The Kingdom of Cambodia
Nation - Religion - King

CAMBODIA'S INITIAL BIENNIAL TRANSPARENCY REPORT (BTR1)

Under Paris Agreement

FOREWORD

The Kingdom of Cambodia, as a country vulnerable to the impacts of climate change, understands the urgency of ambitious climate action. Despite bearing minimal responsibility for the historical and current climate crisis, we have consistently responded to international calls for actions on climate change and contributed to the efforts, in line with our capacities and responsibilities under the United Nations Framework Convention on Climate Change (UNFCCC).

We are proud to be among the very first members of the Group of Least Developed Countries to submit this Initial Biennial Transparency Report (BTR1), in line with Decision 18/CM A.1, paragraphs 3: "Decides that Parties shall submit their first biennial transparency report and national inventory report, if submitted as a stand-alone report, in accordance with the modalities, procedures and guidelines, at the latest by 31 December 2024" This is a highly significant step for a developing country like Cambodia, that reflects leading by example on climate change action to address global challenges.

This BTR1 is an improved document in several important ways in accordance with the Decision 18/CMA.1, paragraphs 4: "Also decides that the least developed country Parties and small island developing States may submit the information referred to in Article 13, paragraphs 7, 8, 9 and 10, of the Paris Agreement at their discretion". The BTR1 covers the National Inventory Report of anthropogenic emissions by sources and removals by sinks of greenhouse gases; Information necessary to track progress made in implementing and achieving Nationally Determined Contributions under Article 4 of the Paris Agreement; Information related to climate change impacts and adaptation under Article 7 of The Paris Agreement; and Information on financial, technology development and transfer and capacity-building support needed and received under Articles 9–11 of the Paris Agreement. Finally, a significant effort has been made to develop a solid framework of the institutional arrangement for monitoring so that we are able generate solid evidence on progress made and on challenges encountered. This will help us to continuously refine our policies so that we not only meet our NDC update, but it is the baseline for the next NDC 3.0 and also our climate change targets under the SDGs.

I would like to appreciate the General Directorate of Policy and Strategy (GDPS) for effective coordinating with all stakeholders for making this document possible and the Technical Working Group on Climate Change (TWGCC). I would like to thank the United Nations Environment Programme (UNEP) funded through the Global Environment Facility (GEF) and in-country supports to the coordination of the process from Food and Agriculture Organization (FAO), Global Green Growth Institute (GGGI) and United Nations Industrial Development Organization (UNIDO).

As Cambodia is committed to do its part to address the global challenge of climate change, we look forward to working with all our partners to address our remaining needs in financing, capacity development and technology transfers. This cooperation and support will be crucial to achieve the ambitious vision set out in this document.

Eang Sophalleth
Minister of Environment

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Acronym

ADB	Asian Development Bank
ADP	The Agriculture Development Policy
AEZ	Agro-Ecological Zones
AFOLU	Forestry and other Land Use
ASDP	Agricultural Strategic Development Plan
ASEAN	Association of South-East Nations
CC	Climate Change
CCA	Climate Change Adaptation
CCAP	Climate Change Action Plan
CCCA	Cambodia Climate Change Alliance
CCCO	Cambodia Climate Change Office
CCCSP	Cambodia Climate Change Strategic Plan
CCDR	Country Climate and Development Report
CCFF	Cambodia's Climate Change Financing Framework
CCKP	Climate Change Knowledge Portal
CCPAPs	Climate Change Priorities Action Plans
CCTWG	Climate Change Technical Working Group
CDM	Clean Development Mechanisms
CEPR	Climate Change Expenditure Review
CFE-DM	Center for Excellence in Disaster Management
CIP	Commune Investment Programs
CNM	National Center for Parasitology, Entomology and Malaria Control
COP	Conference of the Parties
CPEIR	Climate Public Expenditure and Institutional Review
CRM	Climate Risk Management
CSDG	Cambodia's Sustainable Development Goals
CSOs	Civil Society Organizations
DCC	Department of Climate Change
DRM	Disaster Risk Management
ENSO	El Niño Southern Oscillation
ERIA	Economic Research Institute for ASEAN and East Asia
ESTD	Strategy on Environmentally Sustainable Transport Development
ETF	Enhance Transparency Framework
FAO	Food and Agriculture Organization of the United Nations
FDI	Foreign Direct Investment
FOD	First Order Decay
FOLU	Forestry and Other Land Use
FRL	Forest Reference Level
FWUC	Farmer Water User Community
GCF	Green Climate Fund
GDAHP	General Directorate of Animal Health and Production

GDANCP	General Directorate of Administration for Nature Conservation and Protection
GDP	Gross domestic products
GDP	Gross Domestic Product
GGA	Global Goal on Adaptation
GHG	Greenhouse Gases
GHG	Greenhouse Gas
GNI	Gross National Income
GSSD	General Secretariat of the National Council for Sustainable Development
GWP	Global Warming Potential
ICEM	International Centre for Environmental Management
IIED	International Institute for Environment and Development
ILO	International Labour Organization
IMF	International Monetary Fund
INC	Initial National Communication
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
L&D	Losses and Damages
LDC	Least Developed Country
LTS4CN	Long-Term Strategy for Carbon Neutrality
M&E	Monitoring and Evaluation
MAFF	Ministry of Agriculture, Forestry and Fisheries
MCF	Methane Correction Factor
MEF	Ministry of Economy and Finance
MIS	Management Information System
MISTI	Ministry of Industry, Science, Technology and Innovation
MLMUPC	Ministry of Land Management Urban Planning and Construction
MME	Ministry of Mines and Energy
MoC	Ministry of Commerce
MoE	Ministry of Environment
MOEYS	Ministry of Education, Youth and Sport
MoH	Ministry of Health
MOP	Ministry of Planning
MOT	Ministry of Tourism
MoWA	Ministry of Women's Affairs
MoWRAM	Ministry of Water Resources and Meteorology
MPWT	Ministry of Public Works and Transport
MRD	Ministry of Rural Development
MRV	Monitoring, Reporting and Verification
NAP	National Adaptation Plan
NAPA	National Adaptation Plan of Actions
NAPFFIP	National Adaptation Plan Financing Framework and Implementation Plan

NCCC	National Climate Change Committee
NCDD	National Committee for Sub-National Democratic Development
NCDM	National Committee for Disaster Management
NCSD	National Council for Sustainable Development
NDC	Nationally Determined Contribution
NESAP	National Environment Strategy and Action Plan
NFP	National Forest Programme
NGO	Non-Governmental Organization
NPASMP	National Protected Area Strategic Management Plan
NSDP	National Strategic Development Plan
ODA	Official Development Assistance
PEARL	Partnerships for Ecologically-Sound Agriculture and Resilient Livelihood
PPCR	Climate Investments Funds-Pilot Program for Climate Resilience
QA	Quality Assurance
QC	Quality Control
R&D	Research and Development
RCPs	Representative Concentration Pathways
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RGC	Royal Government of Cambodia
SCA	Societe Concessionaire des Aeroport
SCALA	Scaling Up Climate Ambition in Land Use and Agriculture
SCCSPs	Sectoral Climate Change Strategic Plans
SDGs	Sustainable Development Goals
SNA	Sub-National Administration
SPCR	Strategic Programme for Climate Resilience
SPEI	Standardized Precipitation Evaporation Index
SSPs	Shared Socioeconomic Pathways
SWDP	Solid Waste Disposal Sites
TAMD	Tracking Adaptation and Measuring Development
TAPs	Technology Action Plans
TNC	Third National Communications
UAN	Urea Ammonium Nitrate
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
UTMP	Urban Transport Master Plan

Executive Summary

Chapter I: National inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases

Cambodia presents Greenhouse Gas (GHG) inventories includes emissions for the years 2016 to 2022 of the gases carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and hydrofluorocarbons (HFCs) from the sectors, namely, Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU) and Waste. The inventory considered as a base year as per Cambodia's NDC. The inventory was based on Articles 4 and 12 of the UNFCCC and Article 13 of the Paris Agreement. The GHG Inventory document has been developed in accordance with the Modalities, Procedures and Guidelines (Annex to Decision 18/CMA.1) established under the enhanced transparency framework of the Paris Agreement. The 2024 edition of the GHG inventory of the Kingdom of Cambodia includes emissions for the years 2016 to 2022 of the gases CO2, CH4, N2O and HFC. The inventory has been calculated following the 2006 IPCC Guidelines.

For Energy sector, the energy sector saw a consistent increase in emissions over the six-year period, rising from 9,073 GgCO2e in 2016 to 14,875 GgCO2e in 2022—a 63.95% increase. This growth reflects the expanding energy demand likely driven by economic growth, urbanization, and industrialization. While energy remains a cornerstone of economic development, the rapid growth of emissions underscores the need for a transition to cleaner energy sources such as renewables and energy-efficient technologies. Followed by IPPU sector, the emissions from industrial process and product use and more than doubled, increasing from 1,858 GgCO2e in 2016 to 4,210 GgCO2e in 2022. This dramatic rise signals heightened industrial activity and reliance on carbon-intensive processes. With this, the agriculture sector continues to dominate as the largest contributor to GHG emissions, consistently accounting for more than 55% of the total emissions. Over the six years, agricultural emissions rose from 36,644 GgCO2e in 2016 to 41,446 GgCO2e in 2022, an 13% increase. These emissions are driven by enteric fermentation from livestock, manure management, and rice production in Cambodia. For FOLU, the data for forestry and other land use (FOLU) was reported only for 2016 and 2018, contributing 27,518 GgCO2e in each year. However, it is estimated that forest land contributed to the sequestration of –9,343 GgCO2e in 1994 and – 1,777 GgCO2e in 2018. The absence of data in subsequent years presents a gap in understanding the full emissions profile and the potential role of forests as carbon sinks. The FOLU sector is critical in balancing emissions, and its omission limits the ability to assess trends and plan interventions effectively. The waste sector emissions grew moderately, from 1,859 GgCO2e in 2016 to 2,797 GgCO2e in 2022, reflecting a 50% increase. Although comparatively smaller, this growth suggests increasing challenges with waste management due to population growth and urban expansion.

Table 1: The GHG emission estimated for the year 2016 to year 2022

Inventory year	Total sectoral GHG emissions ($GgCO_2e$)						
	Energy	IPPU	Waste	Agriculture	FOLU	Total (With FOLU)	Total (Without FOLU)
2016	9,073	1,858	1,859	36,644	27,518	76,952	49,434
2017	10,492	2,019	1,985	37,018	27,518	79,031	51,513
2018	11,338	2,179	2,133	38,141	27,518	81,309	53,790
2019	14,131	2,343	2,320	37,770	NE	56,564	56,564
2020	14,470	4,187	2,523	38,291	NE	59,471	59,471
2021	13,943	4,665	2,677	40,748	NE	62,033	62,033
2022	14,875	4,210	2,797	41,446	NE	63,328	63,328

Uncertainty assessment within Cambodia's GHG inventory is a critical component in evaluating the reliability and robustness of the compiled emissions data. It involves a thorough examination of data sources, sector-specific methodologies, and quantification of uncertainties, resulting in an overall estimation of uncertainty for the entire inventory. Cambodia provides comprehensive information regarding the completeness of its national inventory report, identifying sources and sinks not considered in the inventory but included in IPCC guidelines. Insignificant categories are described, and total aggregate emissions considered insignificant are assessed to ensure transparency and accuracy in reporting. For reporting aggregate emissions and removals of GHGs, Cambodia utilizes the 100-year time-horizon global warming potential (GWP) values specified in the IPCC Fifth Assessment Report. As a developing country Party, Cambodia applies flexibility measures to accommodate its specific circumstances and capacity constraints. This includes adjustments in the scope, frequency, and level of reporting detail and modifications in the review process, with self-determination and adherence to established frameworks guiding the application of flexibility.

Chapter 2: Information necessary to track progress made in implementing and achieving nationally determined contributions under Article 4 of the Paris Agreement

Cambodia, located in Southeast Asia and spanning 181,035 square kilometers. The nation's population projected to grow from 16.3 million in 2021 to 21 million by 2050. The country experiences a tropical monsoon climate with distinct wet and dry seasons, where the wet season, from May to October, contributes 80-90% of annual rainfall. Economically, Cambodia experienced strong growth with annual GDP increases of over 7% before the COVID-19 pandemic, which slowed growth to 4.4% from 2017 to 2022. Natural disasters, including storms, floods, and droughts, significantly challenge development by causing economic losses and increasing vulnerabilities. The energy sector has expanded rapidly, with electricity consumption surging in recent years.

Energy-related CO2 emissions are projected to rise from 33 million tons in 2030 to 114.2 million tons by 2050. Investment in Cambodia's industrial sector (IPPU), including manufacturing and construction, grew significantly, reaching $2.5 billion by 2016. The mineral industry remains the largest contributor to industrial emissions, with cement manufacturing and refrigeration also contributing substantial amounts. The agricultural sector plays a critical role in Cambodia's economy. Rice dominates the sector, covering 90% of the cultivated land and achieving production increases from 8.78 million tons in 2016 to 10.89 million tons in 2023. Other crops like maize and cassava also experienced significant growth. Livestock emissions are linked to population growth and dietary trends, with projections indicating increases in methane and nitrous oxide emissions from manure management and rice farming. Cambodia's forest cover, assessed every two years, was 46.86% of the country's total area in 2018. Decades of civil conflict and deforestation have led to steady declines in forest land, though participation in REDD+ programs has helped improve resource management. Under various scenarios, forest depletion rates range from 0.5% to 2.6% annually. The waste sector is another contributor to emissions, with solid waste disposal and wastewater treatment being the largest sources. Projections under a Business-As-Usual (BAU) scenario suggest emissions will rise in line with population growth, which is expected to slow from 1.25% annually by 2030 to 0.76% by 2050.

Cambodia's undate Nationally Determined Contributions (NDC) demonstrate significant progress by expanding climate change mitigation efforts in agriculture and waste sectors while introducing detailed initiatives like energy efficiency improvements. The updated NDC emphasizes a pathway to halve deforestation rates in the Forestry and Land Use sector by 2030. The imlementation actions and their emission reductions - 2017 – 2023, Cambodia achieved notable greenhouse gas emission reductions in both the energy and waste sectors. The energy sector demonstrated consistent progress, with reductions steadily increasing from approximately 500,000 tCO2e in 2017 to over 2.5 million tCO2e by 2023. This trend reflects the successful implementation of cleaner energy sources and enhanced energy efficiency measures. The waste sector, although contributing on a smaller scale, experienced a significant acceleration in emission reductions starting in 2021. Emissions reductions rose sharply, reaching around 30,000 tCO2e by 2023, driven by advancements in recycling, solid waste management, and wastewater treatment. The GHG emission reductions in Cambodia's Agriculture, Forestry, and Other Land Use (AFOLU) sector from 2017 to 2023 remained relatively minimal and steady. However, starting in 2020, a significant increase in emission reductions is observed, peaking in 2022 at approximately 18,000 tCO2e. This growth reflects the implementation of impactful mitigation measures, such as reforestation, sustainable land management, and improved agricultural practices. By 2023, a slight decline is noted, suggesting a stabilization or tapering of the pace of emission reductions. Overall, the graph highlights Cambodia's focused efforts in the AFOLU sector to contribute to its climate goals. The projections of GHG emissions and removals in Cambodia under three scenarios—**without measures**, **with measures**, and **with additional measures**—from 2016 to 2030 hihghlighted that scenarios start at a baseline of approximately 125 million tCO2e while the emissions under the **"without measures"** scenario rise to nearly 170 million tCO2e, whereas the **"with additional measures"** scenario achieves the greatest reductions, maintaining emissions below 150 million tCO2e in 2030.

Chapter 3: Information related to climate change impacts and adaptation under Article 7 of the Paris Agreement

Cambodia, with a GNI per capita of $1,700 in 2022, faces challenges like rural poverty, limited industrial diversification, and inadequate infrastructure despite progress in urbanization and social services. One-third of the population lived on less than $3.20 per day in 2019, highlighting economic vulnerability. Transitioning to a market-driven economy, Cambodia saw 7.6% GDP growth (1995–2019) and aims to graduate from LDC status by 2027.

Agriculture, contributing 22% of GDP and employing 33% of the workforce, struggles with low productivity, limited mechanization, and poor infrastructure. Only 22% of arable land is irrigated, and post-harvest systems remain underdeveloped, requiring significant investment for growth. At the same time, the nation faces high exposure to flooding, including riverine and flash floods, with some risk from tropical cyclones and significant drought concerns, as seen in the severe 2015–2017 drought. In additions, high temperatures, with an average of 64 days annually exceeding 35°C. Heatwaves, with a current median probability of 3%, are becoming more frequent and intense, contributing to extreme temperatures in Southeast Asia, such as the April 2016 event driven by ENSO (49%) and climate change (29%). The overall INFORM risk index ranking of 55th indicated worsened by limited coping capacity and population vulnerability, with climate change further intensifying these risks.

For institutional arrangement, Cambodia established the National Climate Change Committee (NCCC) in 2006 to coordinate and monitor climate change and sustainable development policies. In 2015, the National Council for Sustainable Development (NCSD) was formed, chaired by the Minister of Environment and including high-level representatives from key ministries, agencies, and provincial governors, with the Prime Minister as Honorary Chair. The NCSD established Climate Change Technical Working Group (CCTWG), coordinated by the GSSD, includes representatives from line ministries. It supports the NCSD by enhancing Cambodia's climate change response capacity, facilitating policy development, and preparing reports like the BTR and BUR for the UNFCCC.

In 2023, the government has launched the 2023–2028 RGC Pentagonal Strategy Phase 1, in contrast to the 2050 vision and 2030 milestones, delineates the fundamental initiatives that shall be executed over the subsequent five years to effectuate a transformation of Cambodia into a high-income economy by 2050. In additions, A total of 86 climate adaptation actions were submitted by line ministries to incooperated into NDC, covering sectors like agriculture (17 actions), coastal areas (2), energy (2), health (5), industry (1), infrastructure (7), livelihoods and biodiversity (7), tourism (3), and water resource management (6). These climate adaptation to enhance national resilience, are relying on both national and international funding. Vulnerability Index (VI) has developed to be able to track annually the percentage and number of communes scoring as highly vulnerable or quite vulnerable to three main types of climate hazards: floods, storms, drought. This Vulnerability index has indicated the proportion of four categories—"Least," "Less," "Quite," and "High"—over the years 2014 to 2022. The "Least" vulnerability consistently dominates, making up over 50% of the total in 2020, 2021, and 2022, showing an increasing trend in recent years. The "Less" vulnerability remains relatively stable but decreases slightly over time. The "Quite" vulnerability fluctuates slightly, while the "High" vulnerrability maintains the smallest share throughout the years, showing a slight decline.

In health sector indicated of a 74% drop in infant mortality (2000–2014) and a 64% reduction in maternal mortality (2005–2014), are threatened by rising temperatures, increased precipitation, and extreme weather events like storms, droughts, and floods. Health sector reforms since the 1990s, including expanded infrastructure, financing, and access to services, have been key to these achievements but face growing climate-related risks. Despite the progress, the country pose significant challenges. Recently, There has been significantly increased in the number of dengue cases in the first nine months of 2023, with 21,568 cases reported, a rise of 184% compared to the same period in 2022, when 7,597 cases were recorded. Additionally, the CNM reported 38 deaths from January to September 2023, up from 14 deaths reported the year prior 2024. The Cambodia Country Climate and Development Report (2023) highlights the health impacts of rising temperatures, with a 35°C monthly average increasing cough incidence by 55% and diarrhea by 83%. By 2050, diarrhea in children could rise by 4%, with provincial increases ranging from 3.1% in Siem Reap to 4.4% in Mondulkiri. Climate change may also reduce annual working hours by 1.1–1.7% and exacerbate stunting (22% average rate) and undernutrition. Additionally, it influences the spread of vector-borne diseases like malaria, dengue, and Japanese encephalitis.

Chapter 4: Information on financial, technology development and transfer and capacity- building support provided and mobilized under Articles 9–11 of the Paris Agreement

Cambodia is making significant efforts on different elements of climate finance, mainly the streamlining of climate change into national and ministerial budgets, as well as the MRV of climate finance. In 2023, domestic funding for climate change spending rose to 48%, up from 37% in 2022, while external funding decreased by 11.5%, still making up 52% of the total. Climate change expenditure remains at 2.1% of GDP, with public spending increasing by 8% to KHR 2,769 billion (USD 692.3 million), driven by investments in resilient infrastructure, energy, and climate-resilient agriculture projects.

The expenditures by ministry from 2020 to 2023, revealing significant investments in infrastructure and water resource management. The Ministry of Public Works and Transport (MPWT) leads with a total expenditure of $562.9M, followed closely by the Ministry of Water Resources and Meteorology (MOWRAM) with $560M, both showing consistent annual increases. The Ministry of Agriculture, Forestry, and Fisheries (MAFF) ranks third, with spending rising sharply to $318.4M in 2023. Other key contributors include the Ministry of Environment (MOE) and the Ministry of Education, Youth, and Sports (MOEYS), which have significantly increased their spending over the years. Meanwhile, Sub-National Administration (SNA) and NGOs maintain steady contributions, totaling $90.3M and $57.5M, respectively. However, ministries like the Ministry of Information (MOINF) and the Ministry of Women's Affairs (MoWA) show minimal engagement in climate-related spending. In example, in 2023, Cambodia allocated 5.5% of its total climate change (CC) expenditure (KHR 938 billion) to external programs with gender relevance. Of the total CDC ODA budget, 66% (KHR 4,977 billion) was tagged as gender-relevant, up from 48% in 2022. However, only 24% (KHR 4,068 billion) of climate change-relevant programs had a specific gender focus, an increase from 20% in 2022. These gender-focused programs primarily targeted disaster management, rural infrastructure, electrification, fisheries, social protection reform, and water resources management.

In term of technology, Cambodia emphasizes the importance of transferring mitigation and adaptation technologies to developing countries to address climate change and promote sustainable development. This approach enables developing nations to bypass traditional growth paths by enhancing energy efficiency, reducing pollution and GHG emissions, and maintaining socio-economic progress. In Cambodia, such technology transfers primarily occur through Clean Development Mechanism (CDM) projects, focusing on renewable energy, industrial waste heat, agricultural and livestock waste energy, and hydropower. Most CDM projects are led by private companies and include details on methodologies, estimated CO2 reductions, and UNFCCC registration.

In relation to Capacity Building support provided and mobilized, the capacity-building projects, totaling $42,080,347 in funding from donors such as UNEP, UNDP, EU, Sida, Sweden, GEF, GGGI, and GCF. Major initiatives include the Cambodia Climate Change Alliance Phases 1, 2, and 3 (2010–2024), which account for over $35 million, focusing on institutional strengthening and climate resilience. A significant $4.57 million project (2016–2019) targeted reducing rural vulnerability through enhanced sub-national climate planning. Several projects supported Cambodia's UNFCCC obligations, including the preparation of INDC, Biennial Update Reports, and National Communications, with combined funding exceeding $1 million. Additionally, Green Climate Fund readiness projects received over $800,000 to enhance financial and operational capacities.

Chapter 5: Information on financial, technology development and transfer and capacity- building support needed and received under Articles 9–11 of the Paris Agreement

Despite ongoing efforts, financial needs remain high, and most actions require financial support. Future resource mobilisation will look towards a reasonable mix of national and international funds, in addition to market mechanisms, where appropriate, and in line with progress on Article 6 of the Paris Agreement. In mitigation, Cambodia's estimated financial needs for climate change mitigation across various sectors, totaling $5.77 billion. The forestry sector requires the largest investment at $3.47 billion, reflecting its critical role in carbon sequestration and climate change mitigation. The waste sector follows with a need for $1.49 billion, indicating significant opportunities for improvement in waste management systems. Energy is another priority, requiring $672.1 million to transition to cleaner energy sources. Industry ($78.7 million), agriculture ($49.4 million), and transport ($10.6 million) have smaller, yet still essential, funding needs. Overalls, mitigation actions account for $3.1 million.

The Adatpation , the investement estimated the financial needs, totaling $2.04 billion. The infrastructure sector requires the largest investment at $957.99 million, highlighting its critical role in enhancing resilience. Water resources follow with $468.8 million, reflecting the importance of water management in adapting to climate impacts. Agriculture is the third-largest priority, requiring $306.3 million, essential for food security and rural livelihoods. Other significant needs include livelihoods, poverty, and biodiversity ($211.1 million), coastal zones ($72 million), and enabling actions ($21.05 million). Smaller allocations are identified for tourism ($2.5 million minimum) and energy ($322,000). The funding required for human health is minimal, while industry needs are not reported.

Cambodia has received substantial technical and financial support for its climate efforts, enabling the preparation of key documents like national communications (first, second, and ongoing third), NAPA (2006), Technology Needs Assessments (2013), BUR, INDC, Updated NDC, and LTS4CN. This policy instrutments urged to push for accountability of nations that today have relatively high levels of wealth and emissions for financial contributions that enable developing countries to achieve low-emission development and greater climate resilience.

An example of Cambodia, between 2009 and 2014, Cambodia's public expenditure on climate change rose from $91.7 million (0.9% of GDP) to $211.7 million (1.4% of GDP), though by 2016 it constituted only 3.1% of total public expenditure. Development partners provided 62% of climate financing, but reductions in external funding have impacted Cambodia's ability to address climate change. Since 2014, Cambodia's climate financing framework has guided funding for adaptation and mitigation, while the 2017 National Adaptation Plan (NAP) Financing Framework was introduced to mobilize resources for the NAP process. Despite identifying 171 climate actions requiring $865.5 million across 15 sectoral plans, only 7% of the proposed budget has been funded for implementation.

Althought, Cambodia has made progress in establishing institutional frameworks and political commitment but faces challenges in enhancing technical capacities, data management, and inter-agency collaboration. Limited financial resources for climate response highlight the urgent need for significant investments to accelerate adaptation measures.

Chapter 1:

National inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases

Under Paris Agreement

A. Background information on GHG inventories

As a country highly vulnerable to climate change impacts, Cambodia recognizes the urgency of ambitious climate action and is committed to leading by example within its capacities and responsibilities under the UNFCCC. The BTR1 serves as a comprehensive overview of Cambodia's development status and needs and an updated analysis of climate change challenges. It includes an updated inventory of anthropogenic emissions by sources and removals by sinks of GHGs, which is essential for evaluating the effectiveness of national mitigation efforts. Furthermore, the BTR1 highlights Cambodia's efforts in climate change adaptation and mitigation, providing valuable insights into its progress toward achieving its climate goals. In light of global trends in GHG emissions and financial commitments to developing countries falling short of targets, the BTR1 underscores the importance of maintaining a strong international commitment to the climate change agenda. The BTR1 will inform the design and implementation of Cambodia's climate change adaptation and mitigation measures, supporting the country's Updated Nationally Determined Contribution (NDC) and Long-Term Strategy for Carbon Neutrality (LTS4CN).

1. Institutional arrangement for GHGI

1.1. National entity or focal point

Creating a robust institutional framework is paramount for effectively executing the Greenhouse Gas Inventory (GHGI) assessments. Such a framework ensures the smooth operation of GHGI assessments and facilitates comprehensive data collection, analysis, and reporting. Below, we elaborate on the critical aspects of the developed institutional arrangement for GHGI in Cambodia.

- **Organizational Structure**: The institutional arrangement delineates a clear organizational structure with designated roles and responsibilities. This structure typically includes governmental bodies, environmental agencies, research institutions, and relevant stakeholders, ensuring a coordinated approach to GHGI assessments.
- **Legal Framework**: A solid legal foundation is established to mandate GHGI assessments, enforce compliance with reporting requirements, and implement emission reduction initiatives. This may involve enacting environmental laws, regulations, and international agreements to govern GHG monitoring, reporting, and verification processes.
- **Capacity Building**: Efforts are directed towards enhancing the capacity of relevant entities involved in GHGI assessments. Training programs, workshops, and technical assistance are provided to equip personnel with the necessary skills and expertise in data collection methodologies, emission calculations, and inventory management techniques.
- **Data Management Systems**: Robust data management systems are implemented to streamline GHG emission data collection, storage, and analysis. This may involve the

development of centralized databases, electronic reporting platforms, and quality assurance procedures to ensure the reliability and accuracy of the reported data.
- **Stakeholder Engagement**: The institutional arrangement emphasizes active engagement with stakeholders, including government agencies, industry associations, civil society organizations, and the public. Consultative processes are employed to solicit feedback, foster transparency, and promote inclusivity in decision-making regarding GHGI assessments.

That developed institutional arrangement is illustrated in Figure I-1 and the role responsibility defined roles and responsibilities are pointed out in the Table I.1.

Table I. 1: Roles & responsibilities of key stakeholders

Role	Responsibilities
Climate Change lead agency	Validation of results, supervision, and strategic oversight.
Inventory coordinator	Coordinate and oversee the work of international and national consultants.
International inventory compilers Team	Estimate the GHG emission inventory, perform quality control processes, write the inventory report, and provide capacity building to national compilers.
National inventory Compilers Team	Gathering activity data, supporting the compilation of GHG emissions estimates, and performing quality checks per the QA/QC plan.
Data provider	Provide the information available as needed for the development of the national inventory.
QA and Verification Team	QA through consultation and validation workshops.
Archiving coordinator	Conduct archive process for activity data, analysis and GHG inventory reports

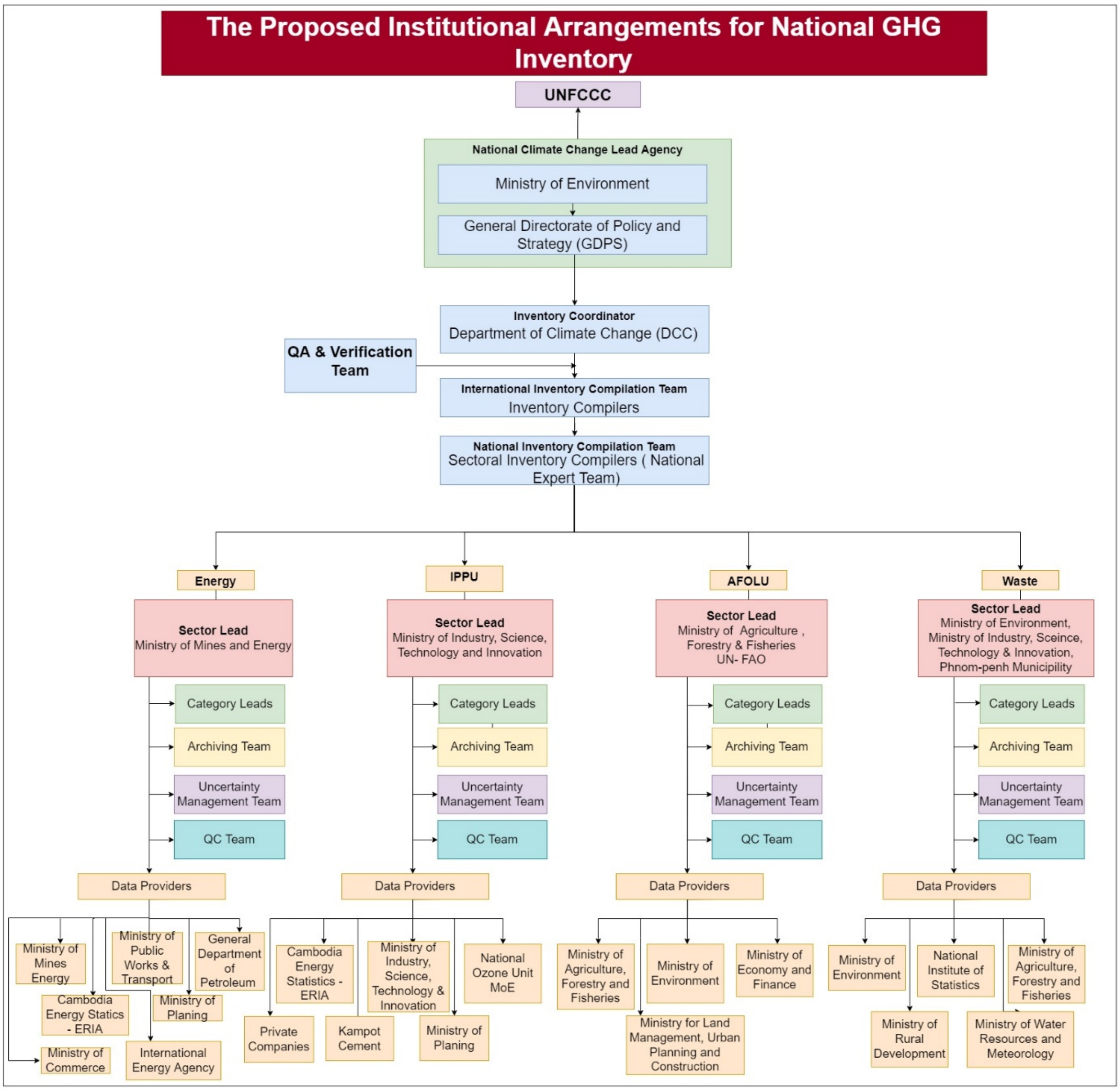

Figure I. 1: Systematic Institutional Arrangement

2. Inventory preparation process

The 2006 IPCC Guidelines provide a structured approach for developing national GHG emission inventories, outlining a series of steps known as the inventory development cycle. Following best practices, this cycle encompasses all the necessary tasks to create a national GHG emission inventory. Key steps in the inventory preparation process include data collection, data verification, quality assurance, and consistency check to ensure the integrity and reliability of the inventory. Additionally, sector-specific analyses were conducted to identify emission trends, hotspots, and potential mitigation opportunities. A diagram representing the inventory development cycle specific to Cambodia has been derived from the steps recommended by the 2006 IPCC Guideline.

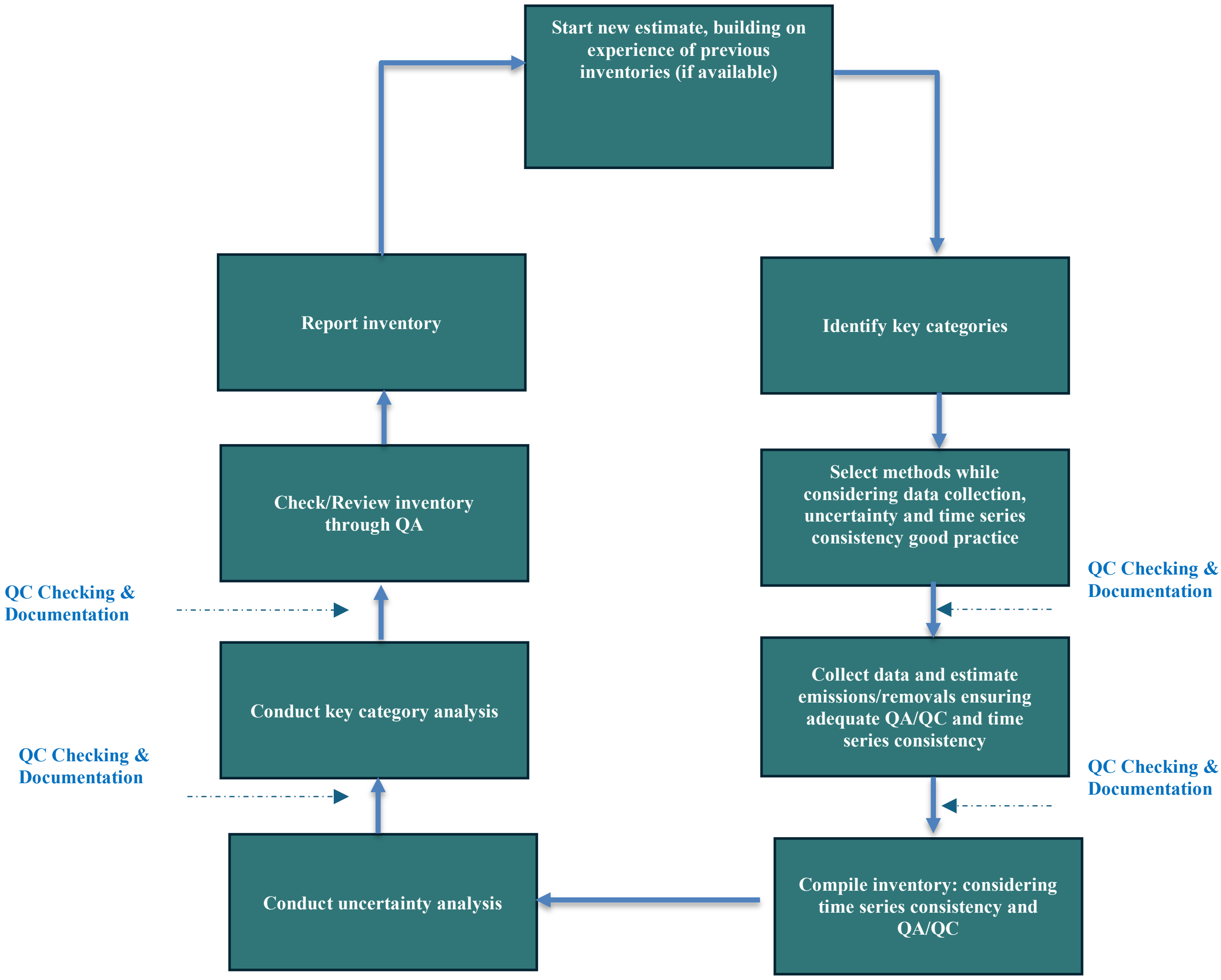

Figure I. 2: GHG Inventory process relevant to Cambodia based on IPCC 2006 guideline

Key category analysis is the IPCC's method for deciding which emissions or removals categories to prioritize in GHG inventory estimation. Key category analysis prioritizes emissions or removal categories for inventory estimation. These categories should use progressively higher-tier methods to enhance accuracy and reduce uncertainty. A category is considered key if it contributes to 95% of total national emissions or removals or 95% of the trend in national emissions or removals when ordered by magnitude. Key category analysis may require iterative approaches. Initially, Tier 1 methods are employed if it is uncertain which categories are key. National Communications, which include emissions data for specific inventory years, are analyzed to identify preliminary key categories. Total national GHG emissions and sectoral emissions breakdowns were examined. In the case of Cambodia, the dominant sectors contributing to GHG emissions were identified. Key categories are determined based on their contribution to emissions levels and trends. For instance, in Cambodia, Forest land, Rice cultivation, and Transport liquid fuels were identified as key categories based on their emissions levels. Additionally, categories like Forest land, Transport liquid fuels, and Rice cultivation were identified based on their potential contributions to emission trends.

The inventory preparation process begins with collecting data from various sources, including government ministries, research institutions, local authorities, and relevant stakeholders. Government ministries which designated as data providers should be well informed (official instruction/decision) about their roles and responsibilities in collecting and gathering GHG inventory related data. National statistical offices provide vital data on energy consumption, industrial activities, agricultural practices, and land use changes. Additionally, sector-specific surveys and studies conducted by research institutions contributed valuable information to the inventory dataset.

Upon collection, the data undergoes compilation and analysis using methodologies tailored to Cambodia's context. Recognizing the country's unique socio-economic and environmental characteristics, such as reliance on agriculture and vulnerability to climate change, specialized models and tools are applied to estimate GHG emissions and removals accurately. The analysis carefully accounts for factors such as deforestation, land degradation, and changes in agricultural practices.

A robust QA/QC plan will be implemented to ensure the reliability and accuracy of the inventory data. This includes data validation, verification, and consistency checks to identify and rectify any errors or discrepancies. QA/QC procedures help maintain data integrity and enhance the credibility of the inventory.

An uncertainty assessment specific to Cambodia's inventory was conducted to evaluate the reliability of emission estimates. Factors contributing to uncertainty, such as data gaps, measurement errors, and variability in emission factors, are carefully analyzed. This assessment provides insights into the confidence levels associated with reported emissions and helps identify areas for improvement in data collection and analysis.

Special attention is paid to ensuring the completeness of Cambodia's GHG inventory, considering the diversity of emissions sources and sinks in the country. Efforts are made to include all relevant sectors, including energy, forestry, agriculture, transportation, and waste management. Any gaps or inconsistencies in data coverage are identified and addressed to enhance the comprehensiveness of the inventory.

Once data compilation, analysis, and quality assurance processes are completed, the inventory report will be submitted to the UNFCCC. The report was included detailed information on GHG emissions and removals, methodologies, data sources, uncertainty assessment results, and relevant contextual information. Reporting guidelines outlined by the UNFCCC were followed to ensure consistency and comparability with other countries' inventories.

The inventory report undergoes a review process to validate its accuracy and completeness. This may involve an internal review by national experts and an external review by international peers or review teams. Feedback received during the review process is considered and incorporated into the inventory as appropriate to improve its quality and reliability.
The inventory preparation process is iterative, with ongoing efforts to improve data quality, enhance methodologies, and strengthen institutional capacity. Lessons learned from previous inventory cycles are used to inform future inventory preparations, ensuring continuous improvement in reporting accuracy and transparency.

3. Archiving of information

The GHG inventory archive process consists of three levels: activity data, analysis and GHG inventory reports for each sector.

4. Processes for official consideration and approval of inventory

The processes for official consideration and approval of inventory in Cambodia involve a systematic approach to ensure accuracy, transparency, and accountability in compiling and reporting GHG emissions data, which will be overseen by the National Council for Sustainable Development (NCSD) and the General Secretariat for Sustainable Development. This process integrates key officials from relevant government ministries and agencies to ensure comprehensive and accurate inventory management.

Inter-ministerial coordination is paramount, with high-level representatives, including Secretaries and Under-Secretaries of State, participating. The NCSD, led by the Minister of Environment, provides overarching guidance and supervision, aligning inventory compilation with national policies and international standards, including commitments under the UNFCCC. Within the General Secretariat for Sustainable Development, the Climate Change Technical Working Group (CCTWG) plays a crucial role. This group, comprised of technical focal points from various ministries, conducts thorough reviews of inventory data. Their assessments ensure accuracy, completeness, consistency, and compliance with established frameworks such as the Cambodian Climate Change Strategic Plan (CCCSP) and sectoral action plans.

B. Analysis of key categories

In Cambodia's efforts to mitigate climate change and accurately assess its GHG missions, the identification of key categories plays a pivotal role. Key categories, as defined by the 2006 IPCC Guidelines, are those significantly influencing the country's total GHG inventory in terms of absolute emissions level, emission trends, or uncertainties. Key categories receive special attention in three crucial aspects of GHG inventories. Firstly, they aid in prioritizing limited resources for inventory preparation, ensuring efficient allocation of efforts. Secondly, key categories often necessitate the application of more detailed higher-tier methods for accurate estimation. Lastly, additional focus on key categories is essential for maintaining quality assurance and control throughout the inventory process.

Cambodia utilized the 2006 IPCC approach 1 to identify key categories. This approach focuses on assessing the current level (amount) and the trend (change over time) of GHG emissions within specific categories. This refers to the sectors or sources of GHG emissions that are identified as significant contributors to the total emissions inventory. This assessment implies that the identified key categories collectively account for approximately 95% of the total greenhouse gas emissions in the inventory. This threshold helps in prioritizing efforts and resources towards understanding, managing, and mitigating emissions from the most impactful sources. As a result of this comprehensive analysis, Cambodia identified key categories that served as a guide for GHG mitigation strategies. A summary of key categories identified for Cambodia is provided in the Table I.2.

