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A sectoral methodology for agriculture and land use

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A sectoral methodology for agriculture and land use

Krystal Crumpler, Sandro Federici, Alexandre Meybeck, Mirella Salvatore, Beau Damen, Giulia Gagliardi, Mario Bloise, Julia Wolf and Martial Bernoux

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The methodology is the result of a collaborative effort by the Office of Climate Change, Environment and Biodiversity (OCB) of FAO. Under the overall leadership of Martial Bernoux (OCB) and Julia Wolf (OCB), the methodology was prepared by Krystal Crumpler (OCB), Sandro Federici (OCB), Mirella Salvatore (OCB), Beau Damen (RAP), Giulia Gagliardi (OCB), Mario Bloise (OCB) and contributing author Alexandre Meybeck (CIFOR/FTA).

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ACRONYMS AND ABBREVIATIONS

AFOLU	Agriculture, Forestry and Other Land Use
BAU	Business-As-Usual
BUR	Biennial Update Report
COP	Conference of the Parties
FAO	Food and Agriculture Organization
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
NC	National Communication
NDC	Nationally determined contribution
NGHGI	National Greenhouse Gas Inventory
PA	Paris Agreement
TACCC	Transparency, Accuracy, Consistency, Completeness and Comparability
UNFCCC	United Nations Framework Convention on Climate Change

CHEMICAL FORMULAE

CH_4	methane
CO_2	carbon dioxide
eq	equivalent
N_2O	nitrous oxide

INTRODUCTION

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 countries in 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 climate change by limiting the global temperature rise this century to well below 2 degrees Celsius (°C) above pre-industrial levels and pursuing efforts to limit the temperature increase even further to 1.5°C (Article 2). Parties also established a global goal on enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change (Article 2). Underpinning the PA are the Nationally Determined Contributions (NDCs), or the efforts that each Party plans to pursue in order to reduce national greenhouse gas (GHG) emissions and, as appropriate, conserve and enhance sinks and reservoirs, and adapt to climate change. The success of the PA rests upon the regular five-year review and revision process of the NDCs, established under Article 4.3 of the PA, where Parties are required to prepare successive NDCs that represent a progression beyond their current NDC and reflect highest possible ambition, in light of different national circumstances and capacities.

The agriculture and land use sectors (crops, livestock, forestry, fisheries and aquaculture), hereafter referred to as the AFOLU (Agriculture, Forestry and Other Land Use) sector for ease of reference, feature prominently amongst the adaptation and mitigation contributions set forth in the NDCs – up to 96 and 88 percent, respectively (FAO, 2016a). This paper presents a step-by-step methodology for identifying mitigation and adaptation policy gaps and opportunities in the AFOLU sector. It also provides a gap-filling methodology for estimating economy-wide and sector-specific baseline and NDC mitigation scenarios. The overall objective is to support policy makers in enhancing NDC ambition in the AFOLU sector in future NDC review and revision cycles. To date, the sector-specific methodology has been adopted by FAO to conduct a series of regional-level analyses, including Eastern Africa (FAO, 2017), Europe and Central Asia (FAO, 2019), Asia (FAO, 2020b) and the Pacific (FAO, 2020c), Latin America (FAO, 2020d) and the Caribbean (FAO, 2020d).

PART 1

PART

1

MITIGATION POLICY GAP AND OPPORTUNITY ANALYSIS

This section presents a basic methodology for assessing the coverage of mitigation policy measures included in an NDC in comparison to key greenhouse gas (GHG) emission sources or "GHG hotspots" in the AFOLU sector. The approach is made up of four main steps:

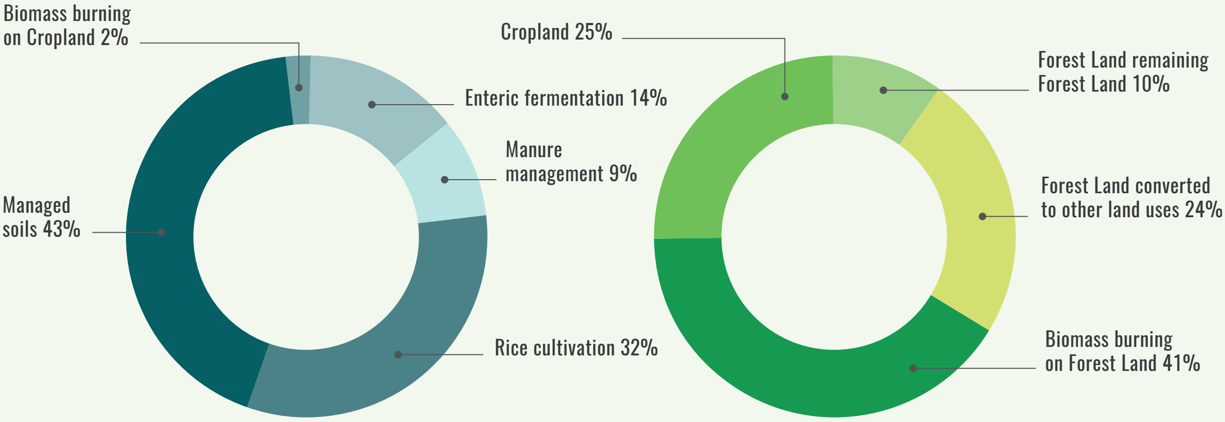
Mitigation policy gap and opportunity analysis

- **Step 1: Sectoral GHG Inventory Profiling** Extract data from latest UNFCCC submission
- **Step 2: Key Category Analysis per Sector** Identify GHG hotspots in Agriculture and LULUCF
- **Step 3: NDC-to-GHG Hotspot Mapping per sector** Identify mitigation policy coverage gaps in NDCs
- **Step 4: Scoring Mitigation Policy Coverage** Find the overall level of mitigation policy coverage in the NDCs

In **Step one**, the user should extract relevant information on GHG emissions and removal in the AFOLU sector from the latest national UNFCCC submissions, i.e. National Communication (NC), Biennial Update Report (BUR), and/or national GHG inventory (NGHGI) report. The data should be disaggregated, when possible, by GHG source/sink category following the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines on National GHG Inventories. For the purpose of the approach, the emissions and removals from the agriculture and land use, land use change and forestry (LULUCF) sectors are treated separately. **Figure 1** illustrates an example sectoral GHG profile for agriculture and LULUCF, disaggregated by GHG source/sink category.

FIGURE 1.

