Food and Agriculture Organization of the United Nations

ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT

WORKING PAPER

76

NDC

ISSN 2226-6062

ASSESSING THE ROLE OF AGRICULTURE AND LAND USE IN NATIONALLY DETERMINED CONTRIBUTIONS

A methodology

ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT
WORKING PAPER
76
NDC

ASSESSING THE ROLE OF AGRICULTURE AND LAND USE IN NATIONALLY DETERMINED CONTRIBUTIONS

A methodology

Krystal Crumpler, Alexandre Meybeck, Sandro Federici, Mirella Salvatore, Beau Damen, Srijita Dasgupta, Julia Wolf and Martial Bernoux

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2019

Required citation:

K. Crumpler, K., Meybeck, A., Federici, S., Salvatore, M., Damen, B., Dasgupta, S., Wolf J., and Bernoux, M. 2019. *Assessing the role of agriculture and land use in Nationally Determined Contributions*. Environment and Natural Resources Management Working Paper no. 76. Rome, FAO.

ISBN 978-92-5-131673-3

CONTENTS

TABLES, FIGURES & BOXES

TABLES

FIGURES

ACKNOWLEDGEMENTS

The methodology is the result of a collaborative effort by the Climate and Environment Division (CBC) of FAO. Under the overall leadership of Martial Bernoux (CBC) and Julia Wolf (CBC), the methodology was prepared by Krystal Crumpler (CBC), Sandro Federici (CBC) and Mirella Salvatore (CBC), Srijita Dasgupta (RAP), Beau Damen (RAP) and contributing author Alexandre Meybeck (CIFOR/FTA).

Gratitude is especially owed to a number of technical experts for their contributions to the overall evolution of the methodological approach developed: Mario Bloise (CBC), Elisa DiStefano (CBC), Maryline Darmaun (CBC), Alessandro Ferrara (CBC), Giulia Gagliardi (CBC), Elizabeth Laval (CBC), Esther Mertens (FOA), Dirk Nemitz (UNFCCC), Zitouni Ould-Dada (CBC), Paolo Prosperi (CBC), Valentyna Slivinska (CBC), Reuben Sessa (SP2), Maylina St-Louis (CBC) and Sophie von Loeben (SP5).

The work was supported through the generous contribution of the Federal Ministry of Agriculture (BMEL) and Cooperation (BMZ) of Germany through the projects "Enhancing country capacity for NDC implementation in the agriculture sectors" (GCP /GLO/890/GER (BMZ), "Advancing the knowledge exchange platform for the agriculture and land sector under climate change" (GCP /GLO/966/GER) and "Supporting the implementation of the Koronivia Join Work on Agriculture roadmap" (GCP /GLO/998/GER). The graphic designer Claudia Tonini is acknowledged for her excellent work.

ACRONYMS AND ABBREVIATIONS

AFOLU	Agriculture, Forestry and Other Land Use
BAU	Business-as-usual
BUR	Biennial Update Report
COP	Conference of the Parties
CSA	Climate-Smart Agriculture
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GHG	Greenhouse Gas
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land Use Change and Forestry
M&E	Monitoring and Evaluation
MRV	Measurement, reporting and verification
NIR	National Inventory Report
NC	National Communication
NDC	Nationally Determined Contribution
NGHGI	National Greenhouse Gas Inventory
TNA	Technology Needs Assessment
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

CHEMICAL FORMULAE

CH_4	Methane
CO_2	Carbon Dioxide
t CO_2 eq	Tons of Carbon dioxide equivalent
N_2O	Nitrous Oxide

INTRODUCTION

BACKGROUND

At the twenty-first Conference of the Parties (COP) to the United Nations Framework on Climate Change (UNFCCC), the adoption of the Paris Agreement (PA) brought together developed and developing nations, into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects. The central aim of the PA is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius (°C) above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. Parties also agreed to a long-term goal for adaptation – to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change, with a view of contributing to sustainable development.

Underpinning the PA are the Nationally Determined Contributions (NDCs),[1] the efforts that each country plans to pursue in order to reduce national emissions and enhance removals, and adapt to the impacts of climate change as part of the collective effort to address global warming. Article 4.2 of the PA requires each Party to prepare, communicate and maintain incrementally ambitious and successive NDCs in accordance with the principle of common but differentiated responsibilities and respective capabilities.

The success of the PA rests upon the enhanced ambition of Parties to progressively revise and strengthen their respective mitigation and adaptation plans over time. Article 4.3 embeds an ambition-mechanism in the agreement by which each Party shall prepare successive NDCs every five years that represent a progression beyond the Party's then current NDC and reflects its highest possible ambition. The second round of revised or new NDCs should be submitted by 2020. In 2023, and every five years thereafter, Parties shall periodically take stock of the implementation of the Agreement to assess the collective progress towards achieving its purpose and long-term goals.[2] The outcome of this global stocktake shall inform Parties in updating and enhancing, in a nationally determined manner, their actions and support in accordance with the relevant provisions of this Agreement.

The tracking of NDC implementation will take place under the Enhanced Transparency Framework,[3] which provides a foundation for building mutual trust and confidence. The "Paris Rulebook" requires Parties to report reliable, transparent and comprehensive information on GHG emissions and removals, climate actions and support, with built-in flexibility for developing countries.[4]

The Special report "Global Warming of 1.5 °C" of Intergovernmental Panel on Climate Change (IPCC) finds that global GHG emissions would have to fall by 45 percent from 2010 levels by 2030 to have a 40-60 percent chance of limiting the temperature rise to 1.5°C above pre-industrial levels and reach net zero around 2050. To stay below 2°C, global GHG emissions would have to decline by 25 percent from 2010 levels by 2030 to have a 10-30 percent chance and reach net zero around 2070. Non-CO_2 emissions in pathways that limit global warming to 1.5°C show deep reductions that are similar to those in pathways limiting warming to 2°C. The benefits of limiting global warming below the 1.5°C threshold are significant, including keeping several hundred million people from falling into poverty by 2050 (IPCC, 2018).

The opportunity to bridge the emissions gap by 2030 is quickly closing. Current commitments expressed in the NDCs imply global warming of about 3°C above pre-industrial levels by 2100. The UN

[1] For the sake of this document, the Intended (I)NDCs and NDCs are referred to collectively as NDCs.

[2] Article 14 of the PA.

[3] Article 13 of the PA.

[4] Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the PA (FCCC/CP/2018/L.23).

Environment (UNEP) 2018 Emissions Gap Report shows that the current level of ambition in the NDCs needs to be roughly tripled for the 2°C scenario and increased around fivefold for the 1.5°C scenario (UNEP, 2018a). While the IPCC suggests that it is still possible to limit the average global temperature rise to 1.5°C, it will require unprecedented action in six key areas: energy transition, climate finance and carbon pricing, industry transition, nature-based solutions, cities and local action and resilience (IPCC, 2018).

While the gap in adaptive capacity between lower-income and higher-income countries is closing, progress is generally too slow (UNEP, 2018b). The UNEP 2018 Adaptation Gap Report finds that countries are increasingly addressing adaptation in laws and policies, but the enabling environments for adaptation to be efficient are still weak and there is a major adaptation finance gap that is estimated to be even wider in the future given the increasing needs.

The agriculture and land use sectors[5] have a large role to play in the global response to climate change, as both a source of GHG emissions but also a significant carbon sink, as well as the most vulnerable sectors to climate extremes and variability. Ninety six percent of the 194 countries that had submitted (I) NDCs as of 1 March 2019 included Agriculture and/or Land Use, Land Use Change and Forestry (LULUCF) as a sector in their mitigation and/or adaptation contributions (FAO, 2019 forthcoming). The agriculture and LULUCF sectors are uniquely placed to deliver on climate change mitigation and adaptation goals.

Adaptation in the agriculture and land use sectors can reduce vulnerability to climate change and bring about greater resilience to nearly 80 percent of the world's extreme poor and protect natural resources (FAO, 2017a). At the same time, reductions in the emission intensity of agricultural production and enhancing carbon sequestration in biomass and soils can significantly contribute to mitigating the 10 billion tons of CO_2 eq. produced by the agriculture sectors each year (Tubiello *et al.*, 2015), or the 25 to 30 percent contribution of agriculture and food systems combined to global GHG emissions (Vermeulen *et al.*, 2012).

Understanding current commitments, as well as the policy gaps and opportunities for upscaling NDCs in 2020, is critical to ensuring a progressive cycle of ambition. There is a need to unpack and assess existing mitigation and adaptation commitments in order to identify common priorities, as well as context-specificities, particularly in the agriculture and land use sectors where stakeholders are multiple, scales are numerous and challenges are complex.

PURPOSE

This paper presents a common framework for synthesizing and analyzing the role of agriculture and land use in the NDCs to facilitate a better understanding of country priorities, challenges and support needs. The methodology developed is directed at policy makers, sectoral experts and technical practitioners in the field of agriculture, climate change and food security with the overall aim of supporting national governments to strengthen their adaptation and mitigation policies in the agriculture and land use sectors. The framework enables a country-level analysis of the extent to which existing adaptation and mitigation policies respond to major emission sources, and climate-related hazards, risks and vulnerabilities undermining country capacity to adapt and build resilient livelihoods. As such, the framework can support the 2020 NDC revision process and future revision cycles. It can also serve as a basis for collective action in the agriculture and land use sectors, evidencing opportunities for directing programmatic support and investment.

Consequent to the lack of standard template associated with the preparation of the NDCs, this exercise presents a number of methodological challenges, as the NDCs are heterogeneous in structure, scope and level of detail. This heterogeneity calls for caution in comparing country priorities and actions beyond broad patterns. The purpose of this framework is to provide a structure for assessing agriculture contributions in the NDCs and their relative comparability over space and time.

[5] For the purpose of this document, the 'agriculture and land use sectors' comprise crops, livestock, fisheries and aquaculture, and forestry.

This publication is built on the extensive work that already surrounds the NDCs, which differ in scope (global or regional), content (sectoral or thematic) and level of detail. **Annex 1** contains a review of existing publications on the NDCs, organized in terms of scope and content, with a focus on agriculture where relevant. Building on FAO's global analysis of the NDCs that captured the extent to which mitigation and adaptation in the agriculture and land use sectors are prioritized in the (I)NDCs (FAO, 2016a), this paper presents a methodology for synthesizing the diversity of strategies countries set forth in the agriculture and land use sectors for delivering on climate change adaptation and mitigation. It also develops metrics for comparing the adaptation and mitigation counterfactuals in the agriculture and land use sectors against the expected outcomes of the NDCs in order to identify gaps, or opportunities, for countries to revisit and revise their ambition levels. By doing so, this paper contributes to the body of literature surrounding the NDCs and speaks to the importance of metrics for signaling progress and driving ambition.

There are significant domestic and international benefits that can be realized through more transparent, quantifiable, comprehensive and ambitious NDCs, including:

- Transparent information on the assumptions and methodologies that underpin the NDCs is required to realistically assess collective progress towards the global 2°C goal;
- Complete information about national circumstances, priorities and barriers can also promote international understanding of what is fair and ambitious and can situate climate action in the broader context of sustainable development;
- Detailed information can provide good examples of adaptation and mitigation options, that address context-specific tradeoffs and leverage synergies, which may inspire other country stakeholders;
- Quantifiable information about the NDCs is critical to understanding individual and aggregate impacts of Party contributions, and to enable an assessment of whether global net emissions after 2020 will be in line with the goal to limit global warming to below 2°C;
- Measurable information about the NDCs is critical to building the individual and aggregate evidence-base for better orienting climate finance; and
- Comprehensive information about climate-related impacts, risks and vulnerabilities in NDCs can inform climate change adaptation planning and disaster risk reduction strategies in line with the global goal on adaptation.

The paper is organized in four parts:

Part 1 describes the data sources and methodological approach for analyzing the NDCs in the agriculture and land use sectors.

Part 2 presents a common framework for transforming the NDCs in the agriculture and land use sectors into a set of raw data points for analysis.

Part 3 presents a methodology for constructing the so-called mitigation and adaptation counterfactual scenarios[6] against which the NDCs in the agriculture and land use sectors are compared.

Part 4 presents a methodology for identifying the "gaps" and "opportunities" for enhancing mitigation and adaptation ambitions in the agriculture and land use sectors. It compares the mitigation policies or measures presented in the NDCs against the major sources of GHG emissions. It also compares adaptation priorities and measures against the major climate-related hazards, impacts and vulnerabilities reported in ecosystems and social systems. It also presents a framework for identifying opportunities to capture mitigation and adaptation co-benefits in the agriculture and land use sectors.

[6] i.e. the absence of mitigation or adaptation.

PART 1

PART

1

DATA

A stocktaking of all NDCs to date served to identify a common set of categories and sub-categories for quantifying and qualifying the types of climate change mitigation and adaptation contributions in the agriculture and land use sectors. The framework created allows for the transformation of the NDCs into a set of raw data.

1.1 DATA SOURCE

Each of the 167 (I)NDCs, representing 194 countries,[7] as of 1 April 2019, from the UNFCCC NDC Registry,[8] or INDC Submissions webpage,[9] were reviewed, using the English version when available, or Spanish or French when the English version is not available. Information on emissions by sources and removals by sinks, as well as climate-related hazards, impacts, vulnerabilities and risks, was sourced from National Communications (NC) and Biennial Update Reports (BURs). Additional mitigation and adaptation actions were also sourced from NCs. Information on barriers and technology needs was sourced from Technology Needs Assessments (TNAs) when available.