Table I. 2: Summary of key categories identified - Trend assessment (with FOLU)

IPCC Category Code	IPCC Category	Greenhouse Gas	Trend Assessment (Txt)	Contribution to Trend	Cumulative Total of Column G
3.B.6	Other Land	CO2	0.98	53%	**53%**
3.C.7	Rice cultivation	CH4	0.47	26%	**79%**
3.B.1	Forest land	CO2	0.13	7%	**86%**
1.A.3	Transport liquid fuels	CO2	0.11	6%	**92%**
1.A.4	Other Sectors liquid fuels	CO2	0.05	3%	**94%**
3.A.1	Enteric Fermentation	CH4	0.03	2%	**96%**
4.A	Solid Waste Disposal	CH4	0.03	1%	**97%**
3.A.2	Manure Management	CH4	0.02	1%	**98%**
1.A.4	Other Sectors biomass solid	CO2	0.01	0%	**99%**
3.A.2	Manure Management	N2O	0.01	0%	**99%**
3.C.3	Urea application	CO2	0.00	0%	**99%**
1.A.1	Energy Industries liquid fuels	CO2	0.00	0%	**100%**
4.D	Wastewater Treatment and Discharge	N2O	0.00	0%	**100%**
1.A.2	Manufacturing Industries and Construction biomass solid	CO2	0.00	0%	**100%**
1.A.3	Transport liquid fuels	N2O	0.00	0%	**100%**

Table I. 3: Summary of key categories identified - Level assessment (without FOLU)

IPCC Category Code	IPCC Category	Greenhouse Gas	Latest Year Estimate Ext [in CO2-eq]	Absolute Value of Latest Year Estimate [Ext]	Level Assessment [Ext]	Cumulative Total of Column
3.C.7	Rice cultivation	CH4	27,825,727	27,825,727	38%	**38%**
1.A.3	Transport liquid fuels	CO2	7,168,842	7,168,842	10%	**48%**
3.A.1	Enteric Fermentation	CH4	6,404,450	6,404,450	9%	**57%**

1.A.2	Manufacturing Industries and Construction biomass solid	CO2	5,101,713	5,101,713	7%	**64%**
1.A.4	Other Sectors biomass solid	CO2	4,149,261	4,149,261	6%	**70%**
2.A	Mineral Industry	CO2	3,953,520	3,953,520	5%	**75%**
1.A.1	Energy Industries solid fuels	CO2	3,223,250	3,223,250	4%	**80%**
3.C.4	Direct N2O Emissions from managed soils	N2O	2,667,054	2,667,054	4%	**83%**
1.A.4	Other Sectors liquid fuels	CO2	2,236,230	2,236,230	3%	**86%**
3.A.2	Manure Management	CH4	1,760,144	1,760,144	2%	**89%**
4.A	Solid Waste Disposal	CH4	1,727,988	1,727,988	2%	**91%**
3.C.5	Indirect N2O Emissions from managed soils	N2O	1,209,112	1,209,112	2%	**93%**
3.A.2	Manure Management	N2O	1,061,557	1,061,557	1%	**94%**
1.A.2	Manufacturing Industries and Construction liquid fuels	CO2	974,578	974,578	1%	**96%**

C. Quality assurance system (QC/QA)

Quality Assurance is a planned system of review procedures normally performed by personnel not directly involved in the inventory compilation/development process. Quality Control (QC) is a System of routine technical activities to assess and maintain the quality of the inventory, which is generally performed by personnel compiling the inventory. As mentioned in the BTR1 of Cambodia, they implement QC and Quality Assurance (QA) procedures when preparing greenhouse gas inventories by following the procedures defined in IPCC guidelines. For example, for the 2019 edition of the GHG emission inventory, Cambodia developed two types of quality control procedures, including general QC procedures and category-specific QC procedures, as proposed by the 2006 IPCC Guidelines. **Figure I.3** illustrates the QA/QC process that followed to develop the inventory.

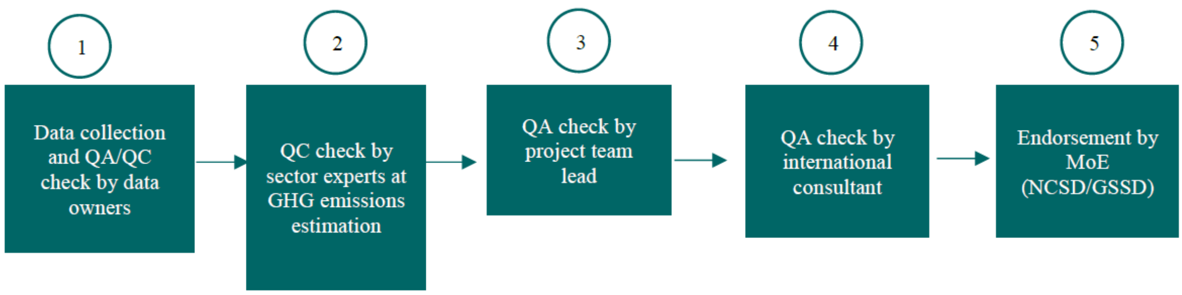

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Figure I. 3: QA/QC process followed to develop the inventory

Defining the roles and QA/QC responsibilities of each personnel responsible for QA/QC is crucial. The sector experts are charged with ensuring that adequate QC procedures are performed for the inventory, its supporting documents, calculation spreadsheets, and the IPCC GHG inventory software usage.

Cambodia's QA/QC plan should be developed with input from relevant stakeholders and experts. It should clearly designate the inventory agency responsible for implementing QA/QC measures, ensuring accountability and transparency. Despite capacity limitations, Cambodia should strive to incorporate key elements of the QA/QC plan outlined in IPCC guidelines, adapting them to suit its context.

Implementation of General Inventory QC Procedures: Cambodia must implement general QC procedures in line with its QA/QC plan and IPCC guidelines. These procedures encompass data validation, verification, and consistency checks to identify and rectify errors or inconsistencies. Despite capacity challenges, Cambodia should prioritize the implementation of these procedures to maintain the integrity of its inventory data.

Category-Specific QC Procedures: Cambodia's current inventory system primarily relies on general QC procedures, as outlined in the 2006 IPCC Guidelines. However, the application of category-specific QC procedures remains limited due to resource and technical capacity constraints (BUR, 2020).

QA Procedures and Expert Peer Review: Cambodia should conduct QA procedures, including a basic expert peer review of its inventories, as prescribed by IPCC guidelines. Peer reviews provide an additional layer of validation and ensure conformity to established methodologies and standards. Comparisons of national estimates with reference approaches serve as benchmarks for evaluating data accuracy and consistency.

Table I. 4: Roles and responsibilities of key stakeholders involved in the QA/ QC process

Role	QA/QC Responsibility
National Inventory Coordinator	All aspects of the inventory program, cross-cutting QA/QC
QA/QC Coordinator	Develop and implement the overall QA/QC plan.
Sector or Category Lead(s)	Develop and implement general, sector-specific (as appropriate), and/or category-specific (as appropriate) QA/QC procedures listed in Tables 4-2 and 4-3 below. Focus on Key Categories
Outside Expert(s)	Expert review of the inventory. Ensure the role of the expert is carefully defined and agreed upon. The expert can be within the country or an international expert.

D. Uncertainty analysis

The general uncertainty assessment within Cambodia's GHG inventory is critical in evaluating the reliability and robustness of the compiled emissions data. Drawing upon the extensive methodology outlined in the inventory process, the uncertainty assessment encompasses various data sources, estimation techniques, and sector-specific factors to provide a comprehensive understanding of the uncertainties inherent in the inventory.

Given the recent implementation of enhanced inventory protocols and structural adjustments within the national inventory system, the responsibility for gathering both inventory data and assessing associated uncertainties in Cambodia now rests with designated data providers. However, owing to the nascent nature of these reforms and ongoing organizational transitions, a comprehensive estimation of data uncertainties for the presented inventories has not yet been realized. As part of Cambodia's Inventory Improvement Plan, there are concerted efforts to refine uncertainty analysis methodologies. Initially, this will involve integrating qualitative assessments with plans to gradually incorporate additional data provided by relevant stakeholders. The uncertainty assessment is begun with thoroughly examining data sources to be utilized across all inventory sectors, including energy consumption, industrial processes, waste and AFOLU. Data collection procedures was adhered to internationally recognized standards and guidelines, ensuring the reliability and consistency of the sector-specific estimation methodologies, such as tier 1 and tier 2 approaches outlined in the 2006 IPCC guidelines, was scrutinized to identify inherent uncertainty sources in each method. The application of default emission factors, assumptions regarding activity data, and the extrapolation of data to national scales will be among the methodological aspects subject to uncertainty evaluation.

Uncertainty quantification involves assigning uncertainty ranges or confidence intervals to key parameters and emission estimates within each sector. Parameters subject to uncertainty will include emission factors, activity data, conversion factors, and assumptions regarding technology deployment and mitigation measures. Within the energy sector, uncertainties may stem from variations in fuel consumption data, inaccuracies in emission factors, and the reliability of energy balance calculations provided by the Ministry of Mines and Energy. IPPU sector uncertainties may arise from the reliance on tier 1 approaches for certain emission sources and the extrapolation of data from limited sources, such as cement production and lubricant consumption. Uncertainties in the AFOLU sector may be multifaceted, encompassing factors such as data accuracy of land use change, emissions from agricultural practices, and the effectiveness of mitigation measures. Uncertainties for the waste sector can be raised from relying on the tier 1 approach and, relying on population and GDP data mainly for solid waste disposal and domestic wastewater treatment and discharge. The culmination of uncertainty assessments across all sectors will result in an overall estimation of uncertainty for the entire GHG inventory. Tables 1-6 and 1-7 illustrate the results of the uncertainty analysis.

Table I. 5: Summarized reporting for uncertainty (With FOLU)

Year	2016	2017	2018
Total Base Year Emissions (1994) - $GgCO_2e$	46,100	46,100	46,100
Total Emissions for the Year T - $GgCO_2e$	85,471	88,792	91,236
Uncertainty in total inventory (%)	49	47	47
Trend Uncertainty (%)	90	94	98

The estimated uncertainty levels for the FOLU sector indicate a higher value for the trend assessment. This is primarily due to the high uncertainty in the base year, 1994, which stems from significant variations in input data or assumptions over the years. Notably, the FOLU sector in 1994 recorded a higher level of GHG removals in the subcategory "Other Land Converted to Forest Land" compared to subsequent years, contributing to the increased uncertainty in the trend assessment. Consequently, the estimated uncertainty level for the trend assessment is lower when the FOLU sector is excluded.

Table I. 6: Summarized reporting for uncertainty, from 2016 to 2022 (Without FOLU)

Year	2016	2017	2018	2019	2020	2021	2022
Total Base Year Emissions (1994) - $GgCO_2e$	22,780	22,780	22,780	22,780	22,780	22,780	22,780
Total Emissions for the Year T - $GgCO_2e$	57,953	61,273	63,717	66,993	68,793	71,898	73,677
Uncertainty in total inventory (%)	**51**	**48**	**48**	**45**	**45**	**45**	**42**
Trend Uncertainty (%)	**72**	**69**	**72**	**69**	**71**	**74**	**67**

E. General evaluation of completeness

Within each source category, the completeness assessment of the inventory was conducted following the IPCC guidelines. The current GHG inventory comprehensively covers all significant emission sources and sinks across the key sectors: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Waste, and Forests and Other Land Use (FOLU). The following notation keys are used in the assessment.

NE	**Not Estimated**
IE	Included Elsewhere
C	Confidential Information
NA	Not Applicable
NO	Not Occurring
FX	Flexibility

The results of the assessment are presented in Tables I.7 to 12.

Table I. 7: Short summary for inventory year 2016

Categories	Emissions (Gg)			Emissions CO_2e(Gg)				Emissions Gg				
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factor	Other halogenated gases without CO_2 equivalent conversion factor	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	**37,805**	**1,248**	**15**	**330**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**
1 - Energy	**8,601**	**12**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
1.A - Fuel combustion activities	8,601	12	1	NA	NA	NA	NA	NA	NO, NE	NO, NE	NO, NE	NO, NE
1.B - Fugitive emissions from fuels	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use	**1,528**	**NO, NA**	**NO, NA**	**330**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2.A - Mineral Industry	1,499	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-energy Products from Fuels and Solvent Use	29	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.E - Electronics Industry	NA	NA	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.F - Products Uses as Substitutes for ozone Depleting Substances	NA	NA	NA	328	NO	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.H - Other	NO	NO	NO, NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	**27,611**	**1,180**	**13**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NA**
3.A - Livestock	NA	244	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B - Land	27,518	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO2 emissions sources on land	93	936	10	NA	NA	NA	NA	NA	NA	NA	NA	NO, NA
3.D - Other	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	**65**	**56**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NA**
4. A - Solid Waste Disposal	NA	31	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
4. B - Biological Treatment of Solid Waste	NA	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.C - Incineration and Open Burning of Waste	65	9	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.D - Wastewater Treatment and Discharge	NA			NA	NA	NA	NA	NA	NO	NO	NO	NA
4.E - Other	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5 - Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NO**

5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA	NE	NA	NA	NA	NA	NA	NO	NO	NO	NO
5B - Indirect CO2 emissions from the atmospheric oxidation of CH4, CO and NMVOC	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
5.C - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items												
International Bunkers	231	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Aviation (International Bunkers)	231	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Water-borne Transport (International Bunkers)	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
Multilateral Operations	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Table I. 8: Short summary for inventory year 2017

Categories	Emissions (Gg)			Emissions CO_2e(Gg)				Emissions Gg				
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factor	Other halogenated gases without CO_2 equivalent conversion factor	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	**39,360**	**1,258**	**16**	**328**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**
1 - Energy	**9,993**	**12**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
1.A - Fuel combustion activities	9,993	12	1	NA	NA	NA	NA	NA	NO, NE	NO, NE	NO, NE	NO, NE
1.B - Fugitive emissions from fuels	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use	**1,691**	**NO, NA**	**NO, NA**	**328**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2.A - Mineral Industry	1,682	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-energy Products from Fuels and Solvent Use	8	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.E - Electronics Industry	NA	NA	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.F - Products Uses as Substitutes for ozone Depleting Substances	NA	NA	NA	328	NO	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.H - Other	NO	NO	NO, NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	**27,611**	**1,186**	**14**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NA**
3.A - Livestock	NA	248	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B - Land	27,518	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO2 emissions sources on land	93	937	10	NA	NA	NA	NA	NA	NA	NA	NA	NO, NA
3.D - Other	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	**65**	**60**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NA**
4. A - Solid Waste Disposal	NA	35	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA

4. B - Biological Treatment of Solid Waste	NA	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.C - Incineration and Open Burning of Waste	65	9	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.D - Wastewater Treatment and Discharge	NA	16	1	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.E - Other	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5 - Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NO**
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA	NE	NA	NA	NA	NA	NA	NO	NO	NO	NO
5B - Indirect CO2 emissions from the atmospheric oxidation of CH4, CO and NMVOC	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
5.C - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items												
International Bunkers	532	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Aviation (International Bunkers)	334	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Water-borne Transport (International Bunkers)	199	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
Multilateral Operations	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Table I. 9: Short summary for the inventory year 2018

Categories	Emissions (Gg)			Emissions CO_2e(Gg)				Emissions Gg				
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factor	Other halogenated gases without CO_2 equivalent conversion factor	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	**40,380**	**1,294**	**17**	**305**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**
1 - Energy	**10,804**	**13**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
1.A - Fuel combustion activities	10,804	13	1	NA	NA	NA	NA	NA	NO, NE	NO, NE	NO, NE	NO, NE
1.B - Fugitive emissions from fuels	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use	**1,874**	**NA, NO**	**NO, NA**	**305**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2.A - Mineral Industry	1,865	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-energy Products from Fuels and Solvent Use	8	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.E - Electronics Industry	NA	NA	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.F - Products Uses as Substitutes for ozone Depleting Substances	NA	NA	NA	305	NO	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.H - Other	NO	NO	NO, NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	**27,638**	**1,216**	**15**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NA**
3.A - Livestock	NA	243	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B - Land	27,518	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO2 emissions sources on land	119	974	11	NA	NA	NA	NA	NA	NA	NA	NA	NO, NA
3.D - Other	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	**65**	**66**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NA**
4. A - Solid Waste Disposal	NA	40	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
4. B - Biological Treatment of Solid Waste	NA	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.C - Incineration and Open Burning of Waste	65	9	0	NA	NA	NA	NA	NA	NO	NO	NO	NA

4.D - Wastewater Treatment and Discharge	NA	16	1	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.E - Other	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5 - Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NO**
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NOx and NH_3	NA	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
5B - Indirect CO_2 emissions from the atmospheric oxidation of CH_4, CO and NMVOC	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
5.C - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items												
International Bunkers	645	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Aviation (International Bunkers)	440	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Water-borne Transport (International Bunkers)	205	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
Multilateral Operations	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Table I. 10: Short summary for inventory year 2019

Categories	Emissions (Gg)			Emissions CO_2e(Gg)				Emissions Gg				
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factor	Other halogenated gases without CO_2 equivalent conversion factor	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	**15,863**	**1,286**	**16**	**286**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**
1 - Energy	**13,614**	**12**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
1.A - Fuel combustion activities	13,614	12	1	NA	NA	NA	NA	NA	NO, NE	NO, NE	NO, NE	NO, NE
1.B - Fugitive emissions from fuels	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use	**2,057**	**NO, NA**	**NO, NA**	**286**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2.A - Mineral Industry	2,048	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-energy Products from Fuels and Solvent Use	8	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.E - Electronics Industry	NA	NA	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.F - Products Uses as Substitutes for ozone Depleting Substances	NA	NA	NA	286	NO	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.H - Other	NO	NO	NO, NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	**126**	**1,202**	**15**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NA**
3.A - Livestock	NA	231	3	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B - Land	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO2 emissions sources on land	126	971	11	NA	NA	NA	NA	NA	NA	NA	NA	NO, NA
3.D - Other				NA	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	**65**	**72**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NA**
4. A - Solid Waste Disposal	NA	46	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
4. B - Biological Treatment of Solid Waste	NA	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.C - Incineration and Open Burning of Waste	65	9	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.D - Wastewater Treatment and Discharge	NA	17	1	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.E - Other	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA

5 - Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NO**
5.A - Indirect N_2O emissions from the atmospheric deposition of nitrogen in NOx and NH_3	NA	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
5B - Indirect CO_2 emissions from the atmospheric oxidation of CH4, CO and NMVOC	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
5.C - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items												
International Bunkers	1,034	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Aviation (International Bunkers)	491	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Water-borne Transport (International Bunkers)	543	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
Multilateral Operations	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Table I. 11: Short summary for inventory year 2020

Categories	Emissions (Gg)			Emissions CO_2e(Gg)				Emissions Gg				
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factor	Other halogenated gases without CO_2 equivalent conversion factor	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	**18,106**	**1,322**	**16**	**274**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**
1 - Energy	**14,008**	**10**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
1.A - Fuel combustion activities	14,008	10	1	NA	NA	NA	NA	NA	NO, NE	NO, NE	NO, NE	NO, NE
1.B - Fugitive emissions from fuels	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use	**3,913**	**NO, NA**	**NO, NA**	**274**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2.A - Mineral Industry	3,904	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-energy Products from Fuels and Solvent Use	9	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.E - Electronics Industry	NA	NA	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.F - Products Uses as Substitutes for ozone Depleting Substances	NA	NA	NA	274	NO	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.H - Other	NO	NO	NO, NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	**120**	**1,233**	**15**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NA**
3.A - Livestock	NA	237	3	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B - Land	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO2 emissions sources on land	139	996	11	NA	NA	NA	NA	NA	NA	NA	NA	NO, NA
3.D - Other	NO	NO	NO	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	**66**	**79**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NA**
4. A - Solid Waste Disposal	NA	53	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
4. B - Biological Treatment of Solid Waste	NA	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.C - Incineration and Open Burning of Waste	66	9	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.D - Wastewater Treatment and Discharge	NA	17	1	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.E - Other	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5 - Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NO**

5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
5B - Indirect CO2 emissions from the atmospheric oxidation of CH4, CO and NMVOC	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
5.C - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items												
International Bunkers	396	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Aviation (International Bunkers)	179	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Water-borne Transport (International Bunkers)	217	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
Multilateral Operations	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Table I. 12: Short summary for the inventory year 2021

Categories	Emissions (Gg)			Emissions CO_2e(Gg)				Emissions Gg				
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factor	Other halogenated gases without CO_2 equivalent conversion factor	Nox	CO	NMVOCs	SO_2
Total National Emissions and Removals	**18,066**	**1,389**	**18**	**259**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**
1 - Energy	**13,442**	**11**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
1.A - Fuel combustion activities	13,442	11	1	NA	NA	NA	NA	NA	NO, NE	NO, NE	NO, NE	NO, NE
1.B - Fugitive emissions from fuels	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use	**4,406**	**NO, NA**	**NO, NA**	**259**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2.A - Mineral Industry	4,398	NA	NE	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-energy Products from Fuels and Solvent Use	8	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.E - Electronics Industry	NA	NA	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.F - Products Uses as Substitutes for ozone Depleting Substances	NA	NA	NA	259	NO	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.H - Other	NO	NO	NO, NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	**152**	**1,294**	**16**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NA**
3.A - Livestock	NA	253	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B - Land	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO2 emissions sources on land	152	1,041	13	NA	NA	NA	NA	NA	NA	NA	NA	NO, NA
3.D - Other				NA	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	**66**	**84**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NA**
4. A - Solid Waste Disposal	NA	58	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
4. B - Biological Treatment of Solid Waste	NA	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.C - Incineration and Open Burning of Waste	66	10	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.D - Wastewater Treatment and Discharge	NA	17	1	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.E - Other	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA

5 - Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NO**
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
5B - Indirect CO2 emissions from the atmospheric oxidation of CH4, CO and NMVOC	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
5.C - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items												
International Bunkers	306	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Aviation (International Bunkers)	205	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Water-borne Transport (International Bunkers)	101	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
Multilateral Operations	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

Table I. 13: Short summary for the inventory year 2022

Categories	Emissions (Gg)			Emissions CO_2e(Gg)				Emissions Gg				
	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factor	Other halogenated gases without CO_2 equivalent conversion factor	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	**18,543**	**1,388**	**21**	**248**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**	**NA, NO, NE**
1 - Energy	**14,312**	**13**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NE**	**NO, NE**	**NO, NE**	**NO, NE**
1.A - Fuel combustion activities	14,312	13	1	NA	NA	NA	NA	NA	NO, NE	NO, NE	NO, NE	NO, NE
1.B - Fugitive emissions from fuels	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
1.C - Carbon dioxide Transport and Storage	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
2 - Industrial Processes and Product Use	**3,962**	**NO, NA**	**NO, NA**	**248**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2.A - Mineral Industry	3,954	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.D - Non-energy Products from Fuels and Solvent Use	1	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
2.E - Electronics Industry	NA	NA	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.F - Products Uses as Substitutes for ozone Depleting Substances	NA	NA	NA	248	NO	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA	NA	NA
2.H - Other	NE	NE	NO, NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
3 - Agriculture, Forestry, and Other Land Use	**202**	**1,287**	**20**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO, NA**
3.A - Livestock	NA	292	4	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.B - Land	NE	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate sources and non-CO2 emissions sources on land	202	995	16	NA	NA	NA	NA	NA	NA	NA	NA	NO, NA
3.D - Other				NA	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	**66**	**88**	**1**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NA**
4. A - Solid Waste Disposal	NA	62	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
4. B - Biological Treatment of Solid Waste	NA	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.C - Incineration and Open Burning of Waste	66	10	0	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.D - Wastewater Treatment and Discharge	NA	17	1	NA	NA	NA	NA	NA	NO	NO	NO	NA
4.E - Other	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA

5 - Other	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NO**	**NO**	**NO**	**NO**
5.A - Indirect N2O emissions from the atmospheric deposition of nitrogen in NOx and NH3	NA	NA	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO
5B - Indirect CO2 emissions from the atmospheric oxidation of CH4, CO and NMVOC	NO	NA	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
5.C - Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items												
International Bunkers	572	0	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Aviation (International Bunkers)	343	-	0	NA	NA	NA	NA	NA	NO	NO	NO	NO
International Water-borne Transport (International Bunkers)	229	0	-	NA	NA	NA	NA	NA	NO	NO	NO	NO
Multilateral Operations	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NO

F. Metric

The inventory has been calculated using methodologies outlined in the 2006 IPCC Guidelines. Global warming potentials (GWPs) are based on the values from the IPCC Fifth Assessment Report (AR5), based on the effects of GHGs over a 100-year time horizon.

G. Flexibility

In paragraph 57 of the MPGs, the provision on annual time series years refers to the requirement that Parties shall report a consistent annual time series of greenhouse gas (GHG) inventories starting from 1990. The flexibility provision for developing country Parties, based on their capacities, allows them to report data covering, at a minimum, the reference year or period for their Nationally Determined Contribution (NDC) under Article 4 of the Paris Agreement. Additionally, they may report a consistent annual time series from at least 2020 onward. Following the flexibility provided for developing countries regarding time series reporting, the GHG assessment does not include data starting from 1990. Instead, the time series begins from 1994, which is the earliest available data. The assessment covers the NDC reference year of 2016 and extends to include the year 2022, ensuring a consistent annual time series from 1994 onward. This approach aligns with the guidance to cover the reference year/period and to report data consistently from at least 2020 onward. Paragraph 48 of the MPGs outlines the requirements for reporting greenhouse gases as per the provision and flexibility applied for developing country parties under the Enhanced Transparency Framework. According to the provision, it is required to report on seven gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6), and nitrogen trifluoride (NF_3). In contrast, developing countries have the flexibility to report at least three gases—CO_2, CH_4, and N_2O—and may also report on any of the additional four gases (HFCs, PFCs, SF_6, and NF_3) if they are included in the Party's Nationally Determined Contribution (NDC) under Article 4 of the Paris Agreement, are covered by an activity under Article 6 of the Paris Agreement, or have been previously reported by the Party. Following the flexibility provision under the Paris Agreement, as a developing country Party, for this submission, emissions for CO_2, CH_4, N_2O, and HFCs have been calculated and reported.

Given the application of the flexibility provisions, there is no consistent record of activity data from 1990. The available records begin from 1994, and therefore the time series is considered starting from that year. The unavailability of consistent activity data from 1990 is a result of capacity constraints faced by Cambodia, as the necessary resources, technical infrastructure, and institutional systems were not in place during that period to collect and maintain comprehensive records. As a result, the emissions time series begins from 1994, when data collection became more feasible. Furthermore, emissions from PFCs, SF_6, and NF_3 are not reported for Cambodia, as these emission sources are not present in the country. Consequently, these gases were not included in the emissions inventory.

H. Archiving System

The archiving system encompasses the country's procedures and arrangements to gather and store data for compiling national GHG inventories. A well-designed archive system ensures that relevant documentation is accessible to authorized parties, enhances the efficiency of inventory compilation, and guards against the loss of valuable information records and institutional knowledge.

The GHG inventory calculation of Cambodia has been currently archived and USEPA templates were used for documentation. Upon analyzing the assessment outcomes, adjustments will be made to the Cambodian archive system to enhance efficiency and uphold the credibility of the BTR archiving process.

To initiate the improvement of the archiving system for the BTR assessment, the following key personnel will be assigned the responsibility of overseeing the overall maintenance of the archiving system for the BTR.

Table I. 14: Summary table for the inventory year 2022

Role	Responsibilities
Archiving Coordinator[1]	Develop and oversee the implementation of the Archiving System Plan.
National Inventory Coordinator (NIC)	General archiving archive documentation of the national GHG inventory management system
Inventory Compilers: Sector/Category Leads, Consultants	Archive category-specific records/files based on the Archiving System Plan

4.1. National inventory assessment of Cambodian BTR1

Archiving documents is crucial throughout every GHG inventory compilation cycle stage, but it holds particular significance after the cycle. In the Cambodian BTR assessment, most records will be stored digitally, while some physical copies will also be retained with assigned tracking numbers. Each reference, compilation file, and feedback from peer reviews will be saved to cloud storage, and most hard copies will be duplicated onto CDs or USB drives.

1 1 Archiving Coordinator is not typically a full-time role.

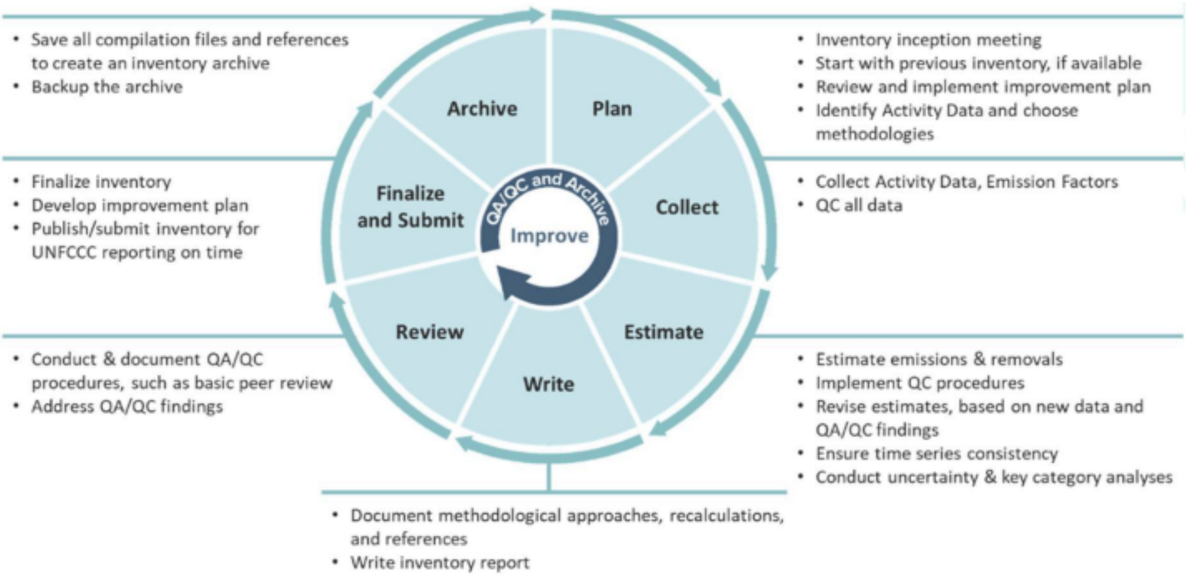


Figure I. 4: Archiving in the National Inventory Compilation Cycle (EPA, 2022))

The following developed template, modeled after the EPA guidelines, will be utilized to identify each important material that requires archiving within the BTR GHG inventory system. According to the template, the staff responsible for providing the necessary materials to be archived will be designated, and specific points in time at which the materials should be obtained will be determined.

Table I. 15: Materials to be archived under Cambodian BTR assessment

Materials to be archived	Point in time at which the materials should be obtained
Institutional Arrangements	At the beginning of the inventory compilation cycle
Inventory compilation plan	At the end of the inventory compilation cycle
Methods and Data Documentation	At the beginning and the end of the inventory compilation cycle
Any files used for calculations. (e.g., spreadsheets or models)	At the end of the inventory compilation cycle
QA/QC Procedures	At the end of the inventory compilation cycle
Results of quality control processes	At the end of the inventory compilation cycle
Drafts and final electronic versions of the inventory report	Intermediate, draft final, and final versions
Internal and external review comments and responses	At the end of the inventory compilation cycle
Archiving System Plan	At the end of the inventory compilation cycle
National Inventory Improvement Plan	At the end of the inventory compilation cycle
Contacts and contact information for data sources	At the end of the inventory compilation cycle
Communication with data sources and the data obtained	At the end of the inventory compilation cycle
Decision-making documents related to the compilation process (e.g., minutes of	Whenever communication takes place

meetings of the GHG inventory compilers, email communication, minutes of phone communication)	

In order to ensure ease of reference for GHG inventory-related documents, it is crucial to adhere to proper file management procedures during the archiving process of the CMB BTR assessment. Therefore, Cambodia will implement consistent naming conventions and organization procedures to facilitate efficient document retrieval and management. The country's archiving coordinator also ensures that all involved parties archive materials according to the inventory year, facilitating easy access to information.

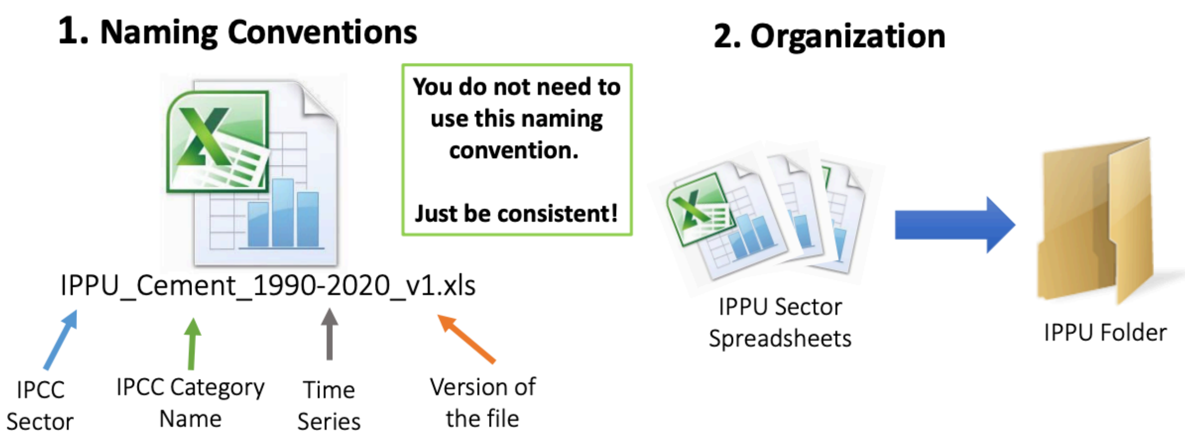


Figure I. 5: File management procedures (EPA, 2022)

During the archiving process, the Cambodian archive coordinator will adhere to a checklist to guarantee the correct implementation of the archiving procedure.

I. Trends in emissions and removals

5. Trends in aggregate emissions and removals

This section analyzes the trends in aggregate greenhouse gas emissions and removals in Cambodia from 1994 to 2022. The analysis includes total GHG emissions and removals across all sectors, with a focus on carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and Hydrofluorocarbons (HFCs) as well as net emissions, which represent the balance between total emissions and total removals. All GHG inventories from 1994 to 2022 have been developed in accordance with IPCC guidelines and UNFCCC methodologies to establish GHGI.

Table I. 16: GHG emissions in Cambodia from 1994 to 2022

Year	Total GHG emissions ($GgCO_2e$)	
	With FOLU	Without FOLU
1994	38,817	15,496
2000	40,698	17,378
2005	43,900	20,579
2010	134,770	25,132
2016	57,930	30,411
2017	38,291	40,748
2018	81,309	53,790
2019	56,564	56,564
2020	59,471	59,471
2021	62,033	62,033
2022	63,328	63,328

Figure I.6 presents the emission of the national inventory trend excluded FOLU.

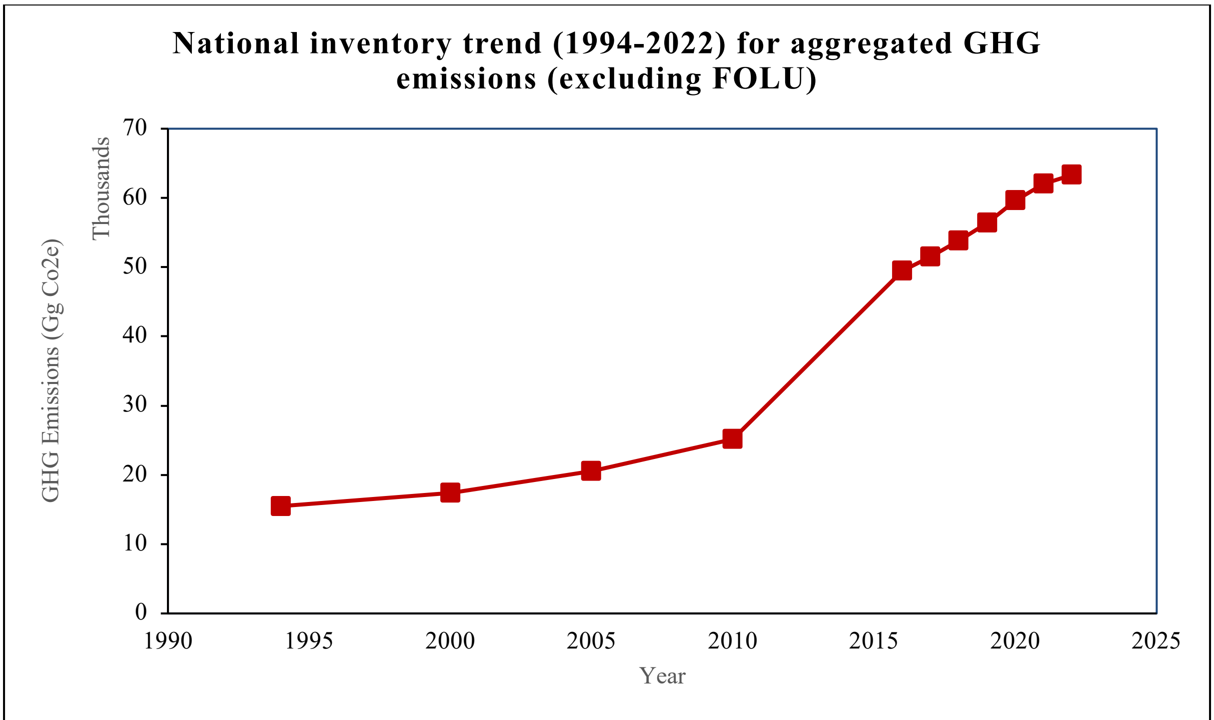


Figure I. 6: National inventory trend (1994-2022) for aggregated GHG emissions (Excluding FOLU)

On the other hand, emissions **with FOLU** fluctuate significantly, indicating that land use contributes both positively and negatively over time.

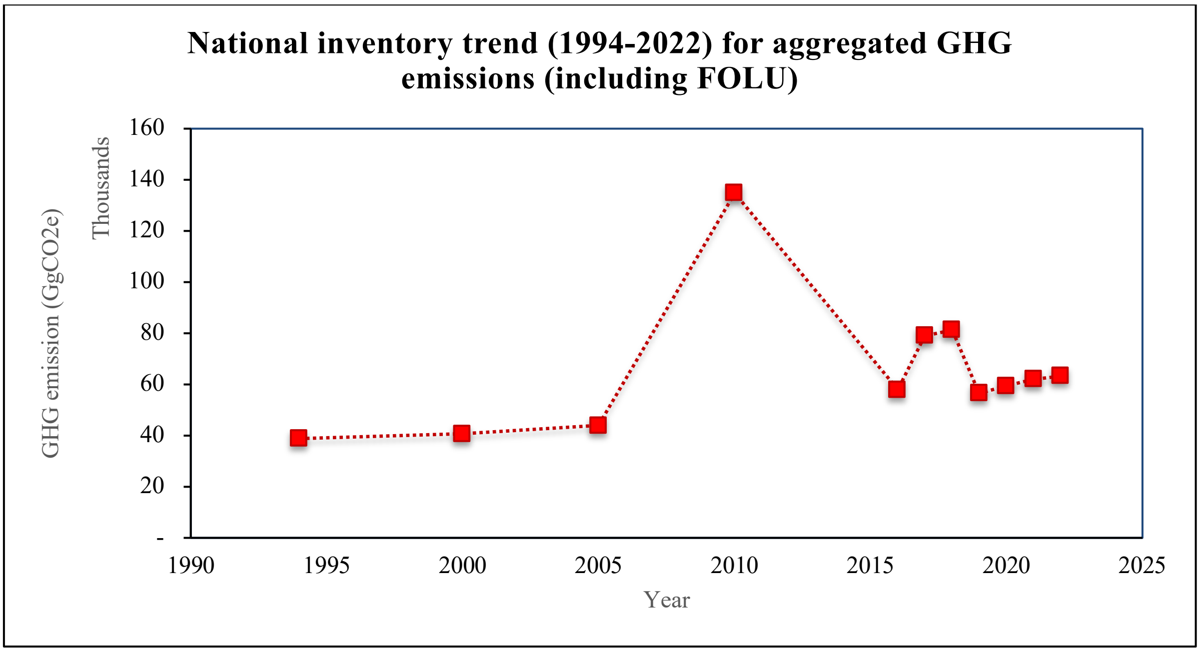


Figure I. 7: National inventory trend (1994-2022) for aggregated GHG emissions (including FOLU)

The following **Table I. 17** presents sectoral greenhouse gas emissions data from 1994 to 2022, broken down into five sectors: **Energy, Industrial Processes and Product Use (IPPU), Waste, Agriculture**, and **FOLU** (Forest and Other Land Use).

Table I. 17: Total sectoral GHG emissions ($GgCO_2e$)

Inventory year	Total sectoral GHG emissions ($GgCO_2e$)				
	Energy	IPPU	Waste	Agriculture	FOLU
1994	2,172	4	1,083	12,237	23,321
2000	2,526	6	1,285	13,560	23,321
2005	3,059	12	1,427	16,081	23,321
2010	5,405	515	1,484	17,729	109,638
2016	9,073	1,858	1,859	17,621	27,518
2017	10,492	2,019	1,985	37,018	27,518
2018	11,338	2,179	2,133	38,141	27,518
2019	14,131	2,343	2,320	37,770	NA
2020	14,470	4,187	2,523	38,291	NA
2021	13,943	4,665	2,677	40,748	NA
2022	14,875	4,210	2,797	41,446	NA

Between 1994 and 2022, GHG emissions have shown notable increases across all sectors except for FOLU, which has seen a sharp decline in its sequestration capacity. The **energy sector** shows a steady increase in emissions, from 2,172 $GgCO_2e$ in 1994 to 14,875 $GgCO_2e$ in 2022. This represents an increase of **585 %** over the 28-year period. The period between 2010 and 2022 marks the steepest rise in emissions. This signals a heavy reliance on fossil fuels. The **IPPU sector** experienced an extraordinary **110,489 %** rise, driven by significant industrial growth. The **waste sector** increased by **158%**, and **agriculture** by **239 %**, indicating growing emissions due to population growth and agricultural expansion. The **FOLU sector**, on the other hand, has reduced its carbon sequestration by **18%**, showing a decrease in forest cover and land-use changes over the years. The below graph provides a visual summary of Cambodia's sectoral greenhouse gas (GHG) emissions trends from 1994 to 2022.