EXAMPLE STEP 1– SECTORAL GHG INVENTORY PROFILING FOR AGRICULTURE AND LULUCF

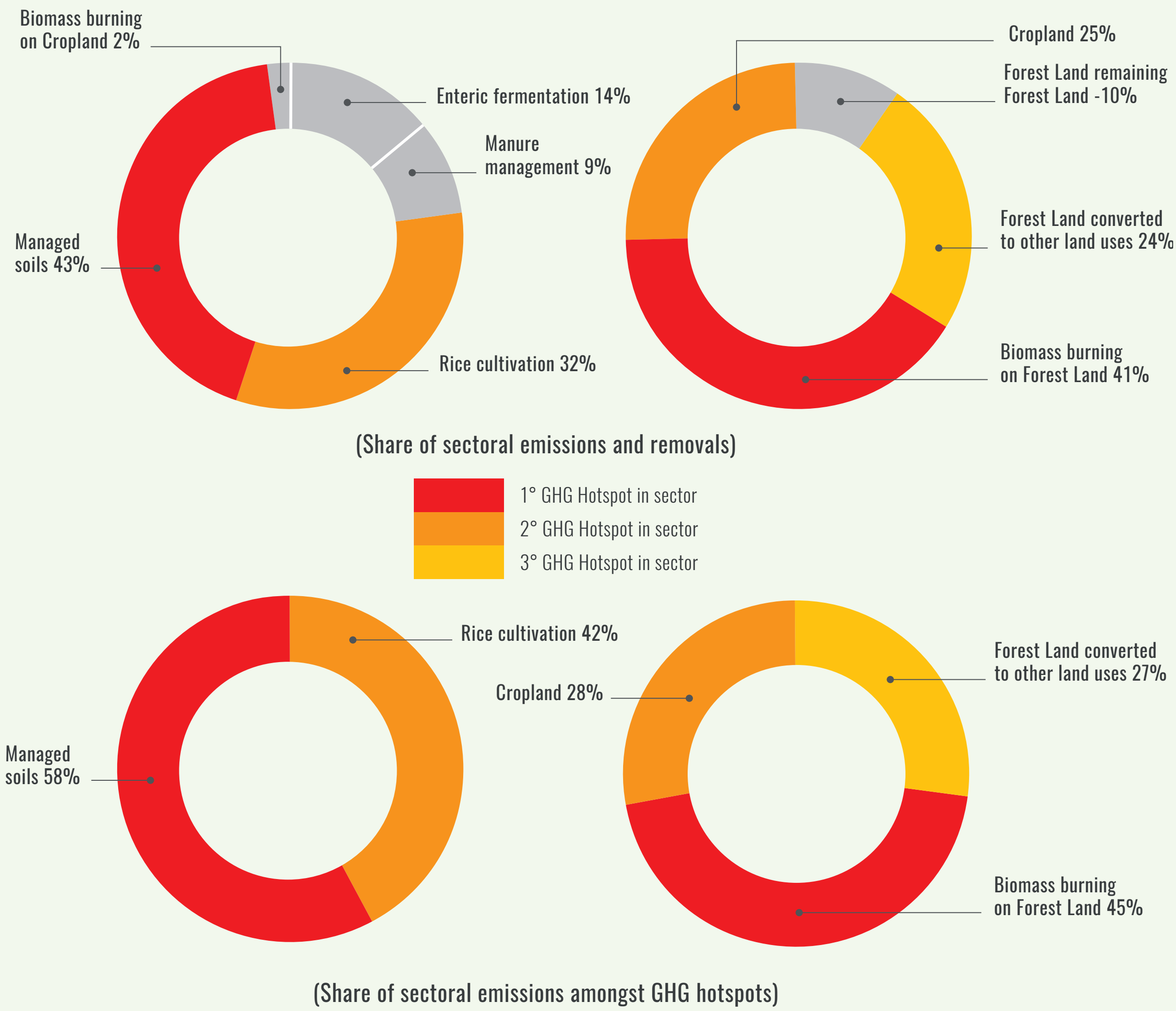


(Share of sectoral emissions and removals)

In **Step two**, the user should identify key GHG emission source categories, or GHG hotspots, in the both the agriculture and LULUCF sector. For the purpose of this approach, a GHG hotspot refers to the top three sources of emissions from a given sector, each with a share greater than 20 percent of total sectoral emissions. Once identified, the overall distribution of emissions amongst GHG hotspots per sector should be calculated. **Figure 2** illustrates an example of a key category analysis where the GHG hotspots are identified in each sector.

FIGURE 2.

EXAMPLE STEP 2 – KEY CATEGORY ANALYSIS IN AGRICULTURE AND LULUCF



In **Step three**, the user should compare the mitigation policy measures included in an NDC specific to the AFOLU sector against the GHG hotspots identified in the previous step in order to determine the general extent of mitigation "policy coverage" in the AFOLU sector in an NDC. To facilitate this mapping process, a "mitigation impact matrix" for the AFOLU sector was developed (**Annex 2**). The matrix indicates the relationship (in terms of GHG fluxes) between each 2006 IPCC GHG source/sink category in the AFOLU sector and each typology of mitigation policy or measure identified in FAO's "NDC-AFOLU Framework" (FAO, 2020e). A positive relationship, or "mitigation benefit," refers to a potential reduction (or avoidance) in emissions and/or potential increase in removals for a particular GHG source/sink category expected from the implementation of a given mitigation policy or measure. Conversely, a negative relationship, or "mitigation tradeoff," refers to a potential increase in emissions for a particular GHG source/sink category expected from the implementation of a given mitigation policy or measure. Overall, the matrix accounts for approximately 100 potential mitigation benefits and 15 mitigation tradeoffs.

Using the mitigation impact matrix as a framework, the user should map the AFOLU-specific mitigation policy measures included in an NDC, categorized by type (refer to the common NDC-AFOLU Framework for the full list, against the GHG source/sink categories in the AFOLU sector to assess whether or not the NDC addresses the sectoral GHG hotspots identified. "Policy coverage" refers to when at least one mitigation policy measure in the NDC is expected to generate a mitigation benefit in relation to one or more GHG hotspot. Conversely, a "policy coverage gap" refers to the absence of at least one mitigation policy measure in the NDC expected to generate a mitigation benefit in relation to one or more of GHG hotspot. **Figure 3** illustrates an example of the NDC-to-GHG hotspot mapping exercise (using the mitigation impact matrix as a guide) where the mitigation policy measures found in an NDC are mapped against the GHG hotspots identified (in **Figure 2**) to assess policy coverage of those hotspots. Refer to **Annex 2** for the full mitigation impact matrix.

FIGURE 3.

EXAMPLE STEP 3 – NDC-TO-GHG HOTSPOT MAPPING IN THE AGRICULTURE AND LULUCF SECTORS

NDC	NDC-AFOLU FRAMEWORK CATEGORY		GHG HOTSPOTS				
TEXT IN NDC	TYPE OF LAND USE OR AGRICULTURAL SUB-SECTOR	TYPE OF MITIGATION POLICY MEASURE	RICE CULTIVATION	MANAGED SOILS	BIOMASS BURNING ON FOREST LAND	FOREST LAND CONVERTED TO OTHER LAND USES	CROPLAND
SUSTAINABLE FOREST MANAGEMENT	FOREST LAND	REDUCING DEGRADATION AND SUSTAINABLE FOREST MANAGEMENT			CH_4 N_2O		
REDUCED RATE OF PLANNED AND UNPLANNED DEFORESTATION	FOREST LAND	REDUCING DEFORESTATION AND FOREST CONSERVATION				CO_2 N_2O CH_4	
IMPROVE FISHERIES PRODUCTIVITY	OTHER	FISHERIES MANAGEMENT					
MANURE MANAGEMENT FOR BIOGAS UP TO 0.06% OF THE TOTAL CATTLE IN 2030	LIVESTOCK	MANURE MANAGEMENT		N_2O			
FEED SUPPLEMENT FOR CATTLE UP TO 2.5% OF THE CATTLE POPULATION IN 2030	LIVESTOCK	ANIMAL FEEDING		N_2O			
IMPLEMENTATION OF WATER EFFICIENCY IS UP TO 820,000 HECTARES IN 2030	CROPLAND	SUSTAINABLE WATER USE AND MANAGEMENT		N_2O			CO_2
POLICY COVERAGE IN NDC			Policy coverage gap	Policy coverage	Policy coverage	Policy coverage	Policy coverage

Policy coverage gap

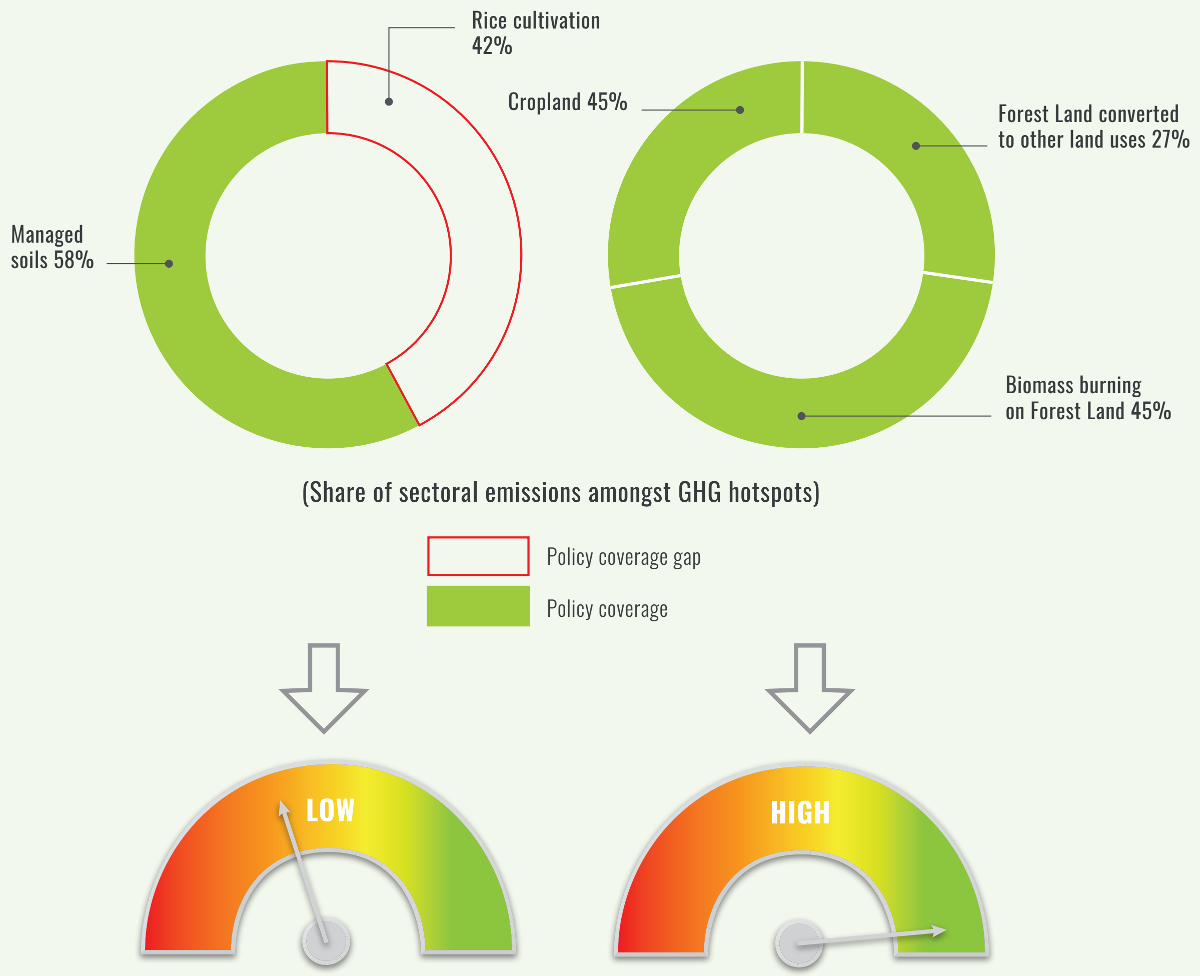
Policy coverage

Note: for each type of policy measure, the expected mitigation impact (emission reduction) is indicated in terms of the GHG flux affected.

