TECHNICAL ASSISTANCE

Strengthening the climate change information system for decision-making in climate change vulnerability and adaptation strategies in Guatemala

A REVIEW OF RELEVANT EXPERIENCES AT GLOBAL AND REGIONAL LEVELS WITH RECOMMENDATIONS FOR THE DEVELOPMENT AND IMPLEMENTATION OF THE INFORMATION SYSTEM ON CLIMATE CHANGE IN GUATEMALA

Working Document 1

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ACRONYMS

AGAAI	Association of Mayors and Indigenous Authorities (Asociación de Alcaldes y Autoridades Indígenas)
AGEXPORT	Guatemalan Association of Exporters (Asociación Guatemalteca de Exportadores)
ANAM	National Association of Municipalities (Asociación Nacional de Municipalidades)
ARCA	Association for the Central American and the Dominican Republic Integration (Asociación Pro Integración Centroamericana y República Dominicana)
ASIES	Association of Research and Social Studies (Asociación de Investigación y Estudios Sociales)
ASOREMA	National Association of Non-Governmental Organizations of Natural Resources and Environment (Asociación Nacional de Organizaciones No Gubernamentales de Recursos Naturales y Medio Ambiente)
Banguat	Bank of Guatemala (Banco de Guatemala)
CALAS	Environmental and Social Legal Action Center (Centro de Acción Legal Ambiental y Social)
CATIE	Tropical Agricultural Research and Higher Education Center (Centro Agronómico Tropical de Investigación y Enseñanza)
CEA	Compendium of Environmental Statistics (Compendio Estadístico Ambiental)
CEMAT	Mesoamerican Center for Studies on Appropriate Technology (Centro Mesoamericano de Estudios sobre Tecnología Apropiada)
CEMEC	Monitoring and Evaluation Center, CONAP (Centro de Monitoreo y Evaluación, CONAP)
CICC	Inter-institutional Committee on Climate Change (Comité Interinstitucional de Cambio Climático)
CNCC	National Council on Climate Change (Consejo Nacional de Cambio Climático)
CONADUR	National Council on Urban and Rural Development (Consejo Nacional de Desarrollo Urbano y Rural)
CONAP	National Council of Protected Areas (Consejo Nacional de Áreas Protegidas)
CONRED	National Coordinator for Disaster Reduction (Coordinadora Nacional para la Reducción del Desastres)
CTCN	Climate Technology Centre & Network
DCBD	Dutch Caribbean Biodiversity Database
DTU	Technical University of Denmark
ES	ecosystem services
EWS	Early Warning System
FLACSO	Latin American Faculty of Social Sciences (Facultad Latinoamericana de Ciencias Sociales)
FUNCAFE	Fundation of Coffee for Rural Development (Fundación de la Caficultura para el Desarrollo Rural)
GBByCC	Group of Forests, Biodiversity, and Climate Change (Grupo de Bosques, Biodiversidad y Cambio Climático)
GCI - REDD+	Inter-institutional Coordination Group for REDD+ (Grupo de Coordinación Interinstitucional para REDD+)
GHG	Greenhouse gases
GIMBOT	Inter-institutional Group for Monitoring Forests and Land Use (Grupo interinstitucional de Monitoreo de Bosques y Uso de la Tierra)
IARNA	Institute of Research and Projection on Natural Environment and Society (Instituto de Investigación y Proyección sobre Ambiente Natural y Sociedad)
ICC	Private Institute of Research on Climate Change (Instituto Privado de Investigación en Cambio Climático)
IGN	National Geographic Institute (Instituto Geográfico Nacional)
INAB	National Institute of Forestry (Instituto Nacional de Bosques)
INDC	Intended Nationally Determined Contribution
INE	National Institute of Statistics (Instituto Nacional de Estadística)
INSIVUMEH	National Institute of Seismology, Volcanology, Meteorology, and Hydrology (Instituto Nacional de Sismología, Vulcanologia, Meteorología e Hidrologia)

LMCC	Framework Law of Climate Change (Ley Marco de Cambio Climático)
MAGA	Ministry of Agriculture, Livestock, and Food (Ministerio de Agricultura, Ganadería y Alimentación)
MARN	Ministry of Environment and Natural Resources (Ministerio de Ambiente y Recursos Naturales)
MCIV	Ministry of Communications, Infrastructure and Housing (Ministerio de Comunicaciones, Infraestructura y Vivienda)
ME	Ministry of Economy (Ministerio de Economía)
MEM	Ministry of Energy and Mines (Ministerio de Energía y Minas)
MICCG	Indigenous Board of Climate Change (Mesa Indígena de Cambio Climático)
MNCC	National Board on Climate Change (Mesa Nacional de Cambio Climático)
MRV	Monitoring, Reporting, and Verification
NAMA	Nationally Appropriate Mitigation Action
OCSE-Ambiente	Sectoral Coordinating Office for Environment Statistics (Oficina Coordinadora Sectorial de Estadísticas de Ambiente)
OECD	Organisation for Economic Co-operation and Development
PANCC	National Action Plan for Adaptation and Mitigation (Plan de Acción Nacional de Adaptación y Mitigación)
REDD	Reducing Emissions from Deforestation and Degradation
REDFIA	National Network for Training and Environmental Research (Red Nacional de Formación e Investigación Ambiental)
SCAEI	Environmental and Economic Accounting System of Guatemala (Sistema de contabilidad Ambiental y Económica de Guatemala)
SCEP	Secretariat of the Executive Coordination of the Presidency (Secretaría de la Coordinación Ejecutiva de la Presidencia)
SEGEPLAN	Secretariat of Planning and Programming of the Presidency (Secretaría de Planificación y Programación de la Presidencia)
SGCCC	Guatemalan System of Climate Change Sciences (Sistema Guatemalteco de Ciencias del Cambio Climático)
SIA	Environmental Information System (Sistema de Información Ambiental)
SIFIGUA	Forest Information System of Guatemala (Sistema de Información Forestal de Guatemala)
SIPECIF	National System for the Prevention and Control of Forest Fires (Sistema Nacional de Prevención y Control de Incendios Forestales)
SNIACC	National System for Climate Change Adaptation Indicators of Colombia (Sistema Nacional de Indicadores de Adaptación Cambio Climático de Colombia)
SNICC	National Climate Change Information System (Sistema Nacional de Información de Cambio Climático)
UG	University Galileo
UIACC	Environmental Information and Climate Change Unit (Unidad de Información Ambiental y Cambio Climático)
UMG	University Mariano Gálvez
UN Environment	United Nations Environment Programme
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
URL	University Rafael Landívar
USCG	University of San Carlos of Guatemala
UVG	Universidad del Valle Guatemala
WENR	Wageningen Environmental Research

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Introduction

The Guatemalan Ministry of Environment and Natural Resources (MARN) has two information systems for making decisions on climate change: the Environmental Information System (SIA) and the National Climate Change Information System (SNICC). The MARN has identified the costs of information technology and the acquisition of skills for the responsible staff as challenges for the implementation and operation of these systems. For this reason, in 2015 the Government of Guatemala requested technical assistance from the Climate Technology Centre & Network (CTCN) under the auspices of "Strengthening of the Climate Change Information System for decision-making in vulnerability and adaptation strategies to climate change in Guatemala." Wageningen Environmental Research (WENR) was contracted by CTCN to implement this assistance between 2017 and 2018, in collaboration with MARN's Environmental Information and Climate Change Unit. This assistance includes the following products:

- Document on relevant experiences in other countries and recommendations for Guatemala
- Narrative description of the conceptual framework showing the possible information flows required for the SNICC adaptation components and climate science, as well as the potential sources of information and users.
- Indicator measurement protocols
- Indicator values and their validation
- Updated technical report on the use of climate change and/or environmental information platforms for decision making (focused on the use of open source platforms)
- Recommendations for System operation in Guatemala, based on an information exchange workshop.

This document is the first product of the technical assistance. Its objective is to analyze relevant experiences in the development and implementation of national environmental and climate change information systems in other countries to identify lessons learned and recommendations for the System in Guatemala.

The creation of national systems related to climate change has gained momentum in recent years, but as will be seen below, few systems have gone beyond the beginning stages of defining the conceptual framework and designing the indicator structure. The same happened with the systems of environmental indicators and sustainable development decades ago. Therefore, this document and the rest of the technical assistance have a practical approach for the definition of the conceptual framework, the selection of an efficient set of indicators and the design and implementation of mechanisms to access, exchange and use information.