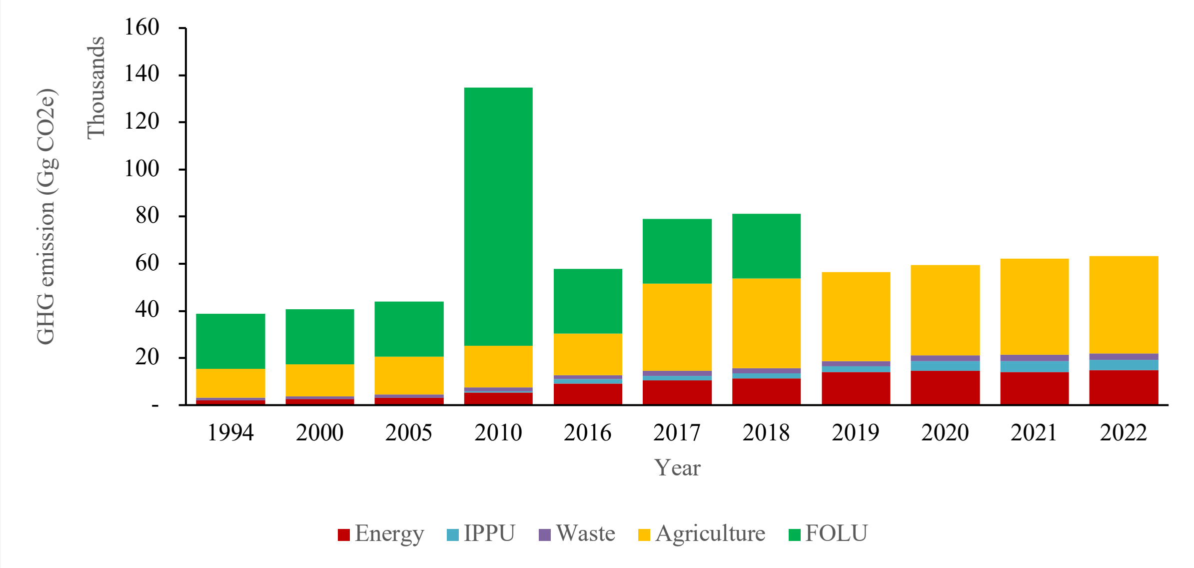


Figure I. 8: Trend in total emissions by sector from 1994 to 2022

In examining the following, it reveals critical trends in greenhouse gas emissions over nearly three decades, highlighting shifts in CO_2, CH_4, N_2O, and HFC emissions.

Table I. 18: Trend in total GHG emissions by gas type, 1994-2022

Total GHG emissions by gas type (Gg)				
Inventory year	CO_2	CH_4	N_2O	*HFC
1994	25,200	440	5	0
2000	25,610	492	5	0
2005	26,120	582	6	6
2010	115,155	641	6	104
2016	37,729	658	5	330
2017	39,360	1,258	16	328
2018	40,380	1,294	17	305
2019	15,862	1,290	16	286
2020	18,106	1,315	16	274
2021	18,066	1,389	18	259
2022	18,543	1,388	21	248

**HFCs are in $GgCO_2e$*

Between 1994 and 2022, greenhouse gas (GHG) emissions by gas type show significant trends. Carbon dioxide emissions peaked dramatically at 115,155 Gg in 2010, followed by a sharp decline, stabilizing around 18,000 Gg from 2019 onwards. Methane emissions rose steadily from 440 Gg in 1994 to 1,388 Gg in 2022, with a notable spike in 2017. Nitrous oxide emissions remained stable until 2016 but increased rapidly thereafter, reaching 21 Gg in 2022, likely due to intensified agricultural activities or fuel consumption activities. Hydrofluorocarbons showed a consistent rise until peaking at 330.00 Gg in 2016, followed by a gradual decline to 248 Gg in 2022.

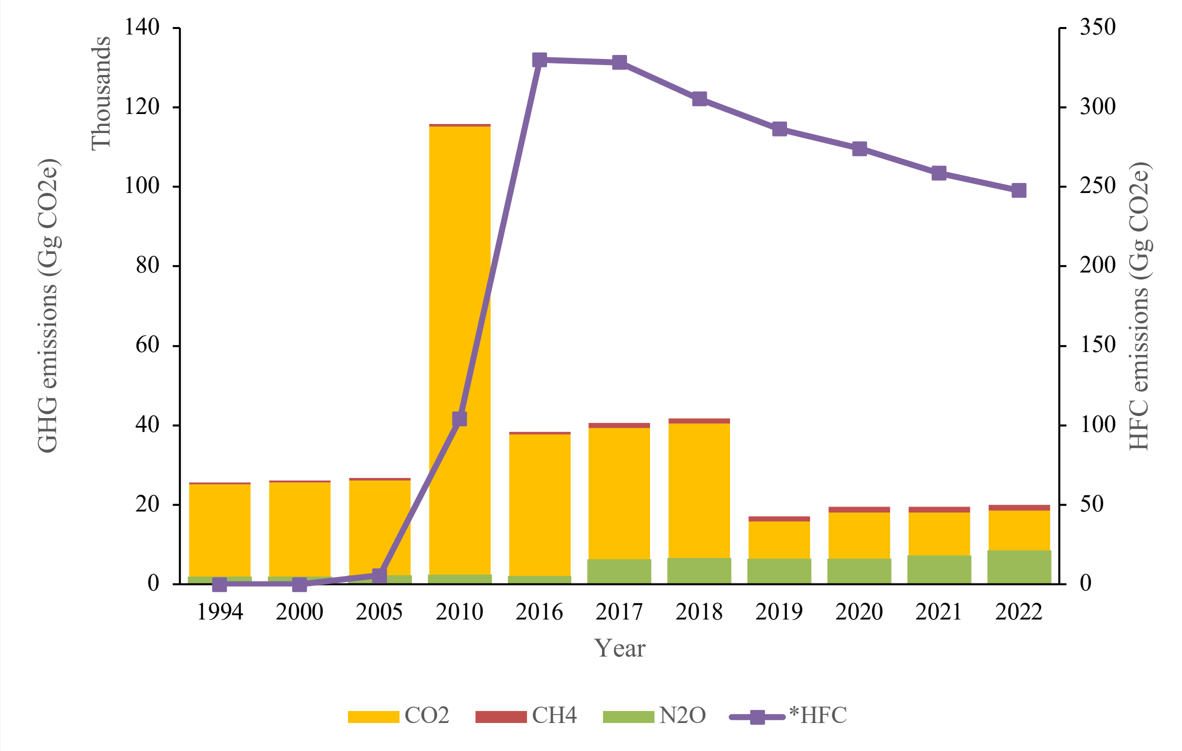


Figure I. 9: Trend in GHG emissions by gas type, 1994-2022

**HFCs are in $GgCO_2e$*

J. Trends by Sector and type of gas

6. Energy Sector

When analyzing emission trends in the energy sector, this GHG inventory includes emissions from 1994 to 2022, calculated based on the IPCC 2006 guidelines and AR5 GWP values. In Cambodia, the transportation and manufacturing industries & construction are the major GHG-emitting subsectors within the energy sector. Following these, the "Other" sectors, which include commercial, residential, agriculture, forestry, fishing, and fish farms, show the second-highest emissions. The energy industry itself ranks third in terms of GHG emissions.

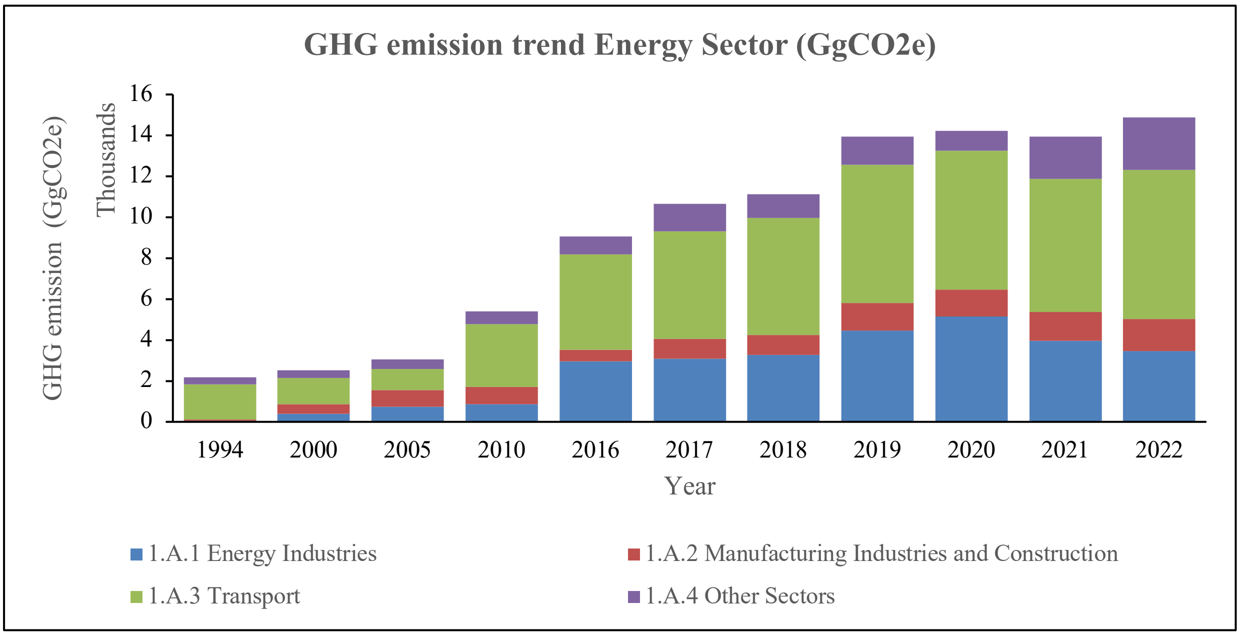


Figure I. 10: GHG emission trend Energy Sector

Further, the following **Table I.19** shows the emission trends in the categories within the Energy sector in Cambodia.

Table I. 19: Emissions in the Energy sector of Cambodia (1994-2022)

Year	GHG Emissions in (Gg)								
	CO_2	CH_4	N_2O	HFC	SF_6	NOX	CO	NMVO C	SO_2
1994	1,824	9	0	NO	NO	NO	NO	NO	NO
2000	2,225	8	0	NO	NO	NO	NO	NO	NO
2005	2,730	9	0	NO	NO	NO	NO	NO	NO
2010	5,016	10	0	NO	NO	NO	NO	NO	NO
2016	8,601	12	1	NO	NO	NO	NO	NO	NO
2017	9,993	12	1	NO	NO	NO	NO	NO	NO
2018	10,804	13	1	NO	NO	NO	NO	NO	NO
2019	13,614	12	1	NO	NO	NO	NO	NO	NO
2020	14,008	10	1	NO	NO	NO	NO	NO	NO
2021	13,442	11	1	NO	NO	NO	NO	NO	NO
2022	14,312	13	1	NO	NO	NO	NO	NO	NO

The emission results presented in the table above indicate that Cambodia's energy sector contributes to emissions of CO_2, CH_4, and N_2O exclusively. The trends and variations of these emissions are depicted in the graphs below.

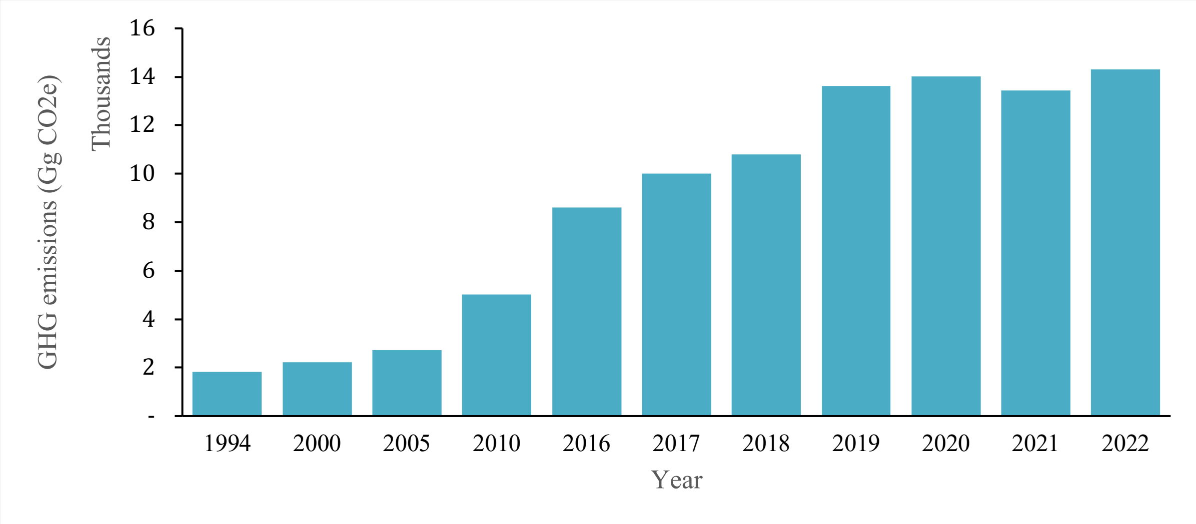


Figure I. 11: CO2 emission trend in the energy sector of Cambodia (1994-2022)

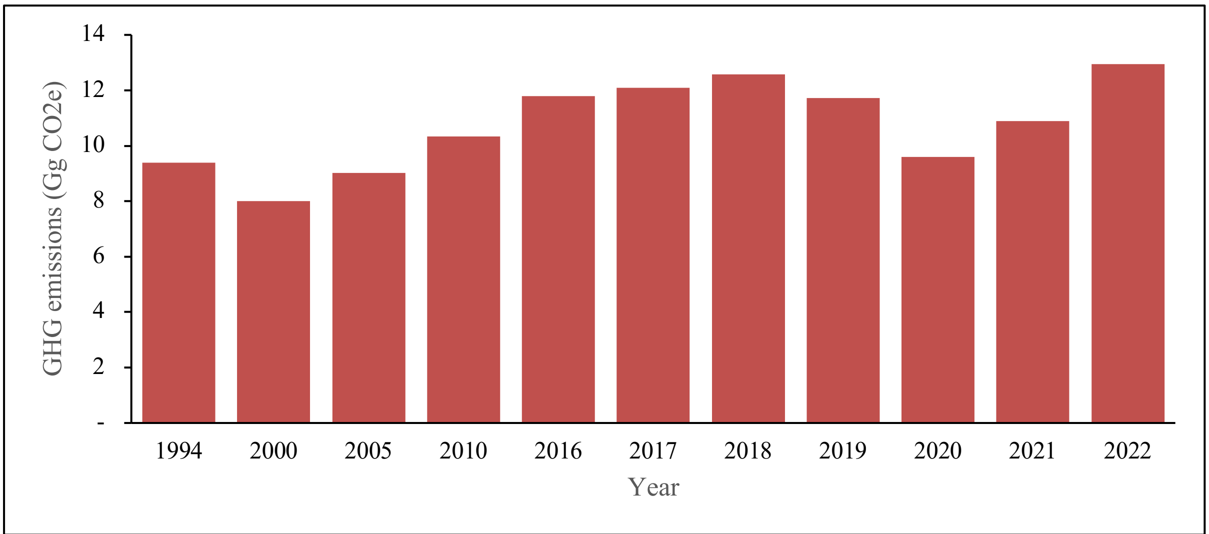


Figure I. 12: CH_4 emission trend in the energy sector of Cambodia (1994-2022)

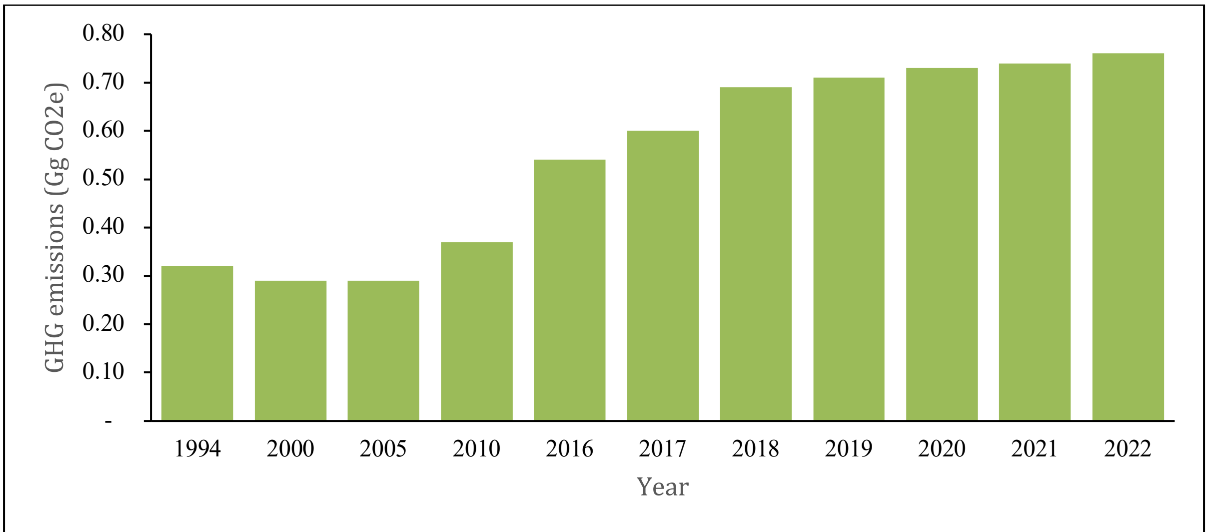


Figure I. 13: N2O emission trend in the energy sector of Cambodia (1994-2022)

7. IPPU Sector

In Cambodia, cement production is a major contributor to the total annual GHG emissions in the IPPU sector. Following cement production, refrigeration and air conditioning contribute to the next highest levels of emissions within the sector. In comparison, lubricant use contributes the least to GHG emissions in Cambodia. The following **Figure I.14** illustrates the total annual emissions in the IPPU sector of Cambodia.

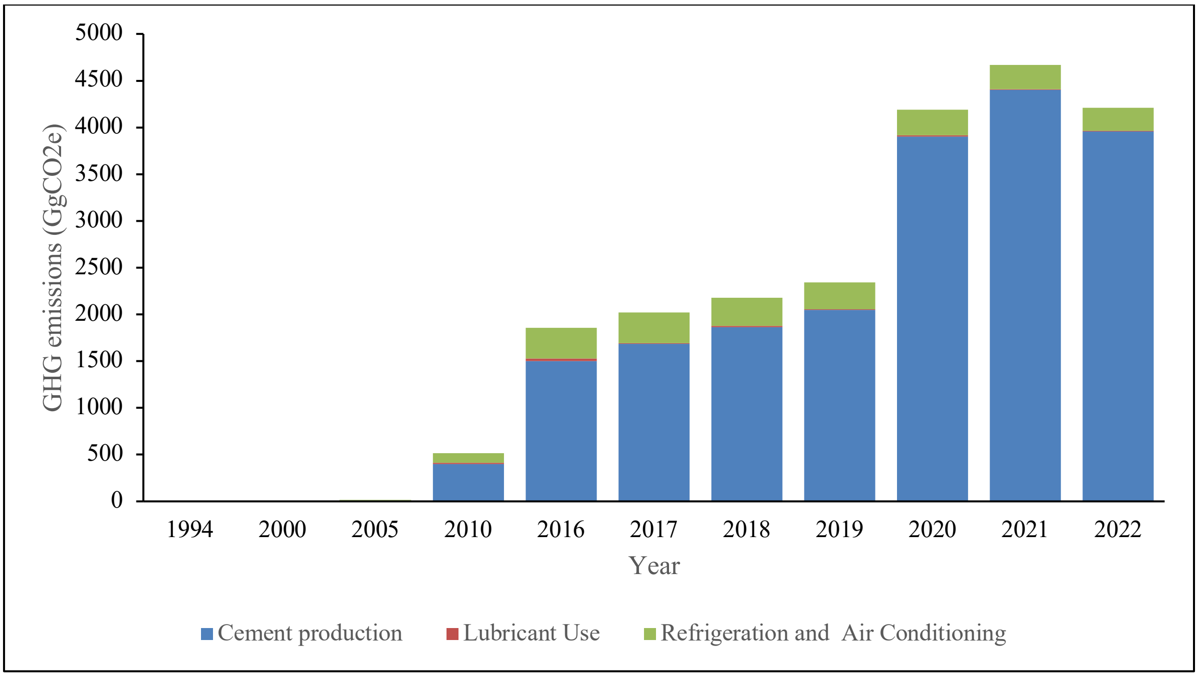


Figure I. 14: Total annual GHG emissions in the IPPU sector of Cambodia

Further, the following **Table I.20** shows the emission trends in the categories within the IPPU sector in Cambodia.

Table I. 20: Emissions in the IPPU sector of Cambodia (1994-2022)

Year	Emissions ($GgCO_2e$)		
	Cement production	Lubricant Use	Refrigeration and Air Conditioning
1994	NA	4	NA
2000	NA	6	NA
2005	NA	6	6
2010	402	9	104
2016	1499	29	330
2017	1682	8	328
2018	1865	8	305
2019	2048	8	286
2020	3904	9	274
2021	4398	8	259
2022	3954	9	248

In the IPPU sector, GHG emissions arise from various gases. The following **Table I.21** summarizes the GHG emissions from various gas types in the IPPU sector of Cambodia.

Table I. 21: GHG emissions by gas type in IPPU sector of Cambodia (1994-2022)

Year	GHG Emissions in (Gg)								
	CO_2	CH_4	N_2O	*HFC	SF_6	NO_X	CO	NMVOC	SO_2
1994	4	NO	NO	NO	NO	NO	NO	NO	NO
2000	6	NO	NO	NO	NO	NO	NO	NO	NO
2005	6	NO	NO	6	NO	NO	NO	NO	NO
2010	411	NO	NO	104	NO	NO	NO	NO	NO
2016	1528	NO	NO	330	NO	NO	NO	NO	NO
2017	1691	NO	NO	328	NO	NO	NO	NO	NO
2018	1874	NO	NO	305	NO	NO	NO	NO	NO
2019	2057	NO	NO	286	NO	NO	NO	NO	NO
2020	3913	NO	NO	274	NO	NO	NO	NO	NO
2021	4406	NO	NO	259	NO	NO	NO	NO	NO
2022	3962	NO	NO	248	NO	NO	NO	NO	NO

**HFC emissions are in GgCO_2*

According to the emission results discussed in **Table I.21** the IPPU sector of Cambodia is responsible for only the CO_2 emissions and HFC emissions. The trends of these emissions are illustrated in the graphs below.

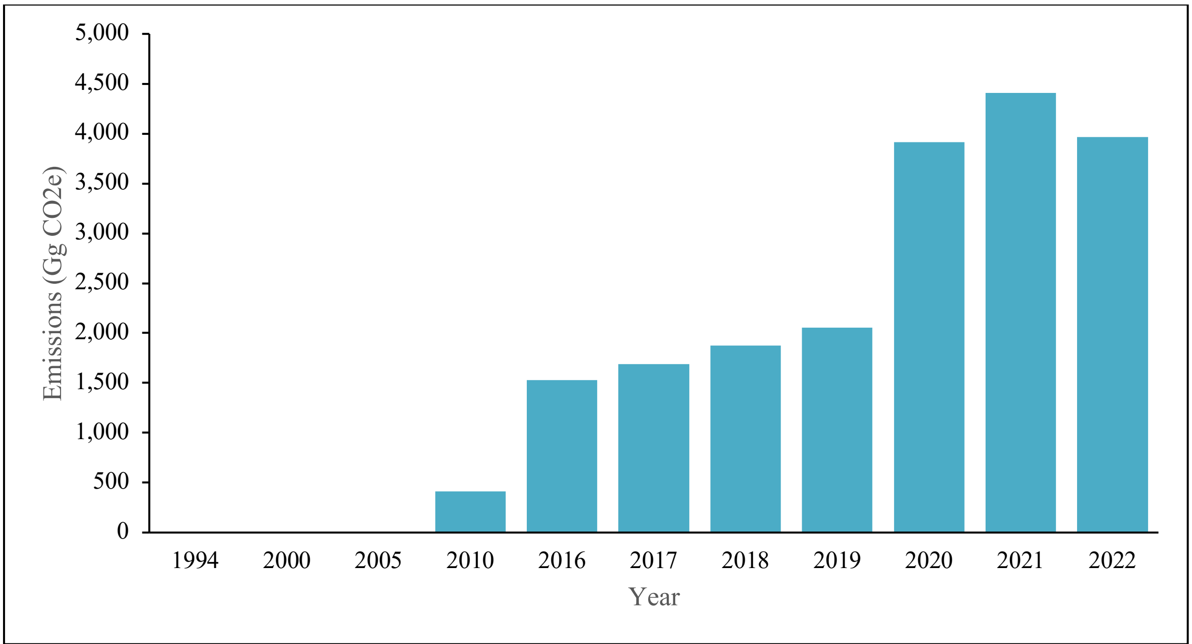


Figure I. 15: CO_2 emission trend in the IPPU sector of Cambodia (1994-2022)

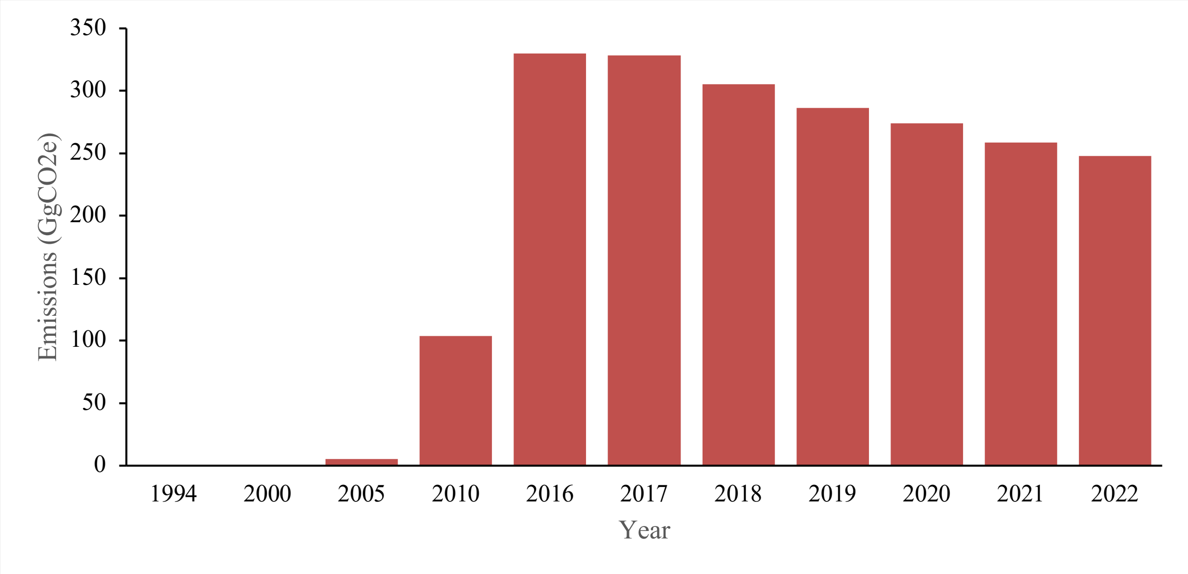


Figure I. 16: HFC emission trend in the IPPU sector of Cambodia (1994-2022)

8. AFOLU sector

The agriculture sector is a large GHG emitter in the country. Cambodia has an economy which is strongly marked by the contribution of agriculture to total GDP, and that is also reflected in the emission pattern. The main driver for the GHG emissions increases in the agriculture sector is the development of rice cultivations, whose activity level and emissions increased by a rate of ~2.5 in the period 1994-2016. The Forest and Other Land Use sector (FOLU), makes significant emissions as well as removals, which is driven by the change in carbon stocks due to deforestation and other changes in land use. The following **Figure I.17** illustrates the total annual emissions in the agriculture sector of Cambodia.

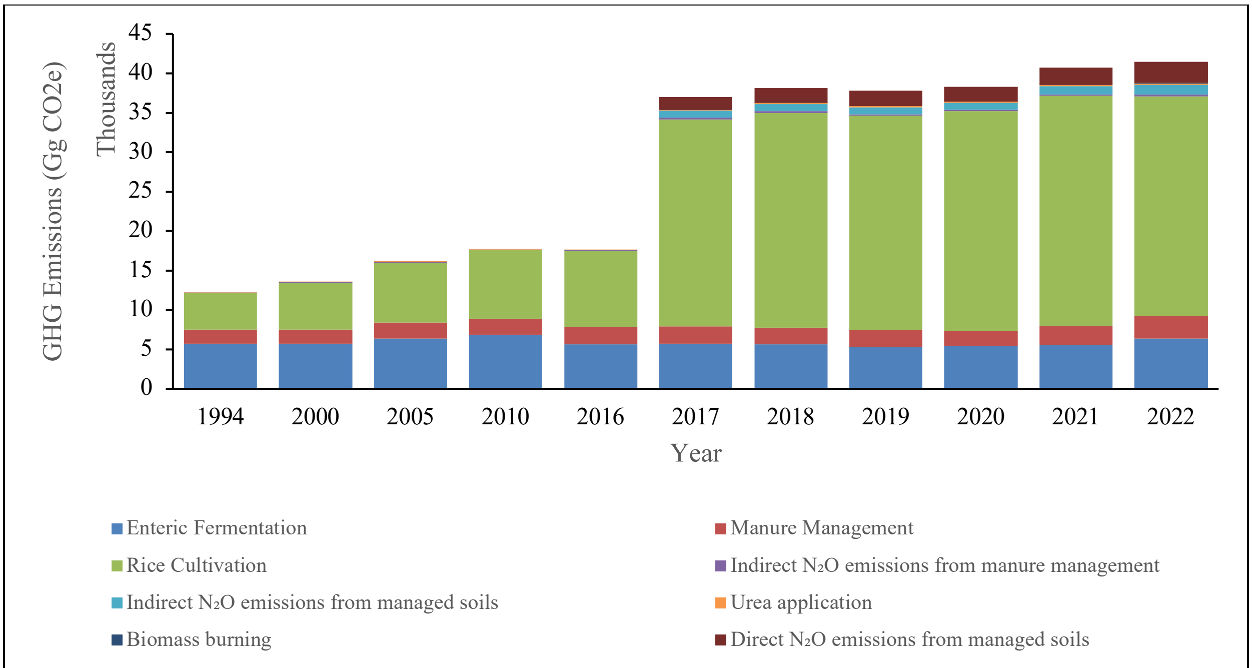


Figure I. 17: Total annual GHG emissions in the agriculture sector of Cambodia

The **Table I-22** illustrates the emission trends in the categories within the agriculture sector in Cambodia.

Table I. 22: Total annual GHG emissions in the agriculture sector of Cambodia

Year	GHG Emissions (Gg CO_2e)								
	Enteric fermentation	Manure management	Rice cultivation	Indirect N2O Emissions from Manure Management	Indirect N2O Emissions from Managed Soils	Direct N2O Emissions from Managed Soils	Urea application	Biomass burning	Total
1994	5,724	1,751	4,683	78	NA	NA	2	NA	12,237
2000	5,762	1,744	5,962	91	NA	NA	2	NA	13,560
2005	6,363	2,054	7,564	99	NA	NA	2	NA	16,081
2010	6,864	2,026	8,701	107	NA	NA	30	NA	17,729
2016	5,662	2,138	9,711	93	NA	NA	17	NA	17,621
2017	5,719	2,213	26,215	253	848	1,635	93	42	37,018
2018	5,724	2,125	27,228	226	893	1,873	119	44	38,141
2019	5,286	2,177	27,162	205	887	1,884	126	44	37,770
2020	5,368	1,956	27,855	216	884	1,847	120	44	38,291
2021	5,589	2,437	29,096	233	1,016	2,179	152	47	40,748
2022	6,407	2,822	27,826	267	1,209	2,668	202	46	41,446

The emission trends in the FOLU sector in Cambodia are shown in **Table I.23** and **Figure I-18**.

Table I. 23: Total annual GHG emissions in the FOLU sector of Cambodia

GHG Source category	GHG Emissions (Gg CO_2e)						
	1994	2000	2005	2010	2016	2017	2018
Land	23,321	23,321	23,321	109,638	27,518	27,518	27,518
Forest Land	-9,343	-9,343	-9,343	-15,597	-1,777	-1,777	-1,777
Other Land	32,664	32,664	32,664	125,235	29,295	29,295	29,295

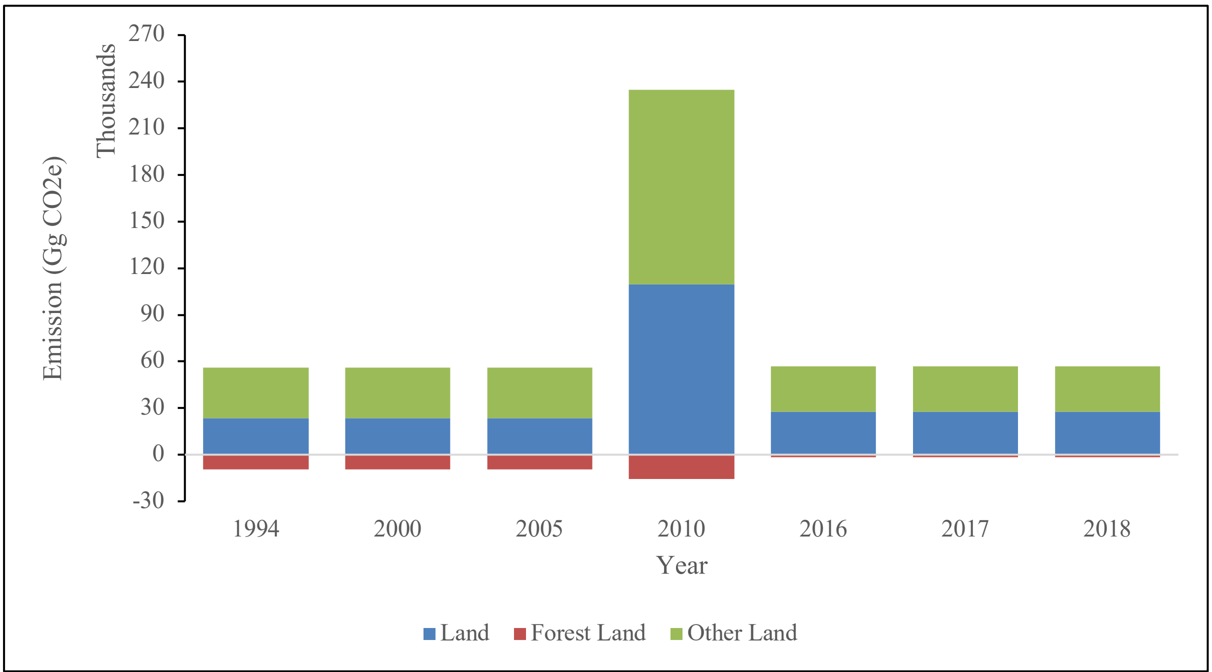


Figure I. 18: Total annual GHG emissions in the FOLU sector of Cambodia

Besides depicting trends by subsector, an analysis of emissions by gas type can also be conducted. **Table I-24** delineates the gas-specific emissions for the AFOLU industry in Cambodia for the years 1994, 2000, 2005, 2010, 2016, 2017, 2018, 2019, 2020, 2021, and 2022 respectively.

Table I. 24: Gas-wise emissions for the AFOLU sector in Cambodia

Year	GHG Emissions (Gg)						
	Emissions (Gg) CO_2	Emissions (Gg) CH_4	Emission (Gg) N_2O	NOx	CO	NMVOC	SOx
1994	23,322	398	4	NO	NO	NO	NO
2000	23,322	445	4	NO	NO	NO	NO
2005	23,322	531	5	NO	NO	NO	NO
2010	109,668	586	5	NO	NO	NO	NO
2016	27,535	590	4	NO	NO	NO	NO
2017	27,611	1,186	14	NO	NO	NO	NO
2018	27,638	1,216	15	NO	NO	NO	NO
2019	126	1,206	15	NO	NO	NO	NO
2020	120	1,226	15	NO	NO	NO	NO
2021	152	1,294	16	NO	NO	NO	NO
2022	202	1,287	20	NO	NO	NO	NO

According to the above table, it can be identified that, AFOLU sector of Cambodia contributes largely for CO_2, CH_4 and N_2O emissions. According to the above graph, it further illustrates that, among all the gas types, CO_2 can be considered as the most contributed gas type under the AFOLU sector followed by CH_4 and N_2O. Figure I-19-21 indicate the emissions of CO_2, CH_4 and N_2O for each year separately.

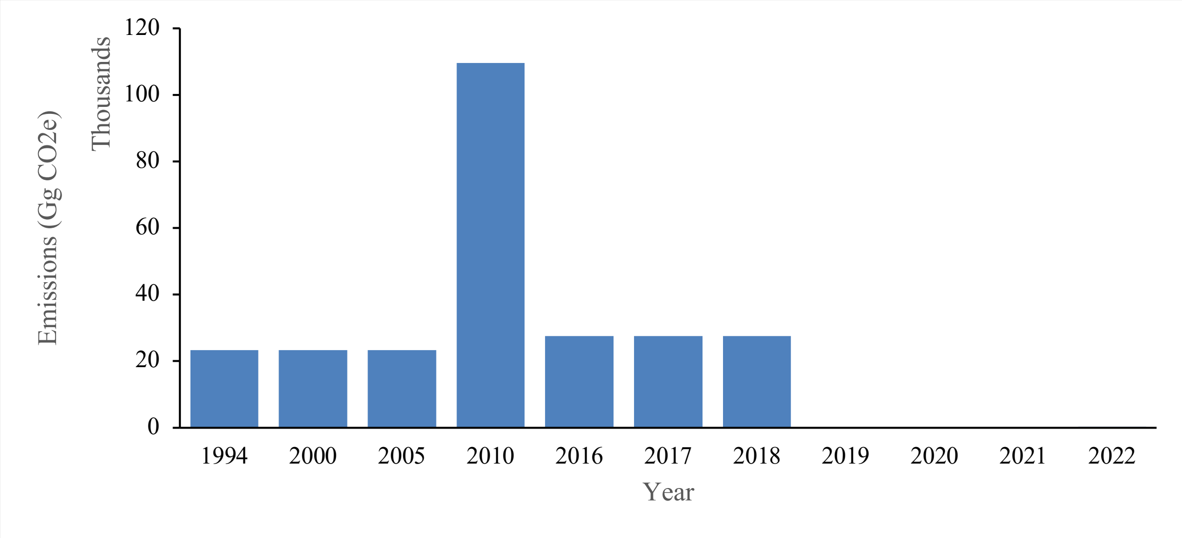


Figure I. 19: CO_2 emission trend in AFOLU sector in Cambodia (1994-2022)

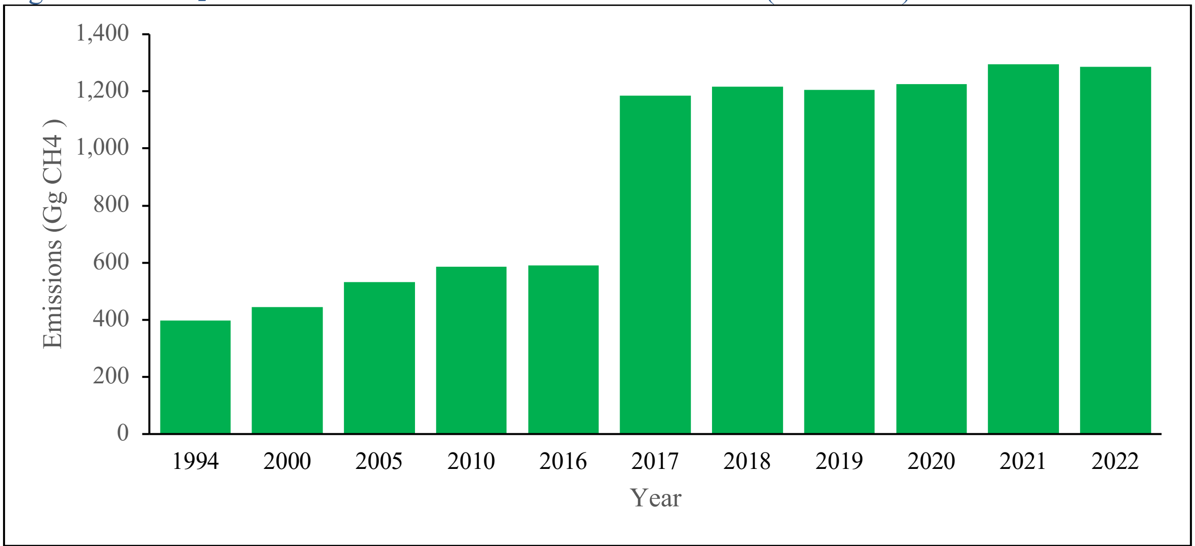


Figure I. 20: CH4 emission trend in AFOLU sector in Cambodia (1994-2022)

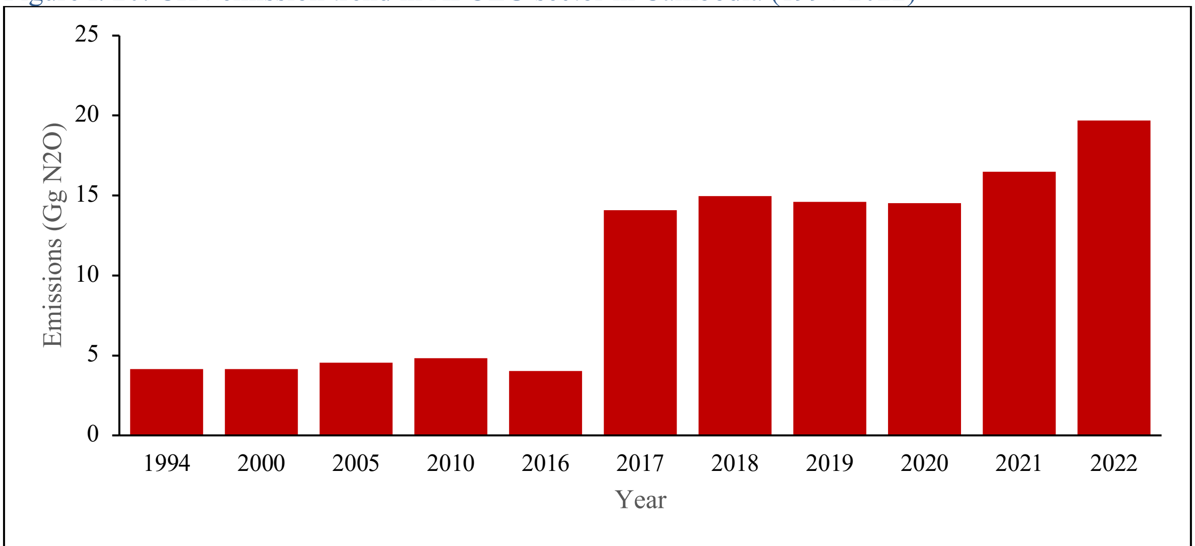


Figure I. 21: N_2O emission trend in AFOLU sector in Cambodia (1994-2022)

9. Waste sector

Waste sector can be taken as a considerable GHG emitter in Cambodia. When analyzing the GHG emissions within the subcategories in the waste sector for the period of 1994-2022, solid waste disposal can be identified as the highest emitter within the waste sector, followed by incineration and open burning of waste subcategory and the wastewater treatment and discharge subcategory. Biological treatment of solid waste contributes the least to GHG emissions, primarily due to the limited number of biological treatment and composting facilities in operation. The graph below indicates the emissions in subcategory under waste sector in Cambodia for 1994-2022.