[7] The European Union comprises 28 countries.

[8] Interim NDC Registry can be found at https://www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx

[9] INDC Submissions can be found at https://www4.unfccc.int/sites/submissions/INDC/Submission%20Pages/submissions.aspx

1.2 DATABASE STRUCTURE

Each NDC was studied in full text to identify common structural elements in the agriculture and land use sectors, which served as the basic parameters for categorizing the NDCs. A database was structured around agriculture-specific categories, in line with standard classifications and/or established literature when possible. In order to account for the cross-cutting nature of agriculture and land use, climate change, and food security, and of their links with multiple sectors, the database was designed to also include elements that are not specific to agriculture and land use but closely tied to it. The final list of categories and sub-categories contained in the database is presented in detail in **Part 2**.

1.3 LIMITATIONS

A systematic analysis of the (I)NDCs presents a number of methodological challenges, owing to their aggregate volume (totaling more than 2 000 pages) and heterogeneity in terms of content, scope and detail. Due to lack of a standard template for NDC formulation, and capacity constraints, not all information was necessarily made available, nor equal in level of detail. For this reason, the information contained in the NDC is supplemented by information from other sources, including the NCs and TNAs. Nonetheless, the information is not always comparable in absolute terms, constituting a limitation to the methodology presented.

PART 2

PART

2

COMMON FRAMEWORK

This section presents a framework under which the content of the NDCs in the agriculture and land use sectors can be classified according to a set of parameters and transformed into data points, allowing for an analysis of their clarity, measurability, comprehensiveness, transparency and ambition. The classification process constructs the so-called mitigation and adaptation counterfactuals against which the mitigation and adaptation objectives can be compared.

2.1 GENERAL MITIGATION CONTRIBUTION

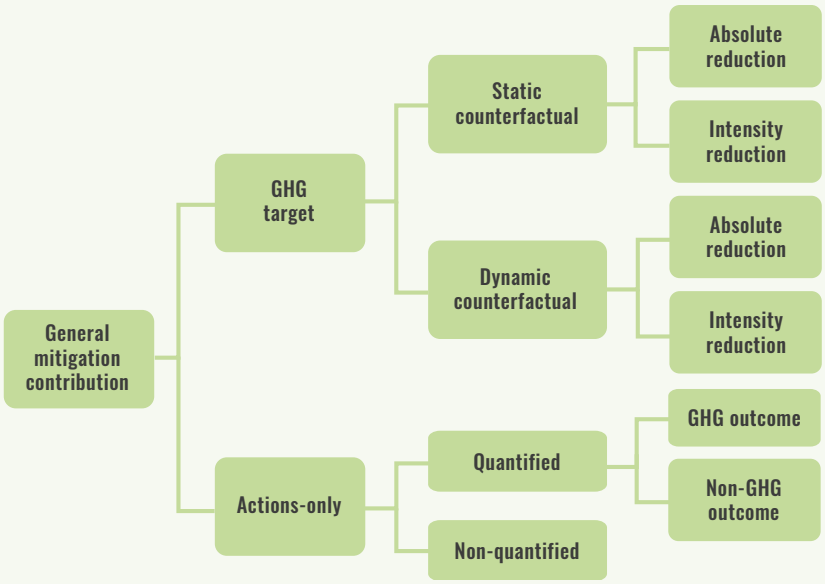
2.1.1 Type of mitigation contribution

A mitigation contribution may cover one or more of the four sectors defined by the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National GHG Inventories (NGHGI): Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU) and Waste. The scope is therefore characterized as either economy-wide, multi-sectoral or uni-sectoral; and a country can have just a single mitigation contribution or several according to sectors and/or actions.

It may take the form of either a GHG target, or a set of actions (i.e. Actions-only). A GHG target constitutes a reduction in net emissions compared to either static counterfactual (i.e. base year or constant business-as-usual (BAU)) or dynamic counterfactual emissions (e.g. projected BAU or projected peak). The reduction may be quantified in absolute terms – as a percent change in net emissions or a cumulated amount of net emissions avoided during the period – or in terms of intensity – as a percent change in net emissions per unit of gross domestic product (GDP) or per capita. On the other hand, if the mitigation contribution is expressed in terms of a set of actions, an action may have a quantified or non-quantified outcome. The quantified outcome may be expressed in terms of GHG, or non-GHG units, e.g. hectares subject to the action or tons of carbon accumulated across time. **Figure 1** illustrates the different types of mitigation contributions.

FIGURE 1.

TYPE OF GENERAL MITIGATION CONTRIBUTION



2.2 MITIGATION CONTRIBUTION IN THE AGRICULTURE AND LAND USE SECTORS

For the purpose of this document, as do most countries' NDCs, the agriculture and land use sectors, or the AFOLU sector in IPCC terminology, are treated as two sectors: the Agriculture and LULUCF sectors.

In general, a mitigation contribution in the agriculture and/or LULUCF sector can be described by the following characteristics:

- Type of mitigation contribution (GHG target, non-GHG target and/or policies or measures);
- Timeframe of mitigation contribution;
- Scope of mitigation contribution;
- Policies or measures in agriculture and/or LULUCF;
- Long-term mitigation goal;
- Barriers and support needs; and
- Information on monitoring, reporting and verification (MRV) progress.[10]

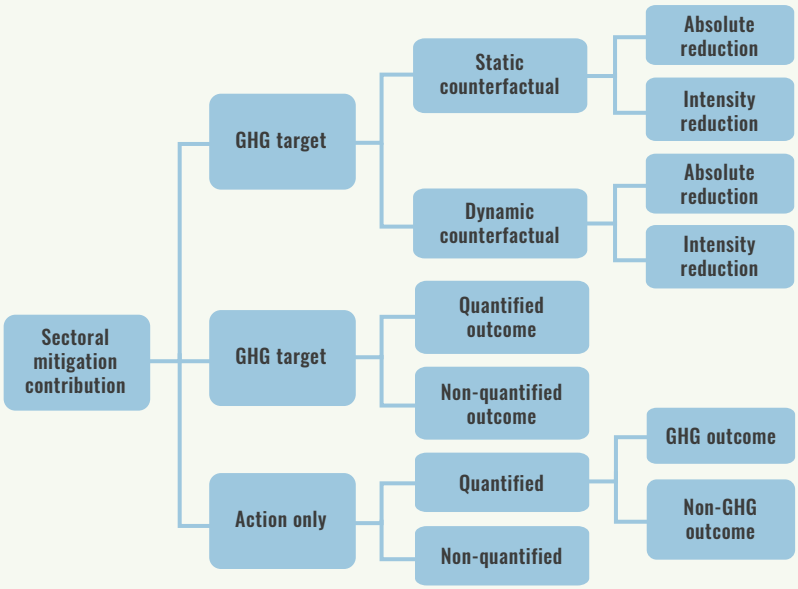
2.2.1 Type of mitigation contribution

A sectoral mitigation contribution may be included in the general mitigation contribution or additional to it. A mitigation contribution in the agriculture and/or LULUCF sector is characterized by the inclusion of a sectoral GHG or non-GHG target and/or a set of policies or measures. **Figure 2** illustrates the different types of mitigation contributions in the agriculture and/or LULUCF sector.

[10] For this paper, the "M" in MRV refers not only to the measuring of GHG fluxes in the conventional sense but also to the monitoring of mitigation actions.

FIGURE 2.

TYPE OF MITIGATION CONTRIBUTION IN THE AGRICULTURE AND/OR LULUCF SECTORS



The extent to which the agriculture and/or LULUCF sector is present in country NDCs can be defined by the following scale of integration (**Figure 3**). The scale indicates increasing levels of integration and does not indicate increasing ambition in terms of tons of CO_2 eq net emissions potentially reduced or avoided.

FIGURE 3.

INTEGRATION OF THE AGRICULTURE AND/OR LULUCF SECTOR IN MITIGATION CONTRIBUTION

2.2.2 Mitigation policies and measures

A mitigation policy or measure in the agriculture and/or LULUCF sectors presented in the NDC can be described by the following characteristics using parameters outlined in Table 1:

- Stage of food value chain;
- Type of intervention;
- Type of land use category or agriculture sub-sector;
- Type of land use or agriculture management activity;
- Type of bioenergy production and use (if applicable); and
- Type of food loss and waste reduction (if applicable).

Each policy or measure is associated with one of five stages in the food value chain defined by FAO (2014), where production includes pre-harvest/slaughter and harvest/slaughter. Each policy or measure is defined by the type of intervention, or the primary approach of the climate change mitigation policy, which may include: biophysical (such as farming practices and land use); economic (such as taxes, subsidies, trade); regulatory and control (such as land planning and protected areas); informational (such as certification

schemes, awareness raising) and institutional (such as enabling policy environments) approaches.[11] Each policy or measure is associated with one of six land use categories, as defined by the IPCC (IPCC, 2014a), or one of two agriculture sub-sectors (FAO, n.d.). Each policy or measure is associated with one of 34 types of land use or agriculture management activities.[12]

If applicable, each policy or measure is associated with one of six types of bioenergy (IPCC, 2014a). Those policy or measures that aim to increase bioenergy production and efficient use through actions classified as mitigation in the agriculture and land use sectors are classified, first, as a mitigation policy in the agriculture and/or LULUCF sector, and, secondly, tagged by the type of bioenergy production and/or use. For instance, if a country includes afforestation/reforestation for the production of solid biofuel, the policy or measure is classified as a mitigation policy in the LULUCF sector (i.e. afforestation/reforestation) and tagged by the type of bioenergy from forest biomass (i.e. solid biofuel). Similarly, if a country includes biogas production from manure, the policy or measure is classified as a mitigation policy in the agriculture sector (i.e. manure management) and tagged by the type of bioenergy from agricultural biomass (i.e. biogas). If applicable, each policy or measure is associated with one of four types of food loss and waste reduction measures (HLPE, 2014), where food losses occur during production, post-harvest and processing operations, and food waste occurs at marketing and consumer levels. **Table 1** lists the categories and parameters used to qualify sectoral mitigation policies and measures in the agriculture and LULUCF sectors found in the NDCs.

TABLE 1.

QUALIFICATION OF MITIGATION POLICIES OR MEASURES IN THE AGRICULTURE AND LULUCF SECTORS

CATEGORY AND PARAMETERS	SOURCE
STAGE OF FOOD VALUE CHAIN PRODUCTION AGGREGATION PROCESSING DISTRIBUTION CONSUMPTION FULL VALUE CHAIN	FAO (2014)
TYPE OF INTERVENTION BIOPHYSICAL ECONOMIC REGULATORY AND CONTROL INSTITUTIONAL INFORMATIONAL	IPCC (2014a)
TYPE OF LAND USE CATEGORIES AND AGRICULTURE SUB-SECTORS ALL LAND AGRICULTURAL LAND CROPLAND GRASSLAND FOREST LAND WETLANDS AND ORGANIC SOILS LIVESTOCK INTEGRATED SYSTEMS BIOENERGY FROM AGRICULTURE BIOENERGY FROM FORESTS	IPCC (2014a) and FAO (n.d.)

[11] Elaboration of sectoral policies in IPCC (2014a).

[12] Elaboration of supply-side mitigation options in IPCC (2014a).

TYPE OF LAND USE AND AGRICULTURE MANAGEMENT ACTIVITY **CROPLAND, GRASSLAND OR AGRICULTURAL LAND** GENERAL CROPLAND MANAGEMENT GENERAL GRASSLAND MANAGEMENT PLANT MANAGEMENT RICE MANAGEMENT NUTRIENT MANAGEMENT TILLAGE/RESIDUE MANAGEMENT FIRE MANAGEMENT SET ASIDE IRRIGATION AND DRAINAGE SUSTAINABLE WATER USE AND MANAGEMENT ANIMAL MANAGEMENT GENERAL AGRICULTURE MANAGEMENT SUSTAINABLE AGRICULTURE PRACTICE/APPROACH **FOREST LAND** GENERAL FOREST LAND MANAGEMENT REDUCING DEFORESTATION AND FOREST CONSERVATION REDUCING DEGRADATION AND SUSTAINABLE FOREST MANAGEMENT FIRE MANAGEMENT AFFORESTATION/REFORESTATION **WETLANDS AND ORGANIC SOILS** WETLANDS MANAGEMENT AQUACULTURE MANAGEMENT REWET ORGANIC SOILS DRAINED FOR AGRICULTURE **LIVESTOCK** GENERAL LIVESTOCK MANAGEMENT FEEDING BREEDING AND HUSBANDRY MANURE MANAGEMENT **INTEGRATED SYSTEMS** AGROFORESTRY OTHER MIXED PRODUCTION SYSTEMS **ALL LAND** GENERAL LAND USE MANAGEMENT **BIOENERGY** GENERAL BIOENERGY PRODUCTION LIQUID BIOFUEL PRODUCTION SOLID BIOFUEL PRODUCTION USE OF ENERGY-EFFICIENT FUELWOOD COOKSTOVES **OTHER** FISHERIES MANAGEMENT BLUE CARBON OTHER	IPCC (2014a) and FAO expert consultation
TYPE OF BIOENERGY PRODUCTION AND USE LIQUID BIOFUEL PRODUCTION • BIOGAS PRODUCTION SOLID BIOFUEL PRODUCTION • WOODFUEL AND CHARCOAL PRODUCTION USE OF ENERGY-EFFICIENT COOKSTOVES NON SPECIFIED BIOMASS FEEDSTOCK PRODUCTION	IPCC (2014a)
TYPE OF FOOD LOSS AND WASTE REDUCTION PREVENTION REUSE RECYCLE RECOVERY	HLPE (2014)

2.3 GENERAL ADAPTATION COMPONENT

Adaptation to climate change refers to changes in processes, practices and structures to moderate potential damages from climate change, or to benefit from opportunities associated with such changes (FAO, 2017b). While developing countries were encouraged to include a section on climate impacts and adaptation in their NDCs, adaptation components are voluntary and not all developing countries included it.