This document is organized as follows:

- Section 1: An overview of the legal and institutional context for the development of the SNICC.
- Section 2: Scope and approaches of two groups of climate information management experiences at a global and regional level. The first group includes national systems of adaptation indicators from twelve countries; the design and implementation processes of these systems have been systematized by different international cooperation entities. Therefore, this document is based on these reviews. The second group includes systems and platforms for climate change indicators and biodiversity management in five countries; in this case, the systematization comes from a direct review of materials generated by these experiences.
- Section 3: Contrast of the main challenges for SNICC implementation (identified based on Section 1) with the lessons emerging from the experiences reviewed (identified based on Section 2).

The authors are grateful for the collaboration of MARN staff and the valuable contributions they made to the preliminary version of this document.

1 The context of the National Climate Change Information System in Guatemala

1.1 Introduction

In 2013, the legal basis for the creation of the National Climate Change Information System (SNICC) was established in Guatemala, which led to actions to establish its institutional framework, operation, design and start-up standards. This section summarizes these advances, presenting the current legal and institutional context panorama for the SNICC development.

1.2 The legal framework for the SNICC creation and operation

System creation

- The Framework Law of Climate Change (LMCC, DL 7- 2013) creates the SNICC and ascribes it to the MARN (Republic of Guatemala Congress 2013).

Priority themes and indicators defined by public policies and strategies

- The National Climate Change Policy defines as priority issues the vulnerability reduction of extreme national events, adaptation capacity reinforcement, greenhouse gases (GHG) emissions reduction and efficient use of carbon markets (MARN 2009).

- The General Government Policy 2016-2020, which establishes this period priorities and public management guidelines, includes the following strategic result: "By 2019, the capacity for resilience and adaptation to climate change has increased in the country. "(Government of the Republic of Guatemala 2016).

- The National Development Plan K'atum Nuestra Guatemala 2032 (CONADUR 2014) establishes goals, results, and indicators for forests and biodiversity conservation and sustainable use, water resources sustainable management, land use planning, agricultural production, solid waste integral management, renewable energy among other climate change adaptation and mitigation strategies.

- The National Action Plan for Adaptation and Mitigation (PANCC, Climate Change National Council & SEGEPLAN 2016) provides guidance to meet LMCC objectives and establishes monitoring progress indicators in:
  - Adaptation: human health, marine-coastal zones, agriculture, livestock and food security, forest resources, ecosystems and protected areas, infrastructure and water resources integrated management
  - Mitigation: energy, industrial processes, agricultural waste, land use, land use change and forestry

- The National Forestry Landscape Restoration Strategy 2015 - 2045 (Forest Landscape Restoration Table of Guatemala 2015) promotes the reduction of deforestation and forest degradation emissions; through forest conservation, sustainable management and restoration, increase of forest reserves, reforestation, and promotion of agroforestry systems. An institutional goal consultancy is currently being developed with GIZ´s support.

- It is expected that Guatemala's National REDD + Strategy (under development) will also provide inputs to establish SNICC indicators.

Priority themes and indicators established by international commitments

- The ratification of the United Nations Framework Convention on Climate Change (UNFCCC) establishes the commitments to submit national communications and biennial reports (BUR). The Intended Nationally Determined Contribution (INDC, Government of Guatemala 2015) establishes as a goal the reduction of GHG emissions from forests and changes in land use, agriculture, and transportation and adaptation priorities in: human health, marine-coastal zones, agriculture, livestock and food security, forest resources and protected areas, strategic ecosystems conservation

and management, infrastructure, water resources integrated management, productive infrastructure quality, soil protection and integral disaster management.

- Adhesion to the Bonn Challenge on forests, climate change and biodiversity (20x20 initiative) with a 1.2-million-hectare goal of degraded forests restored by the year 2020 (Board of Forest Landscape Restoration of Guatemala 2015).

- Adhesion to the WAVES initiative, a global alliance led by The World Bank, to incorporate natural capital accounting in development and environmental planning, as well as in economic and social policies. SEGEPLAN, the Ministry of Public Finances, MARN, and INE participate in this initiative implementation in the country (The World Bank 2017).

1.3 Institutional framework

The entity in charge and regulation of the SNICC

- The MARN Ministerial Agreement 5-2016 establishes the SNICC regulation, whose objective is to regulate procedures and mechanisms to collect, systematize, analyze and present information related to climate change (MARN 2016). This regulation stipulates that the SNICC will be made up of three subsystems focused on: climate science, vulnerability and adaptation, and GHG emissions and removals (see Figure 1). This regulation establishes that:
  - Protocols for collecting, processing, analyzing and exchanging information will be developed in a participatory manner.
  - Information provided by the SNICC should contribute to improving Early Warning Systems (EWS), emergency situation preparation, risk management and community, livelihood and ecosystem resilience.
  - Subsystem emission mitigation and removals will include preparation of collection, processing and exchange protocols for GHG inventory preparation.
  - Technical instances should be created to information review and analyze, as well as distribution and dissemination mechanisms.

- MARN Ministerial Agreement 8-2017 creates and defines **Environmental Information and Climate Change Unit (UIACC) functions**, among which are: managing the Environmental Information System (SIA) and SNICC, and coordinating the development of the manual and instructive for their procedures. The UIACC is part of the Vice Ministry of Natural Resources and Climate Change of MARN (Figure 2). A diagnosis commissioned by GIZ (Regalado & Araujo 2015) defines specific posts need for SNICC coordination at the computer, technical and operational level, as well as budget allocation. Currently, the UIACC has three workstations, one for Geographic Information Systems and two servers managed by the IT department of MARN.

Relationship with other monitoring systems

- The **SIA** it is also in charge of the UICC. The SIA includes nine topics: water, soil, atmosphere, natural ecosystems, risk to natural hazards, solid waste, pollution by noise and socioeconomic indicators; its manual contains descriptive cards of 43 indicators (MARN 2003). Each card considers the indicator name, thematic axis, type of indicator within the State-Pressure-Impact-Response framework, entity in charge of measurement, definition, and purpose, unit of measurement, geographical scale of measurement, periodicity, limitations, methodological description, references to methodological resources and reference values. The link between the SIA and the SNICC is essential to avoid effort duplication, manage resources and coordination among organizations

- The **National System of Monitoring and Information on GHG Emissions** is being developed by a consultancy in support of the REDD+ project (MARN 2017). The Geoportal of the SIREDD is available at https://siredd.marn.gob.gt/geoportal.

- **National policies, plans, and strategies** focus on adaptation and mitigation of the country's climate change need to monitor their progress, results, and impacts. See indicative aspects of interest in the preliminary synthesis of these instruments in Annex 1.

Figure 1. Components of the National Climate Change Information System (Source: material provided by MARN)