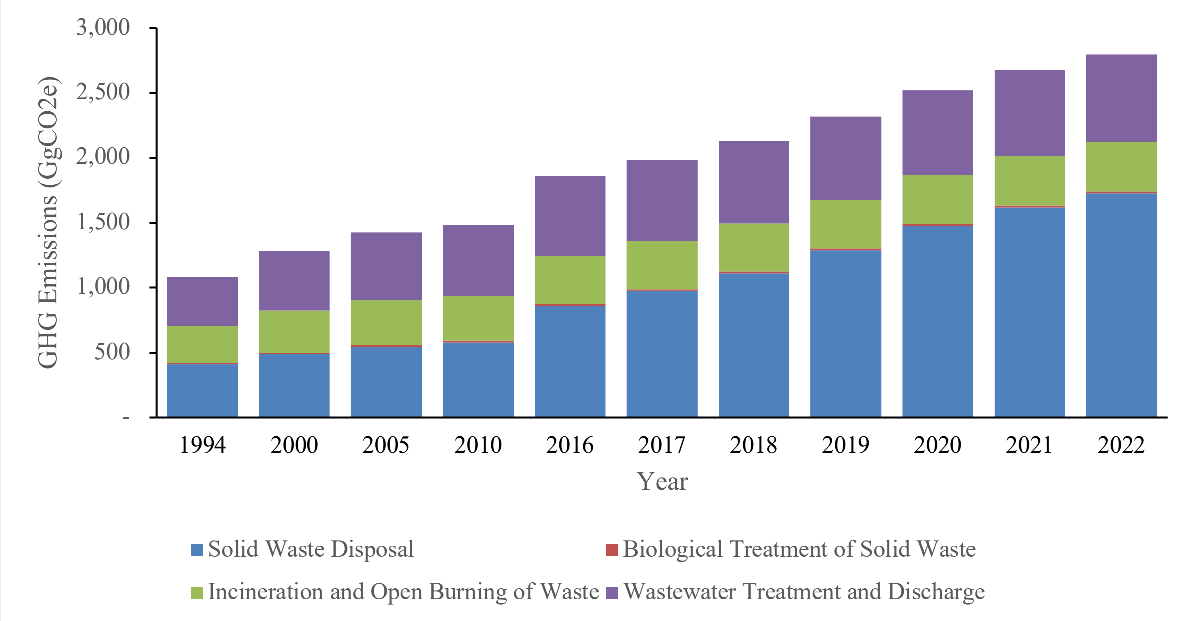


Figure I. 22: Total annual GHG emissions in the waste sector of Cambodia

In addition to that, the following **Table I.25** illustrates the values for GHG emissions for each subcategory under the waste sector in Cambodia for the indicated year. According to these results, there is an increasement in the total GHG emissions with the time.

Table I. 25: Gas-wise emissions for the Waste sector in Cambodia

Year	GHG Emissions (Gg CO_2e)				
	Solid Waste Disposal	Biological Treatment of Solid Waste	Incineration and Open Burning of Waste	Wastewater Treatment and Discharge	Total
1994	411	9	286	377	1083
2000	488	11	324	462	1285
2005	543	12	348	523	1427
2010	580	13	346	545	1484
2016	858	14	373	614	1859
2017	975	15	371	625	1985
2018	1110	15	373	635	2133

2019	1286	15	374	645	2320
2020	1477	15	376	655	2523
2021	1619	15	378	665	2677
2022	1728	15	380	675	2797

In addition to illustrating the trends by subsector, it can be done by analyzing the gas-wise emissions as well. The **Table I. 26** illustrates the gas-wise emissions for the waste sector in Cambodia for 1994, 2000, 2005, 2010, 2016, 2017, 2018, 2019, 2020, 2021 and 2022.

Table I. 26: Gas wise emissions for the waste sector in Cambodia

Year	GHG Emissions (Gg)						
	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SOx
1994	50	33	0	NO	NO	NO	NO
2000	57	39	1	NO	NO	NO	NO
2005	61	42	1	NO	NO	NO	NO
2010	60	44	1	NO	NO	NO	NO
2016	65	56	1	NO	NO	NO	NO
2017	65	60	1	NO	NO	NO	NO
2018	65	66	1	NO	NO	NO	NO
2019	65	72	1	NO	NO	NO	NO
2020	66	79	1	NO	NO	NO	NO
2021	66	84	1	NO	NO	NO	NO
2022	66	89	1	NO	NO	NO	NO

According to the above table, it can be identified that, waste sector of Cambodia contributes only for CO_2, CH_4 and N_2O emissions. And it further illustrates that, among all the gas types, CH_4 can be considered as the most emitted gas type under the waste sector followed by N_2O and CO_2. Graphs 2-19, 2-20 and 2-21 indicate the emissions of CO_2, CH_4 and N_2O for each year separately.

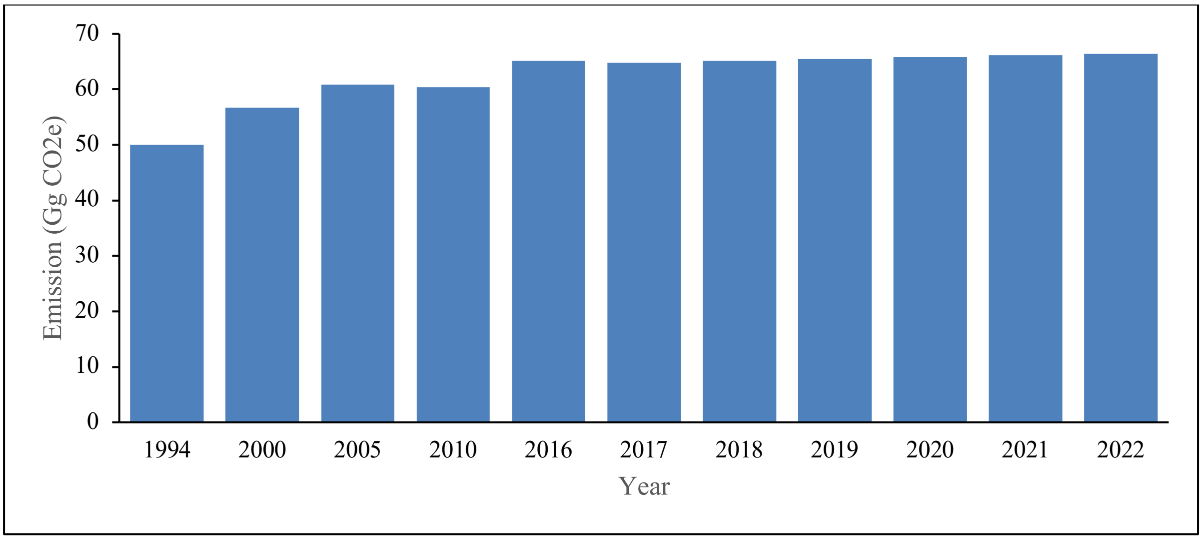


Figure I. 23: CO_2 emissions under the waste sector In Cambodia for 1994-2022

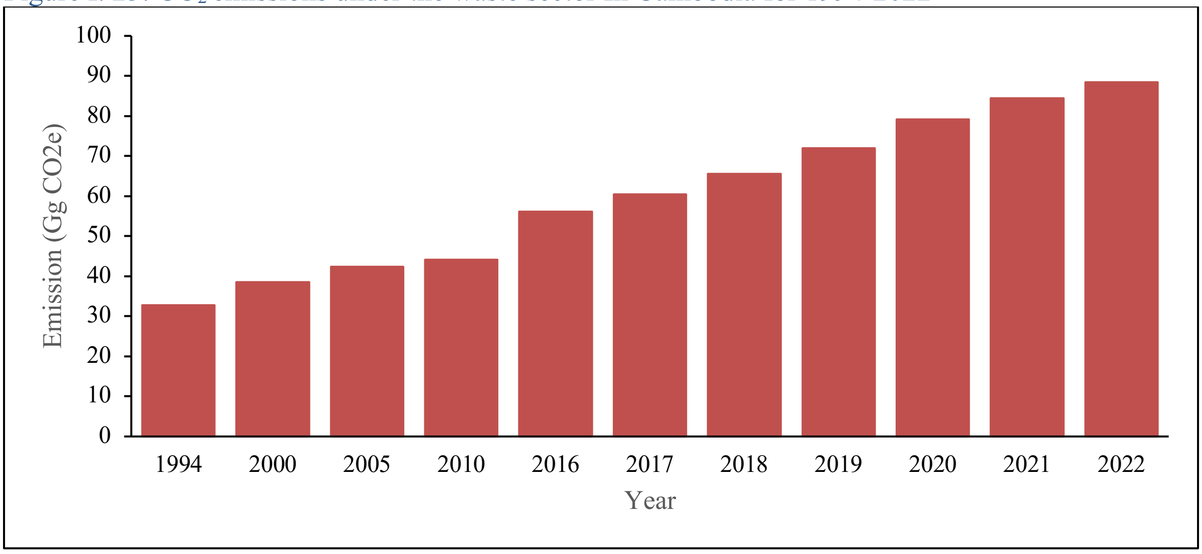


Figure I. 24: CH_4 emissions under the waste sector in Cambodia for 1994-2022

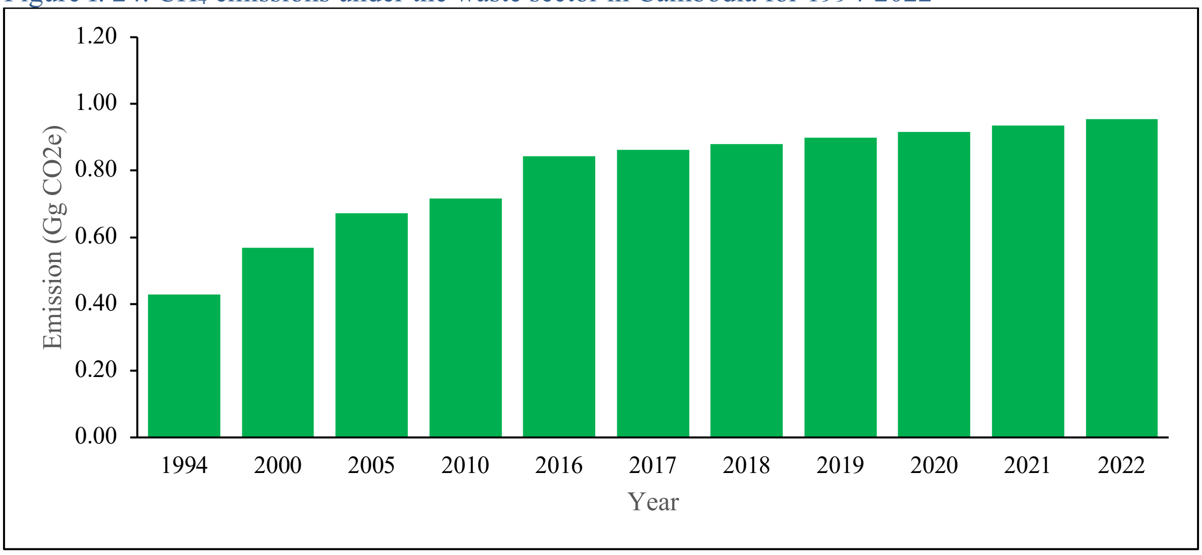


Figure I. 25: N_2O emissions under the waste sector in Cambodia for 1994-2022

K. Energy sector

10. Overview

Based on the IPCC 2006 Guidelines, the main GHG emission categories included in the energy sector are

- 1A: Fuel Combustion Activities,
- 1B: Fugitive Emissions from Fuels, and
- 1C: CO_2 Transport and Storage.

In Cambodia's energy sector profile, the only emissions category estimated in the current inventory is Fuel Combustion Activities (1A). Fugitive Emissions (1B) do not occur as Cambodia primarily imports fuels. Emissions from charcoal production are allocated to energy industries under stationary combustion (1A1c). CO_2 Transport and Storage (1C) is also not present in Cambodia.

To avoid double counting activity data with other sectors as per the IPCC 2006 guidelines, several precautions must be taken. In the Fuel Combustion sector, it is crucial to use fuel combustion statistics instead of fuel delivery statistics, be cautious about incomplete combustion data and potential double counting, and coordinate estimates between stationary source categories to avoid inaccuracies. For the Industrial Processes and Product Use (IPPU) sector, emissions from synthesis gas production should be accounted for in IGCC under fuel combustion, and emissions from carbide production, especially when using carbon-rich fuels, should be considered.

In the Metal Production sector, emissions from the use of coal, coke, natural gas, and by-product fuels must be included, and it is important to differentiate between fossil carbon materials and biogenic content for wood chips and charcoal. For the Energy and Waste sectors, consistency must be ensured between stationary combustion and fugitive emissions accounting for methane from coal mine waste, landfill gas, and sewage gas. Emissions from waste incineration with energy recovery should be reported in the Energy sector, while in the Waste sector, it is necessary to distinguish between waste incineration with and without energy recovery and assess the carbon content accurately. Finally, coordination with those recovering used oils is important to assess the extent of burning, and if used oils are utilized as fuel, the emissions should be estimated and reported in the Energy sector.

11. Fuel Type

The IPCC guidelines define several fuel types as follows:

- Solid (Coal and Coal Products)
  - Including Coal, Coke, and Derived Gases
- Liquid (Crude Oil and Petroleum Products)
  - Including Fuel Oil, Gasoline, LPG, Ethane, and Petroleum Coke
- Gas (Natural Gas)

- Other Fossil Fuels
    - Non-biomass municipal and industrial wastes, waste oils
- Peat
    - Treated as fossil fuel
- Biomass
    - Wood, Charcoal, Biofuels, Biomass fraction of MSW
    - CO_2 emissions from biomass are not included in total energy emissions

Refer to the definition of fuel types in Table 1.1, Volume 2, 2006 IPCC Guidelines.

CO_2 Emissions

CO_2 emissions depend almost entirely on the carbon content of the fuel, with less than 1% of carbon remaining un-oxidized. During the combustion process, most carbon is immediately emitted as CO_2, regardless of the combustion technology used. The 2006 IPCC Guidelines assume a complete combustion process by default, meaning 100% carbon conversion (oxidation fraction is 1).

$C+O_2=CO_2$
1 tons C⇒ (44/12) tons CO_2

Non-CO2: CH4 and N2O Emissions

Emission factors for non-CO_2 gases (CH_4 and N_2O) from fuel combustion depend on the type of fuel and the technology used, including operating conditions, control technologies, quality of maintenance, and the age of the equipment. Due to the considerable variation in technologies applied across different sectors, the emission factors for these gases also vary significantly. Therefore, it is not useful to provide default emission factors for these gases based solely on fuel types.

Biomass

Biomass is a special case:

- **CO_2 Emissions**: CO_2 emissions from biomass combustion are not included in the national total. They are reported separately as an information item.
- **Non-CO_2 Emissions**: Non-CO_2 emissions (such as CH_4 and N_2O) from biomass combustion are included in the national total.
- **Net Carbon Emissions**: Net carbon emissions from biomass are accounted for in the LULUCF/AFOLU sector.
- **Peat**: Peat is treated as a fossil fuel.

Tier selection

Using the Tier 3 method is preferable to minimize errors in the GHGI inventory and increase accuracy. However, due to insufficient data availability in Cambodia, the Tier 3 approach cannot be implemented. Therefore, the Tier 1 approach is selected to estimate the GHG inventory.

Tier 1:

Uses the amount of fuel combusted, default NCV (Net Calorific Value), carbon content, and CO_2 emission factors assuming complete combustion.

$$Emissions = AD \times EF$$

The following equation is used to estimate GHG emissions:

Figure 0-1 : Estimate GHG emissions

$Emissions_{GHG,Fuel}$ = (Fuel $Consumption_{fuel}$) x (Emission $factor_{GHG,fuel}$)

Where;

- $Emissions_{GHG,fuel}$ = emissions of a given GHG by type of fuel (kg GHG) Fuel $Consumption_{fuel}$ = amount of fuel combusted (TJ) Emission
- $Factor_{GHG,fuel}$ = default emission factor of a given GHG by type of fuel (kg gas/TJ). (For CO_2, it includes the carbon oxidation factor, assumed to be 1.)

Default emission factors vary based on:

- Stationary Combustion Type: (e.g., Energy, Residential, Industrial, etc.)
- Mobile Combustion Type: (e.g. , Civil aviation, Road transport, Railway, etc.)
- Fuel Type

From this point onward, the discussion will focus solely on fuel combustion activities, as the relevant emissions in Cambodia's GHGI energy sector are derived from these activities. Fuel combustion activities are primarily divided into two components:

1. Stationary Combustion
2. Mobile Combustion

The following sections will discuss the emission source categories for stationary and mobile combustion under the IPCC 2006 guidelines, along with the methodologies for estimating GHG emissions.

12. Stationary Combustion

An overview of the stationary combustion section is shown in the **Figure I.26** below. It illustrates the emission source categories for stationary combustion under each subsector of fuel combustion activities, based on the IPCC 2006 guidelines.

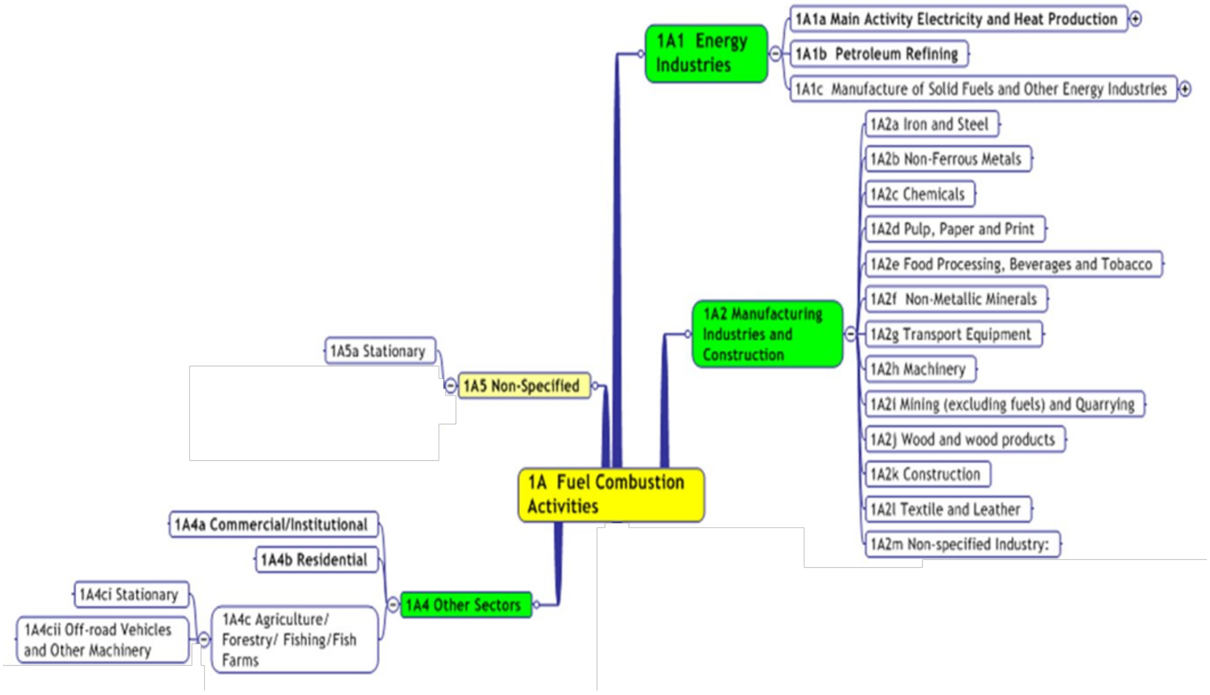


Figure I. 26: Overview of the stationary combustion activities based on IPCC 2006 guideline

13. Stationary combustion sources in the Cambodia

Cambodia's relevant stationary combustion activities are presented below:

- 1.A.1- Energy Industries
  - Electricity Generation
- 1.A.2- Manufacturing Industries and Construction
  - Non-Metallic Minerals
  - Textiles and Leather
  - Other Not Specified
- 1.A.4- Other sectors
  - Commercial/Institutional
  - Residential
  - Agriculture/Forestry/Fisheries
- 1.A.5- Non Specified
  - Stationary

14. Mobile Combustion

An overview of the mobile combustion section is shown in the **Figure I.27** below. It illustrates the emission source categories for stationary combustion under each subsector of fuel combustion activities, based on the IPCC 2006 guidelines.

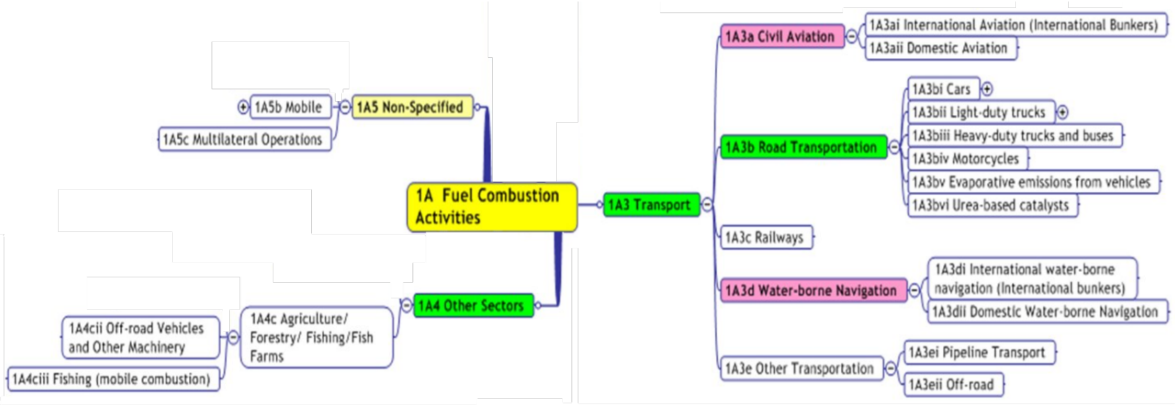


Figure I. 27: Overview of the Mobile Combustion

15. Mobile combustion sources in the Cambodia

Cambodia's relevant mobile combustion activities are presented below:

- 1.A.3.a- Civil Aviation
- 1.A.3.b- Road Transport
- 1.A.3.c- Railway
- 1.A.3.d- Water-born Navigation
- 1.A.4.c.iii-Fishing (mobile combustion)

16. Energy Supply in Cambodia

In 2022, the total energy supply in Cambodia was 344, 005 TJ, predominantly sourced from oil, which accounted for approximately 41% of the total energy supply. The next major source of energy was biofuels and waste, contributing about 35% of the total energy supply. The remaining energy supply was derived from other sources, including hydropower and coal. **Figure I.28** below illustrates the overview of Cambodia's energy supply in 202 (IEA-Org, n.d.).

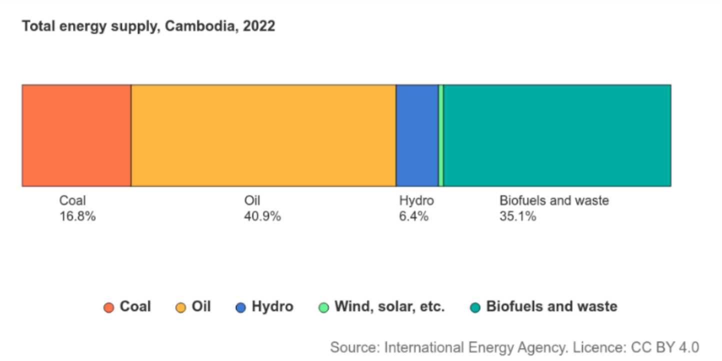


Figure I. 28: Overview of Cambodia's energy supply in 2022

The evaluation of total energy supply in Cambodia since 2000 is illustrated in **Figure I.29** below, showing the trends and changes over the past two decades.

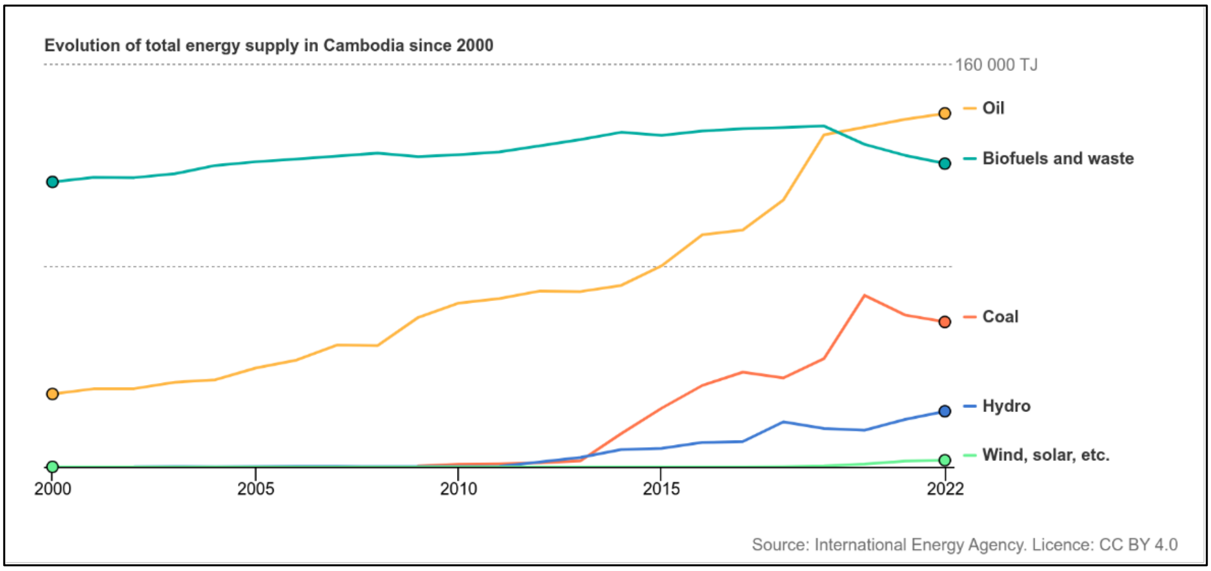


Figure I. 29: Evaluation of total energy supply in Cambodia since 2000

17. Domestic energy production

Energy production includes the combustion of fossil fuels for electricity generation and fuel use, as well as energy from renewable sources like hydro, wind, and solar PV. It also covers bioenergy, which includes both modern and traditional sources such as the burning of municipal waste. In 2021, the largest domestic energy source in Cambodia was biofuels and waste, accounting for 86% of domestic energy production (IEA-Cambodia, n.d.). The below **Figure I.30** illustrates the domestic energy production in Cambodia in 2021.

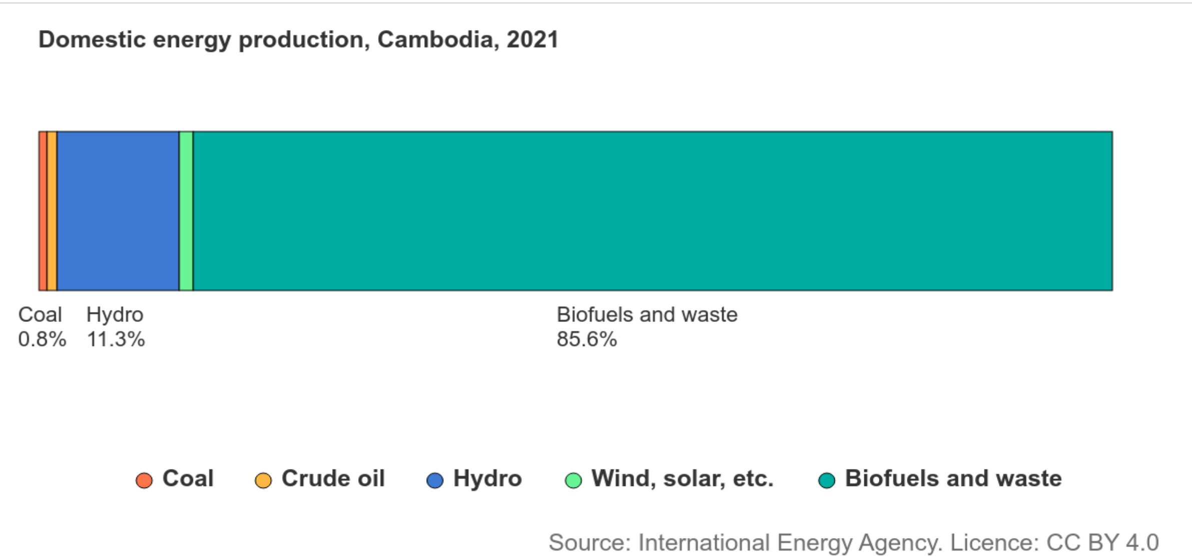


Figure I. 30: The domestic energy production in Cambodia in 2021

18. GHGI emission Sources in Energy Sector

The energy sector encompasses all greenhouse gas (GHG) emissions resulting from both the combustion and fugitive releases of fuels. Following the IPCC 2006 Guidelines, GHG emissions in this sector are categorized into three main sub-sectors:

- **Fuel Combustion Activities (1A)**: This includes emissions from the burning of fossil fuels for energy production across various sectors, such as electricity generation, transportation, industry, and residential use. Combustion activities are the primary source of CO_2, CH_4, and N_2O emissions in the energy sector.
- **Fugitive Emissions from Fuels (1B)**: These emissions arise from the extraction, processing, and distribution of fossil fuels. This sub-sector includes emissions from coal mining, oil and natural gas extraction, processing, and transportation. Fugitive emissions are typically in the form of methane (CH_4) but can also include other hydrocarbons and gases.
- **CO_2 Transport and Storage (1C)**: This sub-sector covers emissions related to the transportation and storage of carbon dioxide, particularly from carbon capture and storage (CCS) operations. These activities aim to mitigate emissions by capturing CO_2 from large point sources, such as power plants and industrial facilities, and transporting it to storage sites where it can be sequestered underground.

As a result of the energy profile of Cambodia, only the emissions of fuel combustion activities (1A Fuel Combustion activities) are estimated in the current inventory.

19. Fuel combustion activities

Several categories are included within fuel combustion, as follows:

Table I. 27: Fuel combustion category under energy sector

Category	GHG emissions included
1A1. Energy industries	Comprises emissions from fuels combusted by the fuel extraction or energy producing industries. This includes emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants; auto producers; and All combustion activities supporting the refining of petroleum products.
1A2. Manufacturing Industries and Construction	Emissions from combustion of fuels in industry. Non-energy consumption of fuels is not included here by in the IPPU sector.
1A3. Transport	Emissions from the combustion and evaporation of fuel for all transport activity (excluding military transport). Emissions from fuel sold to any air or marine vessel engaged in international transport are excluded from national totals
1A4. Other Sectors	Emissions from combustion activities in the commercial and institutional buildings, in the residential sector and emissions from fuel

	combustion in agriculture, forestry, fishing and fishing industries.

20. Data Collection

The following sections outline the sources and methodologies used for collecting activity data across various sectors. Data was primarily gathered from national reports, including the ERIA Cambodia Energy Statistics(2000-2019) and the 2019 GHGI report, complemented by energy statistics and balance sheets for more recent years. Where necessary, data for 2022 was forecasted based on available trends and previous records. Key contributors to this data collection include the Ministry of Mines and Energy (MME) and Electricite du Cambodge (EDC).

Table I. 28: Activity data collection under energy sector

Subcategory	Description of the data	Data Providers
Energy Industry	• The ERIA Cambodia Energy Statistics 2000-2019 report was used to collect activity data from 2000-2019. • Statistics and the energy balance sheet for 2020-2021 were used to gather data for 2020-2021. • EDC provided the data for 2022.	• Ministry of Mines and Energy (MME) • Electricite du Cambodge (EDC) •
Manufacturing industries and construction	• The 2019 GHGI was primarily used for collecting data from 1994 to 2016. • Additionally, the ERIA Cambodia Energy Statistics 2000-2019 report was used to collect activity data for several fuels. • Data for 2020-2021 was taken from the Energy Statistics Report 2020-2021, published by MME. • Activity data for 2022 was forecasted based on the available data, with several activity data points for 2017-2019 also forecasted.	• Ministry of Mines and Energy
Transport Sector	• The ERIA Cambodia Energy Statistics 2000-2019 report was primarily used to collect activity data from 2000-2019. • Activity data for 1994 was taken from the GHGI-2019 report.	• Ministry of Mines and Energy

	• Statistics and the energy balance sheet for 2020-2021 were used to gather data for 2020-2021. • Activity data for 2022 was forecasted based on the available data.	
Other sectors	• Activity data for 1994, and for some fuels from 1994-2016, was taken from the GHGI-2019 report. • The ERIA Cambodia Energy Statistics 2000-2019 report was primarily used to collect activity data from 2000-2019. • Statistics and the energy balance sheet for 2020-2021 were used to gather data for 2020-2021. • Activity data for 2022 was forecasted based on the available data.	• Ministry of Mines and Energy

21. Energy industries

Electricity generation is the primary emission source category within this sub-sector, based on the available data in Cambodia. The **Table I.29** below presents activity data and fuel consumption in electricity generation from 1994 to 2022. For the years prior to 2016, the activity data is taken from the GHG inventory report published in 2019. For the years after 2016, the data has been collected directly from Cambodia. Any data gaps have been filled using recalculation methods in accordance with IPCC guidelines.

Table I. 29: Activity data used for energy industries

Year	Fuel Consumption			
	Coal-Sub bituminous coal	Crude oil	Diesel Oil	Biomass
	kt	kt	kt	GWh
1994	NA	6	9	NA
2000	NA	54	71	NA
2005	NA	98	135	NA
2010	35	100	150	6
2016	1,394	53	80	42
2017	1,546	32	48	59
2018	1,655	33	50	64
2019	2,093	82	122	91
2020	2,631	99	16	66
2021	1,979	117	NA	50
2022	1,775	74	1	50

The emission factors are taken from the IPCC 2006 guidelines, and the AR5 GWP values are used to convert emissions to equivalent CO_2e values. The emission factors and GHG emissions are shown in **Table I.30**. Emissions from 1994 to 2016 were recalculated using the 2006 guideline GWP values and emission factors.

Table I. 30: Emission factors for fuels in energy industries

Fuel Type	CO_2 ($kgCO_2/TJ$)	CH_4 (kg CH_4/TJ)	N_2O (kg N_2O /TJ)
Coal- (Sub-bituminous coal)	96100	30	4
Heavy Fuel Oil (HFO)- Crude oil	73,300	3	0.6
Diesel Oil	74,100	3	0.6
Firewood	112000	30	4
Other primary solid biomass(Sugarcane)	100,000	30	4

21.1. Emissions result

Table I. 31: Emissions for energy industries

Year	GHG Emissions in (Gg)								
	CO_2	CH_4	N_2O	HFC	SF_6	NOX	CO	NMVOC	SO_2
1994	47	0.00	0.00	NO	NO	NO	NO	NO	NO
2000	392	0.02	0.00	NO	NO	NO	NO	NO	NO
2005	733	0.03	0.01	NO	NO	NO	NO	NO	NO
2010	853	0.04	0.01	NO	NO	NO	NO	NO	NO
2016	2952	0.06	0.05	NO	NO	NO	NO	NO	NO
2017	3062	0.05	0.05	NO	NO	NO	NO	NO	NO
2018	3268	0.06	0.05	NO	NO	NO	NO	NO	NO
2019	4443	0.10	0.07	NO	NO	NO	NO	NO	NO
2020	5134	0.08	0.08	NO	NO	NO	NO	NO	NO
2021	3958	0.06	0.06	NO	NO	NO	NO	NO	NO
2022	3456	0.06	0.06	NO	NO	NO	NO	NO	NO

22. Manufacturing industries and constructions

Based on the energy balance sheet in Cambodia, the industry sector includes non-metallic minerals, textiles & leather, and other unspecified industries. However, specific data for each industry is not available. The data received from Cambodia pertains to the overall industry sector, without detailed breakdowns for each specific industry. Therefore, all fuel consumption is considered under the unspecified sector for calculations. Data from 1994 to 2016 has been taken from the GHGI -2019 Cambodia report and recalculated using the 2006 IPCC guidelines and AR5 GWP values. The activity data, emission factors, and results are shown in the **Table I.32.**

Table I. 32: Activity data used for manufacturing industries and construction

Fuel Consumption(kt)						
Fuel Type / Year	LPG	Diesel	Black Oil	Biomass	Sub bituminous coal	Crude oil
1994	NA	NA	NA	3,159	NA	NA
2000	NA	71	NA	3034	NA	54
2005	NA	135	NA	2931	NA	98

2010	NA	150	NA	2371	10	100
2016	3.22	80	NA	3176	35	53
2017	2.52	125	4	3938	163	42
2018	1.81	134	3	4216	152	44
2019	1.11	160	3	4493	253	87
2020	0.4	193	2	4770	215	61
2021	0.6	217	1	5048	239	60
2022	0.8	247	1	4398	262	59

Emission factors for fuels in manufacturing industries and construction

Table I. 33: Emissions factors for fuels in manufacturing industries and construction

Fuel Type	CO2 (kgCO2/TJ)	CH4 (kg CH4/TJ)	N2O (kg N2O /TJ)
LPG	63100	1	0.1
Coal (Sub-bituminous coal)	96100	30	4
Heavy Fuel Oil (HFO)- Crude oil	73,300	3	0.6
Residual fuel oil (Black oil)	77400	3	0.6
Diesel Oil	74,100	3	0.6
Other primary solid biomass	100,000	30	4

22.1. GHG Emissions result

Table I. 34: Emissions for manufacturing industries and construction

Year	GHG Emissions in (Gg)								
	CO2	CH4	N2O	HFC	SF6	NOX	CO	NMVO C	SO2
1994	NO	1	0.15	NO	NO	NO	NO	NO	NO
2000	392	1	0.14	NO	NO	NO	NO	NO	NO
2005	733	1	0.14	NO	NO	NO	NO	NO	NO
2010	807	1	0.12	NO	NO	NO	NO	NO	NO
2016	492	1	0.15	NO	NO	NO	NO	NO	NO
2017	843	1	0.2	NO	NO	NO	NO	NO	NO
2018	855	2	0.2	NO	NO	NO	NO	NO	NO
2019	1249	2	0.22	NO	NO	NO	NO	NO	NO
2020	1203	2	0.23	NO	NO	NO	NO	NO	NO
2021	1288	2	0.25	NO	NO	NO	NO	NO	NO
2022	1450	2	0.22	NO	NO	NO	NO	NO	NO

23. Transport Sector

Based on the available data in Cambodia, information is provided for civil aviation, railway, road transport, and waterborne navigation. Data from 1994 to 2016 has been sourced from the GHGI -2019 report and emissions have been recalculated using the 2006 IPCC guidelines and AR5 GWP values. Fuel-wise and sub-sector-wise activity data and emissions are shown in the **Table I.35** below. Emission factors for the calculations have been taken from the 2006 guidelines.

Table I. 35: Activity data for the transport sector

Fuel Consumption(kt)								
Sub Category	International aviation	Domestic aviation	Railway	Road			International water-borne navigation	Domestic water-borne navigation
Fuel Type	Jet Fuel	Jet Fuel	Diesel	Motor gasoline	LPG	Diesel	Black Oil	Diesel
1994	5	0	NA	289	0	250	NA	NA
2000	12	5	NA	120	1	277	NA	NA
2005	14	6	NA	129	2	186	NA	NA
2010	32	14	NA	384	21	536	NA	NA
2016	73	33	NA	514	63	853	NA	NA
2017	106	47	1	562	72	876	63	62
2018	140	62	2	606	87	941	65	64
2019	156	69	2	726	110	1120	67	66
2020	57	3	3	696	75	1278	69	68
2021	65	2	4	636	26	1295	32	70
2022	109	38	4	681	79	1405	73	72

Emissions, including those from international bunkers, are shown in the **Table I.36**. Emissions from international bunkers will be separately reported in the annexures.
Emission factors for fuels used in the transport sector

Table I. 36: Emission factors for fuels used in the transport sector

Fuel Type	CO2 (kgCO2/TJ)	CH4 (kg CH4/TJ)	N2O (kg N2O /TJ)
Jet Fuel	71,500	2	0.5
Motor gasoline	69,300	4	3
LPG	63100	62	0.2
Residual fuel oil (Black oil)	77400	3	0.6
Diesel Oil	74,100	4	4

23.1. GHG Emissions result

Table I. 37: Emissions for the transport sector

Year	GHG Emissions in (Gg)								
	CO2	CH4	N2O	HFC	SF6	NOX	CO	NMVO C	SO2
1994	1,685	0.47	0.08	NO	NO	NO	NO	NO	NO
2000	1,272	0.23	0.06	NO	NO	NO	NO	NO	NO
2005	1,014	0.23	0.05	NO	NO	NO	NO	NO	NO
2010	2,995	0.71	0.15	NO	NO	NO	NO	NO	NO
2016	4,583	0.41	0.22	NO	NO	NO	NO	NO	NO
2017	5,081	0.47	0.24	NO	NO	NO	NO	NO	NO
2018	5,526	1.36	0.31	NO	NO	NO	NO	NO	NO
2019	6,561	0.65	0.31	NO	NO	NO	NO	NO	NO
2020	6,665	0.57	0.32	NO	NO	NO	NO	NO	NO
2021	6,397	0.42	0.32	NO	NO	NO	NO	NO	NO
2022	7,169	0.61	0.35	NO	NO	NO	NO	NO	NO

24. Other Sectors

The "Other" sector includes emissions from 1.A.4.a - Commercial/Institutional, 1.A.4.b - Residential, and 1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms. Data for these sectors from 1994 to 2016 has been sourced from the GHGI 2019 report. All emissions have been recalculated using the 2006 IPCC guidelines and AR5 GWP values. For additional years activity data has been collected from Cambodian institutions. Emission factors are based on the 2006 guidelines. Activity data and emissions are presenting in **Table I.38**.

Table I. 38: Activity data used for other sectors in Energy

Fuel Consumption(kt)												
Sub Category	Commercial			Residential						Agriculture -Stationary	Other Sectors	
Year	Kerosene	Residual Fuel oil	LPG	LPG	Charcoal	Firewood	Biogas	Other Primary Solid Biomass	Kerosene	Diesel	Diesel	Residual Fuel Oil
1994	6	0	2	0	339	1243	NA	NA	4	16	NA	NA
2000	8	1	12	2	212	1160	0	NA	5	21	NA	5
2005	9	1	25	3	247	1328	1	NA	6	25	NA	10
2010	13	10	39	5	283	1501	2	NA	9	31	NA	7
2016	NA	5	116	15	342	1731	3	NA	NA	37	NA	15
2017	NA	NA	134	18	343	1658	2	61	NA	62	109	2
2018	NA	NA	162	21	332	1575	2	52	NA	87	98	6
2019	NA	NA	204	27	321	1522	3	44	NA	113	86	12
2020	NA	NA	133	114	91	1377	22	35	NA	138	75	9
2021	NA	NA	186	186	96	1648	23	26	NA	144	64	9
2022	NA	NA	238	258	235	1919	12	17	NA	176	53	9

Emission factors for fuels used in other sectors

Table I. 39: Emission factors for fuels used in Other sector

Fuel Type	CO_2 ($kgCO_2/TJ$)	CH_4 (kg CH_4/TJ)	N_2O (kg N_2O /TJ)
LPG	63100	5	0.1
Firewood	112000	300	4
Charcoal	112000	200	1
Biogas	54600	5	0.1
Kerosene	71900	10	0.6
Fuel Oil - Crude oil	73,300	3	0.6
Residual fuel oil (Black oil)	77400	3	0.6
Diesel Oil	74,100	3	0.6
Other primary solid biomass	100,000	30	4

24.1. GHG Emissions result

Table I. 40: Emissions for other sectors in Energy

Year	GHG Emissions in (Gg)								
	CO_2	CH_4	N_2O	HFC	SF_6	NOX	CO	NMVO C	SO_2
1994	92	8	0.09	NO	NO	NO	NO	NO	NO
2000	168	7	0.08	NO	NO	NO	NO	NO	NO
2005	250	8	0.09	NO	NO	NO	NO	NO	NO
2010	360	9	0.10	NO	NO	NO	NO	NO	NO
2016	573	10	0.12	NO	NO	NO	NO	NO	NO
2017	1007	10	0.12	NO	NO	NO	NO	NO	NO
2018	1156	10	0.12	NO	NO	NO	NO	NO	NO
2019	1361	9	0.11	NO	NO	NO	NO	NO	NO
2020	1006	7	0.09	NO	NO	NO	NO	NO	NO
2021	1800	9	0.11	NO	NO	NO	NO	NO	NO
2022	2236	11	0.14	NO	NO	NO	NO	NO	NO

L. Reference Approach

The reference approach for the 2016-2022 inventories was conducted using Cambodia's Energy Balance Sheets for 2020 and 2021, along with additional integrated fuel import data provided by the BTR Working Group. A comparison between the sectoral approach and the reference approach is presented annually in the relevant CRT table.