In **Step four**, the user should quantify mitigation policy coverage in the AFOLU sector, disaggregated by agriculture and LULUCF. Policy coverage and the coverage gap can be quantified simply as the relative share of sectoral emissions either covered or not covered, respectively, of total emissions amongst GHG hotpots, and then scored. **Figure 4** illustrates an example quantification and scoring of mitigation policy coverage and the coverage gap in the NDC.

FIGURE 4.

EXAMPLE STEP 4 – QUANTIFYING AND SCORING OF MITIGATION POLICY COVERAGE IN THE AGRICULTURE AND LULUCF SECTORS



POLICY COVERAGE SCORE	RANGE OF MITIGATION POLICY COVERAGE PER SECTOR IN NDC
HIGH	76-100 PERCENT
MODERATE	51-75 PERCENT
LOW	26-50 PERCENT
VERY LOW	0-25 PERCENT

At the aggregate level, policy coverage and policy coverage gaps can be quantified as the share of countries with or without, respectively, at least one policy measure expected to generate a mitigation benefit, per GHG hotspot, of the total number of countries with that GHG hotspot.

It should be noted that the gap analysis provides for a broad review of mitigation policy coverage in the AFOLU sector in the NDCs and is therefore subject to the content of the NDCs and the accuracy of NGHGI reports. A more in-depth analysis of the "strength" or "ambition" of the mitigation contribution in an NDC would require consideration of various aspects, including the range of policy instruments (e.g. programme, project or activity), scale (e.g. national, sub-national, community or household level), scope (i.e. sectors and sub-sectors), timeframe (i.e. short-, medium- or long-term), impact potential, feasibility (e.g. technical, economic), inclusiveness (i.e. gender responsive, youth and indigenous peoples) and degree of institutional integration, which could all be scored and weighted according to national priorities.

Annex 1 provides additional guidance on estimating the expected "mitigation impact" of national and sectoral GHG emission reduction targets communicated in the NDC.

PART 2

PART

2

ADAPTATION POLICY GAP AND OPPORTUNITY ANALYSIS

This section presents a basic methodology for assessing the coverage of adaptation policy measures included in an NDC in comparison to the major climate-related impacts, risks and vulnerabilities, or "adaptation hotspots," reported in the AFOLU sector. The approach is made up of four main steps:

Adaptation policy gap and opportunity analysis

Step 1: Climate Risk and Vulnerability Profiling
Extract data from latest climate risk and vulnerability assessments

Step 2: Adaptation Hotspot Analysis
Identify major hotspots in ecosystems and social systems

Step 3: NDC-to-Adaptation Hotspot Mapping per system
Identify adaptation policy coverage gaps in NDCs

Step 4: Scoring Adaptation Policy Coverage
Find the overall level of adaptation policy coverage in the NDCs

In **Step one**, the user should review the observed and/or projected climate-related impacts, vulnerabilities and risks reported in the most recent national reports, such as National Communications, and catalogue each using the climate-impact categories defined in the common NDC-AFOLU Framework (FAO, 2020a), where the impact should then be identified at the primary natural resource and/or ecosystem service level. Table 1 illustrates an example categorization of climate-related impacts, vulnerabilities and risks reported in ecosystems and social systems based on the categories defined in the NDC-AFOLU Framework.

TABLE 1.

EXAMPLE STEP 1 – CLIMATE RISK AND VULNERABILITY PROFILING IN THE AFOLU SECTOR

CLIMATE-RELATED HAZARDS AND SLOW ONSET EVENTS

CLIMATE-RELATED HAZARD REPORTED IN NDC*	NATURAL RESOURCE IMPACT CATEGORY
DROUGHT	LAND AND SOIL
WILDFIRE	BIODIVERSITY
FLOOD	WATER
CLIMATE-RELATED SLOW ONSET EVENT REPORTED IN NDC*	**NATURAL RESOURCE IMPACT CATEGORY**
SOIL EROSION	LAND AND SOIL
WATER STRESS	WATER
COASTAL EROSION	LAND AND SOIL

CLIMATE-RELATED IMPACTS IN ECOSYSTEMS

TEXT IN NDC*	VULNERABLE ECOSYSTEM CATEGORY	VULNERABLE AGRICULTURAL SUB-SECTOR/LAND USE CATEGORY	CLIMATE-RELATED IMPACT CATEGORY	NATURAL RESOURCE IMPACT CATEGORY	ECOSYSTEM SERVICE IMPACT CATEGORY
PRODUCTIVITY LOSS OF SOME CROPS	AGRO-ECOSYSTEM	CROPS	PRIMARY PRODUCTION AND PRODUCTIVITY LOSS	GENETIC RESOURCE	PRIMARY PRODUCTION
SHIFTS IN CROP SEASONS	AGRO-ECOSYSTEM	CROPS	CHANGES IN PHENOLOGY	GENETIC RESOURCE	PRIMARY PRODUCTION
INCREASE THE INCIDENCES OF VECTOR-BORNE DISEASES OF LIVESTOCK	AGRO-ECOSYSTEM	LIVESTOCK	PEST AND DISEASE INCIDENCE	GENETIC RESOURCE	BIOLOGICAL CONTROL
PROLONGED LENGTH OF DRY SEASONS AND INCREASED SEVERITY OF PERIODIC DROUGHTS WILL LIKELY REDUCE PASTURE FERTILITY	AGRO-ECOSYSTEM	GRASSLAND	SOIL FERTILITY LOSS	LAND AND SOIL	NUTRIENT CYCLING AND SOIL FORMATION
FOREST SPECIES VULNERABILITY TO DROUGHT WILL LEAD TO LOSS IN BIODIVERSITY	AGRO-ECOSYSTEM	FORESTRY	BIODIVERSITY LOSS	BIODIVERSITY	MAINTENANCE OF GENETIC DIVERSITY AND ABUNDANCE
CHANGE IN FISH SPECIES COMPOSITION	AGRO-ECOSYSTEM	FISHERIES	CHANGES IN SPECIES RANGE, ABUNDANCE AND EXTINCTION	GENETIC RESOURCES	FISHERIES PROVISION
CORAL BLEACHING	OCEAN AND COASTAL ZONE		MANGROVE MORTALITY AND/ OR CORAL REEF DEGRADATION	GENETIC RESOURCES	HABITAT FOR SPECIES
WAVE SURGE CURRENTS WEAKEN THE COASTLINE AND UPROOT COASTAL MANGROVES, WHICH STABILIZE THE SHORELINE	OCEAN AND COASTAL ZONE		MANGROVE MORTALITY AND/ OR CORAL REEF DEGRADATION	LAND AND SOIL	MODERATION OF EXTREME EVENTS
CHANGE IN THE HYDROLOGICAL REGIME OF CATCHMENT BASINS	INLAND WATER		CHANGES IN HYDROLOGICAL FLOW AND WATER CYCLING	WATER	WATER CYCLING

CLIMATE-RELATED RISKS IN SOCIAL SYSTEMS

CLIMATE-RELATED RISK REPORTED IN NDC*	SOCIAL SYSTEM DIMENSION	CLIMATE-RELATED RISK CATEGORY
INCREASE IN INCIDENCE OF INFECTIOUS DISEASES	SOCIO-ECONOMICS AND WELL-BEING	ADVERSE HEALTH
WOMEN MAY FACE CERTAIN BIO-PHYSICAL STRESSES DUE TO CLIMATE CHANGE AND ITS IMPACTS	SOCIO-ECONOMICS AND WELL-BEING	GENDER AND YOUTH INEQUALITY