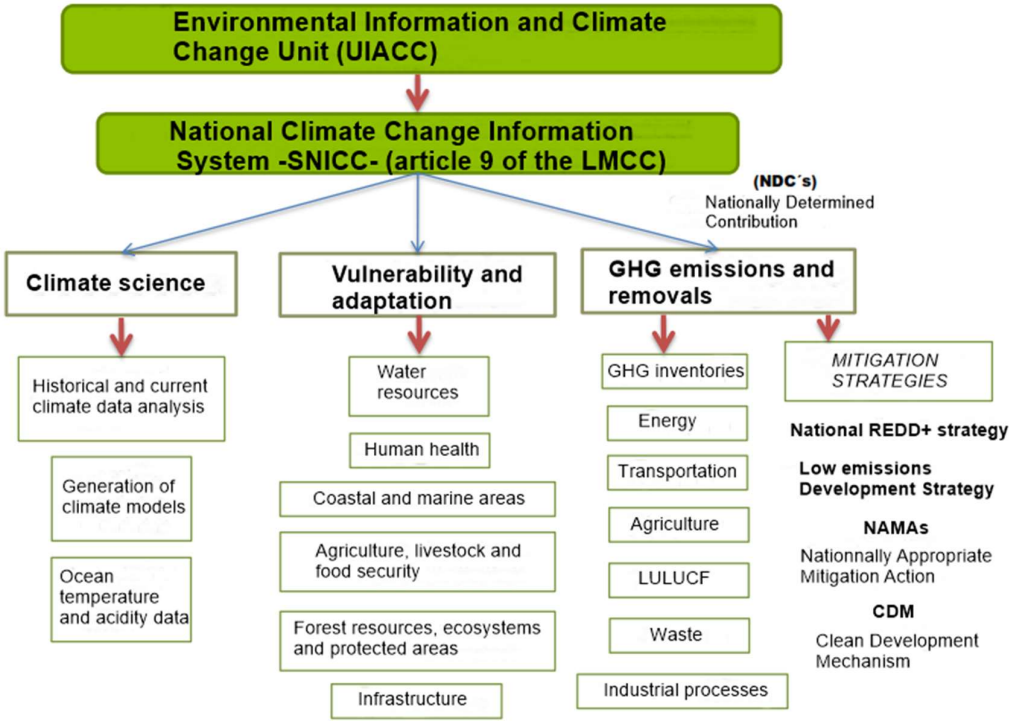
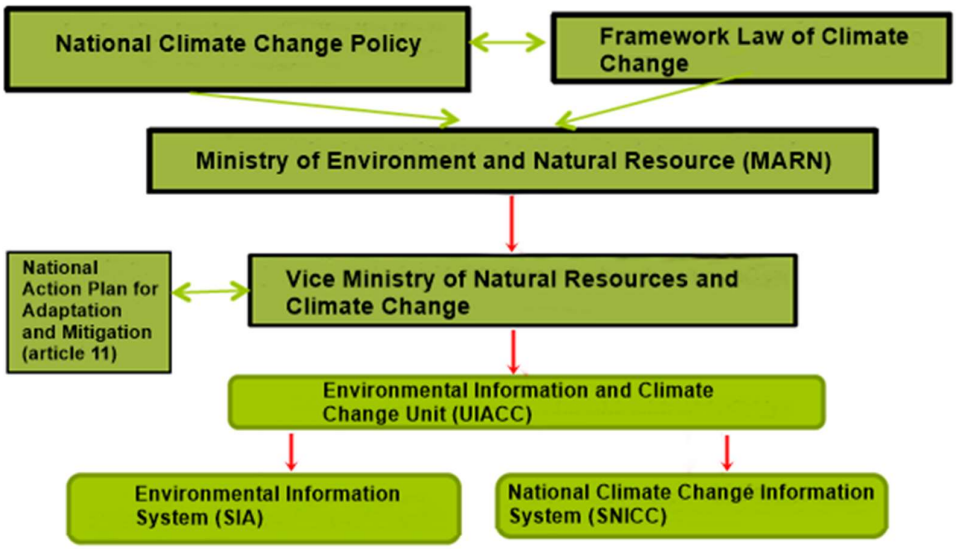


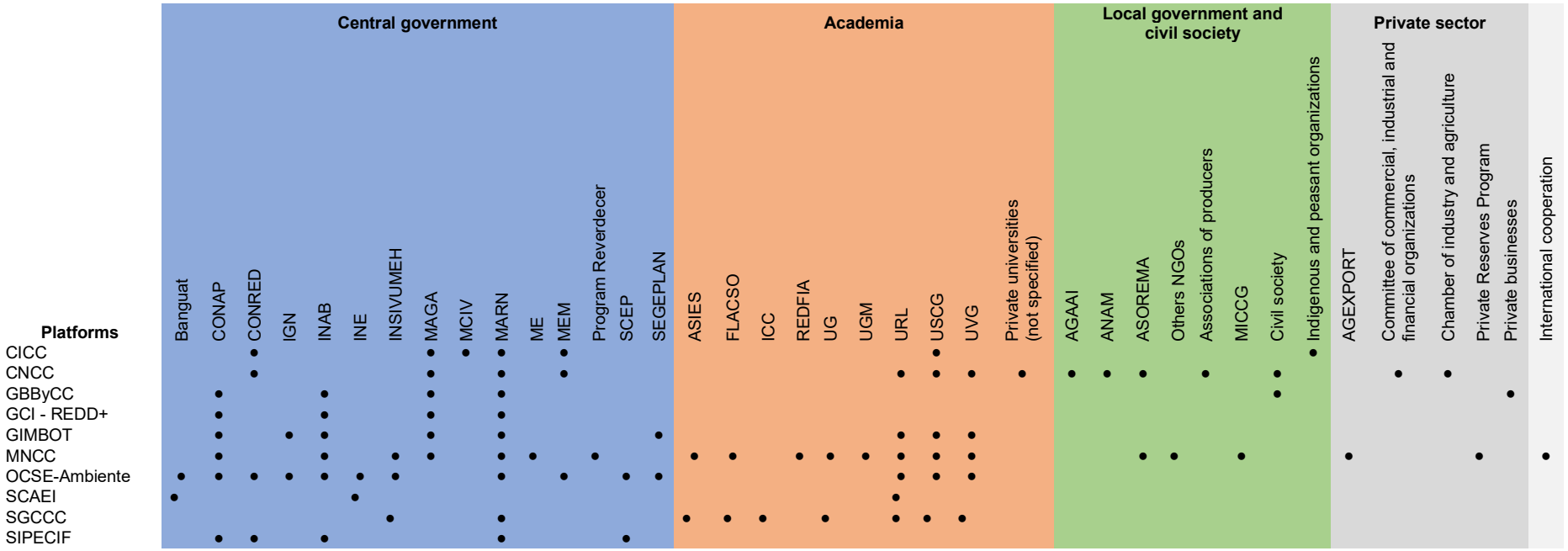
Figure 2 Governance scheme for MARN information systems in accordance with current legislation (Source: Regalado 2016)



Inter-institutional coordination

- There are several institutional coordination platforms related to climate change (Table 1). The Inter-institutional Group for Monitoring Forests and Land Use (GIMBOT) and the Sectoral Coordinating Office for Environment Statistics (OCSE-Ambiente) are the most suitable to support the SNICC, according to Regalado & Araujo (2015). Its suitability to support the development of the SNICC must be evaluated, considering, among other factors, the effective participation of organizations from the governmental sector, academia, civil society and the private sector and congruence of its objectives and structure with the SNICC.

Table 1. Climate change related coordination platforms and the organizations that compose them (compiled by the authors).



Platforms: CICC - Inter-institutional Committee on Climate Change, CNCC - National Council on Climate Change, GBByCC - Group of Forests, Biodiversity, and Climate Change, GCI – REDD+ - Inter-institutional Coordination Group for REDD+, GIMBOT - Inter-institutional Group for Monitoring Forests and Land Use, MNCC - National Board on Climate Change, OCSE-Ambiente - Sectoral Coordinating Office for Environment Statistics, SCAEI - Environmental and Economic Accounting System of Guatemala, SGCCC - Guatemalan System of Climate Change Sciences, SIPECIF - National System for the Prevention and Control of Forest Fires

Organizations: Banguat - Bank of Guatemala, CONAP - National Council of Protected Areas, CONRED - National Coordinator for Disaster Reduction. IGN – National Geographic Institute, INAB - National Institute of Forestry, INE - National Institute of Statistics, INSIVUMEH - National Institute of Seismology, Volcanology, Meteorology and Hydrology, MAGA - Ministry of Agriculture, Livestock, and Food, MARN - Ministry of Environment and Natural Resources, MCIV - Ministry of Communications, Infrastructure and Housing, ME - Ministry of Economy, MEM - Ministry of Energy and Mines, SCEP - Secretariat of the Executive Coordination of the Presidency, SEGEPLAN - Secretariat of Planning and Programming of the Presidency, ASIES - Association of Research and Social Studies, FLACSO - Latin American Faculty of Social Sciences, ICC - Private Institute of Research on Climate Change, REDFIA - National Network for Training and Environmental Research, UG - University Galileo, UMG - University Mariano Gálvez, URL - University Rafael Landívar, USCG - University San Carlos de Guatemala, including CECON – Center for Conservationist Studies in the MNCC, UVG - Universidad del Valle de Guatemala, AGAAI - Association of Mayors and Indigenous Authorities, ANAM - National Association of Municipalities, ASOREMA - National Association of Non-Governmental Organizations of Natural Resources and Environment, MICCG - Indigenous Board of Climate Change, AGEXPORT - Guatemalan Association of Exporters.

Others NGOs include: Calmecac Foundation, CEMAT - Mesoamerican Center for Studies on Appropriate Technology, Solar Foundation, KukulKan, The Nature Conservancy, Rainforest Alliance; Conservation International, Environmental Advocacy Institute, A´tita La, Fundaeco, Defensores de la Naturaleza, ARCA - Association for the Central American and the Dominican Republic Integration, Bosque Tropical Foundation, Verapaz Association, CALAS - Environmental and Social Legal Action Center, FUNCAFE - Foundation of Coffee for Rural Development, and CARE

2 Selected global and regional experience description for lesson learned identification

2.1 Introduction

This section describes two groups of experiences. The first group includes national systems indicators on adaptation and vulnerability from twelve countries; in this case, the design and implementation processes have been systematized by different entities, so this document takes these revisions as the main source. The second group includes indicators systems and systems and information platforms of five countries; in this case, the systematization comes from a direct review of materials generated by these experiences.

