are treated in the strategic review. The relevance of diversifying the energy mix is discussed in 40% of the reports checked, while rural electrification is considered in 25% of them.

Figure 8



The sector of renewable energies has been addressed from two main perspectives in the literature review. The first approach considers energy in its broad spectrum and as a national sector of relevance, while the second one focuses on the relevance of implementing renewable energies under a climate change context. Therefore, although both perspectives address similar issues of the sector, such as diversification of the energy mix, they tackle them from different perspectives. For example, the diversification of the energy matrix is analyzed as a key component for the reduction of air pollution, but also as an area of concern because of the generation of GHG emissions and its impacts on climate change.

Despite the difficulty of separating these two perspectives, the following section focuses on the first perspective, the one that considers energy as an independent sector and the implications it has at national and regional levels. The section of “Climate change” briefly addresses the relevance of implementing renewable energies under the context of extreme events.

Diversification of the energy mix

Central America exhibits a high carbon footprint, mostly explained by its large dependency on fossil fuels and fuelwood for energy production (Programa Estado de la Nación, 2011). According to UNEP (2012), 26% of the region’s greenhouse gas emissions are CO₂ from energy generation. However, there is a potential and increasing use of “clean energy sources” in the region, mainly based on hydropower (GWP, 2011). Actually, hydropower generation has increased fivefold between 1970 and 2009 (UNEP, 2012).

Under this context, SICA (2015) has manifested its interest in increasing the share of renewable energies in its energy matrix as a way to reduce pollution in the productive processes and increase the competitiveness of the private sector. Through the creation of the Regional Strategy for Sustainable Energy, the region plans to reduce its level of GHG emissions and to take advantage of carbon markets (SICA, 2009). Some other benefits of incorporating renewable energy sources into

the energy matrix include the decentralization of investment towards less developed regions, which helps create jobs, capacity building and technology transfer; improvements in air quality and human health; decrease in the external energy dependency; increase in the reliability of power supply; and the diminishment of congestion in cities (UNEP, 2012). However, it has to be taken into account that most of these benefits will be palpable only over the long term.

As mentioned in the Climate Change section, the need to diversify the energy mix also comes as a strategy to address climate change (SICA, 2009). Some countries in the region have committed to implement international and regional agendas, seeking for energy efficiency and the development of new and renewable energy sources (UNEP, 2012). In addition, the highly inefficient use of energy (Programa Estado de la Nación, 2011) and lack of electricity saving (UNEP, 2012) are also issues affecting the region.

At national levels, the concern is not different. In Costa Rica, 75% of the energy consumption depends on fossil fuels, 60% of which is used in the transportation sector, as mentioned earlier in the Pollution and Transportation section. However, when it comes to the use of energy to produce electricity, the numbers vary. According to GIZ (2015), between 80% and 90% of Costa Rica's electricity comes from renewable sources, well above the Central American average of 53%. Geothermal energy is also a significant source in the country, while wind energy is rapidly growing. In addition, the country's latest development measures plan to provide 97% of the national electricity from renewable sources by 2018.

This expansion in the electricity generation from renewable sources is however very dependent on hydropower, which represents a risk for the country because of the vulnerability water resources face under the context of climate change (GIZ, 2015). Therefore, the need to incorporate alternative energy sources becomes crucial (MIDEPLAN, 2015). In this regard, Costa Rican agricultural policies are also including the relevance of this sector in diversifying the energy mix through biomass production (SEPSA, 2015; MAG, 2014; SEPSA, 2014).

Another country interested in diversifying its energy matrix is Nicaragua, which created a national Policy for Energy Infrastructure in 2007. By 2011, the country had already achieved a national record of generating 35% of its electricity from renewable sources (Gobierno de Nicaragua, 2011). Expenditures in this sector are planned to continue, as the National Human Development Plan 2012-2016 has destined USD \$1,719 million to this field (Gobierno de Nicaragua, 2011). In addition, through its "Country Strategy for Nicaragua 2013-2017", the Central American Bank for Economic Integration (BCIE) plans to spend 21% of its total budget for Nicaragua in energy (BCIE, 2010).

In Honduras, the situation seems more difficult. In 2001, 65% of the country's energy generation came from fuelwood, which is one of the most GHG emitting sources (República de Honduras, 2001). Therefore, the government elaborated a national Program for Rural Electrification and the program "Solar Towns", which aim to diversify Honduras' energy matrix and increase the electricity coverage in rural areas.

Rural electrification

Around 50 and 65 million people live without electricity in Latin America, with electrification rates being below 30% in Honduras and Nicaragua (UNEP, 2012). This topic is thus recurrent in national documents, mainly when concerning poverty reduction strategies and rural populations.

In Honduras, for instance, only 20% of the rural population has access to electricity at their places, while in urban areas it amounts 85% (República de Honduras, 2001). This inequity between rural and urban populations has encouraged the creation of the Electrification National Fund, which plans to extend electricity coverage in rural areas through the “Solar Towns” initiative (República de Honduras, 2001).

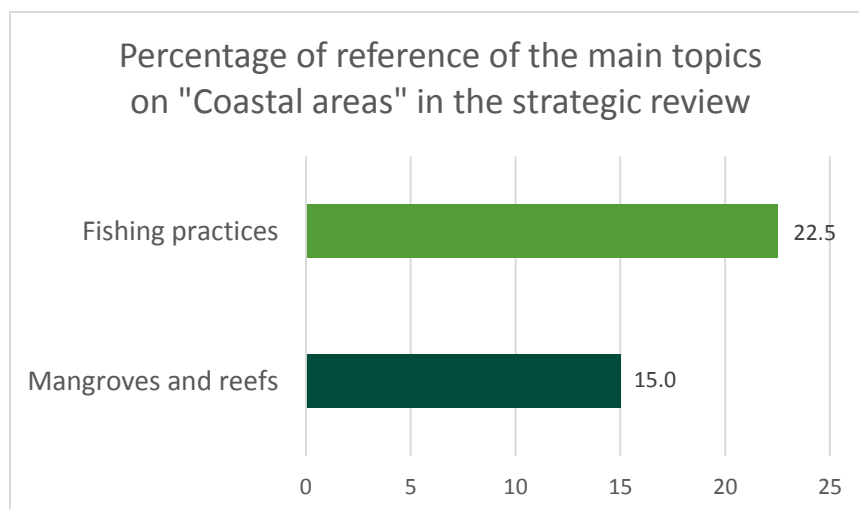
The government of Guatemala is also following this line of work, as it has been detected that more than half of its poor population, mostly residing in rural areas, lacks of electricity access (Gobierno de la República de Guatemala, 2001). Therefore, the government created the Program for Rural Electrification, which planned to bring electricity to 280,000 people in 2,600 rural communities during the period 2000-2004. Expectations are that access to this public service will improve their quality of life and productivity at work, among other positive repercussions (Gobierno de la República de Guatemala, 2001).