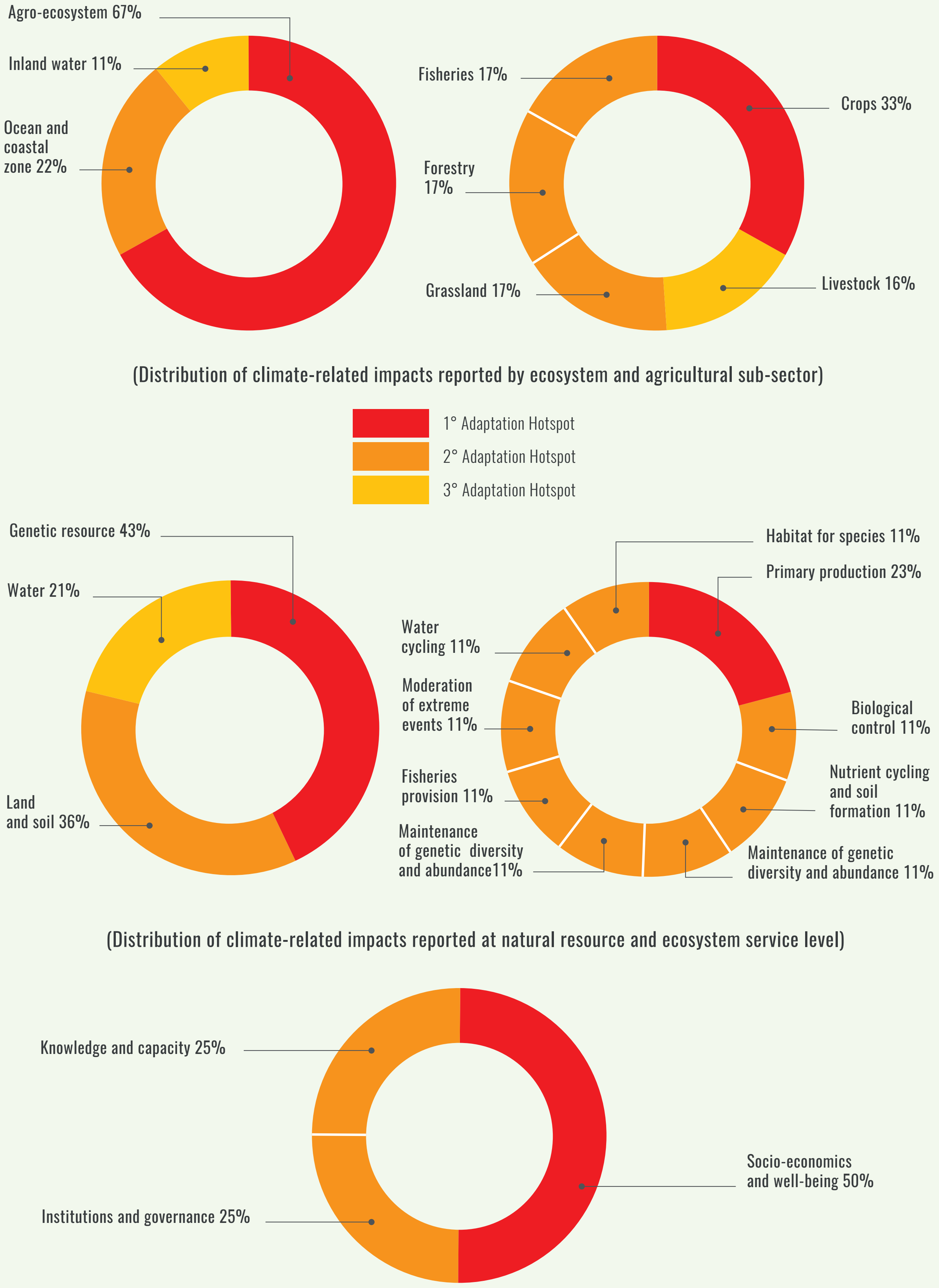
OBSERVED CHANGES IN THE LAST DECADES INCLUDE RAIN PATTERNS VARIATIONS THAT ARE CAUSING CLIMATE-DRIVEN MIGRATION	SOCIO-ECONOMICS AND WELL-BEING	MIGRATION AND DISPLACEMENT
CLIMATE-RELATED RISKS IN SOCIAL SYSTEMS		
NON-CLIMATIC DRIVER OF VULNERABILITY REPORTED IN NDC*	SOCIAL SYSTEM DIMENSION	CLIMATE-RELATED RISK CATEGORY
INSTITUTIONAL CHALLENGES RELATING TO HIGH STAFF TURNOVER RATES IN SENIOR EXECUTIVE POSITIONS, LIMITED SECTOR SPECIFIC TRAINING	INSTITUTIONS AND GOVERNANCE	WEAK INSTITUTIONS AND GOVERNANCE
SEVERELY CONSTRAINED BY THE LACK OF CAPACITY, HUMAN RESOURCES, TECHNOLOGY, FINANCIAL RESOURCES, DATA, KNOWLEDGE AND AWARENESS	KNOWLEDGE AND CAPACITY	LIMITED KNOWLEDGE AND CAPACITY

** Or national climate change report, such as a National Communication.*

In **Step two**, the user should identify the most frequently observed and/or projected climate-related impacts, risks and vulnerabilities reported, or "adaptation hotspots", in the AFOLU sector. An "adaptation hotspot" refers to one of the top three most frequently reported climate-related impact categories reported per ecosystem, sub-sector, natural resource and ecosystem service impact category. The relative weight of each climate-impact category is determined by its frequency (or count) amongst all impact categories reported. **Figure 5** illustrates an example analysis of the major adaptation hotspots identified in the AFOLU sector, disaggregated at the system, natural resource and ecosystem service level.

FIGURE 5.

EXAMPLE STEP 2 –ADAPTATION HOTSPOT ANALYSIS IN THE AFOLU SECTOR



In **Step three**, the user should compare the AFOLU-specific adaptation policy measures included in an NDC against the "adaptation hotspots" identified in the previous step in order to determine the general extent of adaptation "policy coverage" in the AFOLU sector in the NDC. To facilitate this mapping process, "adaptation impact matrices" for the AFOLU sector were developed (**Annex 3-4**) to illustrate the multi-dimensional relationship between each climate-related impact category reported and each type of adaptation policy measure defined in the common NDC-AFOLU Framework (FAO, 2020e). A positive relationship, or "adaptation benefit," refers to an expected reduction in the vulnerability and increase in the adaptive capacity and resilience of an ecosystem, community or household with respect to a given adaptation hotspot generated from the implementation of a particular adaptation policy measure. Conversely, an "adaptation tradeoff," refers to an unintended reduction in the adaptive capacity and resilience, and increased vulnerability, of an ecosystem, community or household with respect to a given adaptation hotspot generated from the implementation of a particular adaptation policy measure. Overall, the matrix accounts for around 1000 potential adaptation benefits and 150 potential tradeoffs.

Using the adaptation impact matrix as a framework, the user should map the AFOLU-specific adaptation policy measures included in an NDC, categorized by type (refer to the common NDC-AFOLU Framework for the full list of types), against the climate-related impact categories in the AFOLU sector to assess whether or not the NDC addresses the sectoral adaptation hotspots identified at the ecosystem-level (Step 3a) and social system-level (Step 3b). "Policy coverage" refers to when at least one adaptation policy measure in the NDC is expected to generate an adaptation benefit in relation to one or more of the major climate-related impact categories identified in the AFOLU sector. Conversely, a "policy coverage gap" refers to the absence of at least one adaptation policy measure in the NDC expected to generate an adaptation benefit in relation to one or more of the major climate-related impact categories identified in the AFOLU sector. It should be noted that the matrix maps the primary link between a climate-impact category and adaptation, based on key word association and expert consultation. **Figures 6-7** illustrate an example mapping of adaptation policy measures included in an NDC against the adaptation hotspots identified in ecosystems and social systems in order to determine adaptation policy coverage and the coverage gap.

FIGURE 6.