The first group focuses on adaptation and vulnerability systems because there are different conceptual frameworks, with metrics not yet standardized and with less implementation experience. In contrast, the mitigation metrics are standard, and several countries have Monitoring, Reporting and Verification (MRV) systems to fulfill the commitments acquired when ratifying the UNFCCC, such as GHG inventories and biennial reports. The emission monitoring systems of the European Environmental Agency, Germany, Mexico, and Peru are just some examples at regional and national level

2.2 National adaptation indicator systems

Due to the growing importance of adaptation as a public policies priority, in the last few years, three cooperation and development agencies have commissioned reviews of adaptation indicator systems that together cover twelve countries (Table 2):

- "Monitoring and evaluating adaptation at aggregated levels: A comparative analysis of ten systems" (Hammill & Dekens 2014) from the German Technical Cooperation (GIZ) considers the context, the institutions in charge, and the results and products of each system.

- "Good practice in designing and implementing national monitoring systems for adaptation to climate change" (Naswa et al. 2015) identifies designing and implementing lessons as part of the technical assistance to the Government of Colombia given by the Partnership between UN Environment and the Technical University of Denmark, and the Tropical Agricultural Research and Higher Education Center (CATIE) within the framework of CTCN. This document takes this systematization and the experience developed in Colombia as a basis.

- "National Climate Change Adaptation Framework: emerging practices in monitoring and evaluation" (OECD 2015) contrasts monitoring frameworks and experience in establishing baselines. "Perspectives of national adaptation monitoring and evaluation systems" (Vallejo 2017) from the OECD climate change expert group complements that review.

Table 2. National systems of climate change indicators included in global reviews (Sources: Hammill & Dekens, 2014; Naswa et al., 2015; OECD, 2015)

Country	National system name	CTCN	OECD	GIZ
Australia	National Adaptation Assessment Framework	●	●	●
France	National Adaptation Plan	●	●	●
Germany	Strategy for Adaptation	●	●	●
Kenya	National Climate Change Action Plan	●	●	●
Mexico	Climate Change Information System	●		
Morocco	Regional Environmental Information System	●		●
Mozambique	National Strategy for Adaptation and Mitigation of Climate Change	●		●
Nepal	Climate Change Support Programme	●		●
Norway	Action Plan for Adaptation	●		●
Philippines	National Climate Change Action Plan	●	●	●
South Africa	National Climate Change Response Monitoring and Evaluation System Framework	●		
United Kingdom	Climate Change Risk Assessment	●	●	●

Indicators. These systems track different sets of indicators; the most common are those that focus on adaptation actions and products, generally related to national and sectoral plans (Table 3). A summary of the resources and their degree of implementation is presented in Table 4.

Table 3. Indicative aspects used in national systems of climate change indicators (Adapted from Hammill & Dekens 2014, updated with data from Naswa et al. 2015, OECD 2015, Vallejo 2017 and national publications)

Country	Climate trends and climate change impacts	Exposure and vulnerability	Adaptation process (actions, outputs)	Adaptation outcomes	Budget	Emissions
Australia			•	•		
France			•			
Germany	•	•	•	•		
Kenya		•	•	Adaptive capacity		
Mexico	•	•	•			•
Morocco	•	•	•	•		
Mozambique	•		•	•	•	
Nepal			•	•		
Norway		•		Adaptive capacity		
Philippines			•	•		
South Africa	•		•		•	•
United Kingdom	•	Risk factors	•			

Table 4. National systems of climate change indicators: resources used and degree of implementation (Adapted from Hammill and Dekens 2014, updated with data from Naswa et al. 2015, OECD 2015, Vallejo 2017 and national publications)

Country	Resources	Degree of implementation
Australia	No information	In review
France	Use of available and easily accessible data, a person for coordination	In operation
Germany	Intensive use of resources (11 experts), databases and existing M&E systems	In review
Kenya	Intensive use of human resources, data available at the governmental level, involves collection new information	In the process of establishment
Mexico	Use of available data	In operation
Morocco	Integration with existing systems, use of available data, indicators not available for subsequent phase	In development
Mozambique	No information	In development
Nepal	Use of existing resources (at the project level)	In operation
Norway	Use of existing initiatives and structures and available information	In operation
Philippines	Intensive use of human resources, ideally using existing data	In final validation stage
South Africa	No information	In operation
United Kingdom	Intensive use of human resources, use of existing data	In operation

The comparison of the systems made by Hammill and Dekens (2014) shows aspects in common but also differences that condition the progress in their effective implementation (Table 5). The latter is related to the emphasis of its content (the monitoring of actions and products requires fewer resources), the information sources (use of accessible compiled data versus new information generation), the diversity of functions (follow-up report production and special studies outsourcing such as vulnerability analysis to other specialized teams) and, of course, to the operation resources allocation.

2.3 Other monitoring and dissemination initiatives of climate change indicators

This group of initiatives includes indicator systems and information systems and platforms (see definitions in Table 6) of three countries and two regions (Table 7). Due to the practical approach of this document, experiences that were selected have available information about their purposes, institutional arrangements and necessary resources for their operation. Since there are few information systems already implemented, sustained over time and that produce decision making information, an experience related to environmental indicators that began in 2016 in the Netherlands Antilles is also included.

Table 5. Elements of national systems for climate change indicators (adapted from Hammill and Dekens 2014).

Scope	Factors	Aspects
Context	What is the source of the mandate?	• Legal norms / laws • Policies or adaptation plans • International commitments (IPCC, NDC, and other reports)
	Why? For what?	• Objective and timely information to formulate and prioritize adaptation measures or to adjust those that are already underway (decision making) • Knowledge management (collecting, organizing, storing and sharing information) around the field of climate change
	At what level(s)?	• National and or subnational (for example, municipalities) • Priority Sectors
Process	Who is in charge?	• Environmental ministries to develop and coordinate the system • Strong demand for inter-ministerial coordination
	How long does it take to start up? Why?	• Long processes for its establishment (2 to 5 years) • Agreements and responsibilities to establish links with other systems (such as population statistics or agricultural production) that possess information • Underestimation of resources and capacities for establishment & operation • New topic that requires learning and review processes
	What is the cost?	• Costs not available: most are in development, associated with other systems, personnel have other assigned functions, or its development is combined with other processes such as national adaptation plans
Content	What is emphasized?	• Monitoring the effects of adaptation plans • Execution of activities – budget • Context • Hybrids
	What is monitored?	• Climate change indicators and their impacts, exposure, vulnerability, process, and results of adaptation, budget, and emissions • Links with other systems on socio-economic & environmental contexts indicators
	What sources are used?	• Existing and easily accessible data versus collection and aggregation of indicators, including the generation of new information
	How are results disseminated?	• Progress reports (activity execution, product procurement, budget spending) • Periodic assessments of vulnerability and impact of actions • Online data distribution platforms

Table 6. Operational definitions for the set of indicators and the information system on climate change for Guatemala (prepared by the authors)

Concept	Definition	Examples
Variable	• The measurement of an attribute (such as the area, volume or cost) of an object	• Forest cover (km²)
Data	• A piece of specific information of a variable, with specific geographic and temporal references	• Forest cover (km²) per municipality in 2010
Indicator	• A specific, observable, and measurable characteristic that shows the state of a social or environmental process or of a planned action. • A standardized unit of measure that summarizes relevant information about a phenomenon based on repeated measures (Verweij et al., 2015) • The definition of an indicator depends on the purpose of its use and the context. In some cases, the data is simply the indicator itself; in others, the indicator requires a comparison of data at different times to give an idea of the change.	• Recovery of forest cover (km²) between 2010 and 2015 • The proportion of reforested hectares of mangroves in relation to planned reforestation (process) • The total cost of building dikes for a project (result) • Number of homes protected from flooding due to dikes that were built (impact)
Index	• Aggregation of indicators that show some property (such as diversity) in a single number.	• Human development index
Information System	• Integrated by the conceptual framework that organizes indicators for specific uses and users, as well as norms and procedures for effective monitoring and reporting • Facilitates the visualization and integration of the information, integrates new functionalities according to user demand and reporting obligations. This is why it should be based on open source, simple and flexible programs.	• Pressure – State – Response (PER) model
Information platform	• Virtual space with functionalities to access, share, exchange and use indicators and other information sources, such as reports and publications. • Allows for the creation of reports on indicators with different visualization resources such as maps, graphs and charts. • Gives information on the scope and limitations of the indicators (e.g., information sources, spatial aggregation and time range)	• FAOSTAT (FAO) • Global Development Indicators (World Bank)

Table 6 (continues)

The set of indicators, the information system, and the platform must: • **ensure the production of information** to mitigate the effects of development on climate change, adapt to variability and climate change and assess risks and vulnerability to natural disasters, food security and water scarcity. • reduce the difficulties in scaling up the results and the findings of projects and actions at different scales in order to contribute to the **evaluation of impacts and monitoring of ongoing processes** • **close the gap** between researchers, decision-makers and the most vulnerable **populations in relation to knowledge and priorities**. This will reduce the asymmetries to access, exchange, use, and share data, information, methods and tools. • help to move **from reactive responses** based on emergencies **to proactive actions** based on the assessment of vulnerability and risks.