The adaptation components in NDCs can be generally characterized by the following sub-components:

- Climate-related hazards, impacts and vulnerabilities;
- Non-climatic drivers (environmental, economic, social and political) of vulnerability;
- Adaptation priority sectors and cross-sectoral priorities;

- Adaptation measures;
- Long-term adaptation vision and/or goal;
- Link to National Adaptation Plan (NAP);
- Barriers and support needs; and
- Information on measuring and evaluating (M&E) progress.

2.4 ADAPTATION COMPONENT IN THE AGRICULTURE AND LAND USE SECTORS

Climate change directly affects the natural resources and ecosystems upon which agricultural production, food systems and rural livelihoods rely. Climate change impacts on food security and nutrition are transmitted through different pathways, and the severity of the impact is determined by climate drivers and risks, and by the underlying vulnerability of ecosystems, agro-ecosystems, rural economies and households (FAO, 2016b).

Adaptation in the agriculture and land use sectors signifies modifying agricultural production and socio-economic institutional systems in response to and in preparation for actual or expected climate variability and change and their impacts, to moderate harmful effects and exploit beneficial opportunities. Resilience can be described as the capacity of systems, communities, households or individuals to prevent, moderate or cope with risk, and recover from shocks. Adaptive capacity encompasses two dimensions: the capacity to manage or moderate climate risks (including extreme climatic events), and the capacity to gradually respond to longer-term climate changes (FAO, 2017b). A key way to moderate, reduce and/or avoid climate-related impacts is to reduce a system's underlying vulnerabilities, strengthen its adaptive capacity and increase its resilience (FAO, 2016c).

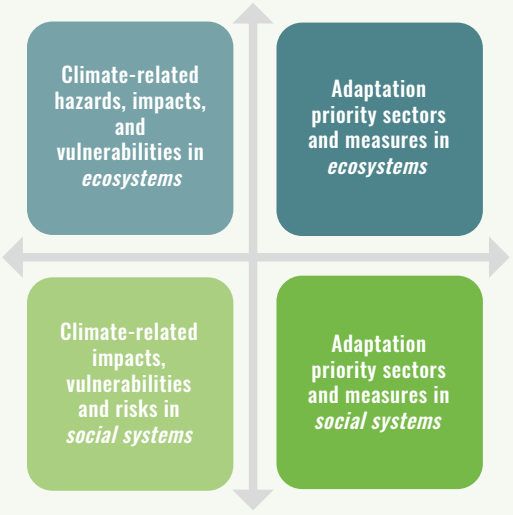
The adaptation component in NDCs is crafted to national circumstances and priorities, which depending on the extent to which agriculture and the ecosystems on which it depends play a role in the social economy, may or may not include adaptation in agriculture.

2.4.1 Type of adaptation component

The adaptation component in the agriculture and land use sectors generally includes observed and/or projected climate-related hazards, impacts, vulnerabilities and risks in ecosystems and social systems, as well as priority sectors and cross-sectoral priorities for adaptation and adaptation measures in ecosystems and social systems. **Figure 4** illustrates the main sub-components of the adaptation component in agriculture and land use and their cross-fertilization.

FIGURE 4.

SUB-COMPONENTS OF ADAPTATION IN THE AGRICULTURE AND LAND USE SECTORS



2.4.2 Climate-related hazards, impacts, vulnerabilities and risks

The impacts of climate change refer generally to the effects of extreme weather and climate events and of climate change on the lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure, due to the interaction of climate changes or hazardous climate events occurring within a specific time period and the vulnerability of an exposed society or system. The vulnerability of an exposed system depends on sensitivity and lack of capacity to cope and adapt. The probability of occurrence compounded by the impact, or risk, results from the interaction of vulnerability, exposure, and hazard.[13]

Countries often include a description of observed and/or expected climate variability and extremes, as well as cite the climate-related hazards, impacts, vulnerabilities and risks that are already being observed or are expected in the future, often in order to contextualize the fairness and ambition of their mitigation contribution, as well as inform their adaptation component. These climate-related variables reported in country NDCs and NCs can serve as the adaptation counterfactual, which captures a country's degree of vulnerability, adaptive capacity and resilience to climate change in ecosystems and social systems, against which the adaptation priorities and measures in agriculture and land use can be compared, informing the adaptation gap analysis methodology presented in **Part 4**.

Observed and/or projected changes in meteorological variables, namely variations in mean annual precipitation and surface air temperature and the frequency and intensity of climate extremes, can be characterized by type. Meteorological variable categories are adapted from IPCC (2014b). Observed and/or projected climate-related hazards and sub-hazards can be characterized by type. Climate-related hazards refer to hydro-meteorological, climatological and biological processes or phenomenon that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. Climate-related hazard categories are adapted from IPCC (2014b) and EM-DAT (2009). Observed and/or projected climate-related slow onset risks and events, or chemical and physical changes in terrestrial ecosystems and freshwater resources and marine and coastal ecosystems, can be characterized by type. Climate-related risk categories are adapted from IPCC (2014b) and EM-DAT (2009). Observed and/or projected climate-driven impacts, vulnerabilities and risks in ecosystems can be qualified by type of biome, ecosystem, natural resource and ecosystem service impact category. Impact categories in ecosystems are adapted from TEEB (2010) and MEA (2005). Observed and/or expected climate-related impacts, vulnerabilities and risks in social systems can be

[13] Definition of impact, vulnerability and risk in natural systems adapted from IPCC (2014b).

characterized by one of eight impact categories. Impact categories in social systems are adapted from FAO (2017b) and IPCC (2014b). **Table 2** lists the categories and parameters used to qualify climate-related hazards, impacts, vulnerabilities and risks in ecosystems and social systems.

TABLE 2.

OBSERVED AND/OR PROJECTED CLIMATE-RELATED HAZARDS, IMPACTS, VULNERABILITIES AND RISKS IN ECOSYSTEMS AND SOCIAL SYSTEMS

CATEGORY AND PARAMETERS	SOURCE
TYPE OF METEOROLOGICAL VARIABLES CHANGES IN ANNUAL MEAN PRECIPITATION AND/OR FREQUENCY AND INTENSITY OF EXTREMES CHANGES IN MEAN SURFACE AIR TEMPERATURE AND/OR FREQUENCY AND INTENSITY OF EXTREMES	IPCC (2014b)
TYPE OF CLIMATE-RELATED HAZARDS EXTREME HEAT DROUGHT FLOOD STORM LANDSLIDES WILD FIRE INVASION BY PESTS AND NON-NATIVE SPECIES IN AGRICULTURE	IPCC (2014b) and EM-DAT (2009)
TYPE OF CLIMATE-RELATED RISKS AND SLOW ONSET EVENTS **TERRESTRIAL ECOSYSTEMS AND FRESHWATER RESOURCES** SNOW AND ICE MELTING EUTROPHICATION SALINIZATION AND SALT WATER INTRUSION DESERTIFICATION SOIL EROSION WATER STRESS **MARINE AND COASTAL ECOSYSTEMS** SEA-LEVEL RISE OCEAN ACIDIFICATION SEA SURFACE TEMPERATURE RISE COASTAL EROSION	IPCC (2014b) and EM-DAT (2009)
TYPE OF BIOME TERRESTRIAL FRESHWATER MARINE ALL BIOMES	TEEB (2010) and MEA (2005)
TYPE OF NATURAL RESOURCE LAND AND SOIL WATER ENERGY GENETIC RESOURCES ALL NATURAL RESOURCES	TEEB (2010) and MEA (2005)
TYPE OF ECOSYSTEM AGRO-ECOSYSTEM DESERT MOUNTAIN INLAND WATER WETLANDS POLAR ICE OCEAN AND COASTAL ZONE ALL ECOSYSTEMS	TEEB (2010) and MEA (2005)
TYPE OF ECOSYSTEM SERVICE **PROVISIONING** GENERAL FOOD, FIBRE, FUEL AND RAW MATERIALS PROVISION CROPS PROVISION LIVESTOCK PROVISION FISHERIES PROVISION AQUACULTURE PROVISION FORESTRY (NTFPS AND WOOD) PROVISION BIOFUEL PROVISION FIBRE PROVISION FRESH WATER PROVISION GENETIC RESOURCES PROVISION	TEEB (2010) and MEA (2005)

REGULATING MODERATION OF EXTREME EVENTS POLLINATION BIOLOGICAL CONTROL EROSION CONTROL WATER PURIFICATION WATER FLOW REGULATION LOCAL CLIMATE AND AIR QUALITY CONTROL **SUPPORTING** PRIMARY PRODUCTION CARBON SEQUESTRATION AND STORAGE NUTRIENT CYCLING AND SOIL FORMATION WATER CYCLING MAINTENANCE OF GENETIC DIVERSITY AND ABUNDANCE HABITATS FOR SPECIES	TEEB (2010) and MEA (2005)
TYPE OF CLIMATE-DRIVEN RISK IN SOCIAL SYSTEMS LOSS OF PRODUCTIVE INFRASTRUCTURE AND ASSETS ADVERSE HEALTH FOOD INSECURITY AND MALNUTRITION RURAL LIVELIHOODS AND INCOME LOSS GENDER INEQUALITY CONFLICT MIGRATION AND DISPLACEMENT POVERTY AND INEQUALITY	FAO (2017b) and IPCC (2014b)

2.4.3 Non-climatic drivers of vulnerability

Countries often report on the intersecting social, economic, cultural, political and institutional variables, or stressors, that can affect individual adaptive capacity to respond, as well as the level of exposure to climate change, creating new or exacerbating existing vulnerabilities to climate change.[14]

Non-climatic drivers of climate change vulnerability can be characterized by one of three types of non-climatic dimensions and one of nine non-climatic vulnerability driver categories. Vulnerability driver categories are adapted from FAO (2017b), IPCC (2014b) and FAO (2013). **Table 3** lists the categories and parameters used to describe non-climatic dimensions and non-climatic vulnerability drivers of climate change vulnerability.

TABLE 3.

QUALIFICATION OF NON-CLIMATIC DRIVERS OF CLIMATE CHANGE VULNERABILITY

CATEGORY AND PARAMETERS	SOURCE
TYPE OF NON-CLIMATIC DIMENSION ENVIRONMENTAL SOCIO-ECONOMIC AND CULTURAL POLITICAL AND INSTITUTIONAL	
TYPE OF NON-CLIMATIC VULNERABILITY DRIVER CATEGORY **ENVIRONMENTAL** GEOGRAPHY AND TOPOGRAPHY NATURAL HAZARDS **SOCIO-ECONOMIC AND CULTURAL** ECONOMIC AND LIVELIHOOD DEPENDENCE ON AGRICULTURE AND NATURAL RESOURCES POPULATION GROWTH AND DEMOGRAPHICS POVERTY AND LOW DEVELOPMENT NATURAL RESOURCE USE AND COMPETITION LIMITED KNOWLEDGE AND CAPACITY **POLITICAL AND INSTITUTIONAL** CONFLICT WEAK INSTITUTIONS AND GOVERNANCE	IPCC (2014b) and FAO (2013)

[14] Definition of non-climatic stressors adapted from IPCC (2014b).

2.4.4 Adaptation priority sectors and cross-sectoral priorities

Countries often identify a number of priority sectors and cross-cutting priorities in ecosystems and social systems as part of their adaptation strategy in agriculture and land use. Adaptation priority sector(s) can be characterized by one or more of six agriculture sub-sectors (FAO, n.d.). Adaptation cross-sectoral adaptation priorities can be associated with one or more of 14 cross-sectoral priorities in either ecosystems or social systems (FAO, n.d.). **Table 4** lists the categories and parameters used to describe adaptation priority sectors and cross-sectoral priorities for adaptation in ecosystems and social systems.

TABLE 4.

QUALIFICATION OF ADAPTATION PRIORITY SECTORS AND CROSS-SECTORAL PRIORITIES FOR ADAPTATION IN ECOSYSTEMS AND SOCIAL SYSTEMS

CATEGORY AND PARAMETERS	SOURCE
TYPE OF PRIORITY SECTOR(S) ALL SUB-SECTORS CROPS LIVESTOCK FISHERIES AND AQUACULTURE BIOENERGY INTEGRATED SYSTEMS FORESTRY	FAO (n.d.)
TYPE OF CROSS-SECTORAL PRIORITIES **ECOSYSTEMS** ECOSYSTEMS AND NATURAL RESOURCES WATER LAND AND SOIL OCEANS AND COASTAL ZONES BIODIVERSITY AGRI-FOOD CHAIN **SOCIAL SYSTEMS** FOOD SECURITY AND NUTRITION DISASTER RISK REDUCTION AND MANAGEMENT HEALTH RESILIENT INFRASTRUCTURE GENDER LOCAL COMMUNITIES AND INDIGENOUS PEOPLES POVERTY AND INEQUALITY REDUCTION HUMAN RIGHTS	FAO (n.d.)