Lastly, Nicaragua is also giving priority to the broadening of rural electricity coverage and energy infrastructure in its poverty policies (Gobierno de Nicaragua, 2011). According to the United Nations Environmental Program (2005), much of Nicaragua’s poverty is due to the lack of access of its inhabitants to basic services, mainly in the energy and health sectors. However, through the implementation of several projects concerning access to drinkable water, dwellings and rural electricity, rural poverty is said to have decreased from 45,8% in 2005 to 42,5% in 2009 (BCIE, 2010). The Nicaraguan government planned to spend USD \$19 million to subsidize the electricity rate in 2012 (Gobierno de Nicaragua, 2011).

3.7 Coastal areas

This section points out the main topics covered on “Coastal areas”, which are: 1) fishing practices, and 2) mangroves and reefs. Figure 9 shows the frequency in which these topics are treated in the strategic review. The issue of fishing practices is discussed in 23% of the documents reviewed, while the relevance of mangroves and reefs is mentioned in 15% of them.

Figure 9



Fishing practices

Fishing and other coastal activities generate around USD \$750 million in Central America, representing a source of income to 27% of its population (UNEP and CCAD, 2005). According to the Programa Estado de la Nación (2011), fishing practices are more productive in the Pacific coast than in the Atlantic, while Costa Rica and El Salvador are the countries with the highest fish catch in the region.

Nevertheless, commercial fishing in the region has been carried out in an inadequate way. It is responsible for the overexploitation of fish and other marine populations, destroying reefs, and incidentally catching companioning fauna (UNEP and CCAD, 2005). The shrimp industry, for example, affects mangroves, thus changing land uses and affecting ecosystems (UNEP and CCAD, 2005). According to the Programa Estado de la Nación (2011), shrimp trawling has an incidental catch rate of 80%, which means that only 20% of what is caught is actually used.

In addition, poor agricultural practices, such as excessive use of agrochemicals and spreading crops to non-suitable areas, represent situations that also put at risk water quality of rivers and seas, and, thus, marine biodiversity (SICA, 2008). Drastic increases in sediment generate impacts on the reproductive cycles of fish, affecting the communities that depend on fishing (Programa Estado de la Nación, 2011).

Therefore, the SICA created in 1995 an internal organism, the Central American Fisheries and Aquaculture Organization (OSPESCA, its acronym in Spanish). Its purpose is to promote sustainable fishing and aquaculture practices, while considering social and economic benefits for the population (GWP, 2011). Another initiative promoted by SICA is the elaboration of the Support Plan for Fishing in Central America (PAPCA, its acronym in Spanish) in 2010, which seeks to establish a regional rivers' and seas' zoning system (Programa Estado de la Nación, 2011).

At national level, poor fishing practices also represent a concern in Costa Rica (Programa Estado de la Nación, 2011). Ross Salazar (2014) elaborated a handbook of methods and instruments for a selective and effective sustainable fishing, so that extractions cause the lowest possible impact. In

addition, in the country's Policies for the Agricultural Sector and the Development of the Rural Territories 2015-2018, coastal areas seem like a relevant issue. Several of the strategic actions include the implementation of a fishing risk insurance directed to small and medium producers and the incorporation of coastal communities in the formulation of land management plans (SEPSA, 2015; SEPSA, 2014). Fundación MarViva (2016) is also promoting Marine Spatial Planning, which is a public process that seeks to balance ecological, economic and social objectives in coastal areas, including mangroves. This approach fosters an active participation of the stakeholders involved in marine spaces and resources. Pilots have already taken place in the Pacific coast of Costa Rica. Lastly, the Forever Costa Rica Association (2016) is designing an integral surveillance and monitoring system for key conservation marine sites located in the Caribbean, and North and South Pacific coasts.

In the case of Nicaragua, fishing and aquaculture products generated USD \$312.5 during the period 2007-2011, which represented 62% more of what was received in the period 2002-2006. Fishing and aquaculture exports also rose more than 50% in monetary and quantity terms, arriving to being the fourth main national export (Gobierno de Nicaragua, 2011). National policies are fostering this activity, but they are focusing on the artisanal and small-scale fishing. The organization and legalization of 189 cooperatives, the reconstruction of 5 quays, and the delivery of 50 outboards to small-scale fishermen are some of the measures taken. Also, the government promised to reorient 1,000 fishermen using poor fishing practices to new economic activities (Gobierno de Nicaragua, 2011).

Mangroves and reefs

The Central American region contains 8% of the world mangroves' surface and the second reefs' barrier of the planet, amounting a total of 1,600 km of coralline reefs (SICA, 2014; SICA, 2008). This type of wetlands extends through 1.4% of the Central American territory, 71% of which are located in the Pacific coast (UNEP and CCAD, 2005). Although the number of Ramsar wetlands went from 37 to 46 from 2005 to 2010, the region lost 248,400 hectares of these ecosystems in twenty-five years (Programa Estado de la Nación, 2011).

Mangroves are ecosystems of high relevance for biodiversity because of the nourishment their roots provide to different species' larva, the protection they give to birds and insects, the reduction of erosion and coastal flood they generate, and carbon sequestration (Programa Estado de la Nación, 2014; Programa Estado de la Nación, 2011). Also, their contribution to local and national economies lies in their link to touristic and fishing activities (SICA, 2008). For example, mangroves and other types of coastal wetlands maintain up to two thirds of the global fisheries (UNEP and CCAD, 2005).