Table 7. Selected experiences of systems of indicators, information systems, and information platforms

Level	Country or region	Initiative
System of indicators	Colombia	• National System for Climate Change Adaptation Indicators in Colombia (SNIACC)
Information systems	Chile	• Design of Biodiversity and Climate Change Monitoring Network
	Netherland Antilles	• Indicators of the status and trends of ecosystems in the Netherlands Antilles (Dutch Caribbean Biodiversity Database: DCBD)
Information platforms	Brazil	• AdaptaClima: Knowledge Platform on Climate Change Adaptation
	EU	• Climate-Adapt: European Climate Adaptation Platform

Indicators. The initiatives monitor different sets of indicators (Table 8) based on the adopted conceptual framework. The National System for Climate Change Adaptation Indicators of Colombia (SNIACC) adopted the conceptual framework of standard risk analysis proposed in the Fifth Report of the Intergovernmental Panel on Climate Change (IPCC 2014). This framework changes the list of factors used for the calculation of vulnerability and has not been implemented much in practice. Other experiences built conceptual frameworks more appropriate to their objectives and needs. Chile's Biodiversity and Climate Change Monitoring Network built a conceptual framework based on the relationships among the ecological integrity of ecosystem services and biodiversity, their uses in society, climate change and biotic changes (MMA et al. 2016). The DCBD system in the Netherlands Antilles focuses on pressures, threats, and the status of important ecosystems and flagship species: which provide the information needed to prepare reports for international conventions such as the Convention on Wetlands (Ramsar) and the Convention on the Conservation of Migratory Species of Wild Animals (Verweij et al. 2015).

The data interface of Brazil's AdaptaClima does not have an explicit conceptual framework, although it does contain elements of the vulnerability concept included in the Fourth Report of the IPCC. The interface contains indicators and indexes around exposure and the status of resources related to water scarcity, to support adaptation initiatives. Likewise, other sections of the platform display practical guidelines for developing adaptation strategies. The European Climate Adaptation Platform (Climate-Adapt) is a partnership between the European Commission and the European Environment Agency, with the aim of supporting member countries in adapting to climate change. The platform helps users access and share data around: forecasted climate change information in Europe, current and future vulnerabilities in different regions and sectors, national and transnational EU strategies and adaptation actions, case studies on adaptation and possible adaptation options, and the use of tools that support adaptation planning.

Uses and users. The main audience for the indicators and information systems are public sector officials who use it for planning, monitoring the impact of policies and projects (Colombia and Chile) and reporting for international agreements (Netherlands Antilles). The platforms contain information of interest for the public sector, but they are designed to also share data with a wider audience for the dissemination of adaptation options.

Table 8. Indicative aspects used in the experiments (prepared by the authors)

Initiative	Climate trends, CC impacts, and other pressures	Exposure and vulnerability	State of the resources	Adaptation processes	Adaptation options
SNIACC Colombia	Climate trends	Population and resources in places potentially affected by climate trends	Observed impacts of the climate on the population and its resources	Adaptation sectoral actions	
Chilean Biodiversity Network	Climatic pressures and effects on abiotic factors, non-climatic pressures		State of ecosystems and species		
DCBD	Climatic and non-climatic pressures		State of ecosystems and species		
AdaptaClima			Socioeconomic context Drought vulnerability index Water supply and storage capacity		Studies, tools and methodologies
Climate-Adapt	Climatic impacts	Current and future vulnerability of regions and sectors		Adaptation strategies and actions	Case studies and adaptation options

Institutional arrangements. All initiatives are (or will be) coordinated by a government agency (usually by the ministry of the environment) and all include actors from other government organizations as well. Except for the case of Colombia, all of the initiatives incorporate the private sector, recognizing that the private sector can be a user and an information provider (Table 9). Based on the idea that it is best to work as a network and to avoid information centralization in one single organization, the Biodiversity Network of Chile establishes several recommendations for the development of instruments to facilitate the exchange and access to information. In this case, each organization reviews its data and provides the measured indicators following the protocols agreed to with the coordinating organization. The initiatives underway do not explicitly explain how they establish agreements for data exchange and access to information, but in practice, they integrate indicators and indexes from other organizations, and they have websites open to the public in order to distribute information.

Resources. The Biodiversity Network of Chile displays a description of functions for specialists in different areas: database administrator, GIS and remote sensing administrator, technical administrator and legal advice. In addition, it describes the requirements and options for collecting data in the field, and processing, storing and exchanging information. These descriptions can be used for cost estimation and fund management.

Degree of implementation. Neither SNIACC Colombia nor the Chilean Biodiversity Network have passed the design phase. Both experiences defined their conceptual framework and a preliminary list of indicators with measurement protocols. SNIACC carried this task out it in a more traditional way, with a workshop that defined a broad list of indicators: whereas in Chile an analysis was carried out on the supply and demand of information, using interviews with users and information providers. SNIACC Colombia has a first measurement of its indicators (baseline) which was a valuable practical exercise to adjust the indicators; the design of the Chilean Biodiversity Network focused on defining and reviewing quality standards and information requirements with the participation of possible network partners.

DCBD provides a central repository for research and monitoring data and products (reports, articles and other documents related to research and monitoring of biodiversity, education, and outreach). Its objective is to guarantee the access and availability of long-term data, support nature management and facilitate international reporting obligations. The structure of the DCBD is based on a GIS-based mapping functionality and a literature file.

Table 9. Main actors and exchange mechanisms and access to information for the reviewed initiatives (prepared by the authors)

Initiative	Actors and functions	Mechanisms for exchange and access to information
SNIACC Colombia	Coordinates: Climate Change Directorate. Participates: other agencies of the Ministry of Environment and Sustainable Development, other ministries, the National Planning Office and public research institutes.	Not established
Chilean Biodiversity Network	Coordinates: the Division of Natural Resources and Environmental Biodiversity, Ministry of the Environment, the Network is integrated into the National Environment Information System. Participates: providers from the public and private sector.	Recommendations for the development of protocols, agreements, and contracts for collection, analysis, storage, data exchange and reporting
DCBD	Coordinates: Environmental Agency and Ministry of Foreign Affairs. Participates: Ministry of Economic Affairs, Statistics Netherlands, academia and local conservation organizations, incorporated into the Dutch Caribbean Nature Alliance.	Only partners can enter data, but access is open to the platform and its products (such as reports for international agreements). The platform is shared by everyone. Each indicator has a space for technical feedback.
AdaptaClima	Coordinates: Ministry of the Environment Organized participation with Advisory committee of government, business, academic and international cooperation sectors Thematic partners: content evaluation and updating Mobilizing partners: platform dissemination	They share geo-referenced data from the Brazilian Institute of Geography and Statistics, Ministry of the Environment, Ministry of National Integration, WWF Brazil, and the National Water Agency. Any registered user can contribute contents. These are analyzed based on evaluation criteria, which serve to determine approval and modification needs.
Climate-Adapt	Directorate General for Climate Action of the EC, JRC through the Institute of Environment and Sustainability, the European Environment Agency and the European Thematic Center on the impacts of climate change, vulnerability and adaptation coordinate development and maintain the operation.	All member countries have access, and broad use and others have restricted use.