Significant differences were observed between the emissions estimated using the reference approach and the sectoral approach for 2016-2022. These discrepancies are primarily due to the absence of direct data sources. Much of the sectoral data utilized during this period was interpolated and extrapolated from the 2020 and 2021 data.

M. Industrial Processes and Product Use

25. Overview

Greenhouse gas emissions arise from a diverse range of industrial activities. Key sources include emissions from industrial processes that chemically or physically alter materials. These processes can generate various greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Additionally, greenhouse gases are commonly employed in products like refrigerators, foams, and aerosol cans. For instance, HFCs are utilized as substitutes for ozone-depleting substances (ODS) in numerous product applications.

IPPU sector in Cambodia

Cambodia had a rapid expansion of investments in different sectors including the industrial sector as well. The industrial sector played an important role with its share of the GDP increased as indicated in following **Figure I.31**.

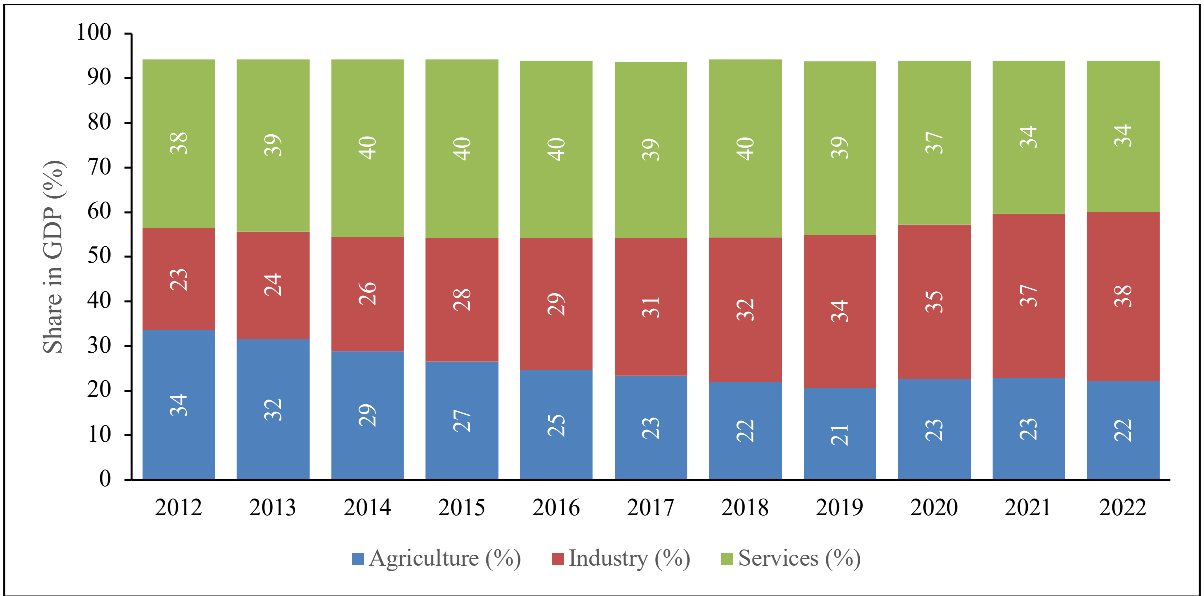


Figure I. 31: Share of economic sectors in the gross domestic product (GDP) from 2012 to 2022 in Cambodia (Source: Statista, 2024)

The image illustrates the share of economic sectors in the gross domestic product (GDP) from 2012 to 2022 (Statista (Cambodia), 2024). It shows that there is an increase in the share of GDP in the industrial sector. Based on the 2006 IPCC guidelines, the IPPU sector comprises eight categories.

- 2.A – Mineral industry
- 2.B – Chemical industry

- 2.C – Metal industry
- 2.D – Non-energy products from fuels and solvent use
- 2.E – Electronics industry
- 2.F – Product uses as substitutes for ozone depleting substances
- 2.G – Other product manufacture and use
- 2.H – Other

Among these categories, the emission sources available in Cambodia can be categorized into the following categories,

- 2.A – Mineral industry
- 2.D – Non-energy products from fuels and solvent use
- 2.F – Product uses as substitutes for ozone depleting substances

In Cambodia, the mineral industry primarily encompasses cement production. The category of non-energy products derived from fuels and solvent use is limited to the lubricant use sub-category. Additionally, products uses as substitutes for ozone-depleting substances focus on refrigeration and air conditioning, as well as fire protection sub-categories.

26. Data Collection

The following sections outline the sources and methodologies used for collecting activity data across emission sources in the IPPU sector. Data was primarily gathered from the Ministry of Mines and Energy, the Ozone unit of the Ministry of Energy. Additionally, data was collected from the websites. Where necessary, data for some years was forecasted based on previous records.

Table I. 41: Overview of the data collection in IPPU sector

Subcategory	Description of the data	Data Providers
Mineral industry	• 1994 to 2016 data was collected from the 2019 GHGI, FBUR and TNC where necessary • From 2016 to 2022, the activity data was sourced as below. o The weight (mass) of cement produced in 2020, 2021, and 2022 was obtained from the www.cemnet.com. The data for the remaining years were forecasted based on the available data. • The imports for consumption of clinker and exports of clinker assumed as zero due to the lack of data. This assumption was made to	The Ministry of Industry, Science, Technology & Innovation Cement production companies

	ensure accuracy of emission estimates in the absence of specific export figures.	
Non-Energy Products from Fuels and Solvent Use	• From 1994 to 2016 was sourced from the first BUR, 3rd National Communication, and the 2019 GHG inventory. • Lubricant consumption data for 2020 and 2021 was obtained from the Ministry of Mines and Energy. • For the years 2016, 2017, 2019, 2022, lubricant consumption data was forecasted using available data from 1994, 2000, 2005, 2010, 2016, 2020, 2021 and 2022.	The Ministry of Mines and Energy
Product Uses as Substitutes for Ozone-Depleting Substances	• From 1994 to 2016 was sourced from the first BUR, 3rd National Communication, and the 2019 GHG inventory where necessary. • From 2016 to 2022, the activity data was sourced from the National Ozone unit of the Ministry of Environment.	The National Ozone unit of the Ministry of Environment

The inventory has been calculated using methodologies outlined in the 2006 IPCC Guidelines. Global warming potentials (GWPs) are based on the values from the IPCC Fifth Assessment Report (AR5), based on the effects of GHGs over a 100-year time horizon.

N. Mineral industry

This sector outlines the CO_2 emissions resulting from using carbonate raw materials in the production and use of mineral industry products.

2.A.1 – Cement production

In cement production, CO_2 is produced during the production of clinker. This process mainly uses Calcium Carbonate as a raw material, heated or calcined to produce lime (CaO) and CO_2 as a by-product.
The activity data for 1994 to 2016 (1994, 2000, 2005, 2010, 2016) was sourced from the first BUR, the 3rd National Communication, and the 2019 GHG inventory. From 2016 to 2022, the activity data was sourced as below.

- The weight (mass) of cement produced in 2020, 2021, and 2022 was obtained from the www.cemnet.com. The data for the remaining years were forecasted based on the available data.

The imports for consumption of clinker and exports of clinker was assumed as zero based on the lack of available data. This assumption was made to ensure accuracy of emission estimates in the absence of specific figures.The emission factor for clinker is 0.51 tons of CO_2 per ton of clinker, with a CKD (cement kiln dust) correction factor of 1.02, both of which are IPCC default values.

Based on the information, data was available for the weight (mass) of cement produced and imports for consumption of clinker for the cement type 'Portland'. The tier 1 methodology of 2006 IPCC guidelines was applied for the cement production emission calculation. This method was utilized because of the absence of data on carbonate inputs or national clinker production data. In this method, the clinker production estimates are inferred from cement production data, correcting for imports and exports of clinker. The default clinker emission factor is 0.52 tons CO_2/ ton clinker which is provided in the 2006 IPCC guidelines used in this methodology. The clinker fraction in cement is considered as 95%.

Equation I. 1: CO_2 emissions from cement production

$$CO_2 \text{emissions} = \left[\sum_i (M_{ci} \cdot C_{cli}) - Im + Ex\right] \cdot EF_{clc}$$

Where,

- CO_2 Emissions = emissions of CO_2 from cement production, tons
- M_{ci} = weight (mass) of cement produced of type i, tons
- C_{cli} = clinker fraction of cement of type i, fraction
- Im = imports for consumption of clinker, tons
- Ex = exports of clinker, tons
- EF_{clc} = emission factor for clinker in the particular cement, tons CO_2/ton clinker. The default clinker emission factor (EF_{clc}) is corrected for CKD.
- The default emission factor for clinker can be taken as follow the Tier 1 emission factor for clinker

The default CaO content for clinker is 65%. It means 1 ton of clinker contains 0.65 tons of CaO from $CaCO_3$. Therefore, to yield 0.65 tons of CaO, 1.1601 tons of $CaCO_3$ is needed. Finally, this amount of $CaCO_3$ releases 0.5101 tons of CO_2. The Cement Kiln Dust (CKD) correction factor is 1.02.

Table I. 42: Activity data for cement production

Year	The weight (mass) of cement produced (tons)
1994	NA
2000	NA
2005	NA
2010	814,105
2016	3,034,231

2017	3,404,252
2018	3,774,273
2019	4,144,294
2020	7,900,000
2021	8,900,000
2022	8,000,000

Clinker exports were assumed to be zero due to the absence of data on clinker exports. Additionally, any data gaps were addressed by supplementing the available information with estimates where necessary. The emissions associated with the above activity for cement production are outlined in **Table I.43**.

Table I. 43: GHG emissions from Cement production

Year	GHG emissions ($GgCO_2e$)
1994	NA
2000	NA
2005	NA
2010	402
2016	1499
2017	1682
2018	1865
2019	2048
2020	3904
2021	4398
2022	3954

O. Non-Energy Products from Fuels and Solvent Use

2.D.1 – Lubricant use

In this category, estimates the emissions from the first use of fossil fuels as a product for primary purposes other than combustion for energy purposes and use as a feedstock or reducing agent. Considering the Cambodia context, the lubricant use sub-category accounts for emissions under this category. The lubricants are used in engines primarily for their lubricating properties. Therefore, emissions associated with lubricant usage are considered as non-combustion emissions to be reported under the IPPU sector. The activity data for 1994 to 2016 was sourced from the first BUR, 3rd National Communication, and the 2019 GHG inventory. Lubricant consumption data for 2020 and 2021 was obtained from the Ministry of Mines and Energy. For the years 2016, 2017, 2019, and 2022, the data was forecasted using available data from 1994, 2000, 2005, 2010, 2016, 2020, 2021 and 2022. The default emission factors were used as in the 2006 IPCC guidelines.

For this, the tier 01 methodology was utilized, and the related equation is as follows.

Equation I. 2: CO_2 emissions from lubricants

$$CO_2 \text{ emissions} = LC \cdot CC_{Lubricant} \cdot ODU_{Lubricant} \cdot 44/12$$

Where:

- CO_2 Emissions = CO_2 emissions from lubricants, ton CO_2
- LC = total lubricant consumption, TJ
- $CC_{Lubricant}$ = carbon content of lubricants (default), ton C/TJ (= kg C/GJ)
- $ODU_{Lubricant}$ = ODU factor (based on default composition of oil and grease)
- fraction 44/12 = mass ratio of CO_2/C

Considering the lubricating oil (motor oil/ industrial oils), already used in Cambodia, the ODU factor is 0.2, and the default carbon content factor considered as 20.0 kg C/ GJ.

The below **Table I.44** demonstrates the activity data utilized in this sub-category. The type of lubricant used is lubricating oil (motor oil /industrial oils).

Table I. 44: Activity data for total lubricant consumption

Year	Total lubricant consumption (TJ)
1994	260
2000	412
2005	437
2010	586
2016	1943
2017	558
2018	568
2019	579
2020	583
2021	539
2022	609

In the absence of data for certain years, estimates were made based on the available information.
The following **Table I.45** illustrates the emissions associated with the above activity for lubricant use.

Table I. 45: GHG emissions from lubricant consumption

Year	GHG emissions ($GgCO_2e$)
1994	4
2000	6
2005	6

2010	9
2016	29
2017	8
2018	8
2019	8
2020	9
2021	8
2022	9

P. Product Uses as Substitutes for Ozone-Depleting Substances

The activity data for 1994 to 2016 was sourced from the first BUR, 3rd National Communication, and the 2019 GHG inventory. From 2016 to 2022, the activity data was sourced from the National Ozone unit of the Ministry of Environment. However, the activity data was available only for the 2.F.1 – Refrigeration and air conditioning, although the 2.F.3 – Fire protection sub-category is mentioned in the FBUR. Therefore, the emissions were calculated only for the 2.F.1 sub-category. The main assumptions taken and default coefficients used for the estimation of the emissions are illustrated in the following **Table I.46**.

Table I. 46: The main assumptions and coefficients used for the emission estimations in Refrigeration and air conditioning

Year of introduction of the gases	2005
Growth rate in new equipment sales	2.5%
Assumed equipment lifetime (years)	10
Emission factor from the installed base	15%
% of gas destroyed at end of life	25%

Hydrofluorocarbons (HFCs) and, to a much lesser extent, perfluorocarbons (PFCs), are being used as alternatives to ozone-depleting substances (ODS) that are being phased out under the Montreal Protocol. However, HFCs and PFCs have high global warming potential (GWP), posing a challenge for climate change mitigation efforts.

2.F.1 – Refrigeration and air conditioning

The tier 01-a methodology provided under 2006 IPCC guidelines is used as the methodology in 2.F.1 Refrigeration and Air conditioning.

Equation I. 3: Net consumption

$$\text{Net consumption} = \text{Production} + \text{Imports} + \text{Exports} - \text{Destruction}$$

The net consumption of each HFC or PFC is then used to calculate annual emissions. Considering the occurrence of banks, the following equation was used to calculate annual emissions.

Equation I. 4: Annual emissions

$$\text{Annual emissions} = \text{Net consumption} \cdot \text{Composite } EF_{FY} + \text{Total banked chemical} \cdot \text{Composite } EF_{B}$$

Where:

- Net Consumption = net consumption for the application
- Composite EF_{FY} = composite emission factor for the application for first year
- Total Banked Chemical = bank of the chemical for the application
- Composite EF_{B} = composite emission factor for the application for bank

The following **Table I.47** illustrate the activity data used in refrigeration and air-conditioning sub-categories.

Table I. 47: Activity data for imports of gases in the refrigeration sub-category in Cambodia

Year	Imports of gases (tons)				
	HFC-125	HFC-134a	R-290	HC-600a	HFC-143a
1994	NA	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA
2005	NA	1	NA	NA	NA
2010	1	4	NA	NA	1
2016	2.41	11.06	NA	NA	2.79
2017	2.24	150.20	NA	NA	2.65
2018	3.25	78.81	NA	NA	3.84
2019	2.16	74.20	NA	NA	2.55
2020	1.13	120.36	NA	NA	1.33
2021	5.51	46.23	NA	NA	6.51
2022	5.83	75.71	0.50	NA	6.89

Table I. 48: Activity data for imports of gases in the air-conditioning sub-category in Cambodia

Year	Imports of gases (tons)				
	HFC-32	**HFC-410A**	**HCFC-22**	**HFC-125**	**HFC-134a**
1994	NA	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA
2005	0	NA	NA	0	27
2010	3	NA	NA	3	186
2016	16	NA	NA	16	325
2017	23	45	84	23	NA
2018	9	18	91	9	NA

2019	17	32	144	16	NA
2020	11	16	121	8	NA
2021	19	37	85	19	NA
2022	24	25	58	12	NA

In Cambodia, no exports or gas production were recorded during the specified years. Additionally, any data gaps were addressed by supplementing the available information with estimates where necessary. The emissions associated with the above activity data in refrigeration and air-conditioning sub-categories are outlined in the following **Table I.49**.

Table I. 49: GHG emissions from refrigeration and air-conditioning

Year	GHG emissions ($GgCO_2e$)
1994	NA
2000	NA
2005	6
2010	104
2016	330
2017	328
2018	305
2019	286
2020	274
2021	259
2022	248

2.F.3 – Fire protection

According to the FBUR, the following illustrates the use of HFCs in fire protection equipment and provides an overview of the emissions related to HFCs employed in these systems.

Table I. 50: Activity data for imports of gases in the fire protection sub-category in Cambodia

Year	Imports of gases (tons)
1994	NA
2000	NA
2005	NA
2010	NA
2016	0.082
2017	NA
2018	NA
2019	NA
2020	NA
2021	NA
2022	NA

Table I. 51: GHG emissions from fire protection

Year	GHG emissions ($GgCO_2e$)
1994	NA
2000	NA
2005	NA
2010	NA
2016	0.03116
2017	NA
2018	NA
2019	NA
2020	NA
2021	NA
2022	NA

Q. Agriculture, Forestry and Other Land Use

27. Overview

The Agriculture, Forestry, and Other Land Use (AFOLU) sector plays a critical role in Cambodia's economy, environment, and society. As a primarily agrarian nation, agriculture forms the backbone of Cambodia's economy, contributing significantly to GDP and employing around 85% of the population across approximately 6.7 million hectares of arable land. The country's key agricultural products include rice, soybeans, corn, cassava, and cashew nuts, which are vital for both domestic consumption and export. Cambodia was able to maintain a relatively high forest cover, with one of the highest levels of forest cover in Southeast Asia. Cambodia's initial Forest Reference Level is assessed at 78.953.951 tCO_2/year based on the historical average net emission level from 2006 to 2014 (Source: Cambodia Initial Emission Reference, 2016).

28. Overview of the FOLU Sector in Cambodia

This sector reports GHG fluxes between the atmosphere and Cambodia's managed lands, as well as fluxes associated with the agriculture activities in Cambodia. Since vegetation can absorb carbon from the atmosphere, this sector can function as a net sink of emissions. This assessment includes emissions and removals of carbon dioxide (CO_2) associated with carbon (C) stock changes; additional emissions of CO_2, methane (CH_4), nitrous oxide (N_2O); CO_2, CH_4 and N_2O emissions from managed organic forest soils.

The land-use change and forestry sector is the largest contributor to Cambodia's GHG emissions. Within this sector, changes in forest land are the primary source, contributing significantly to the sector's emissions. Historical data shows that the LUCF sector was once a net sink, absorbing more GHG emissions than it emitted. However, the sector's emissions have fluctuated due to ongoing deforestation and changes in land use. According to the IPCC 2006 guidelines, the AFOLU sector has been divided into 4 subcategories.

- 3A- Livestock
- 3B-Land

- 3C- Aggregated Sources and non-CO_2 Emissions Sources on Land
- Other

29. Data Collection

Table I.52 discusses the summary of data providers and the description of required data for the calculations.

Table I. 52: Description of the needed activity data and their data providers

Subcategory	Description of the data	Data Providers
Livestock (Population data)	• Estimated animal population data	• General Directorate of Animal Health and Production (GDAHP)
Land	• Forest conversion to other land categories between 2016 and 2018 based on the published transition matrices of the Cambodia's Forest Cover Map 2018 (Forest Cover Change Data 2016-2018), published by the Ministry of Environment (MOE) in 2020 • Carbon stock changes for the periods 2006-2010, 2010-2014, and 2014-2016, using the forest cover transition matrices published by the Royal Government of Cambodia • Cambodia's Forest Cover 2010 (Forest Pattern Change Data 2006-2010), published by the Forestry Administration in 2011, Cambodia Forest Cover 2016-2018 (Forest Cover Change Data 2014-2016), and Cambodia Forest Cover 2018 (Forest Cover Change Data 2016-2018), published by the Ministry of	• Ministry of Environment (MOE)

	Environment in 2018 and 2020	
Urea application	• The amount of urea in the fertilizer • The amount of urea applied	• Food and Agriculture Organization
Rice cultivation		• Food and Agriculture • Organization
Biomass burning	• Crop area burned • Amount of available aboveground biomass from the crop area burned	• Food and Agriculture • Organization
Indirect N_2O emission from manure management	• N that volatilizes from the manure system, and the N that leached or washed out (due to runoff) from the manure system	• Food and Agriculture • Organization
Indirect N_2O emission from managed soils	• Synthetic or inorganic N fertilizers • organic N applied as fertilizer, both manure and non-manure (e.g., animal manure, compost, sewage sludge, rendering waste) • urine and dung N deposited on pasture, range and paddock (PRP) by grazing animals • N in crop residues (above-ground and below-ground), including from N-fixing crops	• Food and Agriculture • Organization
Direct N_2O emission from managed soils	• Synthetic or inorganic N fertilizers • organic N applied as fertilizer, both manure and non-manure (e.g., animal manure, compost, sewage sludge, rendering waste) • urine and dung N deposited on pasture, range and paddock (PRP) by grazing animals	• Food and Agriculture • Organization

	• N in crop residues (above-ground and below-ground), including from N-fixing crops	

30. Livestock

30.1. Activity data

A revised time series for population data for the period 1990-2022 was compiled from the data held by the General Directorate of Animal Health and Production (GDAHP). However, for some species and some sub-categories, there was missing data for some years. To complete the time series for each species and each sub-category, methods to fill data gaps recommended by the IPCC were used, such as interpolation and extrapolation, as explained below.

Cattle

Cattle are divided into 'dairy cattle' that produce milk and 'other cattle' that produce meat and manure and are also used for draft power.

Dairy cattle: Dairy production in Cambodia is quite recent. Data were obtained from General Directorate of Animal Health and Production (GDAHP) for dairy cattle populations for the period 2019-2022.

Other cattle: Other cattle are divided into cattle on commercial farms and cattle produced on household scale. Commercial cattle farming began in 2006 and population data were collected from the former Department of Animal Health and Production (DAHP) which at the end of 2016 became the General Directorate of Animal Health and Production (GDAHP). Data on other cattle populations raised at the household scale were available from GDAHP from 1990 to 2022. Missing data for 2011 was filled using linear interpolation.

Buffalo

Data on the total population of buffalo were available from DAHP and GDAHP from 1990 to 2022.

Sheep

The total population of sheep was available from DAHP and GDAHP from 2009 to 2022. The recorded value for 2010 was inconsistent with other values in the time series and was replaced using linear interpolation between the 2009 and 2011 values. From 1990-2008, no data was available. The average population from 2009-2011 was calculated and this value was applied to each year in the period 1990-2008. This gives an estimate of 937 sheep per year during this period, which is higher than in the previous inventory. However, the small total population indicates a low contribution to overall emissions and inventory uncertainty.

Goats

Total populations of goat were available from DAHP and GDAHP from 2009 to 2022. The recorded value for 2010 was inconsistent with other values in the time series and was replaced using linear interpolation between the 2009 and 2011 values. From 1990-2008, no data was available. The average population from 2009-2011 was calculated and this value was applied to each year in the period 1990-2008. This gives an estimate of 20,882 goats per year during this period, which is lower than the 1990-2008 estimate in ahe previous inventory, while the estimated populations in 2009 to 2014 are higher than in the previous inventory. The small total population indicates a low contribution to overall emissions and inventory uncertainty.

Horses

Total populations of horse were available from DAHP and GDAHP from 2009 to 2022. From 1990-2008, no data was available. The average population from 2009-2011 was calculated and this value was applied to each year in the period 1990-2008. This gives an estimate of 13,591 horses per year during this period, which is higher than in the previous inventory.

Pigs

Data were collected from DAHP and GDAHP on total pig population (1990-2022), and for breeding and fattening pigs in commercial farms, and total pig populations on household scale. Commercial pig farming began in 2005. Data on total pig populations in commercial farms were available from 2005 to 2022, except 2013. For 2013, the total commercial pig population as a % of total pig populations was calculated for years with available data, and the value for 2013 was estimated by linear interpolation. This percentage was then multiplied by the total pig population to estimate total commercial pig population. Data on numbers of fattening and breeding pigs on commercial farms were available from 2010 and 2019-2022. To disaggregate commercial pig populations into breeding and fattening pigs, the percentage of breeding pigs was calculated for years with available data. From 2011-2018, the missing data was filled using linear interpolation **Table I.53** and these percentages were multiplied by the total commercial pig population to estimate the numbers of breeding pigs in each year. For 2005-2009, linear extrapolation would result in negative breeding pig numbers, so it was assumed that breeding pigs were 3.28% of total commercial pigs in each of these years. The total number of fattening pigs was then calculated as the total commercial pig population minus the total population of breeding pigs.

Table I. 53: Breeding pigs as a percentage of total commercial pigs 2010-2022

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
2.23	3.28	4.32	5.37	6.42	7.47	8.51	9.56	10.61	11.65	22.65	17.49	18.43

Note: Blue color indicates linear interpolation.

For household scale pig populations, data was obtained from GDAHP for 1990-2004 and 2014-2022. For years with missing data, total household scale pig populations were calculated as total pig population minus total commercial pig population. Following IPCC (2006) guidelines, populations of species that are alive for less than one year should apply the annual average population using IPCC Equation 10.1. However, no consistent data source on numbers of animals sold or slaughtered was identified. This has been highlighted as an inventory improvement to explore implementing together with using the Tier 2 method for pigs.

Chicken

Data on total poultry numbers were available from GDAHP for 1990-2022. This included small numbers of minor species (i.e., geese, pigeon, quail, turkey, ostrich) in 2010-2022. On average, these minor species accounted for 0.5% of total poultry population. It was estimated that total emissions from these species would be less than 4 ktCO_2e. In line with Decision 18/CMA.1 (Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement) paragraph 32, emissions from these minor poultry species were not included because they total less than 500 ktCO_2.

For years with available data, chicken and duck populations averaged 99.5% of total poultry population. Therefore, for years without specific data (i.e. 1990-2009), the combined populations of chicken and duck were estimated to be 99.5% of the total poultry population. For chicken, data on total chicken population was available for 2002, 2005-2010, and 2018-2022. In years with available data, chicken accounted for 75% of chicken and duck combined populations. Therefore, the same percentage was applied to all years to estimate total chicken populations. Data on commercial chicken layer and broiler populations were available from DAHP and GDAHP for some years between 2003 and 2022. The remaining years after 2003 were filled using linear interpolation. According to available reports,[2] commercial poultry farming started to develop between 1995 and 2000 and grew rapidly after 1997. So, this inventory assumes commercial chicken populations in 1994 were zero, and assumes linear growth from 1995 to 2003. Chicken raised on household farms were calculated as total chicken minus commercial layer and broiler populations.

Ducks

Data on total duck populations were available from DAHP and GDAHP for 2002 and 2018-2022. In years with missing data, ducks were assumed to be 25% of combined chicken and duck populations. It was assumed that commercial duck farming began in 1995, as this was the first year of operation of a commercial feed mill in Cambodia. Data on commercial duck farm populations were available from GDAHP for 2003, 2004 and 2018-2022. For years with data, the percentages in commercial and household scale farms were calculated. For years with missing data, the percentages of commercial and household scale duck were linearly interpolated and multiplied by the estimated total duck population. Commercial duck populations from 1995 to 2003 assumed a linear growth rate.

Population data time series

Table I.54 show the trend in total livestock numbers for each livestock species and the main sub-categories, including poultry populations which were used in the calculation of manure management emissions. Populations of the main ruminant species (except buffalo and horses)

2 https://www.fao.org/3/ai323e/ai323e00.pdf

have generally increased over the 1994-2022 period. The cattle population reached a peak in 2009, after which it first declined and then recovered. Pig populations also show a generally increasing trend, but with decreases in some years due to animal disease and/or unfavourable production conditions. For both pigs and chicken, growth of commercial farm populations has been notable. In 2022, the commercial pig population accounted for 65% of pigs, and commercial chicken accounted for 47% of the total chicken population.

Table I. 54: Time series for cattle, buffalo, goat, sheep and horse populations, 1994-2022 (head)

Year	Livestock population (head)						
	Dairy cattle	Other cattle, commercial	Other cattle, household	Buffalo	Sheep	Goat	Horse
1994	NA	NA	2,621,946	814,193	937	20,882	13,591
2000	NA	NA	2,813,581	676,466	937	20,882	13,591
2010	NA	3,856	3,480,745	702,074	937	20,882	13,210
2016	NA	23,382	2,896,932	523,514	467	28,977	5,674
2017	NA	20,561	2,951,161	508,656	461	28,907	5,137
2018	NA	11,232	2,917,302	500,995	459	26,447	4,296
2019	300	9,877	2,769,885	447,385	648	27,740	3,801
2020	1,176	12,040	2,836,536	423,825	1,725	30,281	2,971
2021	1,058	13,589	2,953,809	432,559	4,293	43,561	3,583
2022	1,126	14,758	3,443,809	447,943	5,524	49,162	2,541

Source: This inventory, using data from DAHP and GDAHP

Table I. 55: Time series for pig, chicken and duck populations, 1994-2022 (head)

Year	Livestock population (head)							
	Pig			Commercial chicken		Household scale chicken	Duck	
	Commercial breeding	Commercial fattening	Household scale	Layer	Broiler		Commercial	Household scale
1994	NA	NA	2,002,306	NA	NA	7,230,095	NA	2,410,031
2000	NA	NA	1,979,113	252,447	252,902	10,258,533	553,728	3,034,233
2005	299	8,811	2,681,338	174,740	365,775	10,264,508	382,230	3,219,444
2010	3,554	155,896	1,897,981	528,790	1,006,715	13,972,543	970,218	4,199,131
2016	51,015	548,457	2,371,152	773,000	3,987,914	21,910,540	2,538,767	6,351,718
2017	71,007	671,740	2,331,536	839,850	4,576,580	21,698,961	2,728,461	6,310,003
2018	86,240	726,576	1,935,039	906,700	5,165,246	22,279,131	3,065,463	6,568,771
2019	134,663	1,020,768	1,030,494	731,587	11,134,517	19,776,979	689,870	7,887,357
2020	312,484	1,067,139	1,137,056	848,710	15,810,426	22,523,571	777,800	7,914,124
2021	309,349	1,459,281	1,250,167	1,219,412	19,433,140	24,215,876	806,200	7,525,543
2022	407,490	1,803,508	1,220,064	1,081,350	22,223,280	26,206,294	833,660	7,433,932

Source: This inventory using data from DAHP and GDAHP

The major differences with the livestock population data time series used in the previous GHG inventory submission are due to disaggregating other cattle, pigs, and poultry into commercial and household scale; breeding and fattening pigs; and layer and broiler chicken, which is in line with guidance in the 2019 Refinement to the IPCC Guidelines. Other differences are due to different methods used to fill data gaps. Differences with previous inventory estimates and data from FAOSTAT were used to estimate the uncertainty of population data estimates (i.e., activity data uncertainty).

3.A.1 Enteric Fermentation

30.2. Category description

Methane is produced during the normal digestive process of enteric fermentation in herbivores. Micro-organisms in the gastrointestinal tract break down carbohydrates and proteins into simple molecules for absorption and CH_4 is produced as a by-product. The inventory covers all major livestock species kept in Cambodia, including cattle, buffalo, pig, horse, sheep and goats. Poultry are not included in the calculation of enteric fermentation because the IPCC Guidelines do not provide a methodology to quantify related emissions.

30.3. Activity data

All emissions are based on animal populations. The activity data for all species was compiled by the General Directorate of Animal Health and Production (GDAHP). The activity data used are shown in **Table I- 56** in the initial activity data section under livestock.

Table I. 56: Activity data – Animal populations (heads), 1994-2022

Year	Cattle	Buffaloes	Poultry	Horses	Sheep	Goats	Swine	Other
1994	2,620,905	809,200	10,017,100	7,682	689	23,987	2,024,178	NA
2000	2,992,670	693,650	15,249,770	7,682	689	23,987	1,933,950	NA
2005	3,193,146	676,646	15,085,547	7,682	689	23,987	2,688,612	NA
2010	3,484,481	702,074	20,543,509	12,468	613	10,547	2,057,431	NA
2016	2,897,126	523,320	28,230,663	5,610	400	22,719	3,074,283	NA
2017	2,971,722	508,656	36,244,939	5,137	461	28,907	3,074,283	NA
2018	2,928,534	500,995	38,166,751	4,296	459	26,447	2,747,855	NA
2019	2,779,762	447,385	40,395,452	3,801	648	27,740	2,185,924	185
2020	3,429,529	423,825	48,062,169	2,971	1,725	30,281	2,516,679	311
2021	2,781,925	432,559	53,422,704	3,583	4,293	43,561	3,018,797	546
2022	3,458,567	447,943	58,154,987	2,541	5,524	49,162	3,431,062	2,199

30.4. Methodology and emission factors

The inventory of enteric fermentation emissions was compiled following the Tier 1 method of the 2019 Refinement to the IPCC 2006 Guidelines, including Tier 1a for cattle and pigs. Recalculations compared to the previous inventory compiled using the IPCC 2006 Guidelines are presented in Section 5.2.6.

Emissions from each animal category were calculated using the equation:

Equation I. 5 : Emission from Enteric fermentation

$$E_T = \sum_{(P)} EF_{(T,P)} \times \left(\frac{N_{(T,P)}}{10^6}\right) \quad \text{(IPCC 2019 Equation 10.19)}$$

where

- E_T = methane emissions from enteric fermentation in animal category T, Gg CH_4 yr^{-1}
- $EF_{(T,P)}$ = emission factor for livestock population T in productivity system P, kg CH_4 $head^{-1}$ yr^{-1}
- $N_{(T,P)}$ = number of head of livestock in animal category T in production system P, $head^{-1}$ yr^{-1}
- *T* = species or category of livestock
- *P* = productivity system (high or low) for those species using the Tier 1a method.

Total enteric emissions were calculated as:

Equation I. 6 : Total enteric emissions

$$\text{Total } CH_{4\ Enteric} = \sum_{i,P} E_{i,P} \quad \text{(IPCC 2019 Equation 10.20)}$$

Where

Total $CH_{4\ Enteric}$ = total methane emissions from enteric fermentation, Gg CH_4 yr^{-1}
$E_{i,P}$ = emissions for the livestock category based on production systems (P)

Table I. 57: Emission factors for enteric fermentation (kg CH4 head-1 yr-1)

Species / category	Emission factors	Reference
Dairy cattle	71	IPCC (2019) Table 10.11 and Table 10A.1 low productivity system value for Asia
Other cattle, commercial	43	IPCC (2019) Table 10.11 and Table 10A.2, high productivity system value for Asia
Other cattle, household scale	56	IPCC (2019) Table 10.11 and Table 10A.2, low productivity system value for Asia
Buffalo	68	IPCC (2019) Table 10.11
Sheep	5	IPCC (2019) Table 10.10 low productivity system value

Goat	5	IPCC (2019) Table 10.10 low productivity system value
Horse	9.6	IPCC (2019) Table 10.10 and Table 10A.5; Emission factor calculated using the ratio of the weights of the animals raised to the 0.75 power.
Commercial breeding pigs	2.7	IPCC (2019) Table 10.10 and Table 10A.5 high productivity system value; Emission factor calculated using the ratio of the weights of the animals raised to the 0.75 power.
Commercial fattening pigs	1.2	IPCC (2019) Table 10.10 and Table 10A.5 high productivity system value; Emission factor calculated using the ratio of the weights of the animals raised to the 0.75 power.
Household scale pigs	1	IPCC (2019) Table 10.10 low productivity system value

Cattle

Cattle are divided into 'dairy cattle' that produce milk in commercial quantities for consumption (IPCC 2019 -Vol 4 Ch 10 p.10.14), and 'other cattle' that produce meat and manure and are also used for draft power.

Applying the IPCC definition of dairy cattle has led to a downward revision of the dairy cattle population compared to the last NIR submission. Commercial dairy cattle production in Cambodia is quite recent. Data on dairy cattle populations were obtained from General Directorate of Animal Health and Production (GDAHP) for dairy cattle populations for the period 2019-2023. The emission factor for dairy cattle used the low productivity value for Asia from IPCC 2019 Table 10.11 and Table 10A.1 because the body weights and milk yields used for this default value are similar to values for dairy cattle in Cambodia.

Other cattle are divided into cattle on commercial farms and cattle produced on household scale. Commercial cattle farming began in 2006. The majority of the other cattle population is on household scale farms. The Tier 1a default emission factor for high productivity systems in Asia was used for cattle on commercial farms, and the low productivity system default value for Asia was used for household scale cattle.

Buffalo

Total buffalo population data were compiled by GDAHP. The emission factor used the Tier 1 default value for Asia.

Sheep

Total sheep population data were compiled by GDAHP. Data for 1990-2008 was missing, so the average population of 2009-2011 was used. This is higher than the estimate for this period in the previous inventory, but the small total population indicates a low contribution to overall emissions and inventory uncertainty. The emission factor used the Tier 1 default value for low productivity systems.

Goats

Total goat population data were compiled by GDAHP. Data for 1994-2008 was missing, so the average population of 2009-2011 was used. This is lower than the estimate for this period in the previous inventory, but the small total population indicates a low contribution to overall emissions and inventory uncertainty. The emission factor used the Tier 1 default value for low productivity systems.

Horses

Total horse population data were compiled by GDAHP. Data for 1994-2008 was missing, so the average population of 2009-2011 was used. This is higher than the estimate for this period in the previous inventory. IPCC (2019) Table 10.10 indicates that the Tier 1 emission factor applies to horses with an average body weight of 550 kg. The method described in IPCC 2019 Section 10.2.4 was used to estimate the enteric emission factor for a horse weighing 238 kg, which was taken from IPCC (2019) Table 10A.5.

Pigs

Populations of breeding and fattening pigs on commercial farms and total pig populations on household scale farms were compiled by GDAHP. The Tier 1a default emission factor for high productivity systems (IPCC 2019 Table 10.10) was scaled by the ratio of weights to the 0.75 power using the live weights provided for high productivity systems in Asia in IPCC 2019 Table 10A.5. For household scale pigs, the low productivity system emission factor in Table 10.10 was used.

31. Results

Table I. 58: Emissions from enteric fermentationby species/category (Gg CH_4)

	Dairy cattle	Other cattle	Other cattle	Other cattle	Buffalo	Sheep	Goats	Horses	Pigs	Pigs	Pigs	Pigs	Pigs	Total
Year	**Total**	**Total**	**Commercial**	**Household scale**	**Total**	**Total**	**Total**	**Total**	**Total**	**Total commercial**	**Commercial breeding**	**Commercial fattening**	**Household scale**	**all species**
2016	0	163.23	1.01	162.23	35.60	0	0.14	0.05	3.17	0.8	0.14	0.66	2.37	**202**
2017	NA	166.15	0.88	165.27	34.59	0	0.14	0.05	3.33	1	0.19	0.81	2.33	**204**
2018	NA	163.85	0.48	163.37	34.07	0	0.13	0.04	3.04	1.1	0.23	0.87	1.94	**201**
2019	0.02	155.54	0.42	155.11	30.42	0	0.14	0.04	2.62	1.59	0.36	1.22	1.03	**189**
2020	0.08	159.36	0.52	158.85	28.82	0.01	0.15	0.03	3.26	2.12	0.84	1.28	1.14	**192**
2021	0.08	166	0.58	165.41	29.41	0.02	0.22	0.03	3.84	2.59	0.84	1.75	1.25	**200**
2022	0.08	193.49	0.63	192.85	30.46	0.03	0.25	0.02	4.48	3.26	1.1	2.16	1.22	**229**

3.A.2 Manure Management

31.1. Category description

Both CH_4 and N_2O are emitted during handling and storage of livestock manure. The magnitude of emissions depends on the quantity of manure managed, its characteristics, and the type of manure management system. In general, poorly aerated manure management systems generate high CH4 emissions but relatively low N_2O emissions, whereas well-aerated systems generate high N_2O emissions but relatively low CH_4 emissions.
The inventory covers all major livestock species kept in Cambodia, including cattle, buffalo, pig, horse, sheep and goats, as well as chicken and duck.

31.2. Activity data

All emissions are based on animal populations as similar to the enteric fermentation. The animal populations are estimated based on different references. Data from 1994-2007 is from Statics Yearbook 2008, data from 2008-2017 is from Annual Report of the General Directorate of Livestock and Livestock Production reports from the Ministry of Agriculture, Forestry and Fisheries (MAFF). Data from 2016 to 2022 on livestock population from the MAFF. The category of poultry only includes chicken and ducks which are the main poultry production in Cambodia (pigeons, quails and geese are neglected).

31.3. Methodology and emission factors for CH_4

Methane emissions were calculated using the Tier 1 method of the 2019 Refinement to the IPCC 2006 Guidelines Equation 10.22:

Equation I. 7: Methane emissions from manure management

$$CH_{4(mm)} = \sum_{(T,S,P)} \left(N_{(T,P)} \times VS_{(T,P)} \times AWMS_{(T,S,P)} \times EF_{(T,S,P)} \right) / 1000$$

where

$CH_{4(mm)}$ = methane emissions from manure management, kg CH_4 yr^{-1}

$N_{(T,P)}$ = number of head of livestock in animal category T in production system P, $head^{-1}$ yr^{-1}

$VS_{(T,P)}$ = annual average volatile solid excretion per head of animal in category T in productivity system P, kg VS $head^{-1}$ yr^{-1}

$AWMS_{(T,S,P)}$ = fraction of total annual VS for each animal category T in productivity system P that is managed using manure management system S, dimensionless

$EF_{(T,S,P)}$ = emission factor for CH_4 emissions from manure management system S by livestock population T in productivity system P, g CH_4 kg VS^{-1}

S = manure management system

T = species or category of livestock

P = productivity system (high or low) for those species using the Tier 1a method and IPCC (2019) Equation 10.22A:

Equation I. 8: Annual average volatile solid excretion per head of animal

$$VS_{(T,P)} = \left(VS_{rate(T,P)} \times \frac{TAM_{(T,P)}}{1000}\right) \times 365$$

where

$VS_{rate(T,P)}$ = default VS excretion rate for animal category T in productivity system P, kg VS (1000 kg animal mass)$^{-1}$ day^{-1}

$TAM_{(T,P)}$ = typical animal mass for livestock in animal category T in production system P, kg head^{-1}

For cattle, buffalo, pig, horse, sheep and goats, animal populations were the same as used for enteric fermentation. A time series for 'poultry' was available for 1994-2022. For this inventory, minor species (i.e., geese, pigeon, quail, turkey, ostrich) occurring in 2010-2022 were removed from the data, and assumptions described in initial activity data section under livestock, used to separate the remaining poultry population into chicken (including commercial broilers, commercial layers and household scale) and duck (commercial and household scale).[3] The manure management system data used the default AWMS values from IPCC 2019 (Tables 10A.6-10A.9) for each livestock species in each productivity system (5-7).

TAM values were taken from IPCC (2019) Table 10A.5 and VS_{rate} values were taken from IPCC (2019) Table 10.13a, selecting the appropriate values for high or low productivity systems to be consistent with the assumptions used to estimate enteric fermentation. Methane emission factors (g CH_4 kg VS^{-1}) for each livestock species and each manure management system were taken from the 2019 Refinement Table 10.14, using values for the appropriate level of productivity and the tropical moist climate. The climate zone was selected based on the decision tree in IPCC (2019) Volume 4 Chapter 3 Figure 3A.5.2, and inspection of temperature and precipitation data for Cambodia from the World Bank Climate Knowledge Portal.[4] The emission factors used are shown in **Table I.59**.