2.4.5 Adaptation measures in ecosystems and social systems

In addition to priority sectors for adaptation, countries often reference a set of adaptation measures in ecosystems and/or social systems that address the inter-linkages between ecosystem goods and services, rural livelihoods and food security and nutrition.

Adaptation measures in ecosystems can generally be characterized by the following parameters:

- Stage of food value chain;
- Type of intervention;
- Type of ecosystem;
- Type of agriculture sub-sector (if applicable);
- Type of management option in ecosystems;
- Type of bioenergy production and use (if applicable); and
- Type of food loss and waste reduction (if applicable).

Each adaptation measure can be characterized by the type of intervention, or the primary approach of the climate change adaptation policy, which may include: biophysical (such as farming practices and land use); economic (such as taxes, subsidies, trade); regulatory and control (such as land planning and protected areas); informational (such as certification schemes, awareness raising) and institutional

(such as enabling policy environments) approaches.[15] Each adaptation measure in ecosystems can be characterized by one of seven ecosystem categories, as defined by the Economics of Ecosystems and Biodiversity (TEEB, 2010) and Millennium Ecosystem Assessment (MEA, 2005). If the adaptation measure is associated with agro-ecosystems, the measure can be further differentiated by one of six land use categories, as defined by IPCC (IPCC, 2014a) and one of six agriculture sub-sectors (FAO, n.d.). Each adaptation measure in ecosystems can be characterized by one of 63 ecosystem and natural resource management options.[16] If applicable, each policy or measure may be associated with one of five types of bioenergy-related adaptation measures.[17] If applicable, each policy or measure can be characterized by one of five stages in the food value chain defined by FAO (2014), where production includes pre-harvest/slaughter and harvest/slaughter. If applicable, each policy or measure is associated with one of four types of food loss and waste reduction measures.[18] **Table 5** lists the categories and parameters used to qualify adaptation measures in ecosystems found in the NDCs.

TABLE 5.

QUALIFICATION OF ADAPTATION MEASURES IN ECOSYSTEMS

CATEGORY AND PARAMETERS	SOURCE
TYPE OF INTERVENTION BIOPHYSICAL ECONOMIC REGULATORY AND CONTROL INSTITUTIONAL INFORMATIONAL	IPCC (2014a)
TYPE OF ECOSYSTEM ALL ECOSYSTEMS AGRO-ECOSYSTEM DESERT MOUNTAIN INLAND WATER WETLANDS POLAR ICE OCEAN AND COASTAL ZONE	TEEB (2010) and MEA (2005)
TYPE OF AGRO-ECOSYSTEM ALL SUB-SECTORS CROPS LIVESTOCK INTEGRATED SYSTEMS FORESTRY AQUACULTURE FISHERIES	IPCC (2014a) and FAO (n.d.)
TYPE OF LAND USE CATEGORY ALL LAND AGRICULTURAL LAND CROPLAND GRASSLAND FOREST LAND WETLANDS	IPCC (2014a)
TYPE OF ECOSYSTEM AND NATURAL RESOURCE MANAGEMENT OPTION **CROPS** GENERAL CROP MANAGEMENT PEST AND DISEASE MANAGEMENT PLANT MANAGEMENT NUTRIENT AND ON-FARM SOIL MANAGEMENT	FAO (2013), IPCC (2014b) and FAO (2017c)

[15] Elaboration of sectoral policies in IPCC (2014a).

[16] Elaboration of FAO (2013), IPCC (2014b) and FAO (2017b).

[17] Elaboration of IPCC (2014a).

[18] Elaboration of HLPE (2014).

LIVESTOCK GENERAL LIVESTOCK MANAGEMENT FEEDING PRACTICES ANIMAL BREEDING AND HUSBANDRY ANIMAL AND HERD MANAGEMENT MANURE MANAGEMENT ECOSYSTEMS AND NATURAL RESOURCES WATER **INTEGRATED SYSTEMS** AGROFORESTRY OTHER MIXED PRODUCTION SYSTEMS **FORESTRY AND LAND/SOIL RESOURCES** REDUCING DEFORESTATION AND FOREST CONSERVATION REDUCING DEGRADATION AND SUSTAINABLE FOREST MANAGEMENT AFFORESTATION/REFORESTATION PROMOTION OF URBAN AND PERI-URBAN FORESTRY WETLANDS MANAGEMENT REWET PEATLANDS DRAINED FOR AGRICULTURE LAND/SOIL CONSERVATION, RESTORATION AND REHABILITATION INTEGRATED LANDSCAPE MANAGEMENT COASTAL ZONE MANAGEMENT CROPLAND MANAGEMENT GRASSLAND MANAGEMENT FIRE MANAGEMENT ON CROPLAND FIRE MANAGEMENT ON GRASSLAND FIRE MANAGEMENT ON FOREST LAND **FISHERIES AND AQUACULTURE** FISHERIES MANAGEMENT AQUACULTURE MANAGEMENT FISHERIES AND AQUACULTURE MANAGEMENT **WATER RESOURCES** WATER AVAILABILITY AND ACCESS WATER STORAGE AND HARVESTING IRRIGATION AND DRAINAGE SUSTAINABLE WATER USE AND MANAGEMENT WATER QUALITY AND POLLUTION MANAGEMENT DESALINISATION WATER-USE EFFICIENCY AND REUSE WATER-RELATED ECOSYSTEM PROTECTION AND RESTORATION INTEGRATED WATERSHED MANAGEMENT FLOOD MANAGEMENT **ECOSYSTEMS AND GENETIC RESOURCES** MANGROVE CONSERVATION AND REPLANTING BIODIVERSITY PROTECTION, CONSERVATION AND RESTORATION PEST AND DISEASE MANAGEMENT ECOSYSTEM MANAGEMENT, CONSERVATION AND RESTORATION PAYMENT FOR ECOSYSTEM SERVICES **ENERGY RESOURCES** BIOENERGY PRODUCTION BIOENERGY USE ENERGY USE IN AGRICULTURE **AGRI-FOOD CHAIN** INPUT PROVISION FOOD LOSS REDUCTION FOOD WASTE REDUCTION VALUE ADDITION CERTIFICATION SCHEMES SHIFT OF CONSUMPTION PATTERNS MARKET ACCESS **GENERAL AGRICULTURE AND LAND USE** SUSTAINABLE AGRICULTURE PRACTICES/APPROACH DIVERSIFICATION INTENSIFICATION CLIMATE-SMART AGRICULTURE (CSA) CONSERVATION AGRICULTURE AGROECOLOGY ECOSYSTEM-BASED ADAPTATION COMMUNITY-BASED ADAPTATION	FAO (2013), IPCC (2014b) and FAO (2017c)
TYPE OF BIOENERGY PRODUCTION AND USE MEASURE LIQUID BIOFUEL PRODUCTION BIOGAS PRODUCTION SOLID BIOFUEL PRODUCTION WOODFUEL AND CHARCOAL PRODUCTION USE OF ENERGY-EFFICIENT FUELWOOD COOKSTOVES	IPCC (2014a)

STAGE OF FOOD VALUE CHAIN PRODUCTION AGGREGATION PROCESSING DISTRIBUTION CONSUMPTION FULL VALUE CHAIN	FAO (2014)
TYPE OF FOOD LOSS AND WASTE REDUCTION MEASURE PREVENTION REUSE RECYCLE RECOVERY	HLPE (2014)

Adaptation measures in social systems can generally be characterized by the following parameters:

- Type of intervention;
- Type of social dimension; and
- Type of management option.

Each adaptation measure in social systems can be characterized by the type of intervention, or the primary approach of the climate change adaptation policy, which may include: biophysical (such as farming practices and land use); economic (such as taxes, subsidies, trade); regulatory and control (such as land planning and protected areas); informational (such as certification schemes, awareness raising) and institutional (such as enabling policy environments) approaches.[19] Each adaptation measure in social systems can be associated with one of three social dimensions.[20] Each adaptation measures can be characterized by one of 36 management options across the three dimensions.[21] **Table 6** lists the categories and parameters used to qualify adaptation measures in social systems found in the NDCs.

TABLE 6.

QUALIFICATION OF ADAPTATION MEASURES IN SOCIAL SYSTEMS

CATEGORY AND PARAMETERS	SOURCE
TYPE OF INTERVENTION BIOPHYSICAL ECONOMIC REGULATORY AND CONTROL INSTITUTIONAL INFORMATIONAL	IPCC (2014a)
TYPE OF SOCIAL DIMENSION SOCIO-ECONOMICS AND WELL-BEING KNOWLEDGE AND CAPACITY INSTITUTIONS AND GOVERNANCE	IPCC (2014a)
TYPE OF MANAGEMENT OPTION **SOCIO-ECONOMICS AND WELL-BEING** HEALTH INFORMATION AND SERVICES DISEASE MANAGEMENT AND PREVENTION FOOD SECURITY AND NUTRITION INDIGENOUS PEOPLES GENDER EQUALITY AND WOMEN EMPOWERMENT DISPLACEMENT AND MIGRATION OF VULNERABLE PEOPLE RESILIENCE AND ADAPTIVE CAPACITY BUILDING RESILIENT INFRASTRUCTURE PRODUCTIVE ASSETS DECENT RURAL EMPLOYMENT ON AND OFF-FARM LIVELIHOOD DIVERSIFICATION FARMER COOPERATIVES AND MARKET ACCESS CREDIT AND INSURANCE SERVICES SOCIAL PROTECTION POVERTY REDUCTION	FAO (2017c), IPCC (2014b) and FAO (2013)

[19] Elaboration of sectoral policies in IPCC (2014a).

[20] Elaboration of IPCC (2014a).

[21] Elaboration of FAO (2013), IPCC (2014b) and FAO, (2017b).

KNOWLEDGE AND CAPACITY TRADITIONAL KNOWLEDGE RESEARCH & DEVELOPMENT EXTENSION SERVICES FOR CLIMATE ACTION AWARENESS RAISING AND EDUCATION HAZARD AND VULNERABILITY MAPPING IMPACT ASSESSMENT AND MONITORING CLIMATE INFORMATION SERVICES CLIMATE INFORMATION SERVICES IN AGRICULTURE EARLY WARNING SYSTEMS EARLY WARNING SYSTEMS IN AGRICULTURE **INSTITUTIONS AND GOVERNANCE** DISASTER RISK REDUCTION AND MANAGEMENT INSTITUTIONAL CAPACITY BUILDING FOR CLIMATE ACTION LAW AND REGULATION LAND TENURE REFORM WATER GOVERNANCE PRICING MECHANISMS INVESTMENT IN AGRICULTURE TRANSPARENCY & ACCOUNTABILITY POLICY MAINSTREAMING AND COHERENCE PARTICIPATORY GOVERNANCE CONFLICT RESOLUTION	FAO (2017c), IPCC (2014b) and FAO (2013)

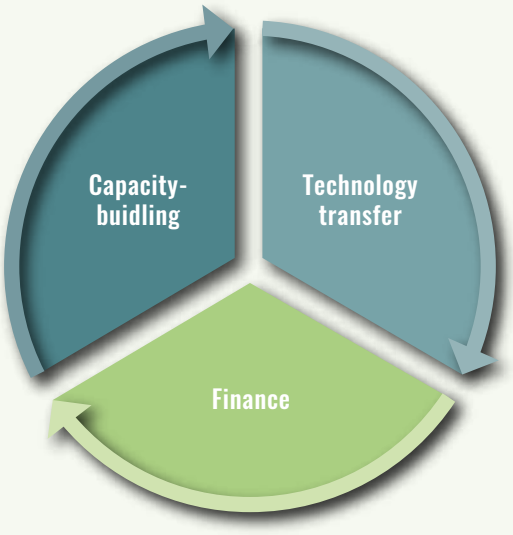
2.5 BARRIERS AND SUPPORT NEEDS

Article 9, 10 and 11 of the PA reiterate the obligations of developed countries to support developing country contributions to build clean, climate-resilient futures through the provision of finance, technology and capacity-building support for climate change mitigation and adaptation. Under Article 13, developing country Parties should also report the financial, technology transfer and capacity-building support needed and received.

The types of support are differentiated by finance, technology transfer and capacity-building needs (**Figure 5**). Financial needs are often expressed in terms of costs for NDC implementation that are unconditional or conditional to external support. Further, financial needs may be characterized by the shares attributed to adaptation and mitigation. Capacity-building needs are often expressed in terms of technical and/or institutional capacity needs. Technology needs are often expressed in terms of the type of priority technology for which support is needed.

FIGURE 5.