The Climate-Adapt platform organizes and makes information available to users under the following main entry points: Adaptation information (Observations and scenarios, Vulnerabilities and risks, Adaptation measures, National adaptation strategies, Research projects); EU sectoral policies (agriculture and forestry, biodiversity, coastal zones, disaster risk reduction, finances, health, infrastructure, marine and fisheries, water management); Tools (adaptation support tool, case study search tool, map viewer). The platform includes a user-friendly database with proven high-quality information.

Information products. DCBD, AdaptaClima, and Climate-Adapt have operational websites for consulting and distributing data, technical documents, and other products. The DCBD has graphs, maps, and downloadable data in Excel, based on the available information and the type of indicator, with the unit of analysis being each of the six islands of the Netherlands Antilles. The data interface of AdaptaClima presents the information at the national level (interactive maps) and municipal level (information sheets with human development indicators, the water supply situation, and a drought vulnerability index). The Climate-Adapt platform provides access to information at the regional, national and urban levels.

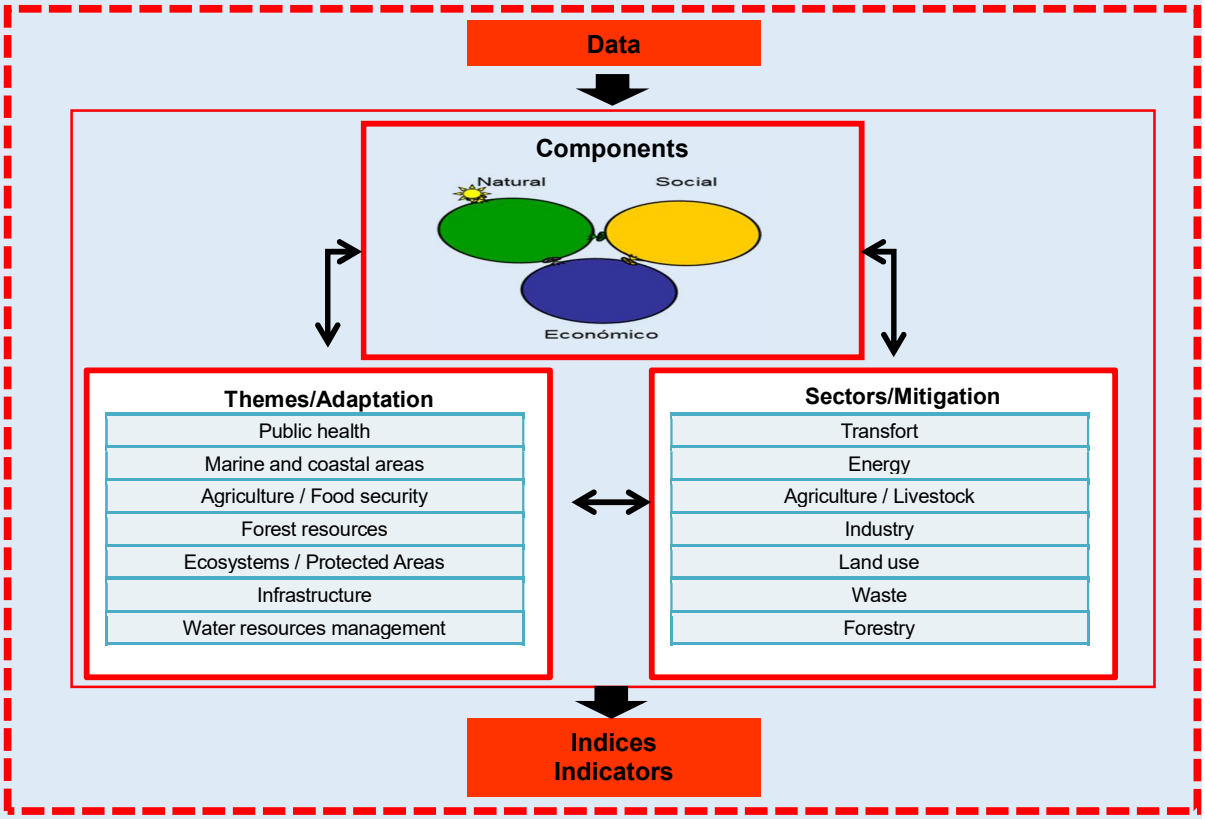
3 Challenges to SNICC implementation and emerging lessons from the reviewed experiences to face those challenges

Reviews of the experiences reveal lessons for SNICC strengthening, design, and implementation. This chapter contrasts the challenges for SNICC implementation (identified from the review of the information presented in Section 1) with the emerging lessons from the experiences presented in Section 2.

CHALLENGE 1 - DESIGN. To define the **conceptual framework** consistent with the country mandates, so that the system provides coherent and easy to interpret information on national and international goals, progress and commitments (first article of Decree 7-2017).

- ➔ Defining the **conceptual framework** is the first step in identifying the set of indicators. The framework defines the relationships among the indicators in a clear way for a more robust interpretation.
- ➔ The conceptual framework should facilitate **data integration** around mitigation, vulnerability and adaptation data in indicators and indices, to support decision-making and help monitor policies, plans, and actions. Data integration must take into consideration different sectors because the actions that favor vulnerability reduction, adaptation and mitigation are found at the local level and are intersectoral (Figure 3).

Figure 3. Conceptual framework to integrate data from different sources, scales, and formats, to produce appropriate information in function of user's needss. Prepared by the authors, based on Ministry Agreement 5-2016 and LMCC, Decree 7-2013.



CHALLENGE 2 - DESIGN. To choose a **suitable set of indicators** for the production of **useful, relevant and up-to-date information** that responds to user demand.

Once the conceptual framework is defined, the set of indicators should also be defined, taking into consideration the following steps so that the **SNICC supports decision-making**:

- ➔ Conduct **consultations** in appropriate spaces. Participatory spaces are crucial to ensure the representation of different interests and a political commitment to the System of indicators, but they must be carefully guided so as not to generate long lists of indicators that limit the efficiency, effectiveness, and sustainability of the System. In this regard, working groups and interviews have proven to be more efficient than workshops. In any case, the goal for any consultation and participation must be for participants to learn the objectives of the system, its conceptual framework and the resources available for its operation.
- ➔ Contrast the **demand** for information (what is relevant in the national context according to the defined conceptual framework and the information needs of decision-makers, rather than academic agendas or technology offers) and **supply** (acceptable quality information available from government, non-governmental and private sector sources, see Challenge 3).
- ➔ Ensure the **integration of issues, sectors, and components** related to climate change, and related policies, plans, and actions (Figure 4).
- ➔ Allow the **use of general indicators and detailed indicators** for planning, monitoring, and evaluation (Table 10).

Figure 4. Scheme for indicators integration in the information system, related to different themes, sectors, and components related to climate change (prepared by the authors, based on Olivier 2015)