Nevertheless, these benefits might get lost because of the deterioration of these ecosystems. UNEP and CCAD (2005) signals water pollution, land use changes and inadequate coastal development, mainly explained by an unplanned expansion of touristic and agricultural activities, as the main sources of this situation. In addition, climate change is rising water temperatures, which adds stress to coralline reefs and mangroves and whitens them (SICA, 2008; UNEP and CCAD, 2005). The live coral cover has fallen in several reefs, though there are signs of recovery in some areas (SINAC, 2009).

Regional solutions have addressed the topic of “integrated coastal management”, as *“it promotes the preservation of ecologically sensitive areas such as mangroves, fosters the sustainability of important socio-economic activities such as fisheries and tourism, preserves natural ecosystem functions and services such as coral reefs, and improves the quality of the marine environment, for example by reducing contamination from vessels and in ports”* (UNEP, 2012, p. 328-329). Guatemala, Honduras and other Mesoamerican countries have adopted the “Initiative for the Reef System of the Mesoamerican Caribbean”, which seeks to jointly create a coordinated marine protected area, and promote sustainable fisheries and an eco-friendly tourism activity (UNEP and CCAD, 2005).

At national levels, mangroves and reefs have been also considered in Costa Rican and Nicaraguan documents. In the case of Costa Rica, the country has been trying to value coastal ecosystem services and include it into their national accounts’ system through the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) initiative (Programa Estado de la Nación, 2014). In the Nicaraguan case, policies for the period 2012-2016 include strengthening the protection of coastal areas and their biodiversity, through mangroves’ and reefs ecosystems’ integral management (Gobierno de Nicaragua, 2011).

4. EEfD research contributions

Interviews with each of the researchers at EEfD were carried out. The purpose was to find out the subjects, objectives and results of their past and current research, as well as how it might be useful to policymakers. This following section summarizes how EEfD research has contributed and is contributing on each of the sectors derived from the literature review.

4.1 Climate Change

Vision of prevention and mitigation and adaptation measures play key roles to face extreme events under the climate change framework. The contribution of the EEfD team to climate change research and policy can be divided into three main areas: mitigation, adaptation, and risk management and vulnerability. The following section explains the work carried out by the research team in these three domains.

Mitigation

One of the most recognized roles of forests is that they serve as carbon sinks, a relevant characteristic when seeking climate change mitigation. SICA (2014) emphasizes the importance of reducing CO₂ emissions from deforestation and forest degradation to mitigate climate change. At EEfD, numerous projects related to forest conservation have taken place. They have focused on conservation policies, such as the implementation of protected areas, national parks and PES schemes. Results of the studies indicate that targeting conservation policies to places with high deforestation threat is crucial in terms of additionality and, therefore, reducing emissions for deforestation. However, leakage effects of these conservation measures should be also taken into consideration. These results have been consistent across countries. EEfD has developed this type of analysis in Mexico, Costa Rica and Brazil with similar findings. The Mexican south is very similar

to the north part of Central America in both socioeconomic and ecological conditions, which implies that the results from Mexico would certainly apply to these areas. Protected areas and PES schemes are still perfectible tools, globally implemented and that need to be adapted to the time-varying conditions. Governments usually do not have the time nor funds to spend on research on these matters. Therefore, policymakers can use this generated information in order to increase carbon sequestration. In this regard, they should not only consider the direct effects of their decisions but also potential unintended effects.

Adaptation

Water has been described as one of the most vulnerable resources to climate change. SICA (2010) states that the increase in the population and the vulnerability of water infrastructure to climate change are putting at risk water availability in the region. In this regard, the EEfD team carried out a three-year project related to the promotion of water adaptation strategies for households and community-based drinking water organizations (CBDWOs) in the driest areas of Nicaragua, Guatemala and Costa Rica. At CBDWOs level, results indicate that certain organizational, financial and infrastructural characteristics, such as the use of volumetric meters and fees, are associated to well-adapted CBDWOs. At household level, the implementation of water-saving innovative technologies can reduce water consumption, though less than the expected engineer estimates. This fewer reduction is related to behavioral characteristics of rural households. This information can be useful to policymakers to foster a reduction in water consumption at communal level in these very-dry climatic regions.

Agriculture has been exposed as another vulnerable sector to climate change. In Costa Rica's INDCs, adaptation in agriculture following the EbA approach is considered of high relevance. The EEfD team has addressed this subject in several of its projects. The research group is currently working under the EbA approach with subsistence and small coffee farmers in Guatemala, Honduras and Costa Rica. Tasks include characterization of livelihoods, identification of highly vulnerable areas, adaptation opportunities and constraints, and forecasting changes in the distribution of agricultural productive zones. Preliminary results indicate that less than half of the subsistence farmers have taken adaptation measures, though most of them are aware of climate change. In addition, subsistence farmers are vulnerable to extreme events, and even so more after the occurrence of every additional extreme event. This information is useful to reorient policy efforts to the main subsistence crops in the identified most vulnerable areas of the region. Policymakers can also work on the underlying determinants of adaptation and food security, while making use of the forecast on changes in the distribution of agricultural productive zones, in order to achieve resilient small farming systems.

Following the topic of agricultural adaptation to climate change, the EEfD team has been also working with a sample of coffee farmers in Costa Rica to explore the uptake of credit combined with insurance. In the country, the National Insurance Institute (INS) is the only institution providing crop insurance. However, insurance demand is low, concentrated mainly in the rice sector and with significant losses due to weather events in the past years. The team aims for future research to design, test, and pilot this and other Financial Instruments to promote climate change adaptation measures and sustainable low-emission practices for commercial agriculture in Costa Rica.

Lastly, coastal areas in Central America are typically poor and highly dependent on natural resources. Climate change forecasts predict an increase in the frequency and intensity of hydrometeorological events, with coastal areas being the most damaged. Therefore, the EEfD is carrying out projects regarding water and agriculture adaptation strategies in these zones. The purpose is to understand which policy instruments are necessary for these regions to better cope with climate change. Results are currently being analyzed.

Risk management and vulnerability

SICA (2014) foresees that the agricultural sector is facing risk under the climate change scenario because of landscape change and loss of infrastructure and crops. In this regard, the EEfD team is currently carrying out a research on the behavioral aspects of climate change adaptation responses of Costa Rican coffee farmers. Researchers have implemented risk and time preferences experiments in two different coffee regions in the country. This project seeks to contribute to the understanding of farmers' economic behavior in support of the design of local and national policies to better prepare for the adverse effects of climate change in Costa Rica and more broadly Central America.