TYPES OF SUPPORT NEEDS



In order to understand the common challenges underpinning the implementation of agricultural priorities in country NDCs, a stocktaking of existing barriers and priority technology needs for NDC implementation was undertaken by a review of the 167 (I)NDCs, 194 NCs and 88 Technology Needs Assessments (TNA) submitted between 2001 and 2018 to the UNFCCC[22].

TNAs can play a unique role in facilitating the implementation of NDCs by providing critical information about the realistic potential, ability and scale of climate change technologies in a country. Understanding the types of barriers impeding diffusion and uptake of priority technologies is key to formulating implementation plans that can address these underlying barriers and drive concrete action. These actions can in turn strengthen longer-term strategies elaborated in NDCs and NAPs.

Each barrier expressed may be characterized by one of nine barrier types and associated with either mitigation and/or adaptation, one of 20 priority sectors or cross-sectoral priorities. Barrier types and priority technology types are adapted from the 2015-2018 TNA Synthesis Report (UNEP DTU/UNFCCC, 2018). **Table 7** lists the categories and parameters used to describe of barriers to NDC implementation and priority support needs in the agriculture and land use sectors.

TABLE 7.

QUALIFICATION OF BARRIERS TO NDC IMPLEMENTATION AND PRIORITY SUPPORT NEEDS IN THE AGRICULTURE AND LAND USE SECTORS

CATEGORY AND PARAMETERS	SOURCE
TYPE OF BARRIER TO IMPLEMENTATION ECONOMIC AND FINANCIAL LEGAL AND REGULATORY TECHNICAL AND HUMAN SKILLS INFORMATION AND AWARENESS INSTITUTIONAL AND ORGANIZATIONAL MARKET CONDITIONS AND NETWORK SOCIAL, CULTURAL AND BEHAVIORAL OTHER	ADAPTED FROM UNEP DTU/UNFCCC (2018)
MITIGATION/ADAPTATION PRIORITY MITIGATION ADAPTATION CROSS-CUTTING	
TYPE OF SUPPORT NEEDED CAPACITY BUILDING TECHNOLOGY TRANSFER GENERAL SUPPORT NEEDS	NDC, NC, TNA
TYPES OF PRIORITY SECTORS AND CROSS-SECTORAL PRIORITIES **PRIORITY SECTORS** AGRICULTURE LAND USE CROPS LIVESTOCK FISHERIES AND AQUACULTURE BIOENERGY INTEGRATED SYSTEMS FORESTRY **CROSS-SECTORAL PRIORITIES** ECOSYSTEMS AND NATURAL RESOURCES WATER LAND AND SOIL OCEANS AND COASTAL ZONES BIODIVERSITY AGRI-FOOD CHAIN FOOD SECURITY AND NUTRITION DISASTER RISK REDUCTION AND MANAGEMENT HEALTH RESILIENT INFRASTRUCTURE GENDER EQUALITY INDIGENOUS PEOPLES POVERTY AND INEQUALITY REDUCTION HUMAN RIGHTS	TNA

[22] As of May 1, 2019.

2.6 INFORMATION ON MONITORING PROGRESS

The Enhanced Transparency Framework of the PA is expected to build mutual trust and confidence, and to promote effective implementation by providing a clear understanding of climate change action, including clarity and tracking of mitigation and adaptation progress.

Smart systems for tracking mitigation and adaptation progress depend on enabling institutional environments that support evidence-based policy making and coordination efforts across line ministries and sub-national institutions, as well as robust technical capacities for collecting and managing data at multiple scales. Countries often communicate whether or not MRV and M&E systems are currently in place, or whether they are needed, to track mitigation and adaptation progress, respectively.

PART 3

PART

3

COUNTERFACTUAL SCENARIO

This section describes the methodology for constructing the counterfactual scenario, or the reference point in the absence of mitigation or adaptation, against which the NDCs compared to illustrate not only current policy "gaps" but also potential "opportunities" for enhancing future ambition. The main sources of GHG emissions in the agriculture and LULUCF sectors, or "GHG hotspots," are identified, which serve as the counterfactual against which the mitigation policies or measures can be assessed. Similarly, the major observed and/or projected climate-related hazards, impacts and vulnerabilities reported in ecosystems and social systems, or "vulnerability/risk hotspots," are identified, which serve as the counterfactual against which the adaptation priorities and measures can be assessed.

3.1 MITIGATION COUNTERFACTUAL

3.1.1 Net emissions and GHG targets

In order to construct the counterfactual mitigation scenario against which the NDCs are compared, several parameters are necessary for quantifying the amount of emissions and removals that would be generated in the absence of NDC mitigation in comparison to the cumulated net reduction of emissions foreseen under NDC implementation. The difference between the two curves constitutes the emissions savings. However, the clarity of GHG targets and counterfactual scenarios are not equal amongst country NDCs, rendering the comparability of mitigation ambition challenging. A methodology is presented for "filling in the gaps" when information is incomplete or national data is unavailable as a means for constructing a counterfactual scenario and a mitigation NDC target for comparison at the regional or sub-regional

level. This gap-filling exercise speaks to the importance of TACCC (Transparency, Accuracy, Consistency, Completeness, and Comparability) principles, contained in Art. 4, par. 13 of the PA, that state that national GHG inventories and NDCs shall be transparent, accurate, complete, consistent and comparable.

In order to construct the counterfactual emission and mitigation curves, the following information is required:

- Historical net emissions, CO_2 eq in 2015; and
- Counterfactual net emissions, CO_2 eq in 2020, 2025 and, if any, 2030; and
- Target net emissions, CO_2 eq in 2020, 2025 and, if any, 2030; or
- Percent reduction of net emissions in 2020, 2025 and/or 2030.

The methodology can be applied to economy-wide, multi-sectoral or uni-sectoral level mitigation contributions.

The 2015 historical net emissions value is either extracted from the national data reported in the (I)NDC or NGHGI, BUR or NC submitted to the UNFCCC or it has been interpolated or projected. If inventory data is only available for a year previous to 2015, the 2015 historical value is linearly interpolated based on: i) historical net emissions previous to 2015 and ii) counterfactual net emissions provided by the country in the NDC for 2020, or 2025 or 2030. If inventory data is only available for a year previous to 2015 but no counterfactual net emissions values is provided by the country in the NDC, the 2015 historical value is projected based on: i) historical net emissions previous to 2015 and ii) the average regional rate of change of net emissions, which is used as a proxy.

The 2020, 2025 and 2030 counterfactual net emissions value**s** are based on country data provided in the NDC, or an interpolated or projected value. If none of the counterfactual net emissions values are available, the average regional rate of change of net emissions between 2015 and 2025, or 2030 and the national 2015 historical value are used to estimate the counterfactual net emissions value for 2025 and 2030, respectively.

The 2020, 2025, and 2030 target net emissions value is the absolute value of the product of the 2020, 2025 and 2030 counterfactual net emissions value and the targeted percent reduction for each five-year interval (if available) set by the country in its NDC. If a percent reduction is not available for all five-year intervals, the value is interpolated or extrapolated based on the data available, assuming a linear reduction of net emissions over the implementation period.

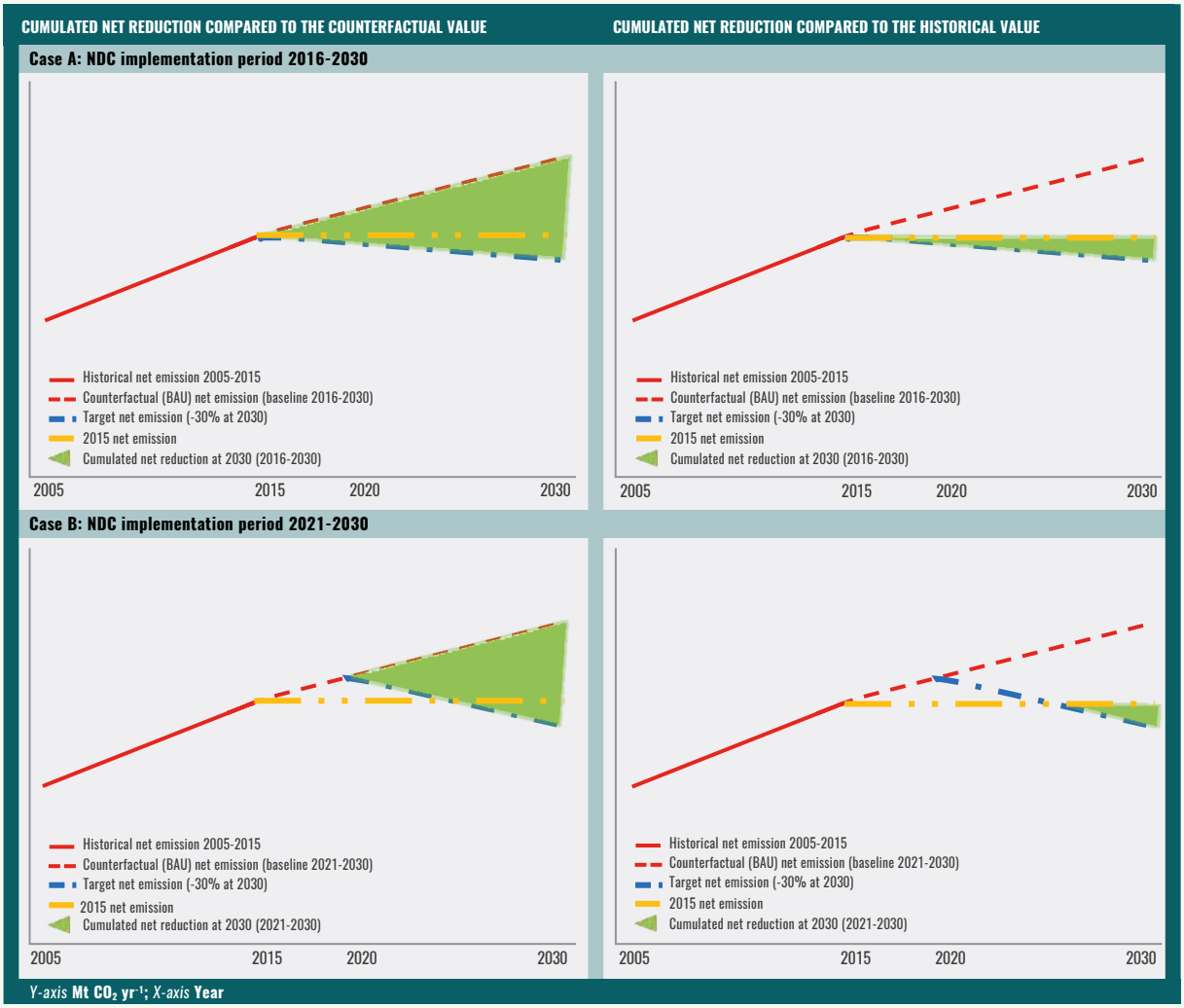
The expected cumulated net emissions reduction at 2030 is based on the difference between the counterfactual net emissions curve and the target net emissions curve integrated[23] from the start to end date of the NDC implementation, assuming linear NDC implementation over the implementation period. The 2030 counterfactual net emissions and the 2030 target net emissions can then be compared against the 2015 historical net emissions value to estimate the percent change of net emissions over the implementation period of both the counterfactual and mitigation scenarios. In some cases, for instance, the difference between the counterfactual and mitigation scenarios is a reduction in net emissions whereas the mitigation scenario is nevertheless higher than the 2015 historical net emissions. For such reason, the estimation of also the cumulated net reduction compared to the historical 2015 net emission value[24] is critical to understanding the total amount of net emissions that will be released into the atmosphere in order to take stock of the global mitigation contribution needed to achieve the global temperature goal under the PA. **Figure 6** illustrates an example of how the cumulated net reduction is estimated based on a hypothetical GHG target defined as a 30 percent absolute reduction in net emissions compared to the 2030 BAU scenario, calculated for two differing implementation periods: 2016-2030 (case A) versus 2021-2030 (case B).

[23] The expected cumulated net emission reduction (negative value) is in practice the sum of the areas of two triangles with a base equal to the implementation period 2016 (or 2021) to 2030 (or 2025) and with heights equal to the difference between the 2015 (or 2020) historical value and the counterfactual net emission value in 2030 (or 2025) and the difference between the 2030 (or 2025) target net emission value and the 2015 (or 2020) historical value, respectively.

[24] The cumulated net reduction compared to the historical 2015 net emission is calculated as the area of the triangle with a base equal to the time period and with a height equal to the difference between the 2015 historical value and the target net emission value at 2030 (or 2025), respectively.

FIGURE 6.