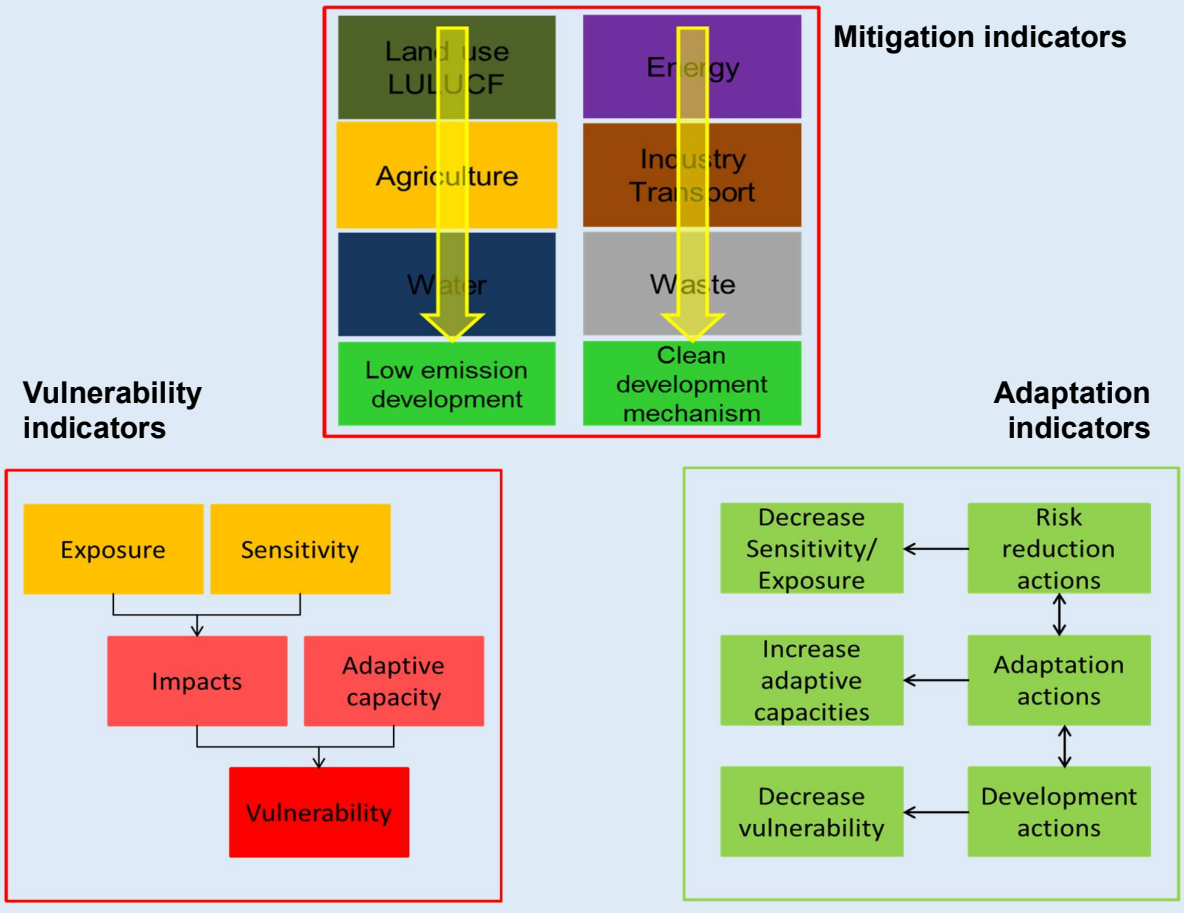


Table 10. Examples of indicators and climatic vulnerability indicators based on information available for pillars of development in Central America (prepared by the authors)

	Environment	Social	Economy
Índex	- Climate risk (risk areas for drought, floods, and landslides)	- Population risk (population at risk for drought, floods, landslides) - Social risk (poor population at risk for drought, floods, landslides)	- Infrastructure risk (risk to roads and power lines due to floods and landslides)
Indicator	- Frequency of natural disasters - Probability of natural disasters - Risk of floods - Risk of droughts - Risk of landslides - Location of fires - Land use	- Population in poverty - Population with access to health services - Population affected by natural disasters - Human losses due to natural disasters - Unsatisfied Basic Needs	- Economic losses due to disasters - Accessibility to markets - Accessibility to services - Infrastructure location

In summary, **the most useful set of indicators is the one that best meets user demand**. This set should permit the relationship among spatial entities (such as landscapes and watersheds) and administrative entities (such as municipalities and departments) to be evaluated, to know who is affected, where there are impacts, when, why and how they occur. This facilitates decision making in relation to regional strategies, national policies, and local actions.

CHALLENGE 3 - DESIGN. To choose **indicators** that capitalize on information collected by different organizations.

Several governmental organizations, NGOs, and academics collect data and generate useful information for the SNICC (Annex 2). Monitoring systems of government policy instruments are also potential information providers. However, there are no agreements or protocols for the exchange of information between different organizations.

The **choice of indicators should consider existing data** from different sectors of the government, private sector and civil society entities. The challenge is to strengthen institutional capacities to analyze information and reduce the effort in data collection. This implies:

- ➔ Ensure that users and producers of information participate.
- ➔ Map the **supply of information** through interviews with the personnel responsible for data management within government entities, academia, and the private sector
- ➔ In addition to determining what data there is and where it is, it is important to know the temporal and spatial coverage, the **degree of reliability and the storage format**.
- ➔ Based on the supply of information, **prioritize indicators measured with standard techniques** covering large areas; for example, remote image analysis to collect land use data, minimizing indicators that require direct measurement in the field.
- ➔ Consider **international sources** for climate science indicators.

The Environmental Statistical Compendium (INE) and the Guatemalan Environmental Profile (IARNA) integrate indicators from different sources and offer potential important lessons for data management.

CHALLENGE 4 - DESIGN. To consider spaces for **review and adjustment** of the set of indicators.

The monitoring of climate change indicators is a new field; therefore, the system's design and implementation process must be flexible to incorporate adjustments.

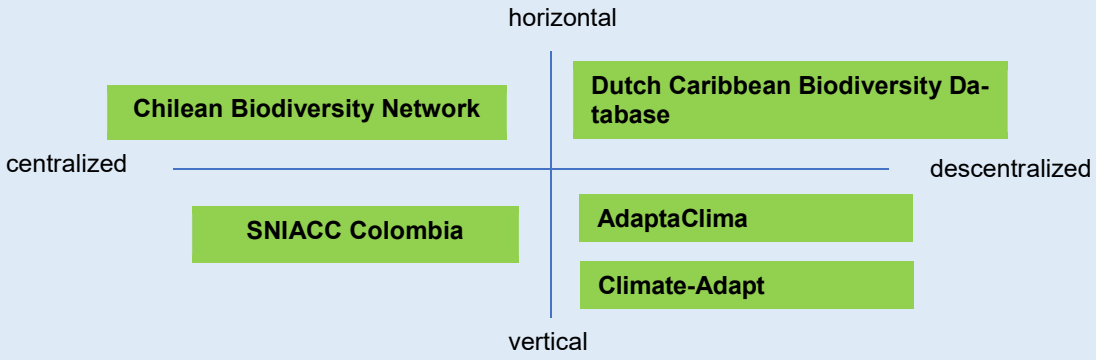
- ➔ It is a good idea to **start modestly to grow later**. For example, start with a group of indicators and then expand them, or start with just a few geographic regions or sectors of government. Piloting the system in a sector where there is high stakeholder cooperation can motivate other actors to participate.
- ➔ There should be enough flexibility to **add or eliminate elements, functionalities, and metrics** depending on technical evolution and user demand.

- ➔ This is especially important for those systems, such as the one proposed, that connect various systems, topics, components and sectors that operate at different levels and scales.
- ➔ Reviewing also allows the system to be more efficient, evaluating operational and technical aspects. **Peer reviews** and **independent evaluations** of indicator reports are very useful for this purpose.

CHALLENGE 5 - DESIGN. To search for correspondence among objectives and the aggregation of information.

There is still no systematized information on data aggregation for the measurement of indicators and indices. In fact, there are few national-level climate change indicator systems that have a coordinated approach to add information from administrative or environmental units, which is fundamental in countries such as Guatemala.

- ➔ Indicator systems are generally defined by institutional, centralized and vertical mandates. Reality requires for horizontal and decentralized systems that permit information integration from different sources and respond to the variety of uses and users.
- ➔ Horizontality refers to the use of information at different environmental scales and administrative decision levels. This includes the transboundary dimension, which is important, for example, to evaluate climatic risks that may affect transnational watersheds.
- ➔ As illustrated in the graph, the different initiatives and systems analyzed respond differently to these needs.



CHALLENGE 6 - DATA MANAGEMENT. To establish agreements for the exchange and analysis of data.

Mapping the information supply (see Challenge 3) is a good time to explore communication channels, collect protocols for data collection and learn the requirements or restrictions to sharing them. This is the starting point to:

- ➔ Establish long-term **agreements or contracts** for the transfer and storage of data and dissemination of results. These instruments must be specific to each organization.
- ➔ Adjust the **existing monitoring processes** to have standardized information between different organizations in order to be technically and scientifically sound, reducing deficiencies in registration, methodological inconsistencies, temporary discontinuity, and duplications.
- ➔ Develop data and information exchange protocols that delineate the responsibilities of both the organizations that provide the information and data and those that receive them. Simple manuals and online platforms can help support this exchange.
- ➔ Give preference to **indicator measurements that are exchanged, reviewed and analyzed in each organization**, rather than the exchange of raw data.
- ➔ Develop **standards** that favor the exchange of data, ensuring its use in a safe, transparent and comprehensive manner.
- ➔ To maximize cooperation and reduce costs, agreements can give preference to the **joint work of expert**s from different organizations for the analysis and preparation of reports.

In summary, the process of information exchange should facilitate presence and attendance (easy to achieve) but above all guarantee involvement and commitment (difficult to achieve and maintain!).

CHALLENGE 7 - DATA MANAGEMENT. Search for alternatives for data generation: crowdsourcing, co-production, and participatory information production.

When monitoring and evaluating processes related to the environment and climate change, there is a tendency to associate participation with the proposal and selection of indicators. Other participation experiences offer a broader perspective to consider innovative formulas in data collection and management.