Lastly and in line with the relevance of climate change forecast, the EEfD created an index that measures the vulnerability to hydrometeorological disasters for Honduras. This index is based on climate anomalies and the municipal socioeconomic factors. It is a useful tool for policymakers to improve risk management in the country, as it tells the probability that an extreme event occurs in each municipality on a monthly basis.

4.2 Water

The EEfD team has addressed the issues of water scarcity and water-use efficiency in its work. Although a large part of the research has been carried out with a focus on climate change (see previous section on Climate Change for more detail), research has been also oriented towards water governance, through matters such as communal management of the resource and establishment of fees. The EEfD team worked in a water district in the north Pacific region of Costa Rica with rice and sugar cane producers to compare the efficiency of community-based versus governmental management of water. In this regard, it must be reminded that the agricultural sector has been recognized as one of the most affected by water problems under the climate change context (SICA, UICN and GWP, 2002). Results of the EfD research indicate that community-based management is more efficient and equitable because farmers have incentives for the maintenance of the resource, as well as they count on local knowledge. Managing water institutions have usually focused more on building infrastructure and the regulation of fees as mechanisms to address water scarcity and water-use efficiency. This study, however, suggests that policymakers should also consider incorporating users of the resources in the design and definition of rules for their management, such as local leaders and peasant organizations. Given that water is a crosscutting resource for the development of many economic activities, the tourism, agricultural and energy sectors should also be taken into account.

In addition, the EEfD has carried out a laboratory experiment on the topic of achievement environmental negotiations under an asymmetric context. Literature associates these joint agreements with collective choices such as the management of the commons, particularly more often with water management. Then, this research seeks to improve the understanding around

the rules of decision for the achievement environmental agreements. Preliminary results indicate that people look for agreements that benefit them individually, although egalitarian proposals are favored. Policymakers should make use of these findings when dealing with the regional issues of water scarcity, water-use efficiency, and water conservation.

4.3 Land, ecosystems and biodiversity

The contribution of the EEfD team regarding the topics of land, biodiversity and ecosystems can be divided into three main subjects: design and impact evaluation of PES and protected areas, ecotourism as a conservation strategy, and inclusion of ES in national accounts. The following segment explains the work carried out by the research team in these domains.

On the one hand, forests are not only recognized because of their role in sequestering carbon sinks, but also as biodiversity and water protection sinks (WAVES, 2015; Programa Estado de la Nación, 2011). Therefore, PES schemes and protected areas can be seen as relevant conservation policies. EEfD has contributed in the design, implementation and improvement of PES programs at municipal and national levels in Honduras, Nicaragua and Costa Rica. For this, the team has worked with international organisms, multilateral organizations and governmental institutions. Results indicate that in order to improve the efficiency or reject the implementation of PES programs, the reality and scale of each location has to be considered. Policymakers acknowledge that there is no one-recipe-fits-all in the case of PES schemes. The Costa Rican program, for instance, has evolved and changed throughout the years, as it has been incorporating learnings from the past.

Regarding protected areas, the EEfD team has oriented its work towards managerial issues of Costa Rican national parks, such as generation of funding and regulation of offered services. Results show that parks are spending large amounts of financial resources in the offering of non-essential services (guidance and hostel services), which would be rather licensed. Since this work was carried out with close collaboration from SINAC, the public entity in charge of managing protected areas in the country, findings have been used for the definition of entrance fees, the establishment of maximum load capacity, and the regulation of non-essential services in national parks.

On the other hand, PES schemes and protected areas can be seen as tools for poverty reduction (UNEP, 2012). The EEfD team has carried out research on the socioeconomic impact of these measures in Costa Rica. Results indicate that this national PES scheme, on average, does not generate any impact on poverty. Poverty increases, however, when the scheme achieves to discourage deforestation. Policymakers have acknowledged that the simultaneous achievement of conservation and socioeconomic goals of the program are not being met. Improvements in the selection criteria and targeting are being considered.

Results from EEfD research also suggest that poverty decreases in areas near their entrance. If ecotourism near the entrances of national parks increases, the benefits of the policy will also increase. The recommendation is thus to support ecotourism as an indirect strategy for national parks to generate positive socioeconomic effects.

The EEfD team has also assessed the relationship between conservation and ecotourism in another study. Researchers at EEfD evaluated the effects on ecotourism of beaches obtaining a

prize from the *Bandera Azul Ecológica* program, which is a Costa Rican award gained through the achievement of conservation goals¹². Results indicate that ecotourism activity increases in beaches that obtain the award, even so more if this prize is received two years in a row. These findings go in line with UNEP's argument of the relevance of ecotourism to foster economic dynamism next to conservation goals (UNEP, 2012).

Lastly, SICA (2008) has stated the need to assess ecosystem services, in order to include them in the national accounts system. In this regard, the EEfD team is currently assessing three different ES in Costa Rica: forests for pollination in agricultural activities, forests for water purification, and green urban spaces. Researchers plan to better understand the benefits provided by the direct use of these ES. In addition, this research is being concurrently developed in Kenya, Tanzania, Ethiopia, South Africa, China and Sweden. Costa Rican policymakers can profit of the coming findings by incorporating the values into the Environmental and Economic Accountability System. Joint statistical criteria generated by the simultaneous international research can be also useful for comparisons and feedback for improvements.

4.4 Pollution and transportation

The EEfD team has addressed the problems of pollution and transportation by focusing on two topics: solid waste management, and the effects of air pollution on public health. Firstly, poor solid waste management has been signaled as a key problem in Central America detrimental to water purification, public health and marine biodiversity (SICA, 2008). Researchers at EEfD have worked on the promotion of recycling in urban households at a Costa Rican municipality. Results indicate that people have a clear interest in recycling; however, they fear that their efforts are lessened because of neighbors who do not practice it. In these cases, people show a preference for “stick” sanctions rather than the implementation of the “carrots” approach. This research was developed in close collaboration with the municipality, which took note on the findings for future policy-making.