EXAMPLE OF HISTORICAL, COUNTERFACTUAL AND TARGET NET EMISSION SCENARIOS AND CUMULATED NET REDUCTION IN 2030



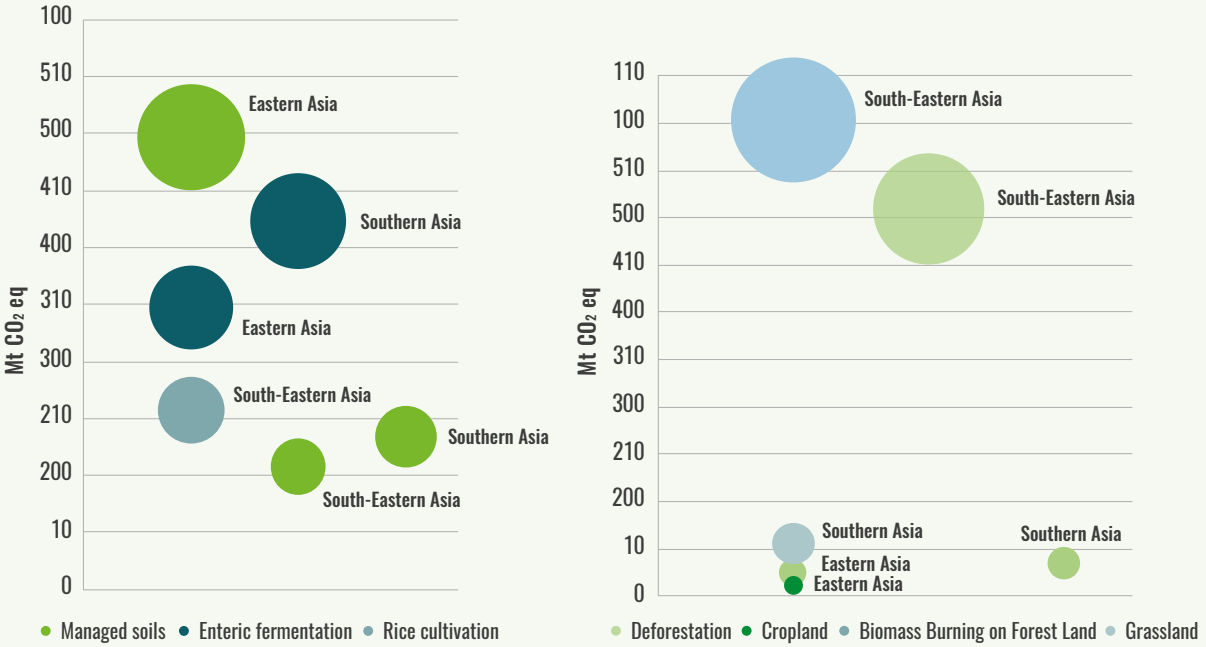
This methodology for constructing the mitigation counterfactual allows for an approximate understanding of mitigation potential at the national and multi-national level, based on the information provided in the NDCs, NCs and BURs. The margin of error is thus subject to the clarity, accuracy and completeness of information reported in national data.

3.1.2 GHG hotspots

Identifying the major sources of GHG emissions in the agriculture and land use sectors is key to assessing the level of sectoral ambition in a country's NDC. In order to identify the GHG hotspots in the agriculture and LULUCF sectors, the first and second largest sources (above a 20 percent share) of emissions from each sector is estimated based on the most recent national GHG inventory data reported to the UNFCCC. The largest sources of agriculture and LULUCF sector emissions identified represent the GHG hotspots for the AFOLU sector. The two-step approach allows for the consideration of emission sources in both relative and absolute terms. Country-level GHG hotspots can be aggregated at sub-regional or regional levels. Sectoral emissions serve as the common metric by which GHG hotspots are quantified and against which the mitigation policies and measures are assessed. **Figure 7** illustrates the GHG hotspots in the AFOLU sector, at the sub-regional level, for Asia (FAO, 2019b) where the size of the bubble corresponds to the amount of net emissions in Mt CO_2 eq.

FIGURE 7.

EXAMPLE OF GHG HOTSPOTS IN THE AGRICULTURE AND LULUCF SECTORS IN ASIA, BY SUB-REGION AND MAJOR CATEGORY



3.2 ADAPTATION COUNTERFACTUAL

3.2.1 Vulnerability hotspots in ecosystems

Using the methodology presented in **Part 2.4.2** by which the climate-related hazards, impacts and vulnerabilities in ecosystems are characterized by the ecosystem, natural resource and ecosystem service impacted, the most frequently reported ecosystem service and natural resource impact categories represent "vulnerability hotspots" in ecosystems. Ecosystem services and natural resources therefore constitute the common metric by which climate-related hazards, impacts and vulnerabilities in ecosystems are qualified and against which adaptation priorities and measures in ecosystems can be assessed. **Figure 4** illustrates this relationship.

3.2.2 Risk hotspots in social systems

Using the methodology presented in **Part 2.4.2** by which the climate-related impacts, vulnerabilities and risks in social systems are characterized by risk category, the most frequently reported risk categories represent "risk hotspots" in social systems. In addition, using the methodology presented in **Part 2.4.3** by which non-climatic drivers of vulnerability are characterized by non-climatic dimension and non-climatic vulnerability driver, the most frequently reported vulnerability driver categories represent "vulnerability hotspots" in social systems. The climate-driven risk categories and non-climatic vulnerability driver categories therefore constitute the common metrics by which climate-related hazards, vulnerabilities and risks in social systems are qualified and against which adaptation priorities and measures in social systems can be assessed. **Figure 4** illustrates this relationship.

PART 4

PART

4

GAP ANALYSIS METHODOLOGY

This section presents a methodology for assessing the degree to which the mitigation and adaptation commitments target the major GHG and vulnerability "hotspots" in a given country. In short, it provides the methodology for assessing whether for each GHG hotspot or vulnerability hotspot, there is a policy or measure that targets that particular hotspot. It also provides a framework for assessing the degree of convergence between mitigation and adaptation measures in the agriculture and land use sectors in order to promote policies that co-deliver.

The results of the mitigation and adaptation gap analysis can inform the review and revision of the NDCs in efforts to enhance post-2020 ambition, by highlighting the extent to which current NDCs address, or "cover", the greatest sources of emissions and most frequently reported climate-related hazards, impacts and vulnerabilities. This assessment can therefore help to realign mitigation and adaptation policies and measures in the agriculture and land use sectors to improve their coverage.

4.1 MITIGATION COVERAGE GAP ANALYSIS

Based on a stocktaking of the various mitigation policies or measures in the agriculture and LULUCF sectors contained in all NDCs, a Mitigation Matrix was developed to indicate the relationship between each typology of mitigation policy or measure and each of the 2006 IPCC GHG sink/source categories in the AFOLU sector – as carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) fluxes. The relationship is qualified as either positive, in which a mitigation "benefit" is potentially generated, or negative, in which a mitigation "tradeoff" is potentially generated. A "mitigation benefit" refers to the potential reduction in net emissions or emission intensity with respect to a given GHG source category, or a potential

enhancement of removals with respect to a given GHG sink category. Conversely, a "mitigation tradeoff" refers to when a policy or measure may reduce net emissions (or intensity) or enhance removals in one GHG source/sink category while unintentionally increasing net emissions or reducing carbon sinks with respect to another GHG source/sink category. This relationship, however, is not assessed in terms of the extent to which a policy or measure will result in the reduction of net emissions (or intensity) or increase in carbon stock. The actual mitigation impact will depend upon various local factors, including biophysical factors, such as climate, soil quality, and water availability, as well as socio-economic factors, including access to productive inputs and services, as well as institutional factors, such as policy mainstreaming, coordination and investment.

The cross-cutting nature of the matrix enables analysis of both mitigation benefits and tradeoffs amongst various agriculture activities and across multiple land uses, which is particularly relevant in the context of biofuels production. Based on the set of mitigation policies or measures in the agriculture and land use sectors identified in the NDCs, over 100 potential mitigation benefits and around 15 potential tradeoffs were generated using the Mitigation Matrix. Refer to **Annex 2** for the Mitigation Matrix, detailing the relationship between each typology of mitigation policy or measure and each IPCC GHG sink/source category in the AFOLU sector, by positive or negative GHG flux.

Based on the Mitigation Matrix, a "coverage gap" analysis can be performed at either the national, sub-regional or regional level, to assess whether the mitigation policies or measures contained in country NDCs in the agriculture and land use sectors address the GHG hotspots identified. "Policy coverage" refers to when at least one mitigation policy or measure in the NDC aims to reduce net emissions (or intensity) or enhance the storage of carbon stocks in relation to the GHG hotspot category identified. At the country level, policy coverage can be quantified using binary coding, which can then be aggregated to the regional level as the share of countries with at least one mitigation policy or measure per GHG hotspot over the total number of countries with that GHG hotspot. A "policy coverage gap" refers to when there is absence of at least one policy or measure in the NDC aiming to reduce net emissions (or intensity) or enhance the storage of carbon stocks in relation to the GHG hotspot category identified. At the country level, the policy coverage gap can be quantified using binary coding, which can then be aggregated to the regional level as the share of countries with a policy coverage gap per GHG hotspot identified over the total number of countries with that GHG hotspot. **Table 8** illustrates the range of policy coverage gaps.

TABLE 8.

RANGE OF MITIGATION POLICY COVERAGE GAP IN THE NDC

SCORE	RANGE OF POLICY COVERAGE GAP (% OF COUNTRIES)
VERY HIGH	61 TO 100 PERCENT
HIGH	31 TO 60 PERCENT
MODERATE	10 TO 30 PERCENT
LOW	0 TO 9 PERCENT

Limitations to the analysis include the lack of disaggregated emissions data contained in national GHG inventories, which would facilitate the design of a more precise analysis of emission sources and mitigation benefits.[25] It should also be noted that the analysis serves as a broad review of the coverage of mitigation policies or measures mentioned in the NDC and not an assessment of their impact, which could be further assessed in terms of type (e.g. action, policy, project, programme or framework), scale, comprehensiveness, feasibility and timeframe. The analysis, therefore, serves as an initial stocktaking of policy coverage and does not necessarily indicate overall impact, which will be place- and context-specific.

[25] For instance, emissions from managed soils are often not disaggregated into corresponding sub-categories (emissions from manure, from synthetic fertilizers, etc.) in the national GHG inventories of many developing countries.

4.2 ADAPTATION COVERAGE GAP ANALYSIS

Based on a stocktaking of the various adaptation priorities and measures in the agriculture and land use sectors contained in the NDCs, adaptation matrices were developed to compare the adaptation priorities or measures set forth in the NDCs in ecosystems and social systems against the major observed and/or projected climate-related hazards, impacts, vulnerabilities and risks reported in ecosystems and social systems. In each matrix, the relationship between the typology of adaptation measures and major climate-related impact categories (i.e. hazards, vulnerabilities and risks) is qualified as either positive, in which an "adaptation benefit" is potentially generated, or negative, in which an "adaptation tradeoff" is potentially generated. An "adaptation benefit" refers to a potential reduction in vulnerability and/or increase in the adaptive capacity of relevant stakeholders with respect to a given climate-related impact category. Conversely, an "adaptation tradeoff" refers to when implementation of one adaptation measure aiming to reduce vulnerability and/or enhance the adaptive capacity of relevant stakeholders in relation to one climate-related impact category may unintentionally increase vulnerability and/or reduce the adaptive capacity of relevant stakeholders in relation to a different climate-related impact category. This relationship, however, is not assessed in terms of the extent to which an adaptation measure will result in a reduction in the level of vulnerability and/or increase in the degree of adaptive capacity of relevant stakeholders. The actual adaptation impact will depend upon various local factors, including biophysical factors, such as climate, soil quality, and water availability, as well as socio-economic factors, including land tenure and access to credit and financial services, as well as institutional factors, such as policy mainstreaming, coordination and investment.

An Adaptation Matrix for ecosystems (**Annex 3**) was develope**d** to illustrate the cross-cutting and multi-dimensional relationship between climate-related impact categories (per ecosystem, ecosystem service and natural resource impacted) and adaptation measures (per ecosystem, ecosystem service and natural resource supported), from which over 750 potential adaptation benefits and around 50 potential tradeoffs were generated.

An Adaptation Matrix for social systems (**Annex 4**) was developed to illustrate the relationship between climate-related risk categories (per social system dimension) and adaptation measures (per social system dimension), from which around 150 potential adaptation benefits were generated.

Based on the Adaptation Matrices, a "coverage gap" analysis can be performed at either the national, sub-regional or regional level to compare adaptation priorities or measures in ecosystems or social systems against the major climate-related vulnerability/risk hotspots identified. "Policy coverage" refers to when at least one adaptation measure in the NDC aims to reduce vulnerability and/or increase adaptive capacity in relation to the major climate-related impact category reported. At the country level, policy coverage can be quantified using binary coding, which can then be aggregated to the regional level as the share of countries with at least one adaptation measure per vulnerability/risk hotspot over the total number of countries with that vulnerability/risk hotspot. A "policy coverage gap" refers to when there is absence of at least one measure in the NDC aiming to reduce vulnerability and/or increase adaptive capacity in relation to the major climate-related impact category reported. At the country level, policy coverage gap can be quantified using binary coding, which can then be aggregated to the regional level as the share of countries with a policy coverage gap per vulnerability/risk hotspot identified over the total number of countries with that vulnerability/risk hotspot. **Table 9** illustrates the range of policy coverage gaps.

TABLE 9.

RANGE OF ADAPTATION POLICY COVERAGE GAPS IN THE NDC

SCORE	RANGE OF POLICY COVERAGE GAP (% OF COUNTRIES)
VERY HIGH	61 TO 100 PERCENT
HIGH	31 TO 60 PERCENT
MODERATE	10 TO 30 PERCENT
LOW	0 TO 9 PERCENT

The gap analysis is limited to the content of the NDCs and performed only for those countries including climate-related hazards, impacts and vulnerabilities in ecosystems and climate-related impacts, vulnerabilities and risks in social systems within the context of the agriculture and land use sectors and rural livelihoods. It should also be noted that the analysis serves as a broad review of the coverage of adaptation priorities and measures mentioned in the NDC and NC and not an assessment of their impact, which could be further assessed in terms of type (e.g. action, policy, project, programme or framework), scale, comprehensiveness, feasibility and timeframe. The analysis, therefore, serves as an initial stocktaking of policy coverage and does not necessarily indicate overall impact, which will be place- and context-specific.