3 On average in 2010-2022, these minor species accounted for 0.5% of the total poultry population. It was estimated that total emissions from these species would be less than 4 ktCO2e, so it was decided not to include these minor poultry species in the revised inventory (Decision 18/CMA.1, paragraph 32).

4 https://climateknowledgeportal.worldbank.org/country/cambodia/climate-data-historical

Table I. 59: Methane emission factors from manure management (g CH_4 kg VS^{-1})

Species	Manure Storage System	Emission factors [Tropical moist]	Reference
Dairy cattle	Liquid/slurry	63.6	IPCC (2019) Table 10.14 low productivity system
	Solid storage	4.4	IPCC (2019) Table 10.14 low productivity system
	Dry lot	1.7	IPCC (2019) Table 10.14 low productivity system
	Daily spread	0.9	IPCC (2019) Table 10.14 low productivity system
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14
Other cattle	Solid storage	4.4	IPCC (2019) Table 10.14 low productivity system
	Dry lot	1.7	IPCC (2019) Table 10.14 low productivity system
	Daily spread	0.9	IPCC (2019) Table 10.14 low productivity system
	Digester	9.5	IPCC (2019) Table 10.14 low productivity system
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14
Buffalo	Solid storage	4.4	IPCC (2019) Table 10.14
	Dry lot	1.7	IPCC (2019) Table 10.14
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14
Sheep	Solid storage	4.4	IPCC (2019) Table 10.14 low productivity system
	Dry lot	1.7	IPCC (2019) Table 10.14 low productivity system
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14
Goats	Solid storage	4.4	IPCC (2019) Table 10.14 low productivity system
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14
Horses	Solid storage	8.7	IPCC (2019) Table 10.14 low productivity system
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14
Commercial fattening and breeding pigs	Lagoon	241.2	IPCC (2019) Table 10.14 high productivity system
	Liquid/slurry	220.1	IPCC (2019) Table 10.14 high productivity system
	Dry lot	6	IPCC (2019) Table 10.14 high productivity system
	Pit < 1 month	108.5	IPCC (2019) Table 10.14 high productivity system
	Digester	7	IPCC (2019) Table 10.14 high productivity system
Household scale pigs	Lagoon	155.4	IPCC (2019) Table 10.14 low productivity system
	Liquid/slurry	141.8	IPCC (2019) Table 10.14 low productivity system
	Solid storage	9.7	IPCC (2019) Table 10.14 low productivity system

	Dry lot	3.9	IPCC (2019) Table 10.14 low productivity system
	Pit > 1 month	69.9	IPCC (2019) Table 10.14 low productivity system
	Pit < 1 month	141.8	IPCC (2019) Table 10.14 low productivity system
	Daily spread	1.9	IPCC (2019) Table 10.14 low productivity system
	Digester	21.2	IPCC (2019) Table 10.14 low productivity system
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14
Commercial layer and broiler chicken and duck	Lagoon	209	IPCC (2019) Table 10.14
	Liquid/slurry	190.7	IPCC (2019) Table 10.14
	Pit storage	190.7	IPCC (2019) Table 10.14
	Dry lot	5.2	IPCC (2019) Table 10.14
	Solid storage	13.1	IPCC (2019) Table 10.14
	Daily spread	0	IPCC (2019) Table 10.14
	Digester	13.1	IPCC (2019) Table 10.14
	Poultry manure with litter	0.36	Calculated
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14
Household scale poultry	Daily spread	2.4	IPCC (2019) Table 10.14
	Pasture/range/paddock	0.6	IPCC (2019) Table 10.14

Source: 2006 IPCC guidelines-2019 Refinement (for Asia) Table 10.14 , 10.15 and 10.16

Table I. 60: Manure management systems used for each livestock species (%)

Manure Management System	Dairy cattle	Other cattle	Buffalo	Goats	Sheep	Horses	Pigs (3A2h)		Chicken (3A2i)			Duck (3A2j)	
	(3A2ai)	(3A2aii)	(3A2b)	(3A2c)	(3A2d)	(3A2f)	Commercial breeding & fattening pigs	Household scale pigs	Commercial broiler	Commercial layer	Household scale	Commercial	Household scale
Lagoon	0	0	0	0	0	0	35	5	0	0	0	0	0
Liquid/slurry	1	0	0	0	0	0	21	27	0	4	0	0	0
Pit storage	0	0	0	0	0	0	35	19	0	94	0	0	0
Dry lot	29	28	64	0	3	0	2	14	0	0	0	0	0
Solid storage	21	29	6	50	17	50	0	18	0	0	0	0	0
Daily spread	0	0	0	0	0	0	0	6	0	1	50	0	50
Burned for fuel or waste – sun dried dung burned for fuel	11	7	2	0	0	0	0	0	0	0	0	0	0
Digester	1	0	0	0	0	0	7	5	0	0	0	0	0
Poultry manure with litter	0	0	0	0	0	0	0	0	100	0	0	100	0
Poultry manure without litter	0	0	0	0	0	0	0	0	0	0	0	0	0
Pasture/range/paddock	38	36	28	50	80	50	0	0	0	1	50	0	50
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

31.4. Methodology and emission factors for N_2O

Direct N_2O emissions were calculated using the IPCC Tier 1 method using IPCC (2019) Equations 10.25 and 10.30:

Equation I. 9: Direct N2O emissions from manure management

$$N2O_{D(mm)} = \sum_S \left[\sum_{(T,P)} \left(\left(N_{(T,P)} \times Nex_{(T,P)} \right) \times AWMS_{(T,S,P)} + N_{cdg(s)} \right) \times EF_{3(S)} \right] \times \frac{44}{28}$$

where

$N2O_{D(mm)}$ = direct nitrous oxide emissions from manure management, kg N_2O yr^{-1}

$N_{(T,P)}$ = number of head of livestock in animal category T in production system P, $head^{-1}$ yr^{-1}

$Nex_{(T,P)}$ = annual average N excretion per head of animal in category T in productivity system P, kg N $head^{-1}$ yr^{-1}

$N_{cdg(s)}$ = annual N input via co-digestate in the country, Kg N yr^{-1}, for which there was no information so a value of zero was used in the calculations.

$AWMS_{(T,S,P)}$ = fraction of total annual VS for each animal category T in productivity system P that is managed using manure management system S, dimensionless

$EF_{3(S)}$ = emission factor for direct N_2O emissions from manure management in system S, kg N_2O-N/ kg N in manure management system S

S = manure management system

T = species or category of livestock

P = productivity system (high or low) for those species using the Tier 1a method.

and:

Equation I. 10: Annual average N excretion per head of animal

$$Nex_{(T,P)} = N_{rate(T,P)} \times \frac{TAM_{(T,P)}}{1000} \times 365$$

where

$N_{rate(T,P)}$ = Default N excretion rate for animal category T in productivity system P, kg N (1000 kg animal mass)$^{-1}$ day^{-1}

$TAM_{(T,P)}$ = Typical animal mass for livestock in animal category T in production system P, kg $head^{-1}$

The manure management system (AWMS) activity data used for N_2O is the same as was used for CH_4 for each livestock species **(Table I.61).** N_{rate} (kg N (1000 kg animal mass^{-1}) day^{-1}) values were taken from IPCC (2019) Table 10.19 and are shown in 5-10 and the same TAM values were used as for CH_4 emissions from manure management. The emission factors (EF_3) used were the IPCC default emission factors from IPCC (2019) Table 10.21 (Table 0-120).

Table I. 61: Nrate values used in the inventory (kg N (1000 kg animal mass-1) day-1)

Species	Sub-category	N rate
Dairy cattle	-	0.41
Other cattle	Commercial	0.36

Other cattle	Household scale	0.39
Buffalo	-	0.44
Sheep	-	0.32
Goats	-	0.34
Horses	-	0.46
Pigs	Commercial, breeding	0.32
Pigs	Commercial fattening	0.63
Pigs	Household scale	0.67
Chicken	Commercial layers	0.89
Chicken	Commercial broilers	1.31
Chicken	Household scale	1.62
Duck	Commercial	0.83
Duck	Household scale	0.83

Table I. 62: Emission factors (EF3) used to calculate direct N2O emissions from manure management

Manure management system	EF3 [kg N2O-N (kg Nitrogen excreted)-1]	Source
Anaerobic lagoon	0	IPCC 2019 Table 10.21
Liquid/slurry	0	IPCC 2019 Table 10.21
Pit Storage	0.002	IPCC 2019 Table 10.21
Dry lot	0.02	IPCC 2019 Table 10.21
Solid storage	0.005	IPCC 2019 Table 10.21
Daily spread	0	IPCC 2019 Table 10.21
Burned as fuel/waste	0	IPCC 2019 Table 10.21
Digester	0.0006	IPCC 2019 Table 10.21
Pasture/range/paddock	NA	
Poultry manure with litter	0.0001	IPCC 2019 Table 10.21

32. Results

Table I. 63: Manure management methane emissions by species/category 2016-2022 (Gg CH4)

	Dairy cattle	Other cattle	Buffalo	Sheep	Goats	Horses	Pigs	Chicken	Duck	Total
	Total	Total	Total	Total	Total	Total	Total	Total	Total	All species
2016	NA	6.7670	1.3175	0.0001	0.0066	0.0165	32.0626	1.1281	0.0762	**41**
2017	NA	6.8871	1.2801	0.0001	0.0066	0.0149	34.3370	1.2100	0.0800	**44**
2018	NA	6.7897	1.2608	0.0001	0.0060	0.0125	32.1011	1.2886	0.0799	**42**
2019	0.0007	6.4450	1.1259	0.0001	0.0063	0.0111	33.3546	1.0800	0.0900	**46**
2020	0.0032	6.6040	1.0666	0.0001	0.0069	0.0086	36.1076	1.2500	0.0900	**45**
2021	0.0029	6.8791	1.0886	0.0001	0.0099	0.0010	43.9667	1.6900	0.0800	**54**
2022	0.0030	8.0181	1.1273	0.0006	0.0112	0.0739	52.0004	1.6107	0.0835	**63**

Table I. 64: Manure management nitrous oxide emissions by species/category 2016-2022 (Gg N2O)

	Dairy cattle	Other cattle	Buffalo	Sheep	Goats	Horses	Pigs	Chicken	Duck	Total
	Total	Total	Total	Total	Total	Total	Total	Total	Total	all species
2016	NA	2.5932	0.8262	0.0001	0.0014	0.0036	0.2670	0.0020	0.0033	**3.7**
2017	NA	2.6390	0.8028	0.0001	0.0014	0.0032	0.266	0.0050	0.0035	**3.7**
2018	NA	2.6010	0.7907	0.0001	0.0012	0.0027	0.2258	0.0056	0.0039	**3.6**
2019	0.0003	2.4689	0.7061	0.0001	0.0013	0.0024	0.1424	0.0098	0.0009	**3.3**
2020	0.0012	2.5300	0.6689	0.0001	0.0014	0.0019	0.1562	0.0135	0.0010	**3.4**
2021	0.0011	2.6354	0.6827	0.0003	0.0020	0.0022	0.1773	0.0169	0.0010	**3.5**
2022	0.0012	3.0717	0.7069	0.0003	0.0023	0.0016	0.1853	0.0187	0.0011	**4.0**

R. Land

Cambodia have set goals to reduce GHG emissions by 42% by 2030 (NDC, 2020). The majority of these emission reductions are foreseen to be achieved through the FOLU sector. The government plans to achieve carbon neutrality by 2031 for the FOLU sector and it is expected that this sector acts as a carbon sink to mitigate emissions from other sectors by 2050.To track the progress towards these goals an accurate and transparent approach to emission estimations from the FOLU sector is needed. To achieve this, the Government is aiming on reducing deforestation to 50% of historical baseline by 2030 as one of its main mitigation strategies, therefore accurate estimation of deforested areas is of utmost importance. The calculations for the lands are based on a comprehensive monitoring of the land use and a country specific estimate for each type of land.

32.1. Activity data

Estimates were made for forest conversion to other land categories between 2016 and 2018, based on the published transition matrices of the Cambodia's Forest Cover Map 2018 (Forest Cover Change Data 2016-2018), published by the Ministry of Environment (MOE) in 2020. Additionally, the analysis revisited carbon stock changes for the periods 2006-2010, 2010-2014, and 2014-2016, using the forest cover transition matrices published by the Royal Government of Cambodia for those years. This includes official data such as Cambodia's Forest Cover 2010 (Forest Pattern Change Data 2006-2010), published by the Forestry Administration in 2011, Cambodia Forest Cover 2016-2018 (Forest Cover Change Data 2014-2016), and Cambodia Forest Cover 2018 (Forest Cover Change Data 2016-2018), published by the Ministry of Environment in 2018 and 2020, respectively. The land-use matrices for the 2014-2016 and 2016-2018 periods were developed within the framework of Cambodia's REDD+ program, with a focus on forest land. It is important to note that the activity data used in this analysis differs from those in **Table 51** of the Biennial Transparency Report (BUR), as the data in this report is based on the above-mentioned sources, while **Table 51** in the BUR relies on extrapolation methods using data from 2000-2009 and 2010-2016.mm. The activity data is the set of land use matrixes implemented thanks to the comparison of different cartographies for 2006, 2010, 2014, 2016 and 2018. These matrixes are mostly focusing on forest areas because they were elaborated in the framework of the REDD+ program to define the forest reference level for Cambodia. As defined by the IPCC categories, activity data for forest land ranges from 7,500,000 ha in 2016 to approx. 7,300,000 ha in 2018 (**Table 5-11**). The data, presented in **Table I.64**, uses the published official forest cover transition matrices from 2010 to 2018, as specified in the methodology to estimate the changes in land cover between the different transition categories.

Categories, activity data for forest land ranges from 7,500,000 ha in 2016 to approx. 7,300,000 ha in 2018. It uses the published official forest cover transition matrices from 2010 to 2018, as specified in the methodology to estimate the changes in land cover between the different transition categories.

Table I. 65: Activity data – Aggregated area land and land use changes (1 year matrixes) – ha or ha/Year

Year	Forest becoming other land	Other land becoming forest	Forest remaining forest	Other land remaining other land	Total forest	Total other land	Total land area
1994	139,471	47,723	11,233,546	6,739,935	11,281,269	6,879,405	18,160,674
2000	139,471	47,723	11,233,546	6,739,935	11,281,269	6,879,405	18,160,674
2005	139,471	47,723	11,233,546	6,739,935	11,281,269	6,879,405	18,160,674
2010	579,280	95,845	10,267,943	7,217,605	10,363,789	7,796,885	18,160,674
2016	140,119	10,309	8,083,437	9,926,810	8,093,746	10,066,928	18,160,674
2017	140,119	10,309	8,083,437	9,926,810	8,093,746	10,066,928	18,160,674
2018	140,119	10,309	8,083,437	9,926,810	8,093,746	10,066,928	18,160,674

32.2. Emission Factors (EFs)

Updated emissions factors for the different forest cover categories were obtained from the Second Forest Reference Level for Cambodia (FRL 2) under the UNFCCC Framework (**Table I.66).** Previous emission calculations (before 2016) were updated with the FRL 2 emission factors for comparability, for reference both values are included.

Table I. 66: Comparison between emission factors from the second (FRL 2) and first (FRL 1) Forest Reference Level for Cambodia under the UNFCCC Framework (RGC, 2017, 2020).

Forest type	FRL 2 * CO_2 (ton/ha)	FRL 1 CO_2 (ton/ha)
Evergreen Forest	314	334
Semi-evergreen Forest	342	495
Deciduous Forest	147	178
Regrowth Forest	155	157
Flooded Forest	165	146
Tree Plantation	207	207
Pine Plantation	207	207
Mangrove	245	308
Rear Mangrove	424	339
Bamboo	0	0
Non-Forest	0	0

*The result of the emission presented in Table I.67-68 used the FRL2

32.3. Methodology

Emissions from the Forest and Other Land Use (FOLU) Sector are calculated using the stock-difference method, following Equation 2.5 from the 2006 IPCC Guidelines (Fig 5-4). These calculations are based on comprehensive land use monitoring using national maps produced by the government. Changes in carbon were estimated and aggregated into the IPCC-defined transition classes.

Equation I. 11: Stock-difference method , Source: Chapter 2 Generic Methodologies applicable to multiple land use categories, 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

EQUATION 2.5

CARBON STOCK CHANGE IN A GIVEN POOL AS AN ANNUAL AVERAGE DIFFERENCE BETWEEN ESTIMATES AT TWO POINTS IN TIME (STOCK-DIFFERENCE METHOD)

$$\Delta C = \frac{(C_{t_2} - C_{t_1})}{(t_2 - t_1)}$$

Where:

ΔC = annual carbon stock change in the pool, tonnes C yr^{-1}

C_{t_1} = carbon stock in the pool at time t_1, tonnes C

C_{t_2} = carbon stock in the pool at time t_2, tonnes C

After calculating the annual carbon stock change (ΔC), it was converted to CO_2 emission by multiplying based on the ratio of molecular weights (44/12). Categories " Forest remaining forests" and "other land converted to forests" were considered as sinks as forests contribute for the removals. The annual carbon stock change (ΔC) of those two categories was multiplied by (-44/12). "Forest land converted to other land" was considered as a source and it was multiplied by (+44/12).

33. Results

The emissions from the 3B1 category decreased between 2016 and 2018, according to the figures published in the Forest Cover 2018 map (MoE, 2020) using emission factors (EFs) from FLR2. **Table I.66** shows the changes in carbon stocks from forestland, based on the IPCC transition categories. **Table I.67** illustrates the conversion of these changes to CO2 equivalents.

Table I. 67: Carbon stock changes in forest land

AGB + BGB Fluxes(tC/yr)	1994	2000	2005	2010	2016	2017	2018
Forest becoming other land*	-8,908,342	-8,908,342	-8,908,342	-34,155,017	-7,989,526	-7,989,526	-7,989,526
Other land becoming forest	2,685,820	2,685,820	2,685,820	4,846,436	556,446	556,446	556,446
Forest remaining forest	-137,625	-137,625	-137,625	-592,666	-71,914	-71,914	-71,914
Other land remaining other land*	NA	NA	NA	NA	NA	NA	NA
Total forest	2,548,195	2,548,195	2,548,195	4,253,770	484,532	484,532	484,532
Total other land *	-8,908,342	-8,908,342	-8,908,342	-34,155,017	-7,989,526	-7,989,526	-7,989,526
Total(tC/yr)	-6,360,147	-6,360,147	-6,360,147	-29,901,247	-7,504,994	-7,504,994	-7,504,994

*Other lands encompass all lands which are not forest (cropland, grassland etc).

Table I. 68: Carbon emissions from forest land converted to CO2 equivalent (GgCO2/year)

AGB + BGB Fluxes (GgCO_2/yr)	1994	2000	2005	2010	2016	2017	2018
Emissions (Gg CO_2/yr)	32,664	32,664	32,664	125,235	29,295	29,295	29,295
Removal (Gg CO_2/yr)	-9,343	-9,343	-9,343	-15,597	-1,777	-1,777	-1,777
Emissions/Removals (Gg CO2/yr)	23,321	23,321	23,321	109,638	27,518	27,518	27,518

S. Aggregate sources and non-CO_2 emissions sources on land

This section covers Cambodia's aggregate sources of GHG emissions for the 3C categories in the agriculture sector as follows:

- 3.C.1. Biomass burning in Cropland (Agricultural residues)
- 3.C.2 CO2 Emissions from Liming (not estimated)
- 3.C.3. CO2 Emissions from Urea Application
- 3.C.4. Direct N2O Emissions from Managed Soils
- 3.C.5. Indirect N2O Emissions from Managed Soils
- 3.C.6. Indirect N2O Emissions from Manure Management
- 3.C.7. CH4 Emissions from Rice Cultivation

The GHG inventory covers the period from 2016 to 2022. It applies Tier 1 method from the IPCC 2006 Guidelines for National GHG Inventories (IPCC 2006 Guidelines), with emission factors taken from the 2019 Refinement to the IPCC 2006 Guidelines, as available and as appropriate.

33.1. 3.C.1 – Biomass burning in Cropland (Agricultural residues)

33.1.1. Activity data and Emission factors

GHG emissions from burning of agricultural residues are influenced by the crop area burned, the amount of available aboveground biomass from the crop area burned, and the combustion factor or the proportion of the biomass that is actually burned.

For Cambodia, the main sources of biomass burned are from the planting or production of maize, rice, and sugarcane. Between 2016 and 2022, the total area planted to these crops did not change much. However, the total biomass burned, from these 3 crops, seems to increase over the years due to increasing crop yield, as well as biomass.

Table I. 69: Main sources of agricultural residues in Cambodia which are subject to burning

Year	Crop Type	Area Burned	Biomass Available	Combustion Factor	Total Biomass Burned
		(ha/yr)	(t dm/ha)	(unitless)	(t dm)
2016	Maize	1,620	10	0.8	12,960
	Rice	93,909	5.5	0.8	413,200
	Sugar Cane	1,914	6.5	0.8	9,953
	Total	97,443			436,112
2017	Maize	2,057	10	0.8	16,456
	Rice	96,196	5.5	0.8	423,262
	Sugar Cane	1,914	6.5	0.8	9,953
	Total	**100,166**			**449,671**
2018	Maize	2,082	10	0.8	16,656
	Rice	100,078	5.5	0.8	440,343
	Sugar Cane	2,002	6.5	0.8	10,410

	Total	**104,162**			**467,410**
2019	Maize	1,855	10	0.8	14,840
	Rice	99,865	5.5	0.8	439,406
	Sugar Cane	1,702	6.5	0.8	8,850
	Total	**103,422**			**463,096**
2020	Maize	1,470	10	0.8	11,760
	Rice	102,124	5.5	0.8	449,346
	Sugar Cane	1,247	6.5	0.8	6,484
	Total	**104,841**			**467,590**
2021	Maize	1,216	10	0.8	9,728
	Rice	106,582	5.5	0.8	468,961
	Sugar Cane	4,571	6.5	0.8	23,769
	Total	**112,369**			**502,458**
2022	Maize	1,985	10	0.8	15,880
	Rice	102,095	5.5	0.8	449,218
	Sugar Cane	4,148	6.5	0.8	21,570
	Total	**108,228**			**486,668**

33.1.2. Methodology and emission factors

A generic methodology to estimate the emissions of individual greenhouse gases for any type of fire is summarised in Equation 2.27 in IPCC 2019 Refinement Volume-4 Chapter- 2as below.

Equation I. 12: Amount of greenhouse gas emissions from fire

$L_{fire} = A \times M \times C_f \times G_{ef} \times 10^{-3}$

Where:

- L_{fire} = amount of greenhouse gas emissions from fire, tons of each GHG e.g., CH_4, N_2O, etc.
- A = area burnt, ha
- M_B = mass of fuel available for combustion, tons ha-1.
- C_f = combustion factor, dimensionless (default values in Table 2.6 – IPCC 2019 Volume 4)
- G_{ef} = emission factor, g kg-1 dry matter burnt (default values in Table 2.5 – IPCC 2019 Volume 4)

33.1.3. Emission factors

Table I. 70: Emission factors for type of burning

Category	CH_4 (g/kg)	N_2O
Agriculture residues	2.7	0.07

33.2. Result

Table I.71 shows the summary of GHG emissions, for the gases, from the burning of agricultural residues in Cambodia

Table I. 71: GHG Emissions from burning of agricultural residues in Cambodia

Year	CH_4 (Gg)	N_2O (Gg)
2016	1.177	0.031
2017	1.214	0.031
2018	1.262	0.033
2019	1.25	0.032
2020	1.262	0.033
2021	1.357	0.035
2022	1.314	0.034

33.3. 3.C.3. CO_2 Emissions from Urea Application

33.3.1. Activity data

The IPCC Tier 1 method requires the following data for estimating CO_2 emission from urea application: the amount of urea in the fertilizer, and the amount of urea applied. **Table I.72** summarizes the variables used in estimating CO_2 emission from urea application, as well as the estimates of CO_2 emissions with the associated uncertainty values.

As shown in **Table I.72**, the amount of urea applied to agricultural soils in Cambodia,

Table I. 72: Activity data and emission factors Urea Application

Year	Fertilizer category	Amount of Urea Applied, ton Urea/yr
2016	Urea	126,406.00
2017	Urea	126,406.00
2018	Urea	162,636.00
2019	Urea	172,442.00
2020	Urea	164,140.00
2021	Urea	206,924.00
2022	Urea	275,697.00

33.3.2. Methodology and emission factors

CO_2 emissions from the urea application are estimated with the tier 1 methodology from the 2006 IPCC guidelines. The emission factor is 0.2 tC/t urea. The fertilizer named "Urea ammonium nitrate" (UAN) contains approximatively 50% of urea, the emission factor is thus 0.1 tC/t UAN.

Equation I. 13: CO2-C emission from urea application

$$CO_2 - C\,\text{emission} = M \times EF$$

Where:

- CO_2-C Emission = annual C emissions from urea application, tons C yr^{-1}
- M = annual amount of urea fertilization, tons urea yr^{-1}
- EF = emission factor, ton of C (ton of urea)$^{-1}$

Table I. 73: Emission factor for the Urea application

Year	Fertilizer type	Emission Factor, ton C/ton Urea
2016-2022	Urea	0.2

33.4. Results

Table I. 74: CO2 emissions from Urea application

Year	Fertilizer type	CO2 Emission, ton CO2/yr
2016	Urea	92,698
2017	Urea	92,698
2018	Urea	119,266
2019	Urea	126,457
2020	Urea	120,369
2021	Urea	151,744
2022	Urea	202,178

33.5. 3.C.4. Direct N2O Emissions from Managed Soils

33.5.1. Activity data

The IPCC Tier 1 method, for estimating direct N_2O emission from managed soils, requires the following activity data as N sources or N inputs to managed soils: synthetic or inorganic N fertilizers; organic N applied as fertilizer, both manure and non-manure (e.g., animal manure, compost, sewage sludge, rendering waste); urine and dung N deposited on pasture, range and paddock (PRP) by grazing animals; N in crop residues (above-ground and below-ground), including from N-fixing crops; N mineralisation associated with loss of soil organic matter resulting from change of land use or management of mineral soils; and drainage/management of organic soils (i.e., Histosols). For this report only the first four sources of N inputs were taken into account as main sources of direct N2O emissions from managed soils in Cambodia.

33.5.2. Methodology

Tier 1 method in 2006 IPCC Guidelines was used.

In its most basic form, direct N_2O emissions from managed soils are estimated using below equation (IPCC 2006 Vol-4 Equation 11.1)

Equation I. 14: Direct N2O emissions from managed soils

$$N_2O_{Direct}-N = N_2O-N_{N\ inputs} + N_2O-N_{OS} + N_2O-N_{PRP}$$

Where;

$$N_2O-N_{N\ inputs}=(F_{SN} + F_{ON} + F_{CR}+ F_{SOM}) x\ EF_1 + (F_{SN} + F_{ON} + F_{CR}+ F_{SOM})_{FR}\ x\ EF_{1FR}$$

$$N_2O-N_{OS}= (F_{OS,CG,Temp}\ x\ EF_{2CG,Temp})+ F_{OS,CG,Trop}\ x\ EF_{2CG,Trop})+ (F_{OS,CG,Temp,NR}\ x\ EF_{2CG,Temp,NR})+ (F_{OS,CG,Temp,NP}\ xEF_{2CG,Temp,NP})+ (F_{OS,F,Trop}\ xEF_{2CG,\ F,Trop})$$

$$N_2O-N_{PRP} = (F_{PRP,CPP}\ x\ EF_{\ 3\ PRP,CPP}) +(F_{PRP,SO}\ x\ EF_{3PRP,SO})$$

Where:

N_2O_{Direct} –N =	annual direct N_2O–N emissions produced from managed soils, kg N_2O–N yr-1
$N_2O-N_{N\ inputs}$=	annual direct N_2O–N emissions from N inputs to managed soils, kg N_2O–N yr-1
N_2O-N_{OS}=	annual direct N_2O–N emissions from managed organic soils, kg N_2O–N yr-1
N_2O-N_{PRP} =	nnual direct N_2O–N emissions from urine and dung inputs to grazed soils, kg N_2O–N yr-1
F_{SN} =	annual amount of synthetic fertilizer N applied to soils, kg N yr-1
F_{ON} =	annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soils
F_{CR} =	annual amount of N in crop residues (above-ground and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils, kg N yr-1
F_{SOM} =	annual amount of N in mineral soils that is mineralised, in association with loss of soil C from soil organic matter as a result of changes to land use or management, kg N yr-1
F_{OS} =	annual area of managed/drained organic soils, ha
F_{PRP}=	annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr-1
EF_1 =	emission factor for N2O emissions from N inputs, kg N2O–N (kg N input)-1
EF_{1FR} =	emission factor for N2O emissions from N inputs to flooded rice, kg N2O–N (kg N input)-1

EF_2 =	emission factor for N2O emissions from drained/managed organic soils, kg N2O–N ha-1 yr-1
EF_{3PRP} =	emission factor for N2O emissions from urine and dung N deposited on pasture, range and paddock by grazing animals, kgN2O–N ha-1 yr-1

33.6. 3.C.4.1. Direct N2O Emissions from Inorganic Fertilizers N Inputs

33.6.1. Activity data and emission factors

The IPCC Tier 1 method, for estimating Direct N2O Emissions from Inorganic Fertilizer N inputs, requires the following: the type of N fertilizer with associated %N content; and the amount of synthetic fertilizer applied to soils, which can be acquired through domestic production or by importation of fertilizer materials.

Cambodia is using 6 types of N fertilizers applied to both rice and other crops: diammonium phosphate (DAP) with 18% N content; mono ammonium phosphate (MAP) with 16%N; NPK fertilizer with 15%N; NPK plus trace element with 20%N; soil conditioner with 5%N; and urea with 46%N.These fertilizer materials are mostly imported.

The amount of N fertilizers applied to rice was separated from the amount applied to non-rice, to allow the use emission factor specific for rice, which is much lower in value than for the non-rice.

Table I. 75: Type of Inorganic N Fertilizers Applied in Cambodia

Fertilizer type	Annual Amount of Synthetic Fertilizer N Applied to Soils (Fsn), kg N/yr					
	2017	2018	2019	2020	2021	2022
DAP (Rice)	10,238,940	13,173,480	13,967,820	13,295,340	16,760,880	22,331,520
DAP (non-rice)	12,514,140	16,101,000	17,071,740	16,249,860	20,485,440	27,293,940
MAP (non -rice)	11,123,680	14,312,000	15,174,880	14,444,320	18,209,280	24,261,280
MAP (Rice)	9,101,280	11,709,760	12,409,440	11,818,080	14,898,560	19,850,240
NPK (non-rice)	8,342,850	10,734,000	11,381,250	10,833,300	13,657,050	18,196,050
NPK (Rice)	6,825,900	8,782,350	9,311,850	8,863,650	11,173,950	14,887,650
NPK TE (non-rice)	27,809,400	35,780,000	37,937,400	36,111,000	44,523,400	60,653,400
NPK TE (Rice)	22,753,000	29,274,400	31,039,600	29,545,200	37,246,400	49,625,400
Soil Conditioner (non-rice)	3,012,700	3,876,150	4,109,850	3,912,000	4,931,700	6,570,750
Soil Conditioner (Rice)	2,464,900	3,171,400	3,362,600	3,200,750	4,035,050	5,376,100
Urea (non-rice)	31,980,580	41,147,000	43,627,780	41,527,420	52,351,680	69,751,180
Urea (Rice)	26,166,180	33,665,560	35,695,540	33,976,980	42,833,360	57,069,440
Total	**172,333,550**	**221,727,100**	**235,089,750**	**223,777,900**	**281,106,750**	**375,866,950**

Emission Factors

Direct N_2O Emission Factor (Efsn), kg N_2O-N/kg N input	0.02

33.7. 3.C.4.2 Direct N_2O Emissions from Non-Manure Organic Fertilizers

33.7.1. Activity data and emission factors

The IPCC Tier 1 method, for estimating direct N_2O emission from the application of organic N fertilizers (non-manure type), requires the type of organic amendments (non-manure) applied, and the annual amount of non-manure organic amendments.

In Cambodia, between the year 2016 and 2022 as shown in **Table I.76**, the amount of N inputs from the application of organic fertilizer (non-manure), has proportionately increased at the rate of 1,568 ton N/yr (RSQ = 0.86).

Table I. 76: Annual Non-Manure Organic Amendment N Applied to Soils (Fon), kg N/yr

Year	Organic Amendment type	Annual Non-Manure Organic Amendment N Applied to Soils (Fon), kg N/yr	Direct N_2O Emission Factor for Non-Manure Amendment (Efon), kg N_2O-N/kg N input
2016	Non-Manure Compost	59,791,828	0.01
2017	Non-Manure Compost	60,347,650	0.01
2018	Non-Manure Compost	64,172,100	0.01
2019	Non-Manure Compost	64,333,450	0.01
2020	Non-Manure Compost	65,424,000	0.01
2021	Non-Manure Compost	69,752,950	0.01
2022	Non-Manure Compost	67,354,100	0.01

33.8. 3.C.4.2b. Direct N_2O Emissions from Manure Organic Fertilizers or Manure Amendments

33.8.1. Activity data and emission factors

The IPCC Tier 1 method, for estimating direct N_2O emission from manure amendments, requires the following: number of head of livestock that produces the manure; the systems on how manures from different animals are managed; the fraction of manure managed in a particular system; the fraction of N lost from the manure system before manure application; and the amount of N in bedding applied with manure to soils. In Cambodia, most of the manure organic fertilizers come from non-dairy cattle (household); pigs (commercial breeding, fattening, and household); and buffalo. Manure from non-dairy cattle (household) is managed by the use of dry lot, solid storage, and burned for fuel. Pig manure (in commercial breeding and fattening) is managed using anaerobic digester, anerobic lagoon, dry lot, liquid/slurry, pit storage below animal confinements. Pig manure in household, is managed using anaerobic digester, anaerobic lagoon, daily spread, dry lot, liquid/slurry, pit storage below animal confinements, and solid storage. For buffalo, the manure is managed using dry lot, solid storage, and burned for fuel. Between 2017 and 2022, the N inputs from manure amendment in Cambodia remain almost steady with the highest amount of N input realized in 2022 in the amount of 114,990 ton N.

Table I. 77: Source of manure amendment

Livestock Categories	Number of Heads (Nt)						
	2016	2017	2018	2019	2020	2021	2022
Buffalo	508,656	508,656	500,995	447,385	423,825	432,559	447,943
Chicken Commercial Broilers	752,315	752,315	849,082	1,830,332	2,598,974	3,194,489	3,653,142
Chicken Commercial Layers	138,058	138,058	149,047	120,261	139,514	601,353	177,756
Chicken Household	3,566,952	3,566,952	3,662,323	3,251,010	3,702,505	3,980,692	4,307,884
Dairy Cows	NA	1	1	263	1,176	1,058	1128
Duck Commercial	448,514	448,514	503,912	113,403	127,858	132,526	137,040
Duck Household	1,037,261	1,037,261	1,079,798	1,296,552	1,300,952	1,237,076	1,222,016
Goats	28,907	28,907	26,447	27,740	30,281	43,561	49,162
Horses	5,137	5,137	4,296	3,801	2,971	3,583	2,541
Non-Dairy Cattle Commercial	33,636	33,636	11,232	9,877	12,040	13,589	14,758
Non-Dairy Cattle Household	3,020,258	3,020,258	2,917,302	2,769,885	2,836,536	2,953,809	3,443,809
Pig Commercial Breeding	458,444	458,444	86,240	134,663	312,484	309,349	407,490
Pig Commercial Fattening	1,886,209	1,886,209	726,576	1,020,768	1,067,139	1,459,281	1,803,508
Pig Household	1,239,350	1,239,350	1,935,039	1,030,494	1,137,056	1,250,167	1,220,064
Sheep	459	459	461	648	1,725	4,293	5,524

33.9. 3.C.4.3. Direct N_2O Emissions from Urine and Dung Deposited on Pasture, Range, and Paddock (PRP)

33.9.1. Activity data and emission factors

The Tier 1 IPCC method, for estimating direct N_2O emission from urine and dung deposited on PRP, requires the following: number of head of livestock that produces or excretes the manure; and the fraction of the manure deposited on PRP.

In Cambodia, the main sources of N from urine and dung deposited on PRP are non-dairy cattle (household), with 82.3% of the total N input in 2023; and buffalo with 11.6% of the total N input in 2022 (**Table I.78**)

Similar to the trend in N inputs from manure amendments between 2017 and 2022, the N inputs from urine and dung deposited on PRP remain almost steady with its peak in the year 2022 at 62,621 ton N.

Table I. 78: Sources of N from Urine and Dung Deposited on PRP

Livestock categories	MAT	Fraction of Manure Deposited on PRP (MS)	Number of Heads (Nt)						
			2016	2017	2018	2019	2020	2021	2022
Buffalo	27 °C (Warm)	0.28	513,470	508,656	500,995	447,385	423,825	432,559	447,943
Chicken Commercial Layers	27 °C (Warm)	0.01	138,058	138,058	149,047	120,261	139,514	200,451	177,756
Chicken Household	27 °C (Warm)	0.5	3,234,101	3,566,952	3,662,323	3,251,010	3,702,505	3,980,692	4,307,884
Dairy Cows	27 °C (Warm)	0.38	NA			300	1,176	1,058	1,126
Duck Household	27 °C (Warm)	0.5	1,055,608	1,037,261	1,079,798	1,296,552	1,300,952	1,237,076	1,222,016
Goats	27 °C (Warm)	0.5	18,834	28,907	26,447	27,740	30,281	43,561	49,162
Horses	27 °C (Warm)	0.5	5,316	5,137	4,296	3,801	2,971	3,583	2,541
Non-Dairy Cattle Commercial	27 °C (Warm)	0.36	24,371	33,636	11,232	9,877	12,040	13,589	14,758
Non-Dairy Cattle Household	27 °C (Warm)	0.36	3,020,258	3,020,258	2,917,302	2,769,885	2,836,536	2,953,809	3,443,809
Pig Household	27 °C (Warm)	0.06	1,239,350	1,239,350	1,935,039	1,030,494	1,137,056	1,250,167	1,220,064
Sheep	28 °C (Warm)	0.8	461	461	459	648	1,725	4,293	5,524

33.10. 3.C.4.4 Direct N_2O Emissions from Crop Residues

33.10.1. Activity data and emission factors

The IPCC Tier 1 method, for estimating direct N_2O emissions from crop residue N inputs, requires the following: the percent of total residue retained in the soils by each crop; and the N content of the crop residue (both aboveground and belowground residues).

For Cambodia, the main sources of crop residue N retained or returned to the soils, are from rice, with 46.4% of the total crop residue N; cassava with 41.6%; maize with 6.9%, and sugarcane with 3.9% as indicated in **Table I.79**. Between 2017 and 2022, the amount of N input from crop residues tend to increase over the years, although with a drop in trend in the year 2021.

Table I. 79: : Crop Residue N Returned to Soils (Fcr), kg N/yr

Crop	Percent Total Residue Retained in the Soils, %	EF for Direct N2O (Efcr)	Crop Residue N Returned to Soils (Fcr), kg N/yr						
			2016	2017	2018	2019	2020	2021	2022
Cassava	80	0.01	21,429,650	21,429,650	21,323,840	20,955,010	18,741,830	22,838,550	22,115,920
Maize	19	0.01	2,929,938	2,929,938	2,966,438	2,155,656	1,775,660	1,682,969	2,799,652
Mungbam	100	0.01	514,125	514,125	410,997	372,144	302,154	93,967	282,712
Peanut (w/pod)	100	0.01	404,931	404,931	307,010	253,356	235,654	231,622	179,449
Rice	17	0.01	20,266,990	20,916,110	21,803,300	21,577,910	22,124,520	23,893,180	23,385,270
Soyabean	100	0.01	934,283	598,448	749,850	343,966	244,596	130,448	158,089
Sugar Cane	10	0.01	755,027	755,027	830,090	741,844	665,172	2,740,562	1,976,194
Tobacco	5	0.01	82,759	82,759	67,731	61,069	61,032	50,901	72,533

33.11. 3.C.4.5. Total Direct N_2O Emissions from Managed Soils (all N sources)

33.11.1. Activity data and emission factors

Table I. 80 presents the Total Direct N_2O Emissions from Managed Soils, with N inputs from all possible sources in Cambodia. Over the years, almost half of the total direct N_2O Emission comes from the application of inorganic or synthetic N fertilizers, followed by N input from Manure Amendments. The level of Direct N_2O Emission from Managed Soils peaks in the year 2022 at 2,688 Gg CO2e, with N input from Inorganic fertilizer at 62% of the Total direct N_2O emission, followed by N input from Manure Amendments at 18% of the total.

Table I. 80: 3C4 Direct N2O Emissions from Managed Soils (All N Sources), Gg CO2e

N Source	2016	2017	2018	2019	2020	2021	2022
Inorganic Fertilizers	588	761	979	1038	988	1239	1659
Organic Fertilizers	149	151	160	161	163	174	168
Manure Amendments	458	458	389	361	382	416	479
Urine and Dung PRP	79	146	143	131	130	135	149
Crop Residues	198	119	202	193	184	215	212
Total Direct N_2O	**1472**	**1,635**	**1,873**	**1,884**	**1,847**	**2,179**	**2,668**

33.12. 3.C.5. Indirect N_2O Emissions from Managed Soils

The IPCC Tier 1 method, for estimating Indirect N_2O Emissions from Manure Management, follows the same approach as for estimating Indirect N_2O Emissions from Managed Soils. The method takes into account how the animal manure is managed, excluding those manure deposited on pasture, range, and paddock. Further, the method takes in account the N that volatilizes from the manure system, and the N that leached or washed out (due to runoff) from the manure system.

33.12.1. Activity data Emission factors

N Volatilization from manure system from livestock category is shown in bellow table.

Table I. 81: Total N Volatilization from manure system(Nvol(b)), kg N/yr

Year	N Volatilization from Manure System (Nvol(b)), kg N/yr
2016	49,183,349
2017	49,183,349
2018	44,181,286
2019	39,921,230
2020	42,129,926
2021	45,463,903
2022	52,014,648

Table I. 82: Total N leached from Manure System (Nleach(b)), kg N/yr

Year	N leached from Manure System (Nvol(b)), kg N/yr
2016	15,301,846
2017	15,301,846
2018	13,588,306
2019	12,372,995
2020	13,042,506
2021	14,075,440
2022	16,092,754

33.12.2. Methodology

Tier 1 methodology was used for the calculation, as in 2006 IPCC Guideline.