Secondly and following regional and Costa Rican concerns on the effects of the transportation sector on air pollution, EEfD carried out an economic assessment of the effects of air pollution on public health in Costa Rican urban areas of the Great Metropolitan Area (GAM). The purpose of the research was to estimate in monetary terms the impact of the externalities generated by the transportation sector on well-being. Results show that compliance with air quality regulations would have positive impacts on health. However, an increase of welfare would be significant only under the scenario of very strict regulations and their compliance, since air quality is already highly acceptable in the GAM and there is a major compliance with the national norms. Mitigation measures would thus not bring large additional benefits. Policymakers should then set policies under a larger framework that include congestion reduction measures, for instance.

4.5 Agriculture

Better agricultural practices foster productivity, biodiversity and human health improvements (SICA, 2008; CAC, 2007). In this regard, the EEfD team has contributed to the topic by carrying out

¹² The *Bandera Azul Ecológica* (Ecological Blue Flag) program annually awards a blue flag to participants who demonstrate their commitment to community work, conservation and protection of natural resources. The idea is that the Ecological Blue Flag becomes a process of improvement, as organizations can lose it if requirements are not met in the following year.

impact evaluations on organic certifications. For this, researchers used the agricultural census to identify organic farmers in a Costa Rican village. Results show that farmers who obtained the organic certification do apply less pesticide than farmers who do not have the certification. In addition, certification programs require compliance with strict and well-defined norms, which are supervised by independent observers. Policymakers should thus realize the relevance of rigorous and monitored norms for the achievement of positive environmental outcomes.

4.6 Renewable energies

The EEfD has not carried out research in the domain of renewable energies. However, as it is detailed in Section One and Six of “Future research at EEfD”, the team plans to approach the subject in coming projects under the climate change context.

4.7 Coastal areas

The EEfD team has worked on two main topics of coastal areas: marine protected areas (MPAs) and community management for marine turtle conservation. On the one hand, the socioeconomic effects of a Costa Rican and a Tanzanian MPA were analyzed to assess the expansion of MPAs. Results oppose for both countries. The Costa Rican case shows a “win-win” situation between livelihoods and the expansion of the MPA, as the latter generated new sources of income (e.g., tourism) while achieving conservation goals (e.g., increase in fish population). On the contrary, the expansion of the Tanzanian MPA was associated with a trade-off in terms of livelihoods, implying less income and subsistence sources for the inhabitants. Therefore, policies regarding the implementation and expansion of MPAs should contemplate the generation of alternative employment and income sources, mostly for fishermen. Otherwise, an opposition towards MAPs can arise, deriving in the non-compliance of regulations and thus the impossibility to achieve conservation outcomes. This research becomes of high relevance for Central America, as fishing represents an important economic activity in coastal areas that is being detrimental to marine life because of its intensity and practices associated (Programa Estado de la Nación, 2011; UNEP and CCAD, 2005).

On the other hand, community management for marine turtle conservation was studied at two similar beaches in Costa Rica and Nicaragua. The purpose of the research was to identify the factors that lead to illegal extraction of turtle eggs, as well as the characteristics related to a successful community management of the marine resource. Although both locations share clear similarities, results oppose. At the Nicaraguan beach, turtle eggs were illegally traded and thus overexploited; while in the Costa Rican case, community participation achieved a successful management of the marine resource. These findings suggest that community management can be effective in achieving conservation goals when the community is engaged in the design of environmental regulations and when the inhabitants have clear economic incentives to comply with the rules. On the contrary, lack of productive assets, stable sources of income and economic opportunities perpetuate the pressure on locals to harvest eggs for their own selling and consumption.

5. Future research at EEfD

Interviews with each of the researchers at EEfD were carried out. The purpose was to find out the subjects and objectives of their future research, as well as how these projects might be useful to policymakers.

This future research agenda was planned based on previous lessons learned by the EEfD team. For the center, when doing research, it is important to consider the timeframe needed to synchronize the agendas of donors, researchers and financing, which often do not match. In addition, many times, when the donors and financing are found, and the research is planned, policymakers have already moved on to another topic. Therefore, for the elaboration of any research project, time is an essential component to be considered in order to create an engagement of policy-makers and other relevant stakeholders, and to involve them in the design and follow-up phases of the project. Also, although a matter might be technically relevant, it can lack of policy importance, and vice versa. EEfD has experimented all of these situations in its past works and is currently trying to generate research that has both types of relevance. Lastly, the center acknowledges the importance of providing a considerable amount of time as a follow-up phase of any project. Therefore, EEfD is planning its future research based on the creation of an agenda rather than concentrating on topics. This approach allows the center to give continuation and depth to its research, as well as to strengthen its relations with stakeholders.

Collaboration with national, regional and international partners has been a constant of EEfD at every stage of its work, from writing proposals until implementing projects. The center regularly interacts with researchers from other universities and research centers, as well as program officers from different organizations and networks, such as Tropi-Dry, LACEEP, Conservation International and the International Development Research Center (IDRC). In addition, researchers at EEfD participate in worldwide seminars and congresses to present their works, build networks, seek for funding, and generate new research ideas.

Joint work with other EfD centers is also of high relevance for EEfD. South-South and North-South collaboration is and has been carried out between the centers. Currently, potential of joint areas of research relate to the matters of the effect of land titling on deforestation in Colombia and Costa Rica, and water pricing in Ethiopia and Costa Rica. In addition, EEfD is looking forward generating joint research on the topic of solid waste management, and energy, water and transportation consumption decisions of urban households. These issues represent global main concerns, which also happen to relate to most of the cities where EfD centers are located. South-South and North-South learnings can enhance EEfD research in these domains. In addition, EEfD sees value of a network with the Colombian and Chilean EfD centers, as some aspects of Latin-American realities can be jointly studied.

To conclude, the following section summarizes the planned research contribution on each of the prioritized sectors from EfD to policy discussions in Central America. A prioritization on this research agenda is given at the end of the section.

5.1 Climate change

An important part of EEfD's work on climate change for the coming years is related to the efficiency of solid waste management, energy and water use, and transportation decisions of

urban households. Studies will explore the role of implementing efficient technologies and other incentives in these sectors, in order to mitigate and adapt to climate change. This research is of relevance for the region since it will deal with various resources that are highly vulnerable to climate change. Furthermore, cities in Central America are experiencing two related phenomena. First, the growing middle classes demand ever more services and ignore environmental concerns in their everyday decisions regarding water and energy use. Second, there is also a strong rural to urban migration of extremely impoverished families. Given that natural resources supporting basic services in large cities are already under high pressure, services can be made available to incoming rural to urban migrants only if the middle classes achieve higher resource use efficiency.