4.3 MITIGATION AND ADAPTATION CO-BENEFITS ANALYSIS

Mitigation and adaptation in agriculture and land use are closely interlinked through a web of feedbacks, synergies, and tradeoffs. Sustainable food and agriculture systems carry the greatest potential for generating synergies across climate change mitigation and adaptation efforts, as well as significant socio-economic and environmental co-benefits (FAO, 2016c). For instance, many land-based mitigation practices that aim to enhance soil carbon will also increase the ability of soils to retain moisture and prevent erosion, which in turn enriches the biodiversity and productivity of cropping systems and enhances resilience to the increasing frequency and severity of droughts and floods under climate change (Rosenzweig and Tubiello, 2007). On the other hand, most categories of adaptation options for climate change have positive impacts on mitigation (IPCC, 2014a). For instance, restoring forest ecosystems also prevents the release of CO_2 emissions and enhances carbon stocks. When mitigation and adaptation synergies are captured, such as through agroforestry where trees planted sequester carbon and tree products provide livelihood to communities (Verchot *et al.*, 2007), the joint mitigation-adaptation outcome is greater than their sum. The most prominent option found in the scientific literature that delivers mitigation in agriculture while also enhancing resilience to future climate change is the enhancement of soil carbon stocks (Smith and Olesen, 2010).

An integrated landscape approach to the design of climate change adaptation and mitigation options is necessary to evaluate the often competing pressures on land use and their impact on adaptive capacities and resilience to climate variability and change, within or across sectors, in order to capture their synergies and reconcile tradeoffs.

The potential channels by which mitigation and adaptation co-benefits in the agriculture and land use sectors are generated, as well as potential tradeoffs can be assessed. A mitigation-adaptation co-benefit matrix was developed (**Annex 5**) to codify the links between the mitigation policies and measures identified in **Table 1** and adaptation measures identified in **Table 4** and 5, from which around 200 potential mitigation-adaptation co-benefits and 50 tradeoffs were generated in the agriculture and land use sectors. Each mitigation policy or measure may generate one or more adaptation co-benefit, and vice versa. Binary coding (0/1) is employed per country.

The analysis reflects a two-way process:

1. Mitigation-to-adaptation co-benefits/tradeoffs: The total number of adaptation co-benefits and/or tradeoffs per mitigation measure is quantified; and
2. Adaptation-to-mitigation co-benefits/tradeoffs: The total number of mitigation co-benefits and/or tradeoffs per adaptation measure is quantified.

The degree of convergence refers to the frequency of adaptation or mitigation co-benefits per mitigation or adaptation measure (and does not reflect how much the measure contributes in absolute terms to achieving a particular outcome). The number of policies or measures with mitigation or adaptation co-benefits is quantified at the country-level and results can be aggregated at the sub-regional and regional levels. The analysis only covers sector- or land use-specific management activities, to pinpoint concrete climate change mitigation actions with adaptation co-benefits, and vice-versa, and excludes general agricultural approaches, such as Climate Smart Agriculture (CSA) or conservation agriculture.

When explicit reference to co-benefits is missing in countries' NDCs, identifying potential pathways for leveraging co-benefits can be critical for driving progress across both mitigation and adaptation agendas and optimizing investment in the agriculture and land use sectors.

CONCLUSION

In light of the heterogeneity of NDCs in terms of scope, detail and length, the methodology presented enables the systematic disaggregation and re-aggregation of country NDCs into a standard set of categories and parameters by which climate change mitigation and adaptation contributions in the agriculture and land use sectors can be assessed. A better understanding of the role of agriculture and land use in the NDCs can inform national or international climate and development policy processes, guide investments and support options, as well as highlight gaps and opportunities for the revision of the NDCs in 2020 and subsequent revision cycles, with the underlying vision of facilitating national transitions towards low-emission and climate-resilient agriculture and land use.

BIBLIOGRAPHY

African Development Bank (ADB). 2016. Assessing the Intended Nationally Determined Contributions of ADB Developing Members. *ADB Sustainable Development Working Paper Series, No 44*. Manila. [also available at https://www.adb.org/sites/default/files/publication/189882/sdwp-044.pdf]

Admiraal *et al.* 2015. Assessing Intended Nationally Determined Contributions to the Paris Climate Agreement – What Are the Projected Global and National Emission Levels for 2025–2030? The Hague. PBL Netherlands Environmental Assessment Agency. [also available at http://www.pbl.nl/sites/default/files/cms/publicaties/pbl-2015-assessing-intended-nationally-determined-contributions-to-the-paris-climate-agreement_1879. Pdf]

Climate Analytics. n.d. Synthesis of the LDCs' NDCs Analysis. [online] [Cited 6 May 2019] https://climateanalytics.org/media/synthesis_of_the_ldcs_____ndcs_analysis_impact_2017.10.04.pdf

Climate Action Tracker (CAT). 2019. Climate Action Tracker [online] [Cited 8 May 2019] https://climateactiontracker.org/about/

Climate Watch. n.d. Climate Watch. [online] [Cited 9 May 2019] https://www.climatewatchdata.org/

Damassa *et al.* 2015. Interpreting INDCs: Assessing Transparency of Post-2020 Greenhouse Gas Emissions Targets for 8 Top-Emitting Economies. Working Paper. Washington, DC: World Resources Institute (WRI). [also available at http://www.wri. org/publication/interpreting-indcs]

Deutsches Gesellschaft fur Zusammenarbeit (GIZ). n.d. Tool for Assessing Adaptation in the NDCs (TAAN). [online] [Cited 9 May 2019] https://www.adaptationcommunity.net/nap-ndc/tool-assessing-adaptation-ndcs-taan/taan/

Deutsches Institut fur Entwicklungspolitik (DIE), African Centre for Technology Studies (ACTS), Stockholm Environment Institute (SEI). 2016. NDC Explorer. [online] [Cited 9 May 2019] https://klimalog.die-gdi.de/ndc/#NDCExplorer/worldMap?NDC??income???catIncome

ECN & New Climate Institute. n.d. SDG Climate Action Nexus Tool. [online] [Cited 9 May 2019] http://ambitiontoaction.net/scan_tool/

Emergency Events Database (EM-DAT). 2009. EM-DAT [online] Brussels. www.emdat.be

European Commission Joint Research Centre (EC-JRC). 2015. Quantifying the contribution of the Land Use sector to the Paris Climate Agreement. [online] [Cited 9 May 2019] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC98451/jrc%20lulucf-indc%20report.pdf

FAO. n.d. FAO TERM Portal. (available at http://www.fao.org/faoterm/en/)

FAO. 2013. *Climate-Smart Agriculture: Sourcebook*. Rome. (also available at http://www.fao.org/3/a-i3325e.pdf)

FAO. 2014. *Developing sustainable food value chains – Guiding principles*. Rome. (also available at http://www.fao.org/3/a-i3953e.pdf)

FAO. 2016a. *The Agriculture Sectors in the Intended Nationally Determined Contributions: Analysis*. Rome. (also available at http://www.fao.org/3/a-i5687e.pdf)

FAO. 2016b. *Climate change and food security: risks and responses*. Rome. (also available at http://www.fao.org/3/a-i5188e.pdf)

FAO. 2016c. *The State of Food and Agriculture 2016: climate change, agriculture and food security*. Rome.

FAO. 2017a. FAO Strategy on Climate Change. Rome. (available at http://www.fao.org/3/a-i7175e.pdf)

FAO. 2017b. *Tracking adaptation in agricultural sectors: Climate Change Adaptation Indicators*. Rome. (also available at http://www.fao.org/3/a-i8145e.pdf)

FAO. 2017c. *Climate Smart Agriculture Sourcebook – Second Edition*. Rome (also available at http://www.fao.org/climate-smart-agriculture-sourcebook/en/)

FAO. 2019 (forthcoming). Update to Analysis of Agriculture in the NDCs: Global Analysis. Rome.

Global Water Partnership (GWP). 2018. Preparing to Adapt: The Untold Story of Water in Climate Change Adaptation Processes. [online] [Cited 9 May 2019] https://www.gwp.org/globalassets/global/events/cop24/gwp-ndc-report.pdf

High Level Panel of Experts (HLPE). 2014. Food losses and waste in the context of sustainable food systems. Rome. Committee on World Food Security (also available at: http://www.fao.org/3/a-i3901e.pdf)

ICF International. 2016. Analysis of Intended Nationally Determined Contributions (INDCs). [online] [Cited 9 May 2019] https://www.climatelinks.org/sites/default/files/asset/document/INDC%20White%20Paper%20-%20June%202016_public_RALI.pdf

Institute for Global Environmental Strategies (IGES). 2016. Analysis of Financial Components of Intended Nationally Determined Contributions (INDCs). Lessons for Future NDCs. IGES Working Paper. Kanagawa. [also available at file:///C:/Users/Gagliardi/AppData/Local/Packages/Microsoft.MicrosoftEdge_8wekyb3d8bbwe/TempState/Downloads/INDC_finance_IGES_workingpaper_20161109_final_2.pdf]

International Union for Conservation of Nature (IUCN). 2017. The Bonn Challenge and the Paris Agreement: How can forest landscape restoration advance Nationally Determined Contributions?. Forest Brief No 21. Gland [also available at https://www.iucn.org/sites/dev/files/content/documents/20171213_ndcs_fbrief.pdf]

IPCC. 1996 (Intergovernmental Panel on Climate Change). Revised Guidelines for National Greenhouse Gas Inventories. (available at https://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html)

IPCC. 2006. Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan (also available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/0_Overview/V0_0_Cover.pdf)

IPCC. 2014a. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* [Core Writing Team, R.K. Pachauri and L.A. Meyer, eds]. Geneva, Switzerland.

IPCC. 2014b. *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* [V.R. Barros, C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken,P.R. Mastrandrea and L.L. White, eds]. Cambridge, UK, and New York, USA, Cambridge University Press.

IPCC. 2018: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

Low Emissions Development Strategies Global Partnership (LEDS). 2017. Role of agriculture, forestry, and other land use mitigation in INDCs and national policy in Asia. [online] [Cited 9 May 2019] http://ledsgp.org/wp-content/uploads/2017/10/LEDS-GP_Agriculture_Pr2Final_WEB.pdf

Millenium Ecosystem Assessment (MEA). 2005. Ecosystems and Human Well-being: Synthesis. Washington, DC, Island Press.

Nachmany, M. and Mangan, E. 2018. Aligning national and international climate targets. London: *Grantham Research Institute on Climate Change and the Environment and Centre for Climate Change Economics and Policy, London School of Economics and Political Science.* (also available at www. lse.ac.uk/GranthamInstitute/publications)

Rainforest Alliance (RA). 2015. The Land Sector and Country Commitments to Global Climate Action: A Rainforest Alliance Assessment of Intended Nationally Determined Contributions (INDCs). [online] [Cited 10 May 2019] https://www.rainforest-alliance.org/sites/default/files/2016-08/INDC-Assessment.pdf

Richards M. *et al.* 2016. How countries plan to address agricultural adaptation and mitigation: An analysis of Intended Nationally Determined Contributions. CCAFS dataset version 1.2. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Rights and Resources Initiative (RRI). 2016. Indigenous Peoples and Local Community Tenure in the INDCs. Status and Recommendations. RRI Issue Brief No 1. [online] http://rightsandresources.org/wp-content/uploads/2016/04/Indigenous-Peoples-and-Local-Community-Tenure-in-the-INDCs-Status-and-Recommendations_RRI_April-2016.pdf [Cited 9 May 2019]

Rosenzweig, C. and Tubiello F. N. 2007. Adaptation and Mitigation Strategies in Agriculture: an Analysis of Potential Synergies. *Mitigation and Change Adaptation Strategies for Global*, 12: pp. 855-873.

Smith P. and Olesen J. E. 2010. Synergies between the mitigation of, and adaptation to climate change in agriculture. *Journal of Agricultural Science*, 148: pp. 543-552.

TEEB. 2010. (The Economics of Ecosystems and Biodiversity). Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. [also available at http://doc.teebweb.org/wp-content/uploads/Study%20and%20Reports/Reports/Synthesis%20report/TEEB%20Synthesis%20Report%202010.pdf]

Tubiello, F. N. *et al.* 2015. The Contribution of Agriculture, Forestry and other Land Use activities to Global Warming, 1990–2012. *Global Change Biology*, 21(7): pp. 26555-2660.