Volatilisation, N_2O(ATD)

The N_2O emissions from atmospheric deposition of N volatilised from managed soil are estimated using Equation 11.9:

Equation I. 15: N2O from atmospheric deposition of N volatilized from managed soils

$$N_2O_{(ATD)} - N = [(F_{SN} \times Frac_{GASF}) + ((F_{ON} + F_{PRP}) \times Frac_{GASM}] \times EF_4$$

Where:

$N_2O_{(ATD)}$-N = Annual amount of N_2O–N produced from atmospheric deposition of N volatilised from managed soils, kg N_2O–N yr^{-1}

F_{SN} = Annual amount of synthetic fertiliser N applied to soils, kg N yr^{-1}

$Frac_{GASF}$ = Fraction of synthetic fertiliser N that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied)$^{-1}$

F_{ON} = Annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}

F_{PRP} = Annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1}

$Frac_{GASM}$ = Fraction of applied organic N fertiliser materials (F_{ON}) and of urine and dung N deposited by grazing animals (F_{PRP}) that volatilises as NH_3 and NO_x, kg N volatilised (kg of N applied or deposited)$^{-1}$

F_{PRP} = Annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1}

EF_4 = Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N–N_2O (kg NH_3–N + NO_x–N volatilised)$^{-1}$]

Conversion of $N_2O_{(ATD)}$-N emissions to N_2O emissions for reporting purposes is performed by using the following equation:

$N_2O_{(ATD)} = N_2O_{(ATD)} - N \cdot 44/28$

1. Leaching/Runoff, $N_2O_{(L)}$

The N_2O emissions from leaching and runoff in regions where leaching and runoff occurs are estimated using Equation 11.10 of the 2006 IPCC Guideline:

Equation I. 16: N2O from N leaching / runoff from managed soils in regions where leaching / runoff occurs

$$N_2O_{(L)} - N = (F_{SN} + F_{ON} + F_{PRP} + F_{CR} + F_{SOM}) \times Frac_{LEACH-(H)} \times EF_5$$

Where:

$N_2O_{(L)}$-N =	Annual amount of N_2O–N produced from leaching and runoff of N additions to managed soils in regions where leaching/runoff occurs, kg N_2O–N yr^{-1}
F_{SN} =	Annual amount of synthetic fertiliser N applied to soils in regions where leaching/runoff occurs, kg N yr^{-1}
F_{ON} =	Annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils in regions where leaching/runoff occurs, kg N yr^{-1}
F_{PRP} =	Annual amount of urine and dung N deposited by grazing animals in regions where leaching/runoff occurs, kg N yr^{-1}
F_{CR} =	Amount of N in crop residues (above- and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils annually in regions where leaching/runoff occurs, kg N yr^{-1}
F_{SOM} =	Annual amount of N mineralised in mineral soils associated with loss of soil C from soil organic matter as a result of changes to land use or management in regions where leaching/runoff occurs, kg N yr^{-1}
$Frac_{LEACH-(H)}$ =	Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff, kg N (kg of N additions)$^{-1}$

EF_5 =	Emission factor for N_2O emissions from N leaching and runoff, kg N_2O–N (kg N leached and runoff)$^{-1}$

Conversion of $N_2O_{(L)}$–N emissions to N_2O emissions for reporting purposes is performed by using the following equation:

$N_2O_{(L)} = N_2O_{(L)} – N \cdot 44/28$

33.13. 3.C.5.1. Indirect N_2O Emissions from Inorganic Fertilizers N Inputs

The fraction of nitrogen fertilizer that volatilizes, leaches, or runs off and Indirect N_2O emission factors for N volatilized/leaching are presented in the **Table I.83**.

Table I. 83: Fraction of N Fertilizer that Volatilizes/leaching and runoff

Fraction of N Fertilizer that Volatilizes ($Frac_{GASF}$), fraction		Fraction of N Fertilizer-lost Leaching/runoff ($Frac_{LEACH}$), fraction
Fertilizer Type	Fraction of N Fertilizer that Volatilizes ($Frac_{GASF}$), fraction	
DAP (Rice)	0.08	0.24
DAP (non-rice)	0.08	0.24
MAP (non-rice)	0.08	0.24
MAP (Rice)	0.08	0.24
NPK (non-rice)	0.01	0.24
NPK (Rice)	0.01	0.24
NPK TE (non-rice)	0.01	0.24
NPK TE (Rice)	0.01	0.24
Soil Conditioner (non-rice)	0.11	0.24
Soil Conditioner (Rice)	0.11	0.24
Urea (non-rice)	0.15	0.24
Urea (Rice)	0.15	0.24

Table I. 84: Indirect N2O emission factors for N volatilized/leaching

Indirect N_2O Emission Factor (Ef_v), kg N_2O-N/kg N volatilized	Indirect N_2O Emission Factor-leaching/runoff (Ef_{lr}), kg N_2O-N/kg N leached
0.014	0.011

33.14. 3.C.5.2 Indirect N_2O Emissions from Non-Manure Organic Fertilizers

The Fractions of organic amendments N that volatilizes/leaching, runoff and Indirect N_2O emission factors for N volatilized/leaching are presented in the **Table I.85**.

Table I. 85: Fractions of organic amendments N that volatilizes/leaching, runoff

Fraction of Organic Amendment N that Volatilizes ($Frac_{GASM}$), fraction	Fraction of Organic Fertilizers N that Leach/runoff ($Frac_{LEACH}$), fraction
0.21	0.24

Table I. 86: Indirect N2O emission factors for N volatilized/leaching

Indirect N_2O Emission Factor- Volatilization (Efv), kg N_2O-N/kg N volatilized	Indirect N_2O Emission Factor-- Leaching/runoff (Eflr), kg N_2O-N/kg leached
0.014	0.011

33.15. 3.C.5.3 Indirect N_2O Emissions from manure amendments

The Fractions of manure amendments N that volatilizes/leaching, runoff and Indirect N_2O emission factors for N volatilized/leaching are presented in the **Table I.87**.

Table I. 87: Fractions of manure amendments N that volatilizes/leaching, runoff

Fraction of Manure Amendments N that Volatilizes ($Frac_{GASM}$), fraction	Fraction of Manure Amendments N lost - Leaching/Runoff ($Frac_{LEACH}$), fraction
0.21	0.24

Table I. 88: Indirect N2O emission factors for N volatilized/leaching

Indirect N_2O Emission Factor - Manure N Volatilization (Efv), kg N_2O-N/kg volatilized	Indirect N_2O Emission Factor - Manure N Leaching/Runoff (Eflr), kg N_2O-N/kg N leached
0.014	0.011

33.16. 3.C.5.4 Indirect N_2O Emissions from urine and dung deposition

In Cambodia, the main sources of N from urine and dung deposited on PRP is, from non-dairy cattle (household), and from buffalo.The Fraction of PRP N that volatilizes/leaching, runoff and Indirect N_2O emission factors for N volatilized/leaching are presented in the **Table I.89**.

Table I. 89: Fraction of PRP N that volatilizes/leaching, runoff

Fraction of PRP N that Volatilizes ($Frac_{GASM}$), fraction	Fraction of PRP N lost - Leaching/Runoff ($Frac_{LEACH}$), fraction
0.21	0.24

Table I. 90:Indirect N2O emission factors for N volatilized/leaching

Indirect N_2O Emission Factor for PRP N Volatilization (Efv), kg N_2O-N/kg N volatilized	Indirect N2O Emission Factor - Leaching/Runoff (Eflr), kg N_2O-N/kg N leached
0.014	0.011

33.17. 3.C.5.5 Indirect N_2O Emissions from crop residues

The main sources of crop residue N retained or returned to the soils in Cambodia, are from the production of rice, cassava, maize, and sugarcane. For crop residues, the IPCC Tier 1 method only accounts from the N losses from leaching and runoff. N losses from volatilization of N in crop residues are assumed to be zero.

The Fraction of crop residue N lost due to leaching and indirect N_2O emission factor for leaching/runoff in **Table I.91**.

Table I. 91: Fraction of crop residue N lost due to leaching and indirect N2O emission factor for leaching/runoff

Fraction Crop Residue N lost - Leaching/Runoff (FracLEACH), fraction	0.24
Indirect N2O Emission Factor - Leaching/Runoff (Eflr), kg N2O-N/kg N leached	0.011

33.18. Results

Table I. 92: Overall result of the direct N2O emissions

N Source	2016	2017	2018	2019	2020	2021	2022
Inorganic Fertilizers	206.857	267.70	344.42	365.18	347.61	437.06	583.86
Organic Fertilizers	65.806	140.23	149.12	149.49	152.02	162.08	156.51
Manure Amendments	272.803	255.59	217.15	201.17	213.14	232.22	499.42
Urine and Dung PRP	132.517	132.52	129.11	120.25	122.39	127.34	145.51
Crop Residues	52.019	52.364	53.275	51.078	48.538	56.796	56.035
Total Direct N_2O	730.002	848.40	893.07	887.17	883.70	1015.50	1441.33

33.19. 3.C.6 – Indirect N_2O emissions from manure management

The IPCC Tier 1 method, for estimating Indirect N_2O Emissions from Manure Management, follows the same approach as for estimating Indirect N_2O Emissions from Managed Soils. The method takes into account how the animal manure is managed, excluding those manure deposited on pasture, range, and paddock. Further, the method takes in account the N that volatilizes from the manure system, and the N that leached or washed out (due to runoff) from the manure system.

33.19.1. Activity data and Emission Factors

N Volatilization from manure system from livestock category are shown in bellow **Table I.93 and 94**.

Table I. 93: N Volatilization from manure system (Nvol(b)), kg N/yr

Year	N Volatilization from Manure System (Nvol(b)), kg N/yr
2016	49,183,349
2017	49,183,349
2018	44,181,286
2019	39,921,230
2020	42,129,926
2021	45,463,903
2022	52,014,648

Table I. 94: :N leached from Manure System (Nleach(b)), kg N/yr

Year	N leached from Manure System (Nvol(b)), kg N/yr
2016	15,301,846
2017	15,301,846

2018	13,588,306
2019	12,372,995
2020	13,042,506
2021	14,075,440
2022	16,092,754

33.19.2. Methodology and emission factors

Tier 1 method was used for the calculation and equations 10.26 and 10.28 equations from 2006 IPCC Guideline were used for calculating N_2O emission from manure management due to volatilization and due to leaching .

Equation I. 17: N losses due to volatilization from manure management systems

$$N_{volatilization-MMS} = \sum_S \left[\sum_T [\left(N_{(T)} * Nex_{(T)} * MS_{(T,S)} \right) * \left(\frac{FracGasMS}{100} \right)_{(T,S)}] \right]$$

Where,

- $N_{volatilization-MMS}$ = Amount of manure nitrogen that is lost due to volatilization of NH_3 and NO_x, kg N yr^{-1}
- $N_{(T)}$ = Number of head of livestock species/category T in the country
- $Nex_{(T)}$ = Annual average N excretion per head of species/category T in the country, kg N $animal^{-1}$ yr^{-1}
- $MS_{(T,S)}$ = Fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless
- $Frac_{GasMS(T,S)}$ = Percent of managed manure nitrogen for livestock category T that volatilises as NH_3 and NO_x in the manure management system S, %

Equation I. 18: N losses due to leaching/runoff from manure management systems

$$N_{leaching-MMS} = \sum_S \left[\sum_T [\left(N_{(T)} * Nex_{(T)} * MS_{(T,S)} \right) * \left(\frac{FracleachMS}{100} \right)_{(T,S)}] \right]$$

Where,

- $N_{leaching-MMS}$ = Amount of manure nitrogen that is lost due to leaching from manure management systems, kg N yr^{-1}, kg N yr^{-1}
- $N_{(T)}$ = Number of head of livestock species/category T in the country
- $Nex_{(T)}$ = Annual average N excretion per head of species/category T in the country, kg N $animal^{-1}$ yr^{-1}
- $MS_{(T,S)}$ = Fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless
- $Frac_{leachMS(T,S)}$ = Percent of managed manure nitrogen losses for livestock category T due to runoff and leaching during solid and liquid storage of manure

Table I. 95: Indirect N2O Emission Factors Indirect N2O Emission Factors

Atmospheric N Deposition (Efv), kg N_2O-N/kg N volatilized	Indirect N_2O Emission Factor - Leaching/Runoff (Eflr), kg N_2O-N/kg N leached
0.01	0.0075

33.20. Results

Table I. 96: Indirect N2O emissions from manure managemnt

Year	N_2O (Gg)
1994	78
2000	91
2005	99
2010	107
2016	93
2017	253
2018	226
2019	205
2020	216
2021	233
2022	267

33.21. 3.C.7 – Rice cultivation

33.21.1. Activity data

This category represents a major category for Cambodia. Currently, the calculation is based on tier 1 methodology from the IPCC. Water management and organic amendment greatly influenced methane emission from rice cultivation. Hence, the IPCC method requires that the rice area is characterized by water management practice (before and during the cultivation periods), and whether organic amendments are applied in the area or not. **Table I.97-98** describes the rice cultivation and management practices in Cambodia in the year 2023, which is also almost similar in other years, except for the Harvested Rice Area. Cambodia cultivates rice in 2 cropping seasons. During the dry season, 3 water management practices are employed: continuously flooded, intermittently flooded with multiple aerations, and intermittently flooded with single aeration. During the wet season, deep water rice and upland rice are possible. Organic amendments are applied in all areas during the dry season, while for the wet season only those areas with intermittent flooding and aeration are the organic amendments applied. Cultivation period is shorter in length during the dry season, with deep water rice grown up to 150 days. The harvested area during the dry season is only about 20% of the Total Annual Harvested area (TAH), with 80% of TAH realized during the wet season.

Table I. 97: Rice Cultivation and Management Practices in Cambodia (year 2023)

Cropping Season	Water Management	Organic Amendment?	Cultivation Period, days	Harvested Rice Area, ha	% of Total Harvested Area
Dry Season	Continuously flooded	Yes	95	545,683	15.4%
Dry Season	Intermittently flooded multiple aerations	Yes	95	68,210	1.9%
Dry Season	Intermittently flooded single aeration	Yes	95	68,210	1.9%
Wet Season	Continuously flooded	No	115	2,765,748	77.9%
Wet Season	Intermittently flooded multiple aerations	Yes	120	28,672	0.8%
Wet Season	Intermittently flooded single aeration	Yes	120	35,841	1.0%
Wet Season	Deep water	No	150	20,042	0.6%
Wet Season	Upland	No	95	16,946	0.5%
Total Annual Harvested Area, ha				**3,549,352**	100%

Table I. 98: Rice Harvested Area (ha)

Year	2017	2018	2019	2020	2021	2022	2023
Harvested Area, ha	3,206,524	3,335,928	3,328,846	3,404,131	3,552,738	3,403,163	3,549,352

33.21.2. Methodology and emission factors

CH_4 emissions from rice cultivation are estimated with the tier 1 methodology from the 2006 IPCC Guidelines.

Equation I. 19: CH4 emissions from rice cultivation

$$CH_{4Rice} = \sum_{i,j,k} (EF_{i,j,k} \times t_{i,j,k} \times A_{i,j,k} \times 10^{-6})$$

Where:

- $CH_{4\ Rice}$ = annual methane emissions from rice cultivation, Gg CH_4 yr^{-1}
- EF_{ijk} = a daily emission factor for i, j, and k conditions, kg CH_4 ha^{-1} day^{-1}
- t_{ijk} = cultivation period of rice for i, j, and k conditions, day
- A_{ijk} = annual harvested area of rice for i, j, and k conditions, ha yr^{-1}
- i, j, and k = represent different ecosystems, water regimes, type and amount of organic amendments, and other conditions under which CH_4 emissions from rice may vary

Parameter and emission factor – kg CH_4/ha/day

Equation I. 20: Daily emission factor for a particular harvested area

$$EF_i = EF_c \times SF_w \times SF_p \times SF_o \times SF_{s,r}$$

Where:

- EF_i = adjusted daily emission factor for a particular harvested area
- EF_c = baseline emission factor for continuously flooded fields without organic amendments
- SF_w = scaling factor to account for the differences in water regime during the cultivation period (from Table 5.12)
- SF_p = scaling factor to account for the differences in water regime in the pre-season before the cultivation period (from Table 5.13)
- SF_o = scaling factor should vary for both type and amount of organic amendment applied (from Equation 5.3 and Table 5.14)
- $SF_{s,r}$ = scaling factor for soil type, rice cultivar, etc, if available

Table I. 99: Adjusted Daily CH4 Emission Factors for Rice Cultivation (Efrice), kg CH4/ha/daySFs,y = scaling factor for soil type, rice cultivar,

Cropping Season	Water Regime	Adjusted Daily CH_4 Emission Factor for Rice Cultivation (Ef_{rice}), kg CH_4/ha/day
Dry Season	Continuously flooded	1.338
Dry Season	Intermittently flooded - multiple aeration	0.736
Dry Season	Intermittently flooded - single aeration	0.95
Wet Season	Continuously flooded	2.94
Wet Season	Intermittently flooded - multiple aeration	1.774
Wet Season	Intermittently flooded - single aeration	2.29

Wet Season	Deep water	0.073
Wet Season	Upland	0

33.22. Results

Table I. 100: Emissions from rice cultivation

Year	Gg CO_2e
1994	4,683.43
2000	5,961.58
2005	7,563.84
2010	8,700.60
2016	9,711.46
2017	26,215
2018	27,228
2019	27,162
2020	27,855
2021	29,096
2022	27,826

T. Waste

The Ministry of Environment (MoE) is the primary government body involved in managing and implementing measures related to the waste sector in Cambodia. The MoE has undertaken several initiatives to strengthen waste management at the source and at final dumpsites to control environmental pollution, including promoting urban waste recycling and coordinating large-scale investments in waste management. Furthermore, the ministry has enhanced sewage management systems at the sub-national levels by establishing wastewater treatment plants in several provinces and improved monitoring of major pollution sources, such as factories and large enterprises, by encouraging the installation of liquid waste treatment plants, air purification devices, and noise reduction equipment.

34. Solid waste

Solid waste generation in Cambodia has continually increased alongside the annual population growth of the country. Due to limited resources and capacity for waste management, the composition of solid waste, particularly in urban centers, has gradually changed from a large proportion of biodegradable and organic waste to non-degradable waste. In a typical Cambodian city, over 50% of waste at the discharge point is organic, followed by plastics (20.9%, including plastic bags, other plastics, and PET bottles), paper (9.9%), and grass and wood (2.3%).

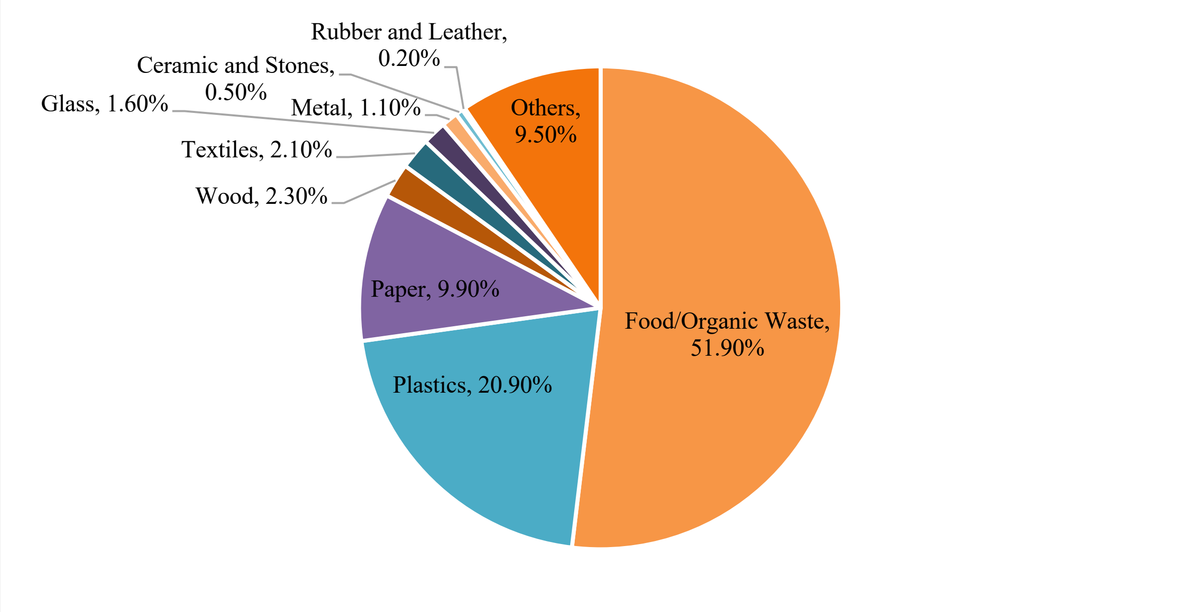


Figure I. 32: MSW Compositions in Cambodia

Over the years, waste disposal and management in Cambodia have advanced significantly, marked by increased landfill disposal and a notable rise in recycled solid waste. In the capital, Phnom Penh, annual solid waste generation increased dramatically from 0.136 million tons in 1995 to 0.361 million tons in 2008 and was estimated to reach 0.635 million tons in 2015.There are approximately 60 official dumpsites, along with numerous unofficial ones, spread throughout the country. In addition, engineered landfills, both operational and nearing completion, are located nationwide, supporting the collection of solid waste for landfill disposal.

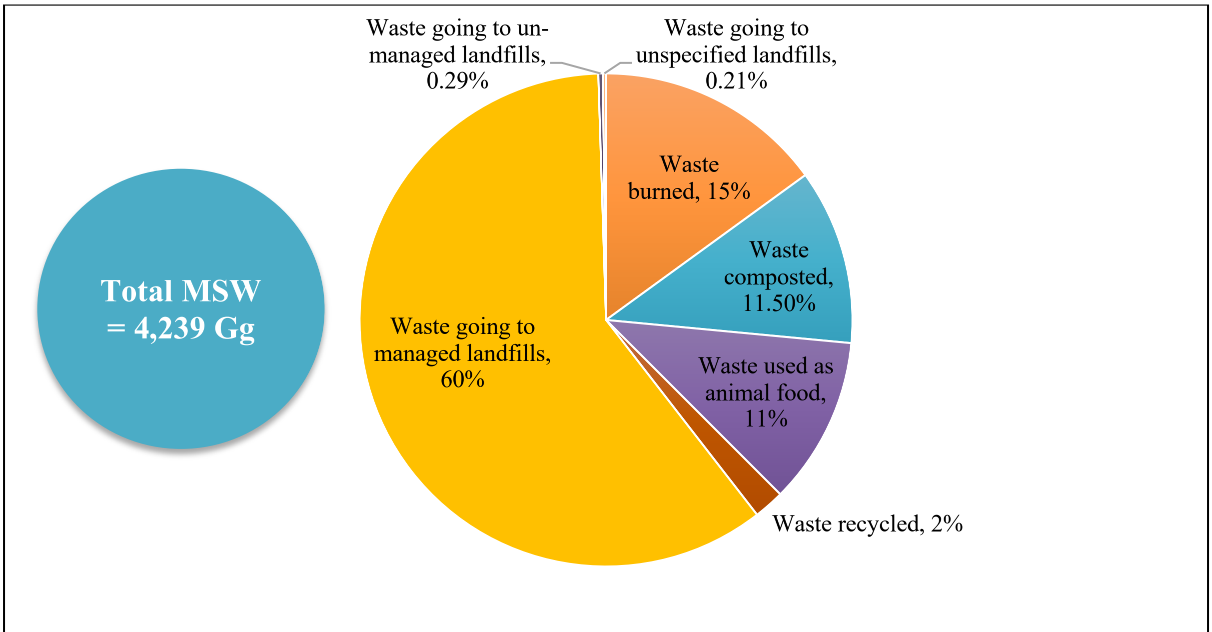


Figure I. 33: Waste Disposal Methods in 2006

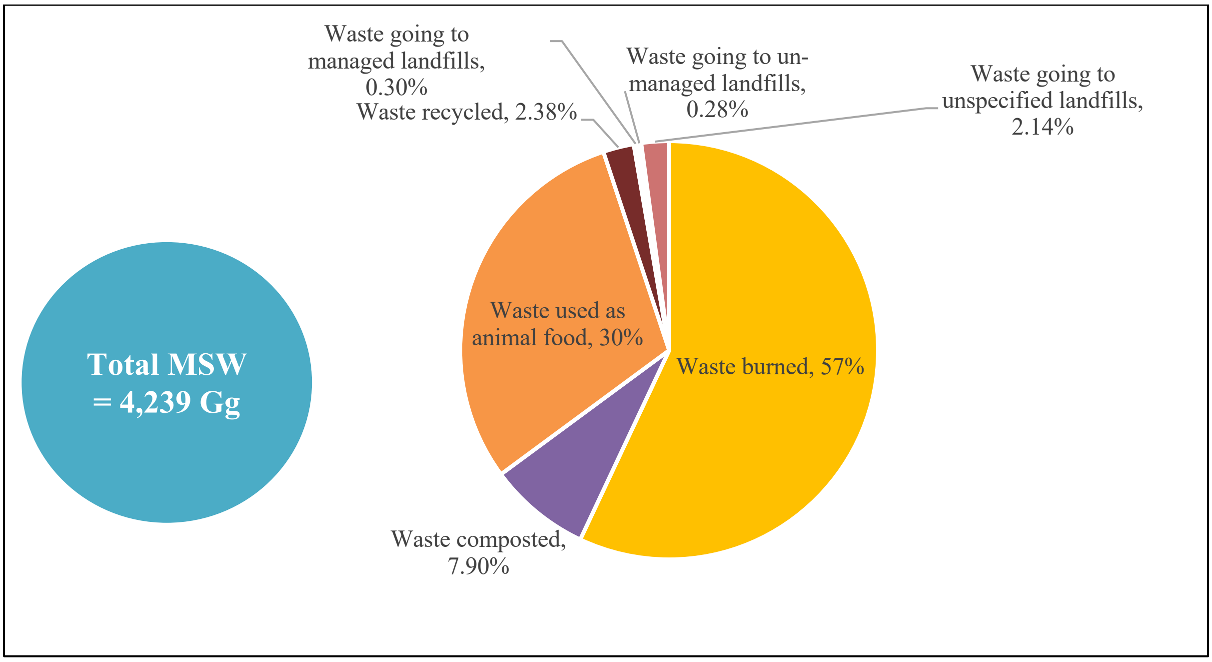


Figure I. 34: Waste Disposal Methods in 2016

35. Wastewater

In Cambodia, the sewage system plays a crucial role in collecting domestic wastewater, rainwater, and treated industrial effluents before they run off to wetlands and other receiving sources. Domestic wastewater and urban sewage are commonly collected by the sewerage system and then run off to drainage systems, retention ponds, lakes, or wetlands for self-purification through natural treatment processes before finally flowing into main watercourses. There is limited wastewater treatment in Cambodia, with wastewater usually left to oxidize in large holding ponds or lakes or directly flushed into waterways. About 9% of Cambodian households are connected to sewage systems, while 78% do not have access to any form of toilet facilities. The water bodies receive about 80% of the waste and sewage water from the city, along with untreated effluent from 3,000 small and large-scale industrial enterprises.

There are nine Cambodian cities in the process of developing centralized treatment systems, with construction currently ongoing. Additionally, there are two Faecal Sludge Treatment Plants (FSTPs) in Cambodia.

35.1. Scope of IPCC Emission Categories in the Waste Sector

The 2006 IPCC methodological guidance for the waste sector covers carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions from the following four categories:

- **4. A – Solid waste disposal:** Emissions resulting from the decomposition of organic waste in landfills.
  - ✓ 4.A.1 Managed waste disposal sites
  - ✓ 4.A.2 Unmanaged waste disposal sites
  - ✓ 4.A.3 Uncategorized waste disposal sites

- **4. B – Biological treatment of solid waste:** Emissions from composting and anaerobic digestion of organic waste.
- **4. C – Incineration and open burning of waste:** Emissions from the combustion of waste materials.
  - ✓ 4.C.1 Waste incineration
  - ✓ 4.C.2 Open burning of waste
- **4.D – Wastewater treatment and discharge:** Emissions from the treatment and discharge of domestic and industrial wastewater.
  - ✓ 4.D.1 Domestic wastewater treatment and discharge
  - ✓ 4.D.2 Industrial wastewater treatment and discharge

- 4.E – Other

Generally, the most important sources of emissions in the waste sector are the CH_4 emissions from solid waste disposal, CH_4 emissions from wastewater treatment and discharge, and CO_2 emissions, which occur during the incineration and open burning of waste.

In Cambodia, emissions from the four primary categories—solid waste disposal, biological treatment of solid waste, incineration and open burning of waste, and wastewater treatment and discharge—are accounted for emissions within the covered assessment period. However, from the above waste subcategories, only the following occurred within the country during the assessment period.

- 4.A.1 Managed waste disposal sites
- 4.A.2 Unmanaged waste disposal sites
- 4.A.3 Uncategorized waste disposal sites
- 4.B Biological treatment of solid waste (composting and anaerobic digestion)
- 4.C.2 Open Burning of Waste
- 4.D.1 Domestic wastewater treatment and discharge

35.2. Data Collection

The following sections outline the sources and methodologies used to gather activity data across various sectors. The data primarily draws from Cambodia's First Biennial Update Report and Third National Communication for 1994 to 2016. Where necessary, data for 2016 to 2022 was projected based on observed trends and historical records.

Table I. 101: Activity data collection for waste sector

Subcategory	Description of the data	Data Providers
Solid Waste Disposal	Municipal Solid Waste • Municipal Solid Waste Quantity in ton per year for 2004 to 2023 was shared by Department of Solid waste Management General Directorate of Environment Protection, Ministry of Environment	Primary data provider Ministry of Environment (MoE)

	• Unmanaged – shallow (%) – Based on BUR and TNC - Estimate based on Yut S. and Seng B., 2018. KAP on waste management • Managed – anaerobic (%) - Based on BUR and TNC – MoE (Ministry of Environment) • Uncategorized SWDS (%) - Based on BUR and TNC - Estimate based on • Food (%)-KOICA project study, 2010 (MoE, 2017)- Only Phnom Penh • Garden (%)- Seng B., 2013, landfill waste at Sihanouk Ville • Paper (%) - The Asia Foundation, 2015 - Only Phnom Penh • Wood (%) - The study "State of Waste Management in Phnom Penh, Cambodia" carried out by the UNEP in 2018. • Textile (%) - The study "State of Waste Management in Phnom Penh, Cambodia" carried out by the UNEP in 2018. • Nappies (%) - The study "State of Waste Management in Phnom Penh, Cambodia" carried out by the UNEP in 2018. • Plastics, Other inert (%) - The study "State of Waste Management in Phnom Penh, Cambodia" carried out by the UNEP in 2018. • For the years 2017 to 2022, percentages data relevant to waste management types was forecasted using available data from 1994 to 2016 data. Industry waste • Data for 1994 to 2016 was sourced from the first BUR, Third National Communication, and the 2019 GHG inventory • GDP – Word Bank - https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=KH • Waste generation rate – Based on TNC – MoE • Waste going to landfills (%), Unmanaged – deep (%), Unmanaged – shallow (%), Managed (%), Managed – semi-aerobic (%), Uncategorized (%) - Based on TNC – 2006 IPCC Guidelines -IPCC Waste Model	

	• For the years 2017 to 2022, percentages data relevant to waste management types was forecasted using available data from 1994 to 2016 data.	
Biological Treatment	• From 1994 to 2016 was sourced from the first BUR, Third National Communication, and the 2019 GHG inventory. - Amount Composted – Based on BUR - Yut S. and Seng B., 2018. KAP on waste management - Amount treated by anaerobic digestion – Based on TNC - The assessment of the Cambodian National Biodigester Programme • For the years 2017 to 2022, amount treated by anaerobic digestion data was forecasted using available data from 1994, 2000, 2005, 2010, and 2016. • Composting data was not extrapolated as no new composting facilities have been established in Cambodia. Extrapolating the trend could therefore lead to inaccuracies.	NA
Open Burning of Waste	• Population – World Bank - https://data.worldbank.org/indicator/SP.POP.TOTL?locations=KH • From 1994 to 2016 was sourced from the first BUR, Third National Communication, and the 2019 GHG inventory where necessary. - Fraction of population burning waste – Based on NIR and TNC - Yut S. and Seng B., 2018. KAP on waste management (data of 2012) - Per capita waste generation – based on BUR and TNC – Based on the given value in 2006 IPCC guideline, Volume 5 - Waste, Chapter 2 - Waste Generation, Composition, and Management Data, page 2.17, Table 2A.1 • From 2017 to 2022, the fraction of population burning waste types was forecasted using available data from 1994 to 2016 data.	NA

Domestic Wastewater Treatment and Discharge	• Population – World Bank - https://data.worldbank.org/indicator/SP.POP.TOTL?locations=KH
	• From 1994 to 2016 was sourced from the first BUR, Third National Communication, and the 2019 GHG inventory where necessary.
	  - Fraction of Population Income Group – rural and urban low income - CDB data, NCDD
	  - Degree of utilization of treatment or discharge – IPCC default - 2006 IPCC Guidelines, Volume 5 (Waste) , Chapter 6 (Wastewater Treatment and Discharge), page 6.15, Table 6.5 (Indonesia)
	• Average annual per capita protein generation – Based on NIR, BUR and TNC - FAO data
		National Committee for Sub-National Democratic Development (NCDD)

35.3. Solid Waste Disposal

The emissions from solid waste disposal were calculated under three sub-categories: managed waste disposal, unmanaged waste disposal, and uncategorized waste disposal. The CH_4 emissions from solid waste disposal sites (SWDS) are estimated using the First Order Decay (FOD) method, which accounts for the slow decay of degradable organic waste in landfills over several decades, producing significant amounts of CH_4 and CO_2.

The emissions from Municipal Solid Waste (MSW) were assessed using country-specific waste data from 2004 to 2022, following the Tier 2 methodology as outlined in the 2006 IPCC uidelines. Industrial solid waste emissions are estimated using GDP data from 1950, applying the Tier 1 methodology as per IPCC guidelines due to the lack of high-quality data for the assessment within the country. Both approaches rely on default factors from the guidelines, supplemented with country-specific information to calculate GHG emissions. However, the key difference is that the Tier 2 approach utilizes high-quality, country-specific activity data on historical and current waste disposal, whereas the Tier 1 approach estimates waste disposal amounts based on population data.

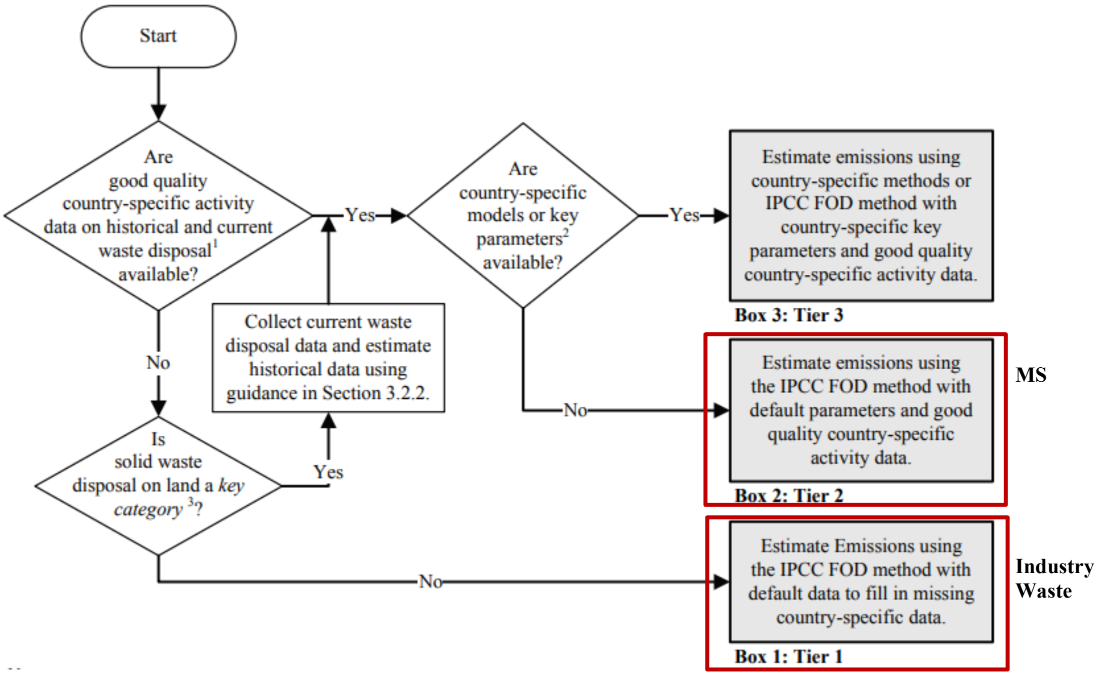


Figure I. 35: Decision Tree to select Tiers for CH_4 emissions from Solid Waste Disposal Sites

The following steps were followed when conducting the assessment for the landfilling of solid waste disposal:

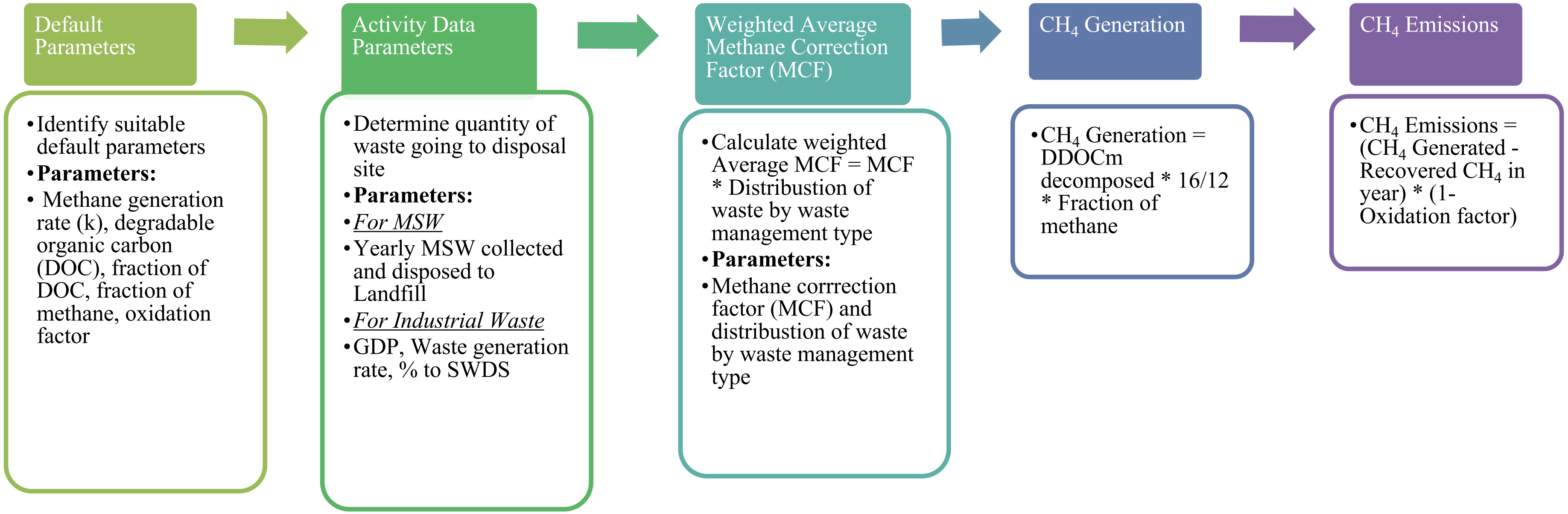


Figure I. 36: Steps followed when conducting the assessment for the landfilling of solid waste disposal

CH_4 generation was calculated following the chain of equations outlined in the IPCC 2006 guidelines, specifically from equation 6.1 to equation 6.2.

Equation I. 21: Decomposable DOCm from Waste Disposal

$$DDOCmd_T = W_T \times DOC \times DOC_f \times MCF$$

Where,

- $DDOCmd_T$ = Decomposable DOC deposited in year T, Gg
- W_T = Mass of waste disposed in year T, Gg
- DOC = Degradable organic carbon in disposal year (fraction), Gg C/Gg waste
- DOC_f = Fraction of DOC that can decompose in the anaerobic conditions in the SWDS (fraction)
- MCF= CH_4 correction factor for year of disposal (fraction)

Equation I. 22: CH4 generation from DDOCm decomposed

$$CH_4generated_T = DDOCm\ decomp_T \times F \times 16/12$$

Where,

- CH_4 generated $_T$ = Amount of CH_4 generated from the DDOCm which decomposes
- DDOCm $decomp_T$ = DDOCm decomposed in year T, Gg
- F = Fraction of CH_4, by volume, in generated landfill gas
- 16/12 = Molecular weight ratio CH_4/C (ratio)

Finally, CH_4 emissions are calculated by first subtracting the CH_4 gas recovered from the disposal site, and then subtracting the CH_4 oxidized to carbon dioxide in the cover layer. The following equation was used to calculate the CH_4 emission from Solid Waste Disposal Sites.

Equation I. 23: CH_4 emissions from SWDS

$$CH_4\ Emissions = (\sum_x CH_4\ generated_{x,T} - R_T) \times (1 - OX_T)$$

Where,

- CH_4 Emissions = CH_4 emitted in year T, Gg
- T = inventory year
- X = waste category or type/material
- R_T = recovered CH_4 in year T, Gg
- OX_T = oxidation factor in year T, (fraction)

35.4. Activity data

For municipal solid waste disposal, country-specific waste disposal amounts are critical for estimating emissions under the Tier 2 methodology. The Department of Solid Waste Management, General Directorate of Environment Protection, MoE provided municipal waste disposal figures for 2004 to 2022. For industrial solid waste disposal, GDP data is the primary input, with most assessment data sourced from the Third National Communication (TNC). GDP figures for 2017 to 2022 were obtained from the latest World Bank statistics. The percentage of waste directed to landfills and the allocation across different landfill types were forecasted for 2017 to 2022 based on historical data from the First Biennial Update Report (BUR) and TNC, which cover the period from 1950 to 2016.