EXAMPLE STEP 3A – NDC-TO-ADAPTATION HOTSPOT MAPPING IN THE AFOLU SECTOR (ECOSYSTEM-LEVEL)

NDC-AFOLU FRAMEWORK CATEGORY			ADAPTATION IMPACT MATRIX CATEGORY																	
TEXT IN NDC	TYPE OF ECOSYSTEM/ LAND USE/ SUB-SECTOR	TYPE OF ADAPTATION POLICY OR MEASURE	CROPS	LIVESTOCK	GRASSLAND	FORESTRY	FISCHERIES	INLAND WATER	OCEAN AND COASTAL ZONE	MODEARATION OF EXTREME EVENTS	BIOLOGICAL CONTROL	EROSION CONTROL	PRIMARY PRODUCTION	NUTRIENT CYCLING AND SOIL FORMATION	WATER CYCLING	MAINTENANCE OF GENETIC DIVERSITY AND ABUNDANCE	HABITATS FOR SPECIES	LAND AND SOIL	WATER	GENETIC RESOURCE
ENHANCING THE SUSTAINABLE MANAGEMENT OF FOREST RESOURCES	FORESTRY	REDUCING DEGRADATION AND SUSTAINABLE FOREST MANAGEMENT				+				+		+	+	+	+	+	+	+	+	+
PROMOTING CLIMATE CHANGE RESILIENT TRADITIONAL AND MODERN KNOWLEDGE OS SUSTAINABLE PASTURE AND RANGE MANAGEMENT SYSTEMS	GRASSLAND	GRASSLAND MANAGEMENT			+					+		+	+	+	+	+	+	+	+	+
ENHANCING PARTICIPATORY SAVANNA FIRE MANAGEMENT	GRASSLAND	FIRE MANAGEMENT ON GRASSLAND			+					+		+	+	+	+	+	+	+	+	+
STRENGHTENING MANAGEMENT OF COASTAL RESOURCES AND BEACH EROSION/ SEA LEVEL RISE CONTROL SYSTEMS	OCEAN AND COASTAL ZONE	COASTAL ZONE MANAGEMENT							+	+		+	+	+	+		+	+	+	+
MANGROVE AND SHORELINE RESTORATION	OCEAN AND COASTAL ZONE	MANGROVE CONSERVATION AND							+	+		+	+	+	+	+	+	+	+	+
ENHANCING PROGRAMME FOR MANAGEMENT OF SALTWATER INUNDATION AND INTRUSION	OCEAN AND COASTAL ZONE	WATER QUALITY AND POLLUTION MANAGEMENT																	+	

Policy coverage gap (white) | Policy coverage (green)

Note: the expected adaptation impact (positive) of each adaptation policy measure per adaptation hotspot is indicated with a "+".

FIGURE 7.

EXAMPLE STEP 3B – NDC-TO-ADAPTATION HOTSPOT MAPPING IN THE AFOLU SECTOR (SOCIAL SYSTEM-LEVEL)

NDC	NDC-AFOLU FRAMEWORK CATEGORY		ADAPTATION IMPACT MATRIX CATEGORY								
			SOCIO-ECONOMICS AND WELL-BEING							KNOWLEDGE AND CAPACITY	INSTITUTIONS AND GOVERNANCE
TEXT IN NDC	SOCIAL DIMENSION	TYPE OF ADAPTATION POLICY OR MEASURE	LOSS OF PRODUCTIVE INFRASTRUCTURE AND ASSETS	ADVERSE HEALTH	FOOD INSECURITY AND MALNUTRITION	RURAL LIVELIHOODS AND INCOME LOSS	GENDER AND YOUTH INEQUALITY	MIGRATION AND DISPLACEMENT	POVERTY AND INEQUALITY	LIMITED KNOWLEDGE AND CAPACITY	WEAK INSTITUTIONS AND GOVERNANCE
PROMOTING SUSTAINABLE AND CLIMATE SENSITIVE HEALTH AND SANITATION INFRASTRUCTURE	SOCIO-ECONOMICS AND WELL-BEING	HEALTH INFORMATION AND SERVICES		+							
PROMOTING LIVELIHOOD DIVERSIFICATION OF LIVESTOCK KEEPERS	SOCIO-ECONOMICS AND WELL-BEING	ON AND OFF-FARM LIVELIHOOD DIVERSIFICATION			+	+			+		
STRENGTHENING THE CAPACITY OF AGRICULTURAL RESEARCH INSTITUTIONS TO CONDUCT BASIC AND APPLIED RESEARCH	KNOWLEDGE AND CAPACITY	R&D								+	
STRENGTHENING KNOWLEDGE, EXTENSION SERVICES AND AGRICULTURAL INFRASTRUCTURES TO TARGET CLIMATE ACTIONS	KNOWLEDGE AND CAPACITY	EXTENSION SERVICES FOR CLIMATE ACTION								+	
IMPROVING MONITORING AND EARLY WARNING SYSTEMS OF BOTH SEA LEVEL RISE IMPACTS AND EXTREME WEATHER EVENTS FOR BUILDING ADAPTIVE CAPACITY	KNOWLEDGE AND CAPACITY	EARLY WARNING SYSTEMS	+			+					
PROTECTING SMALLHOLDER FARMERS AGAINST CLIMATE RELATED SHOCKS, INCLUDING THROUGH CROP INSURANCE	SOCIO-ECONOMICS AND WELL-BEING	CREDIT AND INSURANCE SERVICES							+		

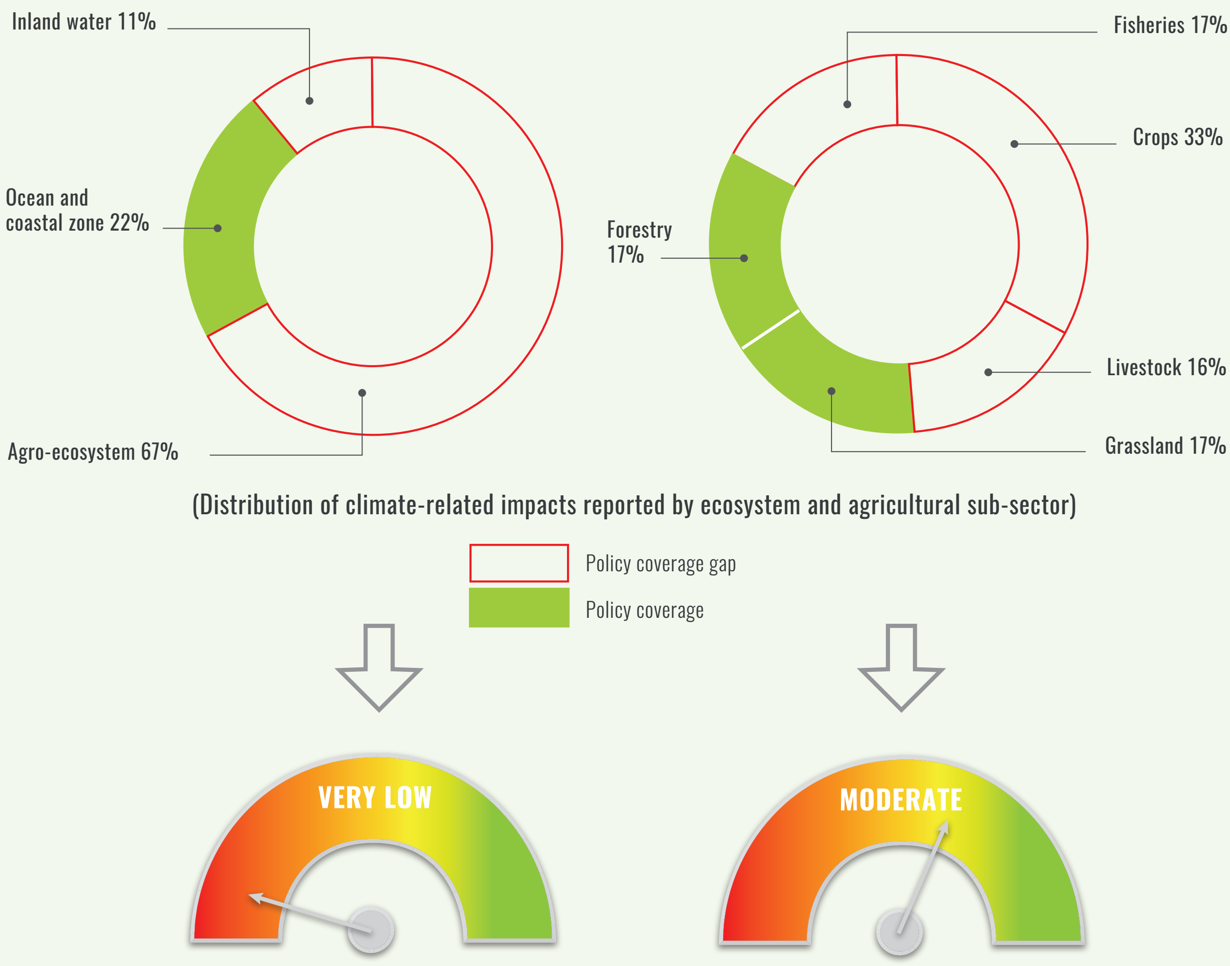
Policy coverage gap | Policy coverage

Note: the expected adaptation impact (positive) of each adaptation policy measure per adaptation hotspot is indicated with a "+".