The national system of indicators and ecosystem trends in the Netherlands Antilles is an incipient effort in this regard. The system facilitates the massive collaboration of trained volunteers with standard, robust and simple monitoring protocols: university students are trained annually in monitoring exercises. The quality of the data may be insufficient for scientific inference, but it is sufficient to indicate long-term trends and allow comparisons at the regional level.

Crowdsourcing: External collaboration to carry out tasks that would pertain to officials or contractors. Example: A bidirectional management system for Site-Specific Agriculture where producers provide soil and crop data from their farm and subsequently receive information on sustainable agriculture practices adapted to the climate.

Co-production of information on mitigation, adaptation, and resilience: Through the participation of all stakeholders, explore and build a portfolio of options. Example: Participatory planning for the exploration of resilient climate options in Latin American cities www.crclatam.net, www.quickscan.pro

Participatory production of indicators: Construction, monitoring and reporting of indicators at the community level with standard protocols. These indicators can be like those that are collected nationally. Example: Sentinel Sites in Guatemala: Early Warning System against seasonal hunger.

There are also some examples of massive collaborative platforms or systems that can benefit Monitoring, Reporting, and Verification (MRV) systems (Table 11).

Table 11. Examples of the use of crowdsourcing for MRV of NAMAs or related programs (prepared by authors)

Country / Region	Name	Sector	Indicators/ Information provided	Crowdsourcing	Source
United States	Smartway	Freight Transport	8 indicators, 4 GHG in gCO_2/mile and gCO_2/ton-mile	Macro-based Excel tool to generate annual reports [1]	PRONAMA (2015)
Europe	Green Freight	Transport	CO_2 emissions	Online platform to enter operation data	PRONAMA (2015)
Mexico	Clean transport	Transport	CO_2 emissions, strategies and improvement technologies used, reduction of fuel use due to improvement, number of technologies evaluated. Environmental performance index for transporters.	FLEET tool	PRONAMA (2015)
Chile	Renewable energy for self-consumption	Energy	Type of energy generated, and technology used, installed capacity, financing, others.	Online platform to register power generation projects for self-consumption and its characteristics	George (no date)
Colombia	REDD	Forestry	Number of REDD projects	Online registration of REDD projects and their progress	Robayo (2015)

CHALLENGE 8. SUSTAINABILITY. To define basic instances of system governance.

The system must have a **coordinating committee** of public and private organizations, with procedures that are agreed upon and accepted by the members of the system. The committee may have different functions, such as:

[1] Example of requested information used to estimate emissions reductions: fleet characteristics, fuel consumption, load, kilometers traveled, among others.

- ➔ A scientific or advisory committee that focuses on the quality of the data and provides high-quality advice
- ➔ Group of partners in charge of information management from different sectors: academia, government organizations, the private sector and civil society. Public organizations should be responsible for carrying out long-term monitoring while the academia supports the definition of protocols and elements for the interpretation of indicators.
- ➔ Each partner organization must have a focal point to follow up on decisions and processes.

CHALLENGE 9 - SUSTAINABILITY. To take into consideration, from the beginning, the resources allocated for the operation of the system. Currently, there is no definition of these resources or their possible sources.

Even when working with existing data, systems need resources to (i) establish frameworks, (ii) collect, reprocess, refine and analyze data, (iii) prepare quality reports, (iv) interact with stakeholders, and (v) strengthen the system and partner organizations.

- ➔ Have clearly defined parameters around the necessary **technicians, equipment and funds** available at the beginning of the process and to make correct decisions for its design and sizing.
- ➔ Define spaces for the capacity building during the process, to ensure sustainability and implementation over the medium and long-term.
- ➔ **Aligning the system with existing structures** can reduce the burden of measurement and reporting (it can also reinforce the message that climate change is a cross-cutting issue).
- ➔ Use **open source programs** that are simple and flexible to make the implementation process transparent and sustainable and less expensive.

CHALLENGE 10 – SUSTAINABILITY. To clearly show the benefits of the system to suppliers and users.

- ➔ The sustainability of the system ultimately depends on what is feeding into it, and whether its products are being used.
- ➔ Information providers must have a clear perception of the benefits of the system in order to maintain their commitment, which entails creating **win-win mechanisms** in the production and exchange of information.
- ➔ The products generated by the system must be differentiated according to their users and purposes: i). strategic (executive reports with trends and aggregate data, percentage of progress of indicators, etc.), ii) operational (technical data sheets of metadata and indicators, reports, lessons learned, etc.), iii) awareness-raising (didactic products, periodicals, etc.) and they must be communicated to users via relevant interfaces.
- ➔ It will be necessary to evaluate the perception that different groups of users have of the products and their use. In the governmental sector, it would be important to evaluate to what extent the system supports the purposes indicated in the previous point. However, other user groups should also be taken into consideration. For example, private sector participation is guided by returns on investment, so the system should include appropriate, useful information to design and prioritize adaptation and mitigation measures.

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Annex 1. Indicative aspects considered in international and national commitments related to climate change.

Policy / system	Climate change	Impacts, exposure and vulnerability	Adaptation process and results	Finances – Budget	Emissions	Sustainable development and environment
National Climate Change Policy			Productive practices Improvement of infrastructure Management of ecosystems and water resources	Innovative financing mechanisms	Mitigation actions Clean energy	
General Government Policy 2016- 2020	Scenarios		PANCC implementation (adaptation actions) Management of environmental services		Reports on mitigation measures GHG national inventories	Application of environmental instruments Sustainable management
Plan Nacional K´atum	National and regional scenarios	Water, agriculture, economy, fishing	Adaptation actions (including research and education) Sectoral adaptation plans Institutional strengthening	Sectoral costing for adaptation Contingency funds to face threats generated by climate change Benefits of carbon credits	Mitigation plans Reporting and verification systems GHG quantification by sector (land use, agricultural, industrial, and transport)	Social and context indicators related to strategic priorities (urban-rural, well-being, wealth, natural resources and human rights) Forests, biodiversity and protected areas, water, soil, waste, marine-coastal, lake, river and wetland systems, non-renewable energy
PANCC		Damages and losses (infrastructure, agricultural sector) Population with drinking water	Water Law and operational instruments Attention given to those affected by extreme events Increase in food production Increase in forest cover and protected territory Treated black water (sewage)	National Fund for Climate Change	Quantification of GHG produced by sector Quantification of GHG removed by forest cover	
National Restoration Strategy 2015 - 2045			Territory management and planning			Forest protection and management Biological connectivity ES provision Employment and income attributable to ES
INDC	Climate information		Early Warning System	Climate information		Early Warning System

Annex 2. Main databases of interest for the SNICC identified (adapted from UNDP).

Database	Coordination	Type of information	Geographic information	Scale	Availability	Format	Access to primary data	Regularity
CEA	INE	soils, forests, air, climate, biodiversity, water, marine coastal, mining, energy, risk management, environmental health, socio-environmental indicators	descriptive	departmental	public – via website	PDF	No	annual - biannual
Maps of forest cover	INAB	land use, from satellite images	yes	1:50,000	public – via website	vector and raster images	yes	biweekly
CONAP statistical database and generated by CEMEC	CONAP	Biodiversity, forest exploitation, and events in protected areas. Fires, forest coverage, and forestry dynamics	yes		public – by request from institution responsible	PDF		
National Climate Change Communications, GHG Inventories, water and air quality studies	MARN	GHG, water and air quality	descriptive	regional	public – via website	vector and raster	yes	annual, daily fires in the dry season
Guatemalan Forest Information System	INAB	Trade in forest resources, security, and justice, forest management, forestry incentive programs, forest pests, forestry companies.	descriptive	departmental	public – by request from institution responsible	PDF	restricted	annual
National agricultural survey, land maps, forest cover and land use; pests	MAGA	maps and statistics on land use, pests, and agricultural survey	yes	national	public – via website	PDF		
Regular newsletters on weather and hydrology	INSIVUMEH	meteorological variables	yes	national	public – via website	tables, graphs and statistics visualizers	yes	annual
Spatial Data Infrastructure (SDI)	SEGEPLAN	Cartographic, geographic, and spatial of a general nature	yes	national	public – by request from institution responsible	PDF	restricted	variable
National Geographic Information System	IGN	geographic information from different institutions	yes		public – by request from institution responsible	PDF	restricted	Daily, monthly, quarterly, and annually

Other platforms: SIFIGUA, coordinated by INAB and the Spatial Data Infrastructure (SDI -SEGEPLAN).