United Nations Development Programme (UNDP) & World Resources Institute (WRI). 2015. Designing and Preparing Intended Nationally Determined Contributions (INDCs). (also available at: https://www.transparency-partnership.net/sites/default/files/indcs_may27_v2.pdf)

United Nations Environment Programme (UNEP). 2018a. The Emissions Gap Report 2018. Nairobi. (also available at: http://wedocs.unep.org/bitstream/handle/20.500.11822/26895/EGR2018_FullReport_EN.pdf?sequence=1&isAllowed=y)

UNEP. 2018b. The Adaptation Gap Report 2018. Nairobi. (also available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/27114/AGR_2018.pdf?sequence=3)

UNEP/DTU Partnership. 2017. Taking stock of the (I)NDCs of developing countries: regional (I)NDC coverage of mitigation sectors and measures. [also available at http://orbit.dtu.dk/files/142227651/NDC_Analysis_2017.pdf]

UNEP DTU Partnership/UNFCCC. 2018. Summary of Country Priorities: Technology Needs Assessments 2015-2018. (also available at: http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNA_key_doc/137ce42be33c4341a9b9e6679f7f8539/4a057ad243164ac6bbaa62bcb96bc39a.pdf)

United Nations Framework Convention on Climate Change (UNFCCC). 2015. Synthesis report on the aggregate effect of the intended nationally determined contributions. FCCC/CP2015/7. Paris. (also available at https://unfccc.int/resource/docs/2015/cop21/eng/07.pdf)

Verchot L. V. *et al.* 2007. Climate change: linking adaptation and mitigation through agroforestry. Mitigation and Adaptation Strategies for Global Change, 12(5): pp. 901-918.

Vermeulen, S. *et al.* 2012. Climate Change and Food Systems. Annual Review of Environment and Resources, 37: pp. 195-222.

Wiley, E. *et al.* n.d. Health in Intended Nationally Determined Contributions (INDCs). [online] https://www.mcgill.ca/epi-biostat-occh/files/epi-biostat-occh/analysis_of_indcs_1.pdf [Cited 9 May 2019]

Women's Environment & Cooperation Development Organization (WEDO). 2018. Gender Climate Tracker. [online] https://genderclimatetracker.org/gender-ndc/quick-analysis [Cited 8 May 2019]

World Bank (WB). n.d. Intended Nationally Determined Contributions (INDCs). [online] http://spappssecext.worldbank.org/sites/indc/Pages/INDCHome.aspx [Cited 9 May 2019]

World Wildlife Fund (WWF). 2015. INDC Analysis: An Overview of the Forest Sector. [online] http://wwf.panda.org/wwf_news/?257883/INDC-Analysis-An-Overview-of-the-Forest-Sector [Cited 9 May 2019]

WRI. n.d. NDC-SDG Linkages. [online] https://www.climatewatchdata.org/ndcs-sdg [Cited 9 May 2019]

ANNEXES

ANNEX 1.

LITERATURE REVIEW OF NDC-RELATED ANALYSES, BY SCALE OR SCOPE

GLOBAL SCALE
The **UNFCCC Synthesis Report**, released in October 2015 and updated in May 2016, assesses the extent to which 161 INDCs from 189 countries contribute to the goal of keeping global warming to 2°C relative to pre-industrial levels and which role the sectors most responsible for anthropogenic GHG emissions – energy, agriculture, forest and land use, industries and waste – play in this regard. The report acknowledges that the INDCs account for land use, land use change and forestry (LULUCF) in different ways, which renders assessments of this sector quite difficult. The aggregate impact of adaptation commitments was not calculated due to methodological uncertainties. Instead, information on adaptation was synthetized by highlighting certain areas and trends.
The **Climate Action Tracker** (CAT) was developed by three research institutions (Newclimate, Ecofys Climate analytics) to track progress towards the PA goal of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C. CAT quantifies and evaluates climate change mitigation commitments of 32 countries covering around 80 percent of global emissions, and assesses, whether countries are on track to meeting those. CAT rates (I)NDCs, 2020 pledges, long-term targets and current policies against whether they are consistent with a country's fair share effort to the 1.5°C temperature goal. It then aggregates country action to the global level, determining likely temperature increase by the end of the century.
The **UNEP 2018 Emissions Gap Report** estimates global emission levels by 2025 and 2030 from NDCs submitted to date, and compare these to levels required to hold warming below 2°C in the long term, and to below 1.5°C by 2100.
The **GIZ** (2017) analyzed the adaptation components of 165 (I)NDCs representing 195 countries as of May 2017 and explored opportunities and challenges for linking the NDCs to NAP or NAP-like processes.
REGIONAL/MULTI-NATIONAL SCALE
A working paper (Damassa *et al.*, 2015) prepared by the **World Resources Institute** (WRI) evaluates the transparency of the GHG emissions targets presented in the INDCs of eight top-emitting Parties—Brazil, China, the European Union, India, Indonesia, Japan, Mexico, and the United States.
The assessment prepared by the **PBL Netherlands Environmental Assessment Agency** provides an overview of INDCs submitted by G20 countries and analyses the level of their ambition. It assesses the aggregate effect of those INDCs on projected global greenhouse gas emissions up to 2030 and compare the result to emission projections based on implementation of current climate policies and on business-as-usual developments. Furthermore, it assesses the emission gap between the global emission levels required for keeping global temperature increase within 2°C, and those that would result from implementation of the submitted INDCs, by 2025 and 2030.
A white paper was developed for the United States Agency for International Development (**USAID**) by ICF International to summarize information in the 37 INDCs of partner countries in the U.S. Government's Enhancing Capacity for Low Emission Development Strategies (EC-LEDS) program, and other designated priority countries in Africa, Asia, Europe and Eurasia, and Latin America and the Caribbean as of 12 February 2016.
A research paper published by **Asian Development Bank** (2016) analyzed the sectoral priorities and support requirement of 38 developing member countries in Asia and the Pacific.
Climate Analytics (2017) developed a policy brief covering the (I)NDCs of the 47 LDCs by means of a broad review of their mitigation, adaptation, loss and damage, and means of implementation components.
UNEP (2017) conducted a stocktaking of the coverage of mitigation sectors and measures in the (I)NDCs of developing countries and the types of support needed for implementation. Mitigation in the AFOLU sector was categorized by three sub-sectors (agriculture, livestock and LULUCF) and sub-categorized by 15 mitigation measures. The data sets were then aggregated at the regional level.
THEMATIC SCOPE
The Women's Environment and Development Organization developed a **Gender Climate Tracker** that examines the extent to which submitted NDCs address women's human rights and the linkages between climate change and gender more broadly. It quantifies the extent to which 190 countries as of October 2016 reference gender or women and gender-responsive budgeting, planning and monitoring processes in their NDCs.
A rapid analysis of the NDCs, conducted by **IUCN and Climate Focus**, looked at the role of forest landscape restoration in light of the Bonn Challenge. A policy brief was developed to illustrate the main findings.
The Rights and Resources Initiative (**RRI**) (2016) assessed the extent to which 161 INDCs of 188 countries made clear commitments to strengthen or expand the tenure and natural resource management rights of Indigenous Peoples and local communities as part of their climate change mitigation plans or associated adaptation actions.
A study by the **IGES** (2016) captured the main characteristics of financial components of INDCs aiming to understand developing countries' financial needs by examining INDCs of 151 countries.
Grantham Research Institute on Climate Change and the Environment (2018) developed a policy brief that compares the quantified targets in the NDCs and in national laws and policies (which we describe as 'national targets') to offer insights about their consistency in terms of time frames and definitions
Wiley *et al.*, (2015) analyzed the role of **health** in 184 (I)NDCs.
The Global Water Partnership (GWP) developed an analysis of **water**-specific commitments in the NDCs of 80 countries.

SECTORAL SCOPE
FAO (2016a) global review of the role of agriculture sectors in 161 NDCs and 22 INDCs, representing 189 countries, as of 29 July 2016. The review quantified the inclusion of agriculture and/or LULUCF in the mitigation and adaptation priorities of countries.
The **CGIAR** Research Program on Climate Change, Agriculture and Food Security (CCAFS) developed a series of short documents and maps to analyze the prominence of the agriculture sectors in 162 (I)NDCs representing 189 countries INDCs that had been submitted as of October 2016. The assessments were conducted using a keyword search to quantify mitigation and adaptation aspects, including gender, livestock and cropping systems.
The **Rainforest Alliance** carried out an in-depth review of agriculture and LULUCF for 22 submissions, focusing in particular on forested countries in the tropics. The study includes countries in which the agriculture sectors are particularly important, as well as some developed and emerging economies that will likely influence trends in the land use sector. The review aims to provide relevant information on forestry, deforestation, climate smart agriculture and adaptation of vulnerable communities to climate change.
The **Joint Research Centre** (JRC) analyzed different mitigation perspectives in the LULUCF sector. The study compares expected net emissions in 2030 (from conditional and unconditional pledges) against countries' business-as-usual (BAU) and pre-INDC scenarios, as well as the share of LULUCF in these contributions. Due to a lack of historical data, the analysis is based on 46 INDCs representing 74 countries.
The Low Emissions Development Strategies Global Partnership (**LEDS**) assessed the role of agriculture and LULUCF in the INDCs of seven Asian countries (Bangladesh, Cambodia, India, Indonesia, Lao People's Democratic Republic, Thailand, and Vietnam). The analysis compares the projected emissions reduction potential to the respective national emission profile for each INDC. The analysis focuses on existing (and potential) mitigation commitments and has a strong focus on the corresponding financial needs.
A study by the **WWF** (2015) examined the inclusion of the forestry sector in 75 INDCs from developing countries and economies in transition with either a globally significant forest cover or with a domestically important forest sector.
Other sectoral focuses include the analysis of the transport sector (GIZ 2017); and the energy sector (**International Energy Agency**) in the NDCs.
ONLINE DATABASE AND TOOLS
The German Development Institute (DIE) developed a database and online visualization tool – **NDC Explorer** – to analyze and compare the quantitative and qualitative content of all (I)NDCs. All (I)NDCs were broken down into 60 sub-categories related to mitigation, adaptation, finance and support, planning and process in all IPCC sectors. At the sectoral level, the (I)NDCs were characterized, using binary coding, by the inclusion of targets and actions for mitigation and climate risks, vulnerabilities and priority sectors (e.g. agriculture, ecosystems, water and forestry) for adaptation.
The World Bank Group developed a searchable database and online visualization tool – **NDC Platform** – to present the general content of the (I) NDCs in terms of mitigation, adaptation and finance in all IPCC sectors. All (I)NDCs were broken down into sub-categories related to mitigation, adaptation and costs. At the sectoral level, the mitigation content is characterized by type of target and/or commitment, conditionality and cost and the adaptation content is characterized by sub-sector priority.
The World Research Institute developed a searchable online database – **Climate Watch** – that contains information from all (I)NDCs. It breaks down the (I)NDCs into main categories, including mitigation, adaptation, sectoral actions and finance and support and uses binary coding to characterize each (I)NDC by the set of indicators identified per main category. At the sectoral level, the mitigation and adaptation content is characterized by sector and whether sector-specific actions were included or not.
A Tool for Assessing Adaptation in the NDCs (**TAAN**) is a knowledge platform developed by the GIZ Climate Policy Support Programme that aims to provide an overview information on adaptation content included in the NDCs of 175 countries as of 20 September 2018. TAAN provides statistics related to adaptation, priority sectors for adaptation, vulnerable sectors and adaptation costs and support needs.
Several tools analyze and/or quantify the linkages between the NDCs and the Sustainable Development Goals (SDGs) at the target level, including SDG Climate Action Nexus (**SCAN**) tool developed by ECN and NewClimate Institute; **NDC-SDG Connections** developed by SEI and the German Development Institute (DIE); and **NDC-SDG Linkages** developed by WRI.

Annexes 2 to **5** can be found accessing the report online via the FAO Climate Change Resources webpage: http://www.fao.org/climate-change/resources/publications/en/

The success of the Paris Agreement rests upon the enhanced ambition of Parties to progressively revise and strengthen their Nationally Determined Contributions (NDCs) over time. Article 4.3 of the Agreement embeds an ambition mechanism by which each Party shall prepare successive NDCs that represent a progression beyond the Party's then current NDC and reflects its highest possible ambition. The second round of revised or new NDCs should be submitted by 2020 and every five years thereafter.

Agriculture and land use have a large role to play in the global response to climate change, as both a source of greenhouse gas emissions but also a significant carbon sink, as well as the most vulnerable sectors to climate extremes and variability.

Understanding current commitments, as well as the policy "gaps" and "opportunities" for upscaling NDCs in 2020, is critical to ensuring a progressive cycle of ambition. This paper presents a common framework for synthesizing and analyzing the role of agriculture and land use in the NDCs to facilitate a better understanding of country priorities, challenges and support needs. The methodology developed is directed at policy makers, sectoral experts and technical practitioners in the field of agriculture, climate change and food security with the overall aim of supporting national governments to strengthen their adaptation and mitigation policies in the agriculture and land use sectors.

The framework enables a country-level analysis of the extent to which existing adaptation and mitigation policies respond to major emission sources, and the climate-related hazards, risks and vulnerabilities undermining country capacity to adapt and build resilient livelihoods. As such, the framework can support the 2020 NDC revision process and future revision cycles by identifying "gaps" and "opportunities" for raising mitigation and adaptation ambition. It can also serve as a basis for collective action in the agriculture and land use sectors, evidencing opportunities for directing programmatic support and investments.

ISBN 978-92-5-131673-3 ISSN 2226-6062

Climate and Environment Division (CBC)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)
WWW.FAO.ORG

9 789251 316733
CA5543EN/1/07.19