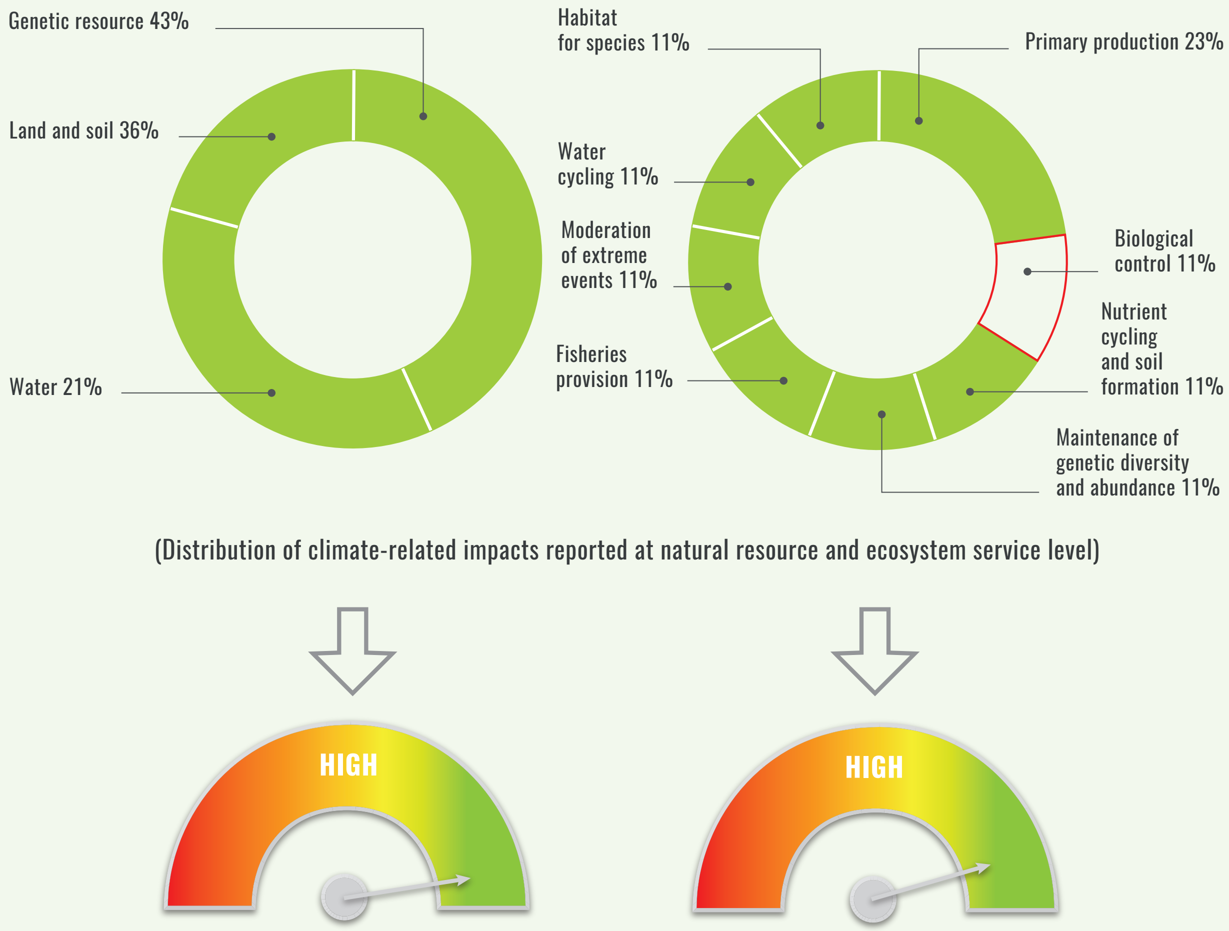
In **Step four**, the user should quantify and score adaptation policy coverage in the AFOLU sector. Policy coverage and the coverage gap can be quantified simply as the relative share of adaptation hotspots either covered or not covered, respectively, amongst the major adaptation hotspots identified, and then scored. **Figure 8** illustrates an example quantification and scoring of adaptation policy coverage and the coverage gap in the NDC.

FIGURE 8.

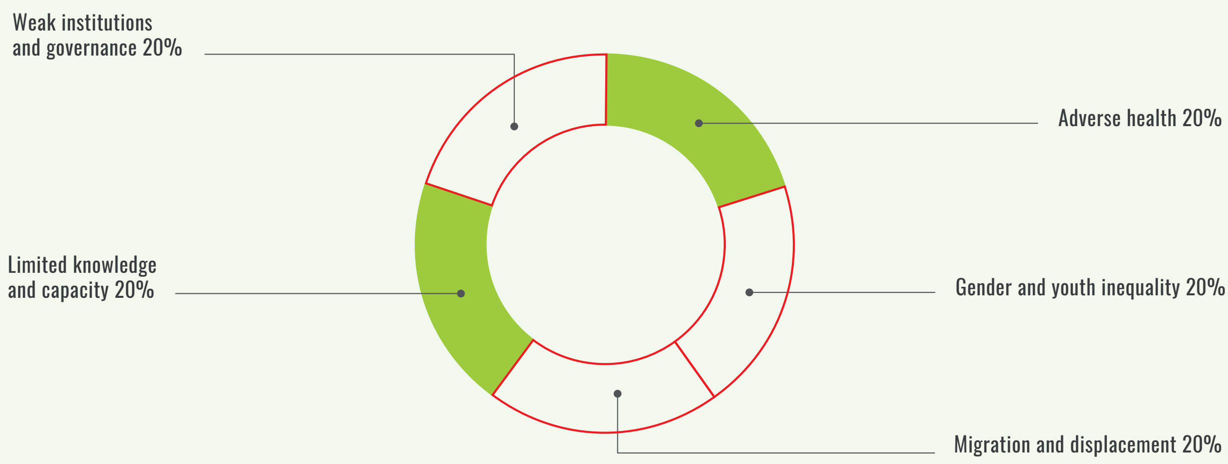
EXAMPLE STEP 4 – QUANTIFYING AND SCORING OF ADAPTATION POLICY COVERAGE IN THE AFOLU SECTOR



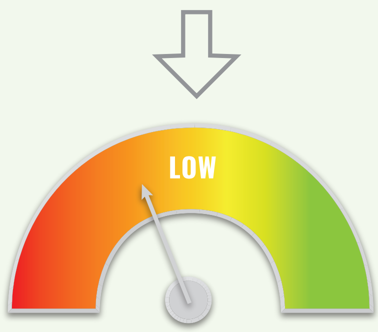
POLICY COVERAGE SCORE	RANGE OF MITIGATION POLICY COVERAGE PER SECTOR IN NDC
HIGH	76-100 PERCENT
MODERATE	51-75 PERCENT
LOW	26-50 PERCENT
VERY LOW	0-25 PERCENT



(Distribution of climate-related impacts reported at natural resource and ecosystem service level)



(Distribution of climate-related impacts reported by social system dimension)



Country-level analysis can be aggregated to reflect overall mitigation policy coverage at the regional or sub-regional level, for instance. At the aggregate level, policy coverage and policy coverage gaps can be quantified as the share of countries with or without, respectively, at least one policy measure expected to generate an adaptation benefit, per adaptation hotspot, of the total number of countries with that hotspot.

It should be noted that the gap analysis provides for a broad review of adaptation policy coverage in the AFOLU sector in the NDCs and is therefore subject to the content of the NDCs and the accuracy of NGHGI reports. A more in-depth analysis of the "strength" or "ambition" of the adaptation component in an NDC would require consideration of various aspects, including the range of policy instruments (e.g. programme, project or activity), scale (e.g. national, sub-national, community or household level), scope (i.e. sectors and sub-sectors), timeframe (i.e. short-, medium- or long-term), impact potential, feasibility (e.g. technical, economic), inclusiveness (i.e. gender responsive, youth and indigenous peoples) and degree of institutional integration, which could all be scored and weighted according to national priorities.

PART 3

PART

3

SYNERGY AND TRADEOFF ANALYSIS

Mitigation and adaptation in the AFOLU sector 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, 2016b). 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, 2014). For instance, converting to agroforestry where tree products provide livelihood to communities, planted trees will also sequester carbon (Verchot ***et al.***, 2007). 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 across sectors and stakeholders and their impact on adaptive capacities and resilience of ecosystems, communities and individuals to climate variability and change, in order to capture their synergies and reconcile tradeoffs.