Attitudes towards risk and investment decisions will be further researched at the EfD center, by expanding the work on the behavioral aspects of climate change adaptation responses of Costa Rican coffee farmers. Besides deepening in the understanding of how farmers prepare and cope with climatic shocks, this project seeks to analyze how coffee farmers' fairness views affect investment decisions to avoid damages from extreme events. Results of the research will improve the understanding of decisions related to adaptation to climate change of vulnerable agricultural communities. Coffee producers have been particularly chosen because they are highly exposed to potentially damaging extreme events, yet still have adapting capacity. Harnessing that capacity through proper incentives in a carefully orchestrated balance of private and public adaptation is key for the future of the coffee sector in Costa Rica and Central America. Therefore, results of the research can be useful for Costa Rica to achieve its INDCs and elaborate its National Adaptation Plan, where the agricultural sector is of high priority.

The topic of agriculture will be also addressed through an impact evaluation of providing drought-resistant seeds on production levels and use adoption. These type of seeds were given to Guatemalan, Salvadorian and Honduran farmers in some of the most vulnerable regions to climate change in these countries. The way these seeds were provided will be also studied, in order to determine the most efficient way of doing so and thus achieving greater use adoption.

5.2 Water

Following the regional and national concerns over water scarcity, EEfD wants to expand its work on economic incentives to increase water-use efficiency in Central America. The team notices that, in general, Central American governments have carried out few technical efforts regarding the design and allocation of water fees. These matters become even more relevant under the climate change scenario. In addition, regional water fees often leave out egalitarian aspects, which is key for the countries to achieve their poverty reduction goals.

EEfD also plans to expand its laboratory experiment on environmental negotiations under an asymmetric context. Besides further contributing to the discussion about when and how agreements could arise, this research will now consider the underlying incentives and how rules to form agreements might play a role in the final result of the negotiation. Although not all of these questions can be answered with the laboratory experiment, it allows for a systematic approach to gain insight from a simple yet relevant decision problem. This work is framed under the "water" sector, as much of the associated literature of joint agreements with collective choices is related to water management.

5.3 Land, ecosystems and biodiversity

EEfD plans to study the impact of protected areas on health in Costa Rica. Data from 1987 until 2015 will be collected to see the effects of conservation on malaria, dengue fever, diarrhea and undernourishment. This research can be useful for the forestry and water sectors of the country, since better forests are associated to more provision and pure water. The Estado de la Región (2011-Panorama ambiental) has highlighted the concern of water pollution on public health.

Lastly, current deforestation and land degradation rates in Central America increase the vulnerability of the region to climate change (Programa Estado de la Nación, 2011). One of the mechanisms mentioned in the literature to deal with the problem is the implementation of REDD strategies (SICA, 2014). EEfD will carry on a forecast study on deforestation rates in Honduras. The purpose of this project is to design and implement adequate REDD strategies in the country.

5.4 Pollution and transportation

The sectors of pollution and transportation will be mostly addressed in a climate change context. Future EEfD research related to solid waste management and transportation will be carried out at household level with the purpose of studying the role of implementing efficient technologies and other incentives in these sectors, in order to mitigate and adapt to climate change. This research is of relevance for the region since it will deal with various resources that are highly vulnerable to climate change.

5.5 Agriculture

The agricultural sector will be mostly addressed in a climate change context. Research related to agriculture will be carried out in El Salvador, Honduras and Guatemala and it will study the impact of drought-resistant seeds on production levels and adoption of the measure. The way these seeds were provided will be also studied, in order to determine the most efficient way of doing so and thus achieving greater use adoption.

In addition, attitudes towards risk and investment decisions of Costa Rican coffee farmers will be further researched. This is the continuation of the work on the behavioral aspects of climate change adaptation responses that seeks to deepen in the understanding of how farmers prepare and cope with climatic shocks and to analyze how coffee farmers' fairness views affect investment decisions to avoid damages from extreme events.

5.6 Renewable energies

The energy sector will be mostly addressed in a climate change context. Future EEfD research related to renewable energies will be carried out at household level with the purpose of studying the role of implementing efficient technologies and other incentives, in order to mitigate and adapt to climate change. This research is of relevance for the region since it will deal with various energy sources that are highly vulnerable to climate change.

5.7 Coastal areas

In the strategic literature review, mangroves have been highlighted as essential ecosystems for biodiversity conservation, carbon sequestration, and reduction of erosion and coastal flood. In addition, their contribution to local and national economies by promoting touristic and fishing activities has been repeatedly stated. The Efd-team has decided to carry on an economic

assessment of mangroves in Honduras and El Salvador. The purpose is to identify the role of these ecosystems on livelihoods, as well as assess the economic costs of their restoration and the benefits they provide.

5.8 Prioritization on areas of high policy impact

EEfD will give priority to three main topics in its research agenda, which the center considers to be key regional concerns and where its contribution to the policy debate can have greater influence. These three main areas of research are water; extreme and hydrometeorological events associated to climate change; and urban consumption decisions on water, transportation, electricity, and solid waste management.

Water

EEfD will continue focusing part of its research to household, industrial and irrigation water consumption. Researchers at the center have been working with topics associated with this resource for several years and they believe research on water can generate large positive impacts on the resource in a short term. Topics of study contemplate water pricing, water community management and assessment of policies, such as subsidies, among others. EEfD will take advantage of the network of stakeholders that researchers have built throughout the long time experience working on the subject. Strong relationships have been created and sustained with the main institutions associated to the resource, such as the National Institute of Aqueducts and Sewage Systems (AyA, its Spanish acronym) and the Ministry of Environment and Energy (MINAE, its Spanish acronym). The structure to further expand research on water is, thus, strong and stable. Opportunities to grow and generate new knowledge on the matter are large.

Extreme and hydrometeorological events associated to climate change

EEfD has been working in recent years on the study of policies related to the reduction of extreme and hydrometeorological events associated to climate change. Issues around this subject are various and the center has the technical team and knowledge to continue working and deepening in them. Matters such as migration, production (insurances and credits), public infrastructure and food security will be studied as adaptation measures to this type of events. In addition, evaluations of the effectivity of these adaptation measures and conservation efforts will be carried out by researchers with expertise on impact evaluation.