To facilitate the analysis, a "mitigation-to-adaptation impact matrix" for the AFOLU sector (**Annex 5**) was developed to map the potential synergies and tradeoffs generated from the implementation of mitigation or adaptation policy measures. A "synergy" refers to a reinforcing relationship between the respective objectives of a mitigation and adaptation policy measure. Conversely, a "tradeoff" refers to an opposing relationship between the respective objectives of a mitigation and adaptation policy measure. Each mitigation and adaptation policy measure may generate one or more co-benefit or tradeoff. Overall, the matrix accounts for around 400 potential mitigation-adaptation synergies and 50 potential tradeoffs.

At the country level, the number of mitigation-to-adaptation synergies and tradeoffs in the AFOLU sector can be assessed by mapping the typology of mitigation and adaptation policy measures found in the NDC against each other, using binary coding, as per the methodology contained in the matrix. Country-level results can be aggregated to facilitate analysis at the regional or sub-regional level. The "degree of convergence (or divergence) between mitigation and adaptation in the AFOLU sector" at the aggregative level can be quantified as the share of countries with at least one synergy or tradeoff, respectively, out of countries with a mitigation or adaptation component, respectively, in the NDCs. It should be noted that the degree of convergence or divergence between adaptation and mitigation refers to the incidence of synergies or tradeoffs generated amongst a group of countries and does not reflect the extent to which a given set of polices or measures actually contribute to achieving a particular mitigation or adaptation outcome.

CONCLUSION

Achieving the collective temperature and adaptation goals of the PA depends on the ability of individual countries to enhance NDC ambition and implementation over time. This paper attempts to support that process by presenting a basic methodology for assessing the overall coverage of mitigation and adaptation policy measures in the AFOLU sector in order to evidence "gaps" and "opportunities" for addressing underlying sectoral GHG and adaptation hotspots in future NDC revision cycles.

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ANNEXES

NDC EMISSION SCENARIO ANALYSIS

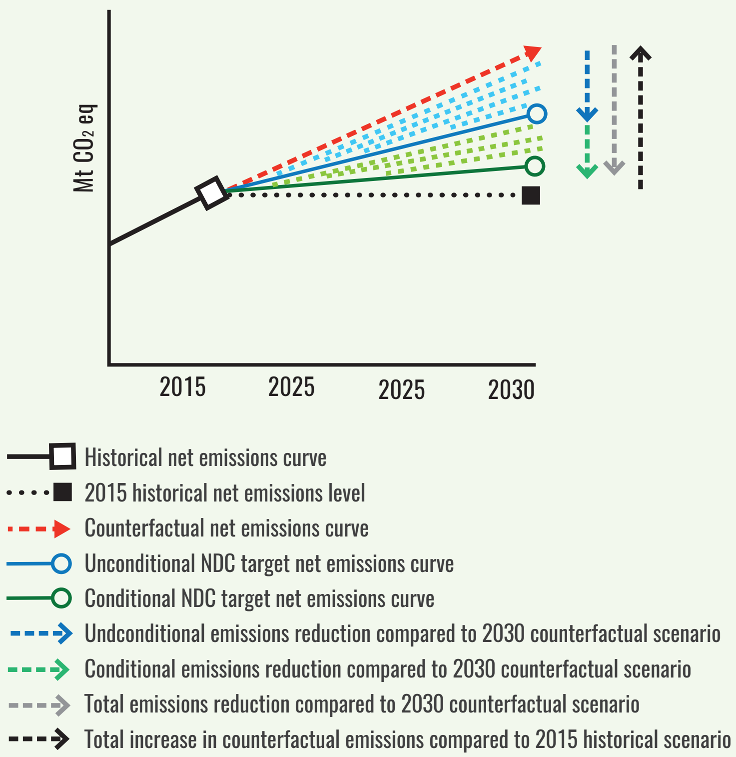
To estimate the expected "mitigation impact" of NDC implementation at the national and/or sectoral level,[1] the following three GHG emission scenarios should be constructed, and compared against each other, based on information provided in an NDC:

1. Historical net emissions level;
2. Counterfactual (i.e. reference level/baseline) net emissions curve; and
3. NDC target net emissions curve (conditional and unconditional).

Figure 9 illustrates the three GHG emission scenarios that should be constructed to estimate the expected mitigation impact of NDC implementation.

FIGURE 9.

HISTORICAL, COUNTERFACTUAL AND NDC MITIGATION TARGET EMISSION SCENARIOS



** It should be noted that the diagram presents one potential scenario amongst many. The methodology (equations below) however can be applied to any NDC target scenario.*

[1] If an economy-wide, multi-sectoral and/or sectoral-level GHG target is included.

The following step-by-step guidance details how to construct the three GHG emission scenarios based on the data reported in the NDC or, in the absence of sufficient information, data points derived from other relevant national reports, i.e. NGHGI, BUR and NC. **Table 2** lists the variables used in Equations 1 to 6 below for estimating the expected mitigation impact of NDC implementation at the national and/or sectoral level.

TABLE 2.

VARIABLES TO DERIVE THE HISTORICAL, COUNTERFACTUAL AND NDC TARGET EMISSION SCENARIOS

SCORE	RANGE OF POLICY COVERAGE GAP (% OF COUNTRIES)
H_{2015}	HISTORICAL NET EMISSIONS IN YEAR 2015, $CO_2EQ\ YR^{-1}$
H_x	HISTORICAL NET EMISSIONS IN YEAR X, $CO_2EQ\ YR^{-1}$
x	YEAR REPORTED (LATEST AVAILABLE PRIOR TO 2015) IN TIME SERIES OF MOST RECENT NGHGI SUBMISSION
C_y	COUNTERFACTUAL NET EMISSIONS IN YEAR Y, CO_2EQYR^{-1}
T_y	NDC TARGET NET EMISSIONS IN YEAR Y, $CO_2EQ\ YR^{-1}$
y	YEAR OF COUNTERFACTUAL OR NDC TARGET NET EMISSIONS (E.G. 2025 OR 2030)
E_W	ANNUAL NET EMISSIONS (LATEST AVAILABLE PRIOR TO YEAR Y) REPORTED, $CO_2EQ\ YR^{-1}$
W	YEAR OF ANNUAL NET EMISSIONS (LATEST AVAILABLE PRIOR TO YEAR Y, E.G. 2020 OR 2015 OR X) REPORTED
P_Y	NDC TARGET EMISSION REDUCTION IN YEAR Y, %
R_H	AVERAGE ANNUAL RATE OF CHANGE IN HISTORICAL NET EMISSIONS BETWEEN YEAR X AND 2015, $CO_2EQ\ YR^{-1}$
r_H	AVERAGE ANNUAL RATE OF CHANGE IN HISTORICAL NET EMISSIONS AT REGIONAL LEVEL BETWEEN YEAR X AND 2015, %
R_C	AVERAGE ANNUAL RATE OF CHANGE IN COUNTERFACTUAL NET EMISSIONS BETWEEN YEARS W AND Y, $CO_2EQ\ YR^{-1}$
r_C	AVERAGE ANNUAL RATE OF CHANGE IN COUNTERFACTUAL NET EMISSIONS AT REGIONAL LEVEL BETWEEN YEARS W AND Y, %
n	NUMBER OF COUNTRIES WITH RELEVANT NGHGI DATA REPORTED IN SELECTED REGION

The 2015 historical net emissions value[2] can be directly sourced from the NDC or other national reports (i.e. NGHGI, BUR or NC). If not available, it can be linearly interpolated based on: i) a historical net emissions value of a year (x) prior to 2015 (the latest available), H_x and ii) the counterfactual net emissions value projected in the NDC for year y, C_y. To interpolate the 2015 net emissions value, refer to **Equation 1**, where the average annual change in net emissions between year y and x, R_H, can be found by dividing the difference in net emissions between Cy and H_x by the difference between y and x. The 2015 net emissions value can then be interpolated as the sum of the historical net emissions in year x and the product of R_H and the difference between 2015 and x.

Equation 1

$$R_H = \left(\frac{C_y - H_x}{y - x}\right) \implies H_{2015} = H_x + [R_H \times (2015 - x)]$$

Alternatively, if the 2025 or 2030 counterfactual net emissions value is not available, or if the reference level is a base-year emission level that is not equal to 2015, the 2015 net emissions value can be projected based on: i) a historical net emissions value of a year (x) prior to 2015 (the latest available), H_x and ii) the average annual rate of change in historical net emissions, at the regional level, between year x and 2015, used as a proxy, r_H. To project the 2015 historical net emissions value, refer to **Equation 2**, where r_H can be calculated (based on information reported by countries, n, in the selected region), as the difference in historical net emissions between 2015 and year x divided by the difference between 2015 and x, weighted by GDP. The 2015 net emissions value can then be projected as the sum of historical net emissions in year x and the product of historical net emissions in year x, r_H, and the difference between 2015 and x.

[2] For the purpose of this framework, the year 2015 represents the historical reference point.

Equation 2

$$r_H = \frac{\sum_{i=1}^{n}\left(\frac{H_{2015} - H_x}{2015 - x} \times GDP\right)_n}{\sum_{i=1}^{n} GDP} \times 100 \implies H_{2015} = H_x + \left(H_x \times \frac{r_H}{100}\right) \times (2015 - x)$$

The counterfactual net emissions values can be sourced directly from the NDC. If not available, an intermediate counterfactual net emissions value for year y can be linearly interpolated based on: i) net emissions of a subsequent year w (closest to year y), E_w (e.g. C_{2020}, H_{2015} or H_x); and ii) the counterfactual net emissions in any previous year, C_y (e.g. C_{2030}). To linearly interpolate the 2025 counterfactual net emissions value, refer to **Equation 3**, where the average annual change in counterfactual net emissions between 2030 and year w, R_C, can be calculated by dividing the difference in net emissions between C_{2030} and E_w by the difference between year 2030 and w. The 2025 counterfactual net emissions value can then be interpolated as the sum of E_w and the product of R_C and the difference between 2025 and w.

Equation 3

$$R_C = \frac{C_{2030} - E_w}{2030 - w} \implies C_{2025} = E_w + [R_C \times (2025 - w)]$$

Alternatively, if it is not possible to interpolate the counterfactual net emissions value due to insufficient data, it can be extrapolated based on: i) the historical net emissions in 2015, H_{2015} and ii) the annual average rate of change of counterfactual net emissions, at the regional level, for a given period between 2015 and 2030, used as a proxy, r_C. To project the counterfactual net emissions value refer to **Equation 4**, where r_C. can be calculated as the difference between counterfactual net emissions in year y and historical net emissions in year 2015 (based on information reported by countries, n, in a given region) divided by the difference between y and 2015, weighted by GDP. The counterfactual net emissions can then be extrapolated as the sum of historical net emission in 2015 and the product of historical net emission in 2015, r_C, and the difference between y and 2015.

Equation 4

$$r_C = \frac{\sum_{i=1}^{n}\left(\frac{C_y - H_{2015}}{y - 2015} / |H_{2015}| \times GDP\right)_n}{\sum_{i=1}^{n} GDP} \times 100 \implies$$

$$C_y = H_{2015} + \left[\left(H_{2015} \times \frac{r_C}{100}\right) \times (y - 2015)\right]$$

The NDC target net emissions values can be sourced directly from the NDC. If not available, refer to **Equation 5**, where the target net emissions value can be calculated as the product of the counterfactual net emissions in year y and the complement to 100 of the percent reduction target in net emissions in year y.

Equation 5

$$T_y = C_y * \left(\frac{100 - P_y}{100}\right)$$

Finally, the "mitigation impact," or cumulative reduction in net emissions expected over the entire period of NDC implementation can be expressed in either of the two ways:

- cumulative net emission reduction by 2030 compared to the counterfactual scenario (i.e. total emissions reduced, avoided or released into the atmosphere by 2030 "with" NDC implementation compared to the "without" scenario) the refer to Area 3 below; or

- cumulative net emission reduction by 2030 compared to the 2015 historical level (i.e. total emissions either reduced, avoided or released into the atmosphere under NDC implementation by 2030 compared to the 2015 starting point), refer to Area 2 below.

While the former value describes the total emissions reduced or avoided under NDC implementation compared to a future scenario without NDC implementation, the latter value describes the total emissions either reduced, avoided or released into the atmosphere under NDC implementation compared to the starting point. As such, the former is particularly relevant for measuring individual ambition and thus informing NDC enhancement, while the latter is particularly relevant for measuring collective progress under the Global Stocktake.

To estimate the cumulative net emissions reduction by 2030 compared to the counterfactual scenario, refer to **Equation 6**, and find the difference in area (Area 3) under the counterfactual curve (Area 1) and NDC emission target curve (Area 2). If the NDC differentiates between an unconditional and conditional scenario, that cumulative net emissions reduction (Area 3) can be disaggregated by unconditional (Area 4) and conditional (Area 5) reduction.

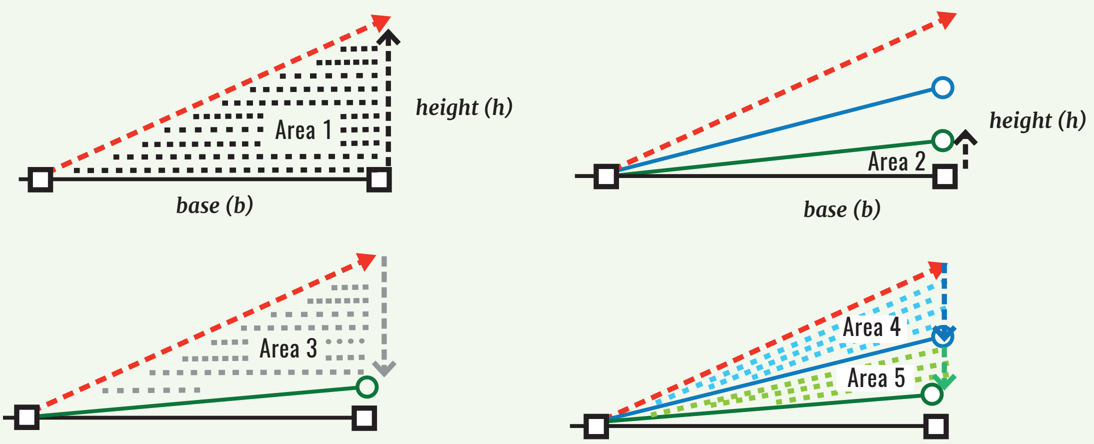
Alternatively, to estimate the cumulative net emissions reduction by 2030 compared to the historical scenario, find the difference in area (Area 2) under the NDC mitigation target emission curve (Area 1) and the 2015 historical emissions level. **Figure 10**, with reference to previous **Figure 9**, illustrates how to estimate the cumulative net emissions reduction of NDC implementation by 2030, where:

Equation 6

$$A = \frac{1}{2} b \times h$$

FIGURE 10.

CUMULATIVE NET EMISSION REDUCTION OF NDC IMPLEMENTATION



Area 1: cumulative increase in net emissions by 2030 under counterfactual scenario compared to 2015 historical emission level.
Area 2: cumulative increase* in net emissions by 2030 under NDC mitigation target scenario compared to 2015 historical emission level.
Area 3: cumulative net emission reduction by 2030 under NDC mitigation target scenario compared to the 2030 counterfactual scenario.
Area 4: unconditional cumulative net emission reduction by 2030 under NDC mitigation target scenario compared to the 2030 counterfactual scenario.
Area 5: conditional cumulative net emission reduction by 2030 under NDC mitigation target scenario compared to the 2030 counterfactual scenario.

** It should be noted that, depending on the NDC, the cumulative change in net emissions under NDC implementation may represent a reduction or increase in net emissions when compared to the 2015 historical level. This diagram presents an example of an expected increase in cumulative net emissions (Area 2) under NDC implementation compared to the historical level.*

A few additional considerations can also be drawn once the historical, counterfactual and NDC mitigation target emissions scenarios have been constructed:

- the percent change in net emissions between the historical 2015 level and 2025 and 2030 counterfactual scenarios (i.e. the expected increase in emissions without NDC implementation);
- the percent change in net emissions between the 2025 and 2030 counterfactual and NDC mitigation target scenarios (i.e. the expected reduction in emissions due to NDC implementation compared to the counterfactual level); and
- the percent change in net emissions between the historical 2015 level and 2025 and 2030 NDC mitigation target scenarios (i.e. the expected reduction or increase in net emissions under NDC implementation compared to the historical level).

This guidance can be applied at varying scales of aggregation (e.g. national, regional and global) and levels of sectoral coverage (economy-wide or sector-specific). The margin of error is subject to the transparency, accuracy, completeness, comparability and consistency (TACCC) of information reported in the NDCs and any supplementary national data sourced.

Annex 2 to **Annex 5** can be found as online annexes at http://www.fao.org/3/cb1579en/cb1579en_annexes.xlsx

The agriculture and land use sectors (crops, livestock, forestry, fisheries and aquaculture) feature prominently amongst the adaptation and mitigation contributions set forth in the NDCs – up to 96 and 88 percent, respectively (FAO, 2016a). This paper presents a step-by-step methodology for identifying mitigation and adaptation policy "gaps" and "opportunities" in the agriculture and land use sectors. It also provides a gap-filling methodology for estimating economy-wide and sector-specific baseline and NDC mitigation scenarios. The overall objective is to support policy makers in enhancing NDC ambition in future NDC review and revision cycles. To date, the sector-specific methodology has been adopted by FAO to conduct a series of regional-level analyses.

Office of Climate Change, Biodiversity and Environment (OCB)

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