To go in depth with this line of work, EEfD already counts on a network of stakeholders. Although contacts are stronger in the agricultural sector, the center will have to strengthen its bonds with institutions managing extreme and hydrometeorological events. Organizations dealing with these matters at national and regional level have a lot of power and autonomy. Therefore, generating research on these issues is also an opportunity to strengthen bonds with important authorities, as well as to seek for better adaptation of the region under the climate change context.

Urban consumption decisions on water, transportation, electricity, and solid waste management

Urban consumption decisions related to water, transportation, electricity, and solid waste management represent a research priority for the coming years and a new area of study for the center. EEfD recognizes the global importance on these issues as they relate to massive consumption decisions. In addition, these matters represent a larger problem in main cities of developing countries because of the excessive and inefficient consumption of the resources. The increasing population migrating to these cities imposes an even stronger demand on the resources and, thus, requires a better management by the municipalities and a more defined legislative framework. For instance, in the case of Costa Rica, legislation for solid waste management has been elaborated in the past, though it still has not been implemented. In addition, the country lacks on incentives to reduce the levels of electricity and water consumption, as well as to switch towards more efficient transportation mechanisms.

Although researchers at EEfD have carried out a small amount of study in these topics, they see an opportunity on working in these issues and creating new networks to strengthen the center and make it grow. Joint work with other Efd centers located in main cities of developing and developed countries seems like a plausible opportunity for South-South and North-South collaboration. Since these problems are broad and versatile, research can be vast and opportunities for collaboration can increase.

6. Sustainable Development Goals tackled and to be tackled by EEfD research

The Sustainable Development Goals were created in 2015 by the United Nations as the continuation of the Millennium Development Goals. They are part of a new sustainable agenda and they are set to be accomplished by 2030.

Ten out of the seventeen UN proposed goals have been or will be approached, directly and indirectly, by the center through its variety of projects, studies and researches. These ten goals are pointed out in Figure 10 and are the following:

- End poverty in all of its forms everywhere
- End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- Ensure healthy lives and promote well-being for all at all ages
- Ensure availability and sustainable management of water and sanitation for all
- Ensure access to affordable, reliable, sustainable and modern energy for all
- Make cities and human settlements inclusive, safe, resilient and sustainable
- Take urgent action to combat climate change and its impacts
- Conserve and sustainable use the oceans, seas and marine resources for sustainable development
- Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

- Strengthen the means of implementation and revitalize the global partnership for sustainable development

Figure 10

Sustainable Development Goals approached or to be approached by EeFD



End poverty in all of its forms everywhere

EeFD has studied the impact on poverty reduction of conservation policies, particularly the implementation of PES schemes and protected areas in Costa Rica. Results differ for both measures. On the one hand, it was found that the PES program, on average, did not generate any impact on poverty. On the other hand, national parks are associated with poverty reduction in areas near their entrance. The recommendation is to support ecotourism as an indirect strategy for national parks to generate positive socioeconomic effects.

End hunger, achieve food security and improved nutrition and promote sustainable agriculture

EeFD has approached the matter of sustainable agriculture in its past works. Researchers have carried out impact evaluations of organic certifications on the use of pesticides. In addition, much of the work done and to be done related with agriculture is being applied on a climate change context, where the behavioral aspects of agricultural adaptation to climate change will be further studied.

Ensure healthy lives and promote well-being for all at all ages

The problem of health has been studied at EeFD as a consequence of air pollution. The center elaborated an economic assessment of the effects of air pollution on public health in Costa Rican

urban areas of the Great Metropolitan Area (GAM). Results show that compliance with air quality regulations would have positive impacts on health. However, an increase of welfare would be significant only under the scenario of very strict regulations and their compliance, since air quality is already highly acceptable in the GAM and there is a major compliance with the national norms.

In the future, the center plans to approach the subject of health as a consequence of the protection of terrestrial ecosystems. Researchers will carry on an impact evaluation of the effect of protected areas in Costa Rica on health, focusing particularly on malaria, dengue fever, diarrhea and undernourishment.

Ensure availability and sustainable management of water and sanitation for all

EEfD has approached the matter of sustainable water management in its past works. Researchers have carried out studies related to communal management of water for agricultural purposes in Costa Rica. In addition, the center is elaborating laboratory experiments on the topic of achievement of environmental negotiations under an asymmetric context. This type of joint agreements on collective choices is usually associated with management of the commons, particularly more often with water management.

For future research, EEfD has made a priority to continue orienting part of its efforts towards water availability and sustainable management. The center will work on economic incentives to increase water-use efficiency in Central America. In addition, researchers will expand its laboratory experiment on the achievement of environmental negotiations by considering the underlying incentives and how rules to form agreements might play a role in the final result of the negotiation.

Lastly, much of the work done and to be done related with sanitation and water availability and sustainable management is being applied on a climate change context. In this regard, research has and will focus on the promotion of water mitigation and adaptation strategies, such as the use of efficient technologies and other incentives. These projects pretend to achieve results at a local (communities) and regional scale.

Ensure access to affordable, reliable, sustainable and modern energy for all

EEfD will orient part of its future work on energy consumption decisions of urban households. The purpose is to generate more sustainable and resilient cities through the implementation of efficient technologies and other incentives related to this sector. Much of this research is, however, framed under the climate change context.

Make cities and human settlements inclusive, safe, resilient and sustainable

The topic of sustainable cities is a new area of concern for the center, though it has become a priority for its future strategic agenda. An important part of EEfD's work on climate change for the coming years is related to solid waste management, and energy, water and transportation consumption decisions of households, particularly middle-class urban dwellings. The purpose is to generate more sustainable and resilient cities through the implementation of efficient technologies and other incentives in these sectors.

Take urgent action to combat climate change and its impacts

Much of the work at EEfD is carried out with a climate change approach. Several resources and sectors (e.g., forests, water, agriculture and coastal areas) are often studied under a climate change framework, where mitigation, adaptation and risk management strategies are sought for.

For future research, EEfD will prioritize research oriented towards the reduction of extreme and hydrometeorological events associated to climate change. Adaptation measures to this type of events related to migration, production (insurances and credits), public infrastructure and food security will be studied. In addition, evaluations of the effectivity of these adaptation measures and conservation efforts will be carried out by researchers with expertise on impact evaluation.

Conserve and sustainable use the oceans, seas and marine resources for sustainable development

EEfD's projects on coastal areas have studied the trade-offs between the generation of economic activities and conservation outcomes. Results generally have shown that it is possible to obtain preservation of marine resources and income generation simultaneously. Key factors for sustainable development are the involvement of local communities in the design of environmental regulations and the existence of clear economic incentives for the inhabitants so that comply with the rules. Policies have to care not only for conservation, but also seek for the generation of alternative sources of income and economic opportunities for the coastal population.

Lastly, EEfD plans to expand its research on coastal areas by identifying the role of mangroves on livelihoods in Honduras and El Salvador, as well as assess the economic costs of their restauration and the benefits they provide.

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Much of EEfD's work has been oriented towards the sustainable use and management of terrestrial ecosystems and forests. In this regard, EEfD has contributed in the design, implementation and improvement of forests conservation policies, such as PES schemes and protected areas. The center has also worked on the link between land degradation and agricultural activities by studying land-use determinants in a watershed in Peru. Lastly, through the elaboration of an economic assessment of several ecosystem services, the research team seeks that policymakers include these benefits into the Costa Rican accounting system.

For the future, EEfD plans to protect and promote a sustainable use of two watersheds in Jamaica by designing and implementing a PES scheme. In addition, the link between land-use management and availability of drinkable water in Uruguayan urban households will be researched.

Strengthen the means of implementation and revitalize the global partnership for sustainable development

EEfD permanently works with a variety of public and private institutions and organizations to seek sustainable development. Collaboration with national, regional and international partners has been a constant of the center at every stage of its research, from writing proposals until implementing projects. EEfD interacts with researchers from other universities and research

centers, as well as program officers from different organizations, such as Tropi-Dry, Conservation International and the International Development Research Center (IDRC). In addition, the center has, is and will carry out parallel research projects with other EFD centers in Africa, Asia and Europe to study key factors on a common matter that lead to different outcomes, generating North-South and South-South exchange of learnings.

Much of the projects at EEfD are developed in close cooperation with public institutions. This action has allowed the center to build a strong and stable network of stakeholders, particularly associated with the water and agriculture sectors. Because of this joint work, results obtained through EEfD research are communicated faster and more directly to the government and, thus, translated into public policies. Work with public entities has been carried out at local, regional and national levels in different Central American countries.

7. Conclusions

This Strategic Research Agenda assesses the relevance of past, current and future EEfD research in Central America. The purpose is to encourage the environmental and economic conditions in the region by improving policy design and increasing the impact of research activities through their alignment with national and regional policy needs.

This document identifies seven main sectors of concern in the policy discussions: climate change; water; land, ecosystems and biodiversity; pollution and transportation; agriculture; renewable energies; and coastal areas. Matters in each of these prioritized sectors are, however, many times intertwined with topics from another sector.

Results show that EEfD has been carrying out extensive research on climate change, the prioritized sector in the policy debate. The center has been particularly focusing its work on adaptation and risk management of water resources and agriculture, two other domains of great relevance in Central America. For the future, EEfD will give priority to three main topics in its research agenda, which the center considers to be key regional concerns and where its contribution to the policy debate can have greater influence. These three main areas of research are water; extreme and hydrometeorological events associated to climate change; and urban consumption decisions on water, transportation, electricity, and solid waste management. It is evident that the center has been and will continue developing economic and environmental research that fits together with national and Central American policy interests.

Taking in learnings from previous experiences has taught the EEfD team to seek for time synchronization between the phases of looking for donors, generating financing, elaborating research, and delivering results to policymakers. Time is an essential component to be considered in order to create an engagement of policy-makers and other relevant stakeholders. The research team also acknowledges the importance of providing a considerable amount of time as a follow-up phase of any project. Therefore, EEfD is planning its future research based on the creation of an agenda rather than concentrating on topics. This approach allows the center to give continuation and depth to its research, as well as to strengthen its relations with stakeholders.

In addition, the center has broadened its scope of work beyond the Central American region by carrying out research in other Latin American countries, as well as working simultaneously with other EfD centers in Africa, Europe and Asia. Collaboration with national, regional and international partners has been a constant of EEfD at every stage of its work, from writing proposals until implementing projects. This has been highly productive for the center. Some of the lessons from other regions apply to Central America. Additionally, the use of methodologies learned by the researchers within these interactions has also contributed in addressing relevant issues in the region. This has strengthened the relations of the center with other international institutions. Lastly, cooperation has also contributed to increase the incidence of EEfD research on the design and implementation of local and national policies.

Nevertheless, EEfD still faces some challenges. It is important that the center improves the communication with national and regional policy-makers, in order to increase its impact. There are also some areas of concern in Central America that are not being tackled by the center, particularly related to the energy, transportation and pollution sectors.

Reasons for not considering these matters might be because of lack of their identification as a priority or because it is out of the capacity of the center. In case of the former, the identification of these prioritized areas as a result of the current report will hopefully help EEfD consider these matters in future studies. In case of the latter, in order to address a broad policy relevant research agenda, the center faces the challenge of stretching its financial and human resources. For this, joint collaboration with partners is key.

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Annexes

Annex 1

Resorted sources				
Type of document	Regional reports		National reports	
	Institution	Checked documents	Institution	Checked documents
Policy	Central American Integration System (SICA)	*Regional environmental strategy 2015-2020 (2014) and 2010-2014 (2009) *Central American policy on integral risk management (2011) *Regional climate change strategy (2010) *Regional agriculture, environment and health strategy 2009-2024 (2008)	Ministry of Development/ Poverty	*National development/ poverty strategies: -Guatemala (2001) -Honduras (2001) -El Salvador: not found -Nicaragua (2011) -Costa Rica (2015)
	Central American Agricultural Council (CAC)	*Regional Agriculture Policy 2008-2017 (2007)	Ministry of Environment and Energy (Costa Rica)	*National environment strategy (2014) *Convention on the United Nations' framework on climate change (2014)
			Executive Secretary for the Planning of the Agriculture and Livestock Sectors (Costa Rica)	*Policies for the agriculture and livestock sectors, and the development of rural territories (2015) * National development plan (2014)
			Ministry of Agriculture and Livestock (Costa Rica)	*Strategic Plan 2015-2018 (2014)

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