Table I. 102: Activity Data for Solid Waste Disposal Assessment

	Municipal Solid Waste (MSW)				Industrial Waste							
Year	Yearly MSW collected and disposed to Landfill (Gg)	Unmanaged – shallow (%)	Managed – anaerobic (%)	Uncategorized SWDS (%)	GDP ($ million)	Waste generation rate (Gg/$ million)	Wastes going to landfills (%)	Unmanaged – deep (%)	Unmanaged – shallow (%)	Managed (%)	Managed – semi-aerobic (%)	Uncategorized (%)
Before 1990	NA	11%	0%	21%	NA	0.007594366	100%	30%	20%	25%	5%	20%
1990	NA	11%	2%	19%	2,209	0.007594366	100%	30%	20%	25%	5%	20%
1991	NA	11%	2%	19%	2,311	0.007594366	100%	30%	20%	25%	5%	20%
1992	NA	11%	2%	20%	2,412	0.007594366	100%	30%	20%	25%	5%	20%
1993	NA	11%	2%	20%	2,514	0.007594366	100%	30%	20%	25%	5%	20%
1994	NA	11%	2%	20%	2,770	0.007594366	100%	30%	20%	25%	5%	20%
1995	NA	11%	2%	21%	3,414	0.007594366	100%	30%	20%	25%	5%	20%
1996	NA	11%	2%	21%	3,479	0.007594366	100%	30%	20%	25%	5%	20%
1997	NA	11%	2%	21%	3,416	0.007594366	100%	30%	20%	25%	5%	20%
1998	NA	11%	2%	22%	3,096	0.007594366	100%	30%	20%	25%	5%	20%
1999	NA	11%	2%	22%	3,490	0.007594366	100%	30%	20%	25%	5%	20%
2000	NA	11%	2%	22%	3,649	0.007594366	100%	30%	20%	25%	5%	20%
2001	NA	11%	2%	23%	3,984	0.007594366	100%	30%	20%	25%	5%	20%
2002	NA	11%	3%	22%	4,280	0.007594366	100%	30%	20%	25%	5%	20%
2003	NA	11%	5%	20%	4,663	0.007594366	100%	30%	20%	25%	5%	20%
2004	317.55	11%	9%	17%	5,339	0.007594366	100%	30%	20%	25%	5%	20%
2005	352.54	11%	9%	18%	6,293	0.007594366	100%	30%	20%	25%	5%	20%
2006	397.31	12%	11%	15%	7,275	0.007594366	100%	30%	20%	25%	5%	20%
2007	484.44	12%	13%	13%	8,631	0.007594366	100%	30%	20%	25%	5%	20%
2008	518.05	12%	14%	13%	10,337	0.007594366	100%	30%	20%	25%	5%	20%
2009	563.03	12%	15%	13%	10,400	0.007594366	100%	30%	20%	25%	5%	20%
2010	570.67	12%	15%	10%	11,634	0.007594366	100%	30%	20%	25%	5%	20%
2011	635.15	12%	16%	9%	12,965	0.007594366	100%	30%	20%	25%	5%	20%
2012	933.14	12%	23%	3%	14,054.44	0.007594366	100%	30%	20%	25%	5%	20%
2013	990.20	12%	24%	3%	15,227.99	0.007594366	100%	30%	20%	25%	5%	20%
2014	1,089.43	12%	26%	0.3%	16,702.61	0.007594366	100%	30%	20%	25%	5%	20%
2015	1,177.68	10%	28%	0.3%	18,049.95	0.007594366	100%	30%	20%	25%	5%	20%
2016	1,266.62	8%	30%	0.3%	20,016.75	0.007594366	100%	30%	20%	25%	5%	20%
2017	1,503.72	9%	30%	0.3%	22,177.2	0.007594366	100%	30%	20%	25%	5%	20%
2018	1,729.82	9%	31%	0.3%	24,571.75	0.007594366	100%	30%	20%	25%	5%	20%
2019	1,986.92	9%	31%	0.3%	27,089.39	0.007594366	100%	30%	20%	25%	5%	20%
2020	1,987.87	9%	31%	0.3%	25,872.8	0.007594366	100%	30%	20%	25%	5%	20%
2021	1,988.81	9%	32%	0.3%	26,961.06	0.007594366	100%	30%	20%	25%	5%	20%
2022	2,558.39	8%	32%	0.3%	29,504.83	0.007594366	100%	30%	20%	25%	5%	20%
Source:	Department of Solid waste Management MOE	Based on BUR and TNC	Based on BUR and TNC	Based on BUR and TNC	World Bank	Based on TNC	Based on TNC	Based on TNC	Based on TNC	Based on TNC	Based on TNC	Based on TNC

The MSW assessment was conducted based on the waste composition. The composition of wastes considered for the assessment is presented in the **Table I.103**, aligned with the BUR and TNC assessments.

Table I. 103: Waste Composition Used

Food	Garden	Paper	Wood	Textile	Nappies	Plastics, Other inert
54.86 %	0 %	10.47%	2.43 %	2.43 %	0 %	29.81 %

35.5. Default factors

The default parameters used in the estimation were taken from the 2006 IPCC guidelines for Southeast Asia, specifically for "Moist and wet tropical" weather. These parameters were cross-checked with the factors provided in the BUR and TNC reports.

Table I. 104: Default Parameter for Solid Waste Disposal Assessment

Data Category	Default Parameter	
Delay time (months)	6	
Fraction of methane (F)	0.5	
Conversion factors, C to CH_4	1.33	
DOC (Degradable organic carbon)	**IPCC default factors** Food waste - 0.15 Garden – 0.2 Paper – 0.4 Wood and straw – 0.43	Textiles – 0.24 Disposable nappies – 0.24 Sewage sludge – 0.05 Industrial waste – 0.15
DOC_f (fraction of DOC dissimilated)	0.5	
Methane generation rate constant (k) – $years^{-1}$	**IPCC default factors** Food waste - 0.4 Garden – 0.17 Paper – 0.07 Wood and straw – 0.035	Textiles – 0.07 Disposable nappies – 0.17 Sewage sludge – 0.4 Industrial waste – 0.17
Methane correction factors (MCF)	**IPCC Defaults** Managed - 1 Managed – semi – aerobic - 0.5 Unmanaged – deep - 0.8 Unmanaged – Shallow - 0.4 Uncategorized – 0.6	

35.6. Results

Table I. 105: Emissions from Solid Waste Disposal (Gg CH4)

Year	4.A Solid Waste Disposal ($Gg\ CH_4$)
1994	20
2000	26
2005	32
2010	40
2016	52
2017	55
2018	58
2019	60
2020	63
2021	65
2022	67

In the MSW category, emissions from 2016 to 2022 were calculated using country-specific data available from 2004 to 2022. However, country-specific data were unavailable to recalculate emissions for the prior GHG inventory assessments conducted in 1994, 2000, 2005 and 2010. Therefore, following the IPCC Good Practice Guidance, a recalculation was performed for those years using the surrogate method. Additional information regarding this assessment is provided in the recalculation and improvement section.

35.7. Biological Treatment of Waste

Category 4B, Biological Treatment of Waste, includes emissions from composting and anaerobic digestion in biogas facilities, both of which took place in the country during the inventory period. The Tier 1 methodological approach was applied for both activities due to the lack of country-specific or facility-specific emission factors. Emissions for composting and anaerobic digestion were calculated based on the following equations.

Equation I. 24: CH4 emissions from biological treatment

$$CH_4 \text{ Emissions} = \sum_i (M_i - EF_i) \times 10^{-3} - R$$

Where,

- CH_4 Emissions = total CH_4 emissions in inventory year, Gg CH_4
- M_i = mass of organic waste treated by biological treatment type i, Gg
- EF = emission factor for treatment i, g CH_4/kg waste treated
- i = composting or anaerobic digestion
- R = total amount of CH_4 recovered in inventory year, Gg CH_4

Equation I. 25: N2O emissions from biological treatment

$$N_2O \text{ Emissions} = \sum_i (M_i - EF_i) \times 10^{-3}$$

Where,

- N_2O Emissions = total N_2O emissions in inventory year, Gg N_2O
- M_i = mass of organic waste treated by biological treatment type i, Gg
- EF = emission factor for treatment i, g CH_4/kg waste treated
- i = composting or anaerobic digestion

For composting, an emission factor of 4 g CH_4/kg waste treated, and 0.24 g N_2O/kg waste treated were used. For anaerobic digestion, an emission factor of 0.8 g CH_4/kg waste treated was considered.

35.8. Activity data

The amount of waste composted from 1994 to 2016 was sourced from previous GHG inventory assessments, BUR, and TNC. The data for 2016 to 2022 were extrapolated based on historical activity data and population growth. Similarly, activity data for anaerobic digestion from 1994 to 2016 were obtained from BUR and TNC assessments, and the data for 2016 to 2022 were forecasted based on past data and population growth.

Table I. 106: Activity Data for Biological Treatment of Waste

Year	Total Annual amount composted (Gg)	Total Annual amount treated by biological treatment facilities (Gg)
1994	51	0
2000	61	0
2005	68	0
2010	71	42
2011	72	54
2012	74	47
2013	76	13
2014	77	18
2015	78	18
2016	79	18
2017	79	31
2018	79	31
2019	79	32
2020	79	33
2021	79	34
2022	79	35

35.9. Emission factors

The Tier 1 methodology proposed by the 2006 IPCC Guidelines has been applied, using an emission factor of 4 g CH_4/kg waste treated and 0.24 g N_2O/kg waste treated for calculating emissions from composting, and an emission factor of 0.8 g CH_4/kg waste treated for calculating emissions from anaerobic digestion, in line with the BUR and TNC assessments. It was also assumed that there is no recovery of methane based on previous GHG inventory assessments.

35.10. Results

Table I. 107: Emissions from Biological Treatment of Solid Waste

	4.B Biological Treatment of Solid Waste	
Year	Gg CH_4	Gg N_2O
1994	0.21	0.01
2000	0.25	0.01
2005	0.27	0.02
2010	0.32	0.02
2016	0.33	0.02
2017	0.34	0.02
2018	0.34	0.02
2019	0.34	0.02
2020	0.34	0.02

2021	0.34	0.02
2022	0.34	0.02

U. Incineration and Open Burning

Category 4C2 Incineration and Open Burning of Waste includes emissions from the combustion of waste in controlled facilities or open dumps. However, as waste incineration does not occur in Cambodia, the inventory only includes emissions from the open burning of waste. The Tier 1 approach was used for the open burning assessment due to limited data, relying on default IPCC values. Consequently, the following equation was used to assess the activity data for the calculation.

Equation I. 26: Total amount of municipal solid waste open-burned

$$MSW_B = P \times P_{frac} \times MSW_p \times B_{frac} \times 365 \times 10^{-6}$$

Where,

- MSW_B= Total amount of municipal solid waste open-burned, Gg/yr
- P = population (capita)
- P_{frac} = fraction of population burning waste, (fraction)
- MSW_p = per capita waste generation, Kg waste/capita/day = per capita waste generation, kg waste/capita/day
- B_{frac} = fraction of the waste amount that is burned relative to the total amount of waste treated, (fraction)
- 365 = number of days by year
- 10^{-6}= conversion factor from kilogram to gigagram

Once the amount of total waste open burned is calculated, the emissions were calculated by applying an emission factor to the waste amount burned in a dry basis for CO_2 emissions by using the following equation.

Equation I. 27: CO2 emission estimate based on the total amount of waste combusted

$$CO_2 \text{ Emissions} = \sum_i (SW_i \times dm_i \times CF_i \times FCF_i \times OF_i) \times 44/12$$

Where,

- SW_i = total amount of solid waste of type i (wet weight) incinerated or open-burned, Gg/yr
- dm_i= dry matter content in the waste (wet weight) incinerated or open-burned, (fraction)
- CF_i = fraction of carbon in the dry matter (total carbon content), (fraction)
- FCFi = fraction of fossil carbon in the total carbon, (fraction)
- OFi = oxidation factor, (fraction)
- 44/12 = conversion factor from C to CO_2

The CH_4 emissions from open burning were calculated on a wet basis, while the N_2O emissions were calculated on a dry basis. The relevant equations considered for the assessment are outlined below.

Equation I. 28: CH4 emissions estimate based on the total amount of waste combusted

Where,

- CH_4 Emissions = total CH_4 emissions in inventory year, Gg CH_4
- IW_i = amount of solid waste of type i incinerated or open-burned, Gg
- EF_i = aggregate CH_4 emission factor, kg CH_4/Gg of waste
- = conversion factor from kilogram to gigagram
- i = category or type of waste incinerated/open-burned

Equation I. 29: N2O emissions estimate based on the total amount of waste combusted

Where,

- N_2OEmissions = total N_2O emissions in inventory year, Gg N_2O
- IW_i = amount of solid waste of type i incinerated or open-burned, Gg
- EF_i = aggregate N_2O emission factor, kg N_2O /Gg of waste
- = conversion factor from kilogram to gigagram
- i = category or type of waste incinerated/open-burned

35.11. Activity data

The population, per capita waste generation, and the percentage of the population burning waste were the activity data considered for assessing the total amount of waste open burned. The activity data for 1994 to 2016 were taken from the BUR and cross-checked with the TNC. However, emissions were calculated on a bulk municipal waste basis, similar to the TNC assessment, due to limited data availability.

The per capita waste generation considered for the assessment was 0.74 kg waste/capita/day, aligned with the value used for the solid waste disposal assessment. The fraction of waste that is burned relative to the total amount of waste treated was taken from the 2006 IPCC Guidelines, which is 0.6.

35.12. Default factors and emissions factors

The CO_2 and N_2O emissions from the open burning of waste were assessed on a dry waste basis. The dry matter content coefficient of 0.78 was used, which aligns with the TNC. For CO_2 emissions, the fraction of carbon in dry matter (0.34) and the fraction of fossil carbon in total carbon (0.08) were considered as default factors, and these were cross-checked with the TNC report for Cambodia.

The Tier 1 approach outlined in the 2006 IPCC Guidelines recommends using an oxidation factor of 0.58 for calculating CO_2 emissions, 6.5 g CH_4/kg for calculating CH_4 emissions, and 0.15 g N_2O/kg for calculating N_2O emissions.

35.13. Results

Table I. 108: Emissions from Open Burning of Waste

	4.C.2 Open Burning of Waste		
Year	Gg CO_2	Gg CH_4	Gg N_2O
1994	50	7	0.13
2000	57	8	0.15
2005	61	9	0.16
2010	60	9	0.16
2016	65	9	0.17
2017	65	9	0.17
2018	65	9	0.17
2019	65	9	0.17
2020	66	9	0.17
2021	66	10	0.17
2022	66	10	0.17

V. Wastewater Treatment and Discharge

Category 4D, Wastewater Treatment and Discharge, encompasses emissions of CH_4 and N_2O resulting from the anaerobic treatment or disposal of wastewater. Wastewater in Cambodia originates from various domestic, commercial, and industrial sources and can be treated on-site (uncollected), transported to a centralized treatment facility (collected), or disposed of untreated into nearby water bodies or outfalls. In Cambodia, the GHG emissions related to wastewater primarily arise from domestic wastewater treatment.

Cambodia has been assessing CH_4 emissions for domestic wastewater from previous GHG inventory assessments by following the steps outlined below for a Tier 1 approach due to the limited data availability.

Step 1: Estimate total organically degradable carbon in wastewater (TOW)

Equation I. 30: organically degradable material in domestic wastewater

Where,
TOW = total organics in wastewater in inventory year, kg BOD/yr
P = country population in inventory year, (person)
BOD = country-specific per capita BOD in inventory year, g/person/day
0.001 = conversion from grams BOD to kg BOD

I = correction factor for additional industrial BOD discharged into sewers (for collected, the default is 1.25; for uncollected, the default is 1.00)
Step 2: Obtain the emission factor for each domestic wastewater treatment/discharge pathway or system.

Equation I. 31: CH4 emission factor for each domestic wastewater treatment discharge pathway or system

Where,

- EF_j = emission factor, kg CH_4/kg BOD
- j = each treatment/discharge pathway or system
- B_o = maximum CH_4 producing capacity, kg CH_4/kg BOD
- MCF_j = methane correction factor (fraction)

Step 3: Estimate emissions, adjust for possible sludge removal and/or CH_4 recovery and sum the results for each pathway/system.

Equation I. 32: Total CH4 emissions from domestic wastewater

Where:

- TOW = total organics in wastewater in inventory year, kg BOD/yr
- S = organic component removed as sludge in inventory year, kg BOD/yr
- Ui = fraction of population in income group i in inventory year
- = degree of utilization of treatment/discharge pathway or system, j, for each income group fraction i in inventory year
- i = income group: rural, urban high income and urban low income
- j = each treatment/discharge pathway or system
- $EF_{i,j}$ = emission factor, kg CH_4/kg BOD
- R = amount of CH_4 recovered in inventory year, kg CH_4/yr

The Tier 1 methodology provided by IPCC 2006 has also been followed to estimate N_2O emissions using a two-step method.

Step 1: Estimate nitrogen in effluent

Equation I. 33: Total nitrogen in the effluent

$$N_{EFFLUENT} = (P * Protein * F_{NPR} * F_{NON-CON} * F_{IND-COM}) - N_{SLUDGE}$$

Where,

- $N_{EFFLUENT}$ = total annual amount of nitrogen in the wastewater effluent, kg N/yr
- P = human population
- Protein = annual per capita protein consumption, kg/person/yr
- = fraction of nitrogen in protein, default = 0.16, kg N/kg protein
- $F_{NON-CON}$ = factor for non-consumed protein added to the wastewater

- $F_{IND\text{-}COM}$ = factor for industrial and commercial co-discharged protein into the sewer system
- N_{SLUDGE} = nitrogen removed with sludge (default = zero), kg N/yr

Step 2: Estimate N_2O emissions from wastewater effluent

Equation I. 34: N_2O emissions from wastewater effluent

Where,

- N_2O emissions = N_2O emissions in inventory year, kg N_2O/yr
- $N_{EFFLUENT}$ = nitrogen in the effluent discharged to aquatic environments, kg N/yr
  $EF_{EFFLUENT}$ = emission factor for N_2O emissions from discharged to wastewater, kg N_2O-N/kg N
- The factor 44/28 is the conversion of kg N_2O-N into kg N_2O.

35.14. Activity data and default data

The total organics in wastewater for the inventory years were calculated based on the population data and the country-specific per capita BOD for the relevant years. The default BOD factor used is 40 kg BOD/cap/year, extracted from Table 6.4 of the 2006 IPCC Guidelines for Asia. A correction factor of 1.25 for additional industrial BOD discharged into sewers was selected, in line with previous GHG inventories, based on the value provided for the "discharge collected" option. For the calculation of CH_4 emissions, the fraction of the population in the rural income group was considered as 0.81, and the urban low-income group as 0.91, consistent with the Third National Communication (TNC). The degree of utilization of treatment/discharge pathways or systems was based on the IPCC default values provided in the 2006 IPCC Guidelines.

Table I. 109: Activity Data to Assess CH4 Emissions for Domestic Wastewater Treatment

		Degree of utilization of treatment or discharge pathway or method for each income group									
		U = rural (0.81)					U = urban low income (0.19)				
Year	Population (million)	Septic Tank	Latrine	Other	Sewer	None	Septic Tank	Latrine	Other	Sewer	None
1994	10.68	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2000	12.58	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2005	13.87	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2010	14.25	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2011	14.46	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2012	14.79	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2013	15.00	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2014	15.21	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2015	15.42	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2016	15.62	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2017	15.83	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2018	16.03	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2019	16.21	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2020	16.40	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2021	16.59	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%
2022	16.77	0%	47%	0%	10%	43%	14%	10%	3%	53%	20%

It was assumed that the organic component removed as sludge in the inventory years and the amount of CH_4 recovered in those years were zero, based on previous GHG inventory assessments.

For the calculation of N_2O emissions, the primary activity data considered were population and annual per capita protein consumption. The annual per capita protein consumption values used for the assessment are provided below. The data from 1994 to 2016 were taken from the BUR and cross-checked with the TNC. The data for 2016 to 2022 were extrapolated based on past data and population growth.

Table I. 110: Activity Data to Assess N2O Emissions for Domestic Wastewater Treatment

Year	Average annual per capita protein generation (kg/person/yr)
1994	16
2000	19
2005	21
2010	22
2011	22
2012	23
2013	23
2014	24
2015	24
2016	24
2017	25
2018	25
2019	25
2020	26
2021	26
2022	26

Other default factors necessary for calculating N_2O emissions were taken from the 2006 IPCC Guidelines. The default factor for the fraction of nitrogen in protein is 0.16 kg N/kg protein. The factor for non-consumed protein added to the wastewater is 1.1 (for countries with no garbage disposal), and the factor for industrial and commercial co-discharged protein into the sewer system is 1.25. Additionally, nitrogen removed with sludge is considered 0 kg N/yr. These factors were aligned with the previous GHG inventory assessments in the country.

35.15. Emissions factors

For CH_4 emissions, the emission factors were estimated using the data provided in the **Table I.114** below. For indirect N_2O emissions, an emission factor of 0.005 kg N_2O-N/kg N for the effluent was considered, in alignment with the Tier 1 approach outlined in the 2006 IPCC Guidelines.

Table I. 111: Emission Factors to Assess CH4 Emissions for Domestic Wastewater Treatment

Type of treatment	Methane correction factor for each treatment system (MCF)	Maximum methane producing capacity (kg CH_4/kg BOD)	Emission factor (kgCH_4/kg BOD)
Untreated-sea, river, lake	0.1	0.6	0.06
Untreated-flowing sewer	0	0.6	0
Treated-septic system	0.5	0.6	0.3
Treated-Latrine with sediments removal	0.1	0.6	0.06

35.16. Results

Table I. 112: Emissions from Domestic Wastewater Treatment

	4.D.1 Domestic Wastewater Treatment and Discharge	
Year	Gg CH_4	Gg N_2O
1994	11	0.29
2000	13	0.41
2005	14	0.50
2010	14	0.54
2016	16	0.66
2017	16	0.67
2018	16	0.69
2019	16	0.71
2020	17	0.73
2021	17	0.75
2022	17	0.76

W.Recalculations and Improvements

36. Energy Sector

In the Energy sector, several recalculation methods were applied to improve the quality of the GHGI inventory. The reasons for these recalculations and the methods used are listed below:

A. **Recalculation of the old GHGI inventory emissions due to changes in GWP values**: Cambodia's latest GHGI report from 2019 covers emissions from 1994 to 2016 and used AR4 GWP values. However, the current inventory is based on AR5 GWP values, necessitating a recalculation of the emissions.
B. **Lack of activity data for 2022 and 2023**: Since no activity data exists for these years, extrapolation/forecasting methods were applied to fill the data gaps in the inventory.
C. **Potential activity data gaps for 2017 to 2019 in some subcategories**: In cases where activity data was missing, interpolation methods were used to estimate the necessary data for these years.

Below is a summary of the recalculations made for each subcategory in the inventory:

Table I. 113: Recalculation made for energy sector

Sub-sector	Identified gaps/ Improvement actions
Energy Industries	Emissions from 1994 to 2016 have been recalculated using the latest emission factors (2006 IPPC) and AR5 GWP values.
Manufacturing industries and construction	Emissions from 1994 to 2016 have been recalculated using the latest emission factors (2006 IPPC) and AR5 GWP values.
	Activity data for 2022 and 2023 are forecasted using the extrapolation method based on existing activity data.
	Activity data for biomass, residual fuel oil, and LPG for 2017-2019 have been interpolated using existing activity data.
Transport sector	Emissions from 1994 to 2016 have been recalculated using the latest emission factors (2006IPPC)) and AR5 GWP values.
	Activity data for 2022 and 2023 are forecasted using the extrapolation method based on existing activity data.
	Activity data for; • Diesel in railway, • Residual fuel oil in international water-born navigation, • Diesel oil in domestic water born navigation • for 2017-2019 have been interpolated using existing activity data.
Other sector	Emissions from 1994 to 2016 have been recalculated using the latest emission factors (2006 IPPC Guidelines) and AR5 GWP values.
	Activity data for 2022 and 2023 are forecasted using the extrapolation method based on existing activity data.
	Activity data for; • Biomass in residential, • Diesel oil in agriculture, • Diesel oil in Fishing (Mobile combustion) • for 2017-2019 have been interpolated using existing activity data.

36.1. Improvement

Below is a summary of the improvement in the energy sector

Table I. 114: Identified improvements in the energy sector

Sector	Sub-sector	Identified gaps	Improvement actions	Responsible institution
Energy (Sectoral Approach)	1.A.1.a.i - Electricity Generation	Activity data for fuel consumption is not available properly	A proper data collection mechanism should be established to collect all the activity data for the entire time series.	Ministry of Mines Energy
	1.A.1.c.i - Manufacture of Solid Fuels	Charcoal production data for 1994, 2005, 2010, 2011,2012, 2013, 2014, 2015 and 2016 are available in the 2019-GHGI Report of Cambodia. But the fuel consumption for charcoal production is needed for the calculation and it is unavailable.	A data collection mechanism should be established to collect fuel consumption data for charcoal production for the considered time period.	Ministry of Mines Energy
	1.A.2 - Manufacturing industries and construction	Although there are 3 categories as non-metallic minerals, textiles and leather, other non-specified under manufacturing industries and construction, the activity data are not available separately for those 3 categories, but they are available combinedly.	A data collection mechanism should be established to collect data separately for the non-metallic minerals, textiles and leather, other non-specified	Ministry of Mines Energy
		Activity data are not available properly. Activity datafor fuel consumption (LPG gas, Diesel, Black Oil (Residual Fuel Oil),	A proper data collection mechanism should be implemented to collect all	Ministry of Mines Energy

		Firewood/Waste- Biomass) are available only for 2010,2016, 2020 and 2021 years. Activity data for sub-bituminous coal is available only for 2010 and 2016.	the data for the entire time period	
	1.A.3.a - Civil Aviation	Fuel consumption data are available only for 2010, 2016, 2020, 2021 and 2022.	A proper data collection mechanism should be implemented to collect all the data for the entire time period	Ministry of Mines Energy
	1.A.3.b - Road Transportation	Activity data for fuel consumption is not available separately for each vehicle type but available as combined data. (It has been considered under "cars").	A data collection mechanism should be established to collect fuel consumption data for each vehicle type separately	Ministry of Mines Energy/ Ministry of Public Works and Transport
	1.A.3.c - Railway	Activity data for fuel consumption is available only for 2020 and 2021	A proper data collection mechanism should be established to collect all the activity data for the entire time series.	Ministry of Mines Energy/ Ministry of Public Works and Transport
	1.A.3.d - Waterborne navigation	Activity data for fuel consumption is available only for 2020 and 2021	A proper data collection mechanism should be established to collect all the activity data for the entire time series.	Ministry of Mines Energy

	1.A.4 - Other Sectors	Activity data are not available properly and consistently. (For 1.A.4.a - Commercial/Institutional sector, fuel consumption data for all fuel types are available only for 2005, 2010 and 2016, only fuel consumption data for LPG is available for 2020 and 2021. For1.A.4.b - Residential sector, fuel consumption data are available only for 2005, 2010, 2016, 2020 and 2021, but the consumption data for kerosene is available only for 2005, 2010 and 2016. For1.A.3.c.i – Stationary sector and 1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms sector , fuel consumption data for diesel oil is available only for 2005, 2010, 2016, 2020 and 2021)	A proper data collection mechanism should be implemented to collect all the data for the entire time period.	Ministry of Mines Energy
Energy (Reference Approach)	Stock Change - The net increases or decreases in stocks of primary and secondary fuels	Activity data are unavailable	A proper data collection mechanism should be implemented to collect all the data for the entire time period.	Ministry of Mines Energy
	Allocation of fuel quantity for Non-Energy Use	Activity data are unavailable	A proper data collection mechanism should be implemented to collect all the data for the entire time period.	Ministry of Mines Energy

37. Waste Sector

In the waste sector, recalculation methods were applied to ensure consistency across the time series of the GHG inventory. The following approaches were utilized:

A. **Recalculation of the old GHGI inventory emissions due to changes in GWP values**: Cambodia's latest GHG inventory in the Third National Communication was calculated using the Global Warming Potential (GWP) values from the IPCC Fourth Assessment Report. However, for this GHG inventory assessment, the GWP values from the IPCC Fifth Assessment Report (AR5) were applied to align with the latest UNFCCC requirements. Consequently, the GHG inventory assessment from 1994 to 2016 has been recalculated using the AR5 GWP values.

B. **Time Series Inconsistency in Municipal Solid Waste Disposal**: In the municipal solid waste disposal assessment under 4A Solid Waste Disposal, if reliable country-specific data on historical and current waste disposal is available, assessments can be assessed based on data covering a minimum of 10 years under Tier 2 method rather than the full 50-year period typically required for Tier 1 method in the absence of such data. For the current assessment year in Cambodia, quality country-specific data were available for 2004 to 2022, which enabled a 10-year assessment for the period 2016 to 2022 under Tier 2 method. However, sufficient data for the years 1994, 2000, 2005, and 2010 were not available to cover a 10-year span for each of these years.

Consequently, the municipal solid waste disposal assessment was conducted for 2014 to 2022 based on available data, while emissions for 1994, 2000, 2005, and 2010 were estimated using the surrogate method. This approach correlates emissions estimates with statistical data that best explain the variations over time in the emission source category. For this assessment in Cambodia, population data and emissions data from 2014 were used to model emission trends for earlier years. The **Table I.115** provides the estimated data and population figures for these years.

Table I. 115: Emissions estimation for municipal solid waste disposal based on surrogate method

Year	Population (Million)	Municipal Solid Waste Disposal Tier 2 method (Gg CH_4)
2014	15.21	20.15
2010	14.25	18.88
2005	13.87	18.38
2000	12.58	16.66
1994	10.68	14.15

The following graph presents a comparison between Tier 1 and Tier 2 assessment results for municipal solid waste disposal.

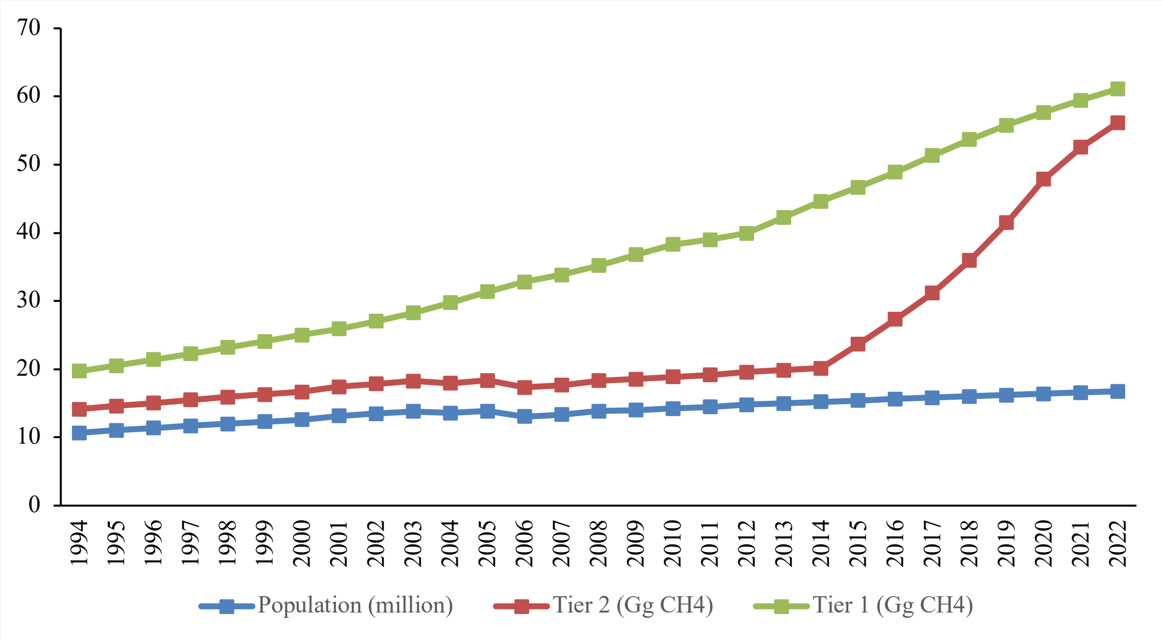


Figure I. 37: Comparing MSW results between Tier 1 and Tier 2 methods

37.1. Improvement

The **Table I.116** outlines the specific improvements identified for the waste sector.

Table I. 116: Identified improvements in the waste sector

Sector	Sub-sector	Identified gaps	Improvement actions	Responsible institution
Waste	4A - Solid Waste Disposal	Activity data for industrial solid waste are inconsistently available and lacks continuity across the years. (Data were forecasted for most of the years by using GDP data for 1950-2016)	A proper data collection mechanism should be implemented to collect all the data for the entire time period.	Ministry of Environment
		For municipal solid waste, only the bulk waste amounts were available for 2004 to 2022 as activity data and activity data for separated waste types were unavailable.	A data collection mechanism should be established to collect the amount of waste for each waste type under municipal waste	Ministry of Environment
	4B - Biological Treatment of Solid Waste	Activity data are not consistently or adequately available due to the absence of a regular data collection system (Data	A proper data collection mechanism should be implemented to collect all the data	Ministry of Environment

		were available only for 1994, 2000, 2005, 2010, 2011, 2012, 2013, 2014, 2015, 2016)	for the entire time period.	
	4C2- Open burning of waste	Activity data are not available consistently and properly (Data were forecasted for most of the years by using data for 1999-2016)	A proper data collection mechanism should be implemented to collect all the data for the entire time period.	Ministry of Environment
	4D1- Domestic Wastewater Treatment and Discharge	Activity data are not available consistently and properly (Data were available only for 1994, 2000, 2005, 2010, 2011, 2012, 2013, 2014, 2015, 2016)	A proper data collection mechanism should be implemented to collect all the data for the entire time period.	Ministry of Environment

38. IPPU Sector

In the IPPU sector, recalculations were conducted to enhance the quality and consistency of the GHG inventory. The following approach was adopted:

A. **Recalculation of historical GHG inventory emissions due to updated GWP values**: Cambodia's latest GHG inventory, presented in the Third National Communication, used Global Warming Potential (GWP) values from the IPCC Fourth Assessment Report. However, to meet current UNFCCC requirements, the GWP values from the IPCC Fifth Assessment Report (AR5) have been applied in this GHG inventory assessment. As a result, emissions from 1994 to 2016 were recalculated using the AR5 GWP values to ensure alignment with the latest standards.

The **Table I.117** below outlines the specific improvements identified for the IPPU sector.

Table I. 117: Identified improvements in the IPPU sector

Sector	Sub-sector	Identified gaps	Improvement actions	Responsible institution
IPPU	2A1 - Cement production	Activity data are not available consistently and properly (Production weight and consumption of imported clinker)	A mechanism should be implemented to collect the required data properly, specially from	Ministry of Industry and Handicrafts/ Cement production companies

			private sector companies	
	2D1- Lubricant Use	Activity data are not available properly. (Activity data are available only for 2020 and 2021)	A mechanism should be implemented to collect the required data for the entire time series	Ministry of Mines and Energy
	2F1 - Refrigeration and Air conditioning	Data for stationery and mobile refrigerators and air conditioners were not available separately.	A data collection mechanism should be implemented to collect data separately for mobile and stationary, for refrigerators and air conditioners sub sector.	National Ozone Unit of the Ministry of Environment

39. AFOLU Sector

39.1. Category-specific recalculations for enteric fermentation

Compilation of a revised Tier 1 inventory involved compilation of a new consistent time series for activity data from 1994-2022, and application of the emission factors and methods in the 2019 Refinement. **Table I.118** presents the recalculation of CH_4 from enteric fermentation from 1994 to 2016, which was the last year in the previous inventory submission. Estimates in this inventory were larger than in the previous inventory for all years in the time series. The differences ranged from 13.7% to 27.7% in different years. These changes resulted in upward revisions of emissions by 29.1 Gg CH_4 in 1990, and by 34.7 Gg CH_4 in 2016. This is mainly because the appropriate Tier 1 emission factors in the 2019 Refinement are higher than in the IPCC 2006 Guidelines. The exceptions were the emission factors used for commercial other cattle and horses in this inventory, which were lower than the IPCC 2006 default values, but these categories have minor contributions to emissions in this category. There were also some differences in population data used. The 1994-2016 trend in the previous inventory submission was +15.7%, and in this inventory is +16.2%.

Table I. 118: Recalculations for enteric fermentation methane emissions, 1994-2016 (Gg CH4)

Year	NIR 2019	This inventory	% difference
1994	170	204	20%
2000	181	206	14%
2005	190	227	20%
2010	205	245	20%
2016	168	202	21%

39.2. Category-specific recalculations for manure management

Table I.119 presents the recalculation of manure management CH_4 and N_2O emissions from 1990 to 2016 and compares them with the previous inventory values. For methane estimates, the time series begins with a similar level of emissions, but in the previous inventory the increase is not notable whereas in this inventory total methane emissions roughly double over the inventory period. The population data used for pigs in the previous inventory is roughly equivalent to the household scale pig population in this inventory, while this inventory also includes commercial breeding and fattening pig populations which grew rapidly after 2005. Also, the previous inventory used the IPCC 2006 default emission factors, whereas this inventory used the 2019 Refinement Tier 1 method which gives much higher methane emissions per head than the IPCC 2006 default values.

For manure management N_2O emissions, the previous inventory consistently estimated emissions at between 1.8 and 2.7 Gg N_2O, while this inventory estimates emissions at 63% to 80% higher. Differences are in part due to differences in N rate and TAM values and manure management systems, with this inventory using default values from the 2019 Refinement as opposed to the former 2006 default values. Average nitrogen excretion rates calculated using the 2019 Refinement default values are 7% higher for cattle, 22% higher for buffalo and 149% higher for pigs than the IPCC 2006 default values. Differences are also due to differences in activity data on animal populations.

Table I. 119: Recalculations of manure management CH4 and N2O emissions, 1990-2016

Year	Methane (Gg CH_4)			Nitrous oxide (Gg N_2O)		
	NIR 2019	This inventory	% difference	NIR 2019	This inventory	% difference
1994	19	26	39%	2	4	76%
2000	18	26	43%	2	4	63%
2005	24	33	41%	3	4	68%
2010	20	30	53%	3	4	69%
2016	21	41	94%	2	4	66%

39.3. Challenges of current emission estimation in Land sector

a. Estimation of area for activity data is based on summing the area of the pixels (i.e. pixel counting) in each land cover type class. This often leads to over and underestimation of map areas and no estimation of area uncertainty.
b. Spatial consistency between consecutive maps could be compromised. The current approach for land cover map production converts pixels to polygons for editing purposes. These could result in the detection of spurious changes when the polygons of two consecutive maps are compared, as it is not the same polygon that is being tracked through time.
c. Current emissions estimation from the FOLU sector does not incorporate emissions resulting from forest degradation in a way which is explicit about forest management

regimes. Moreover, it assumes that all changes in forest land remaining as forest land are anthropogenic. In these calculations, the emission due to forest degradation within forestland are assumed to be equivalent to removals due to forest regrowth.

d. The national definition of forest includes rubber, oil palm and tree plantations as forests, while the REDD+ definition excludes them. The published transition matrices for 2014-2018 present the data aggregated into non-forest land, making it challenging to accurately estimate emissions from the conversion of forest land to plantations.
e. Emissions related to changes in three IPCC land cover categories: grasslands, croplands and wetlands are not included because the activity data is aggregated (a similar problem as described above for tree plantations) or unavailable. Other land remaining other land has a default value of 0, the emissions are calculated in other categories. This is considered conservative.
f. The current analysis does not separate emissions that are a direct result of anthropogenic activity from emissions that could result from natural processes. It assumes that changes from forest to other land cover are most likely anthropogenic.

Table I. 120: Identified improvements in the AFOLU sector

Sector	Sub-sector	Identified gaps	Improvement actions	Responsible institution
AFOLU	3A1 – Enteric Fermentation	An inventory of emissions from other cattle calculated using the IPCC Tier 2 method is required since it has been identified as a key category in the previous NIR submission	An inventory of emissions from other cattle calculated using the IPCC Tier 2 method is under preparation	GDAHP
	3A2 – Manure Management	An inventory of emissions from pigs calculated using the IPCC Tier 2 method is required since it has been identified as a key category by the previous NIR submission	An inventory of emissions from pigs calculated using the IPCC Tier 2 method is under preparation	GDAHP
	3B – Land	The current estimation of area for each land cover type lacks an effective methodology to estimate uncertainty.	Enabling SBAE methodology to enable the estimation of uncertainty. Ideally, this process will be coordinated with the update of the	

			Forest Reference Level (FRL) 2025.	
		Unavailability of a process to monitor changes between forests and croplands	It is important to start setting up a process to monitor changes between forests and croplands	
		There is no system in place to track how land use changes over time or to track pixels to maintain consistency with IPCC guidelines (20-year rule for land use categories).	An approach that tracks pixels through time will be developed	
		Need to strengthen the improvement plan	SBAE approach and a pixel-based change detection system, will be strengthened as a part of the improvement plan	
		Emission factors from different land uses should have a more accurate estimation of carbon fluxes for 3B	This will be an improvement area in the future. In this analysis, the other IPCC LU categories are assumed to have a default value of 0, therefore overtime more accurate carbon stock estimates from different land uses (e.g. grassland, wetlands) will be included.	
		Removals due to forest regrowth can be incorporated into the emission calculation	A sequestration rate of 4.7 tCO_2/ha/year (equivalent to 1.28 tC/ha/year) has	

			been proposed in the context of forest protection for REDD+ as relative mitigation potential (GSSD 2015). Nevertheless, this number could be too high for the forest remaining as forest category and must be adjusted considering forest type, forest age and management regime. In addition, removals by forest plantations can be incorporated for Acacia and Eucalyptus, but the data is aggregated into a unique tree plantation category.	
		Lack of having emission factors for other forest types and tree crops (rubber, oil palm and cashew)	Emission factors for other forest types and tree crops (rubber, oil palm and cashew will be developed over time	
		Country-specific value for carbon stocks loss to degradation is needed	Should be proposed	
		Need to address Uncertainty and Reporting Transparency	To enhance transparency in activity data, land cover and land cover change matrices should be disaggregated. In addition, land	

			cover data should be produced on a regular basis, with a standardized methodology that allows comparison between maps at different periods.	
			A computing-based track record or data processing log system to keep a record of assumptions, data sources, emission factors and any update in methodologies is needed for each BTR report, to advance the Enhanced Transparency Framework. Uncertainty and the impact on the total emissions should be included. Information on uncertainty from the future FRL will be used to provide a notion on the uncertainty of the AD.	

Chapter 2:

Information necessary to track progress made in implementing and achieving nationally determined contributions under Article 4 of the Paris Agreement

Under Paris Agreement

A. National circumstances and institutional arrangements

(paras. 59-63 of the MPGs)

1. Government Structure

The Kingdom of Cambodia (KoC) operates as a parliamentary monarchy under a constitution established in 1993, with liberal democracy and a free-market economy forming the basis of its political system. The King is the Head of State, symbolizing national unity and eternity, yet does not govern.

The government of Cambodia functions through a bicameral legislature comprising the National Assembly and the Senate, with separate branches for the Legislative, Executive, and Judiciary. The Parliament, endowed with primary legislative authority, consists of the National Assembly and the Senate. Members of the National Assembly are elected directly through a proportional representation system. The King appoints the Prime Minister and the Council of Ministers upon recommendation from the National Assembly. The constitution ensures the judiciary's independence from the Legislative and Executive branches. Legislation undergoes scrutiny by the National Assembly, followed by review by the Senate, culminating in the promulgation of laws through the Royal Kram of the King.

2. Geographical Profile

Cambodia is situated in Southeast Asia, spanning between latitudes 10° and 15°N and longitudes 102° and 108°E, covering an area of 181,035 square kilometers. It shares borders with Thailand to the northwest, Lao PDR to the northeast, and Vietnam to the east and south, totaling a 2,428-kilometer land border. The country's landscape is characterized by central plains surrounded by mountainous and highland regions, with a southern coastline. At the heart of Cambodia lies its capital city, Phnom Penh, strategically located where the Mekong, Tonle Sap, and Bassac Rivers converge. The Mekong River and its tributaries dominate the hydrology, while the Tonle Sap Lake, in the northwest, expands during the rainy season, creating a unique ecological phenomenon. Additionally, natural boundaries are formed by the Dangrek mountain range in the north and the Cardamom Mountains in the southwest. Cambodia boasts lush forests, with its highest peak, Phnom Aural, reaching 1,813 meters above sea level.

Figure II. 1: Geographical map of Cambodia.

3. Climate Profile

Cambodia experiences a tropical climate characterized by distinct wet and dry seasons, predominantly influenced by tropical monsoons. The country undergoes the wet season from May to October, marked by heavy rainfall brought about by south-westerly winds. This period contributes to approximately 80-90% of Cambodia's annual precipitation. The rainfall varies across different regions, with the central plains receiving around 1,400mm annually, while mountainous areas and coastal regions witness higher rates, reaching up to 3,800mm. Conversely, the dry season spans from November to April and is characterized by drier conditions and cooler temperatures, particularly between November and January. Despite the seasonal variations, Cambodia maintains uniform average temperatures throughout the year, with the highest temperatures typically occurring in the early summer months preceding the onset of the wet season. During this period, maximum temperatures often exceed 32°C. Throughout the rest of the year, temperatures remain moderate, ranging between 25-27°C. The wet season commences with the arrival of the summer monsoon in May. It extends until November, with the heaviest rainfall concentrated in the southeast and northwest regions of the country. The annual average rainfall ranges from 1,400mm to 2,000mm, with coastal and highland areas experiencing higher rates than inland regions (WB, 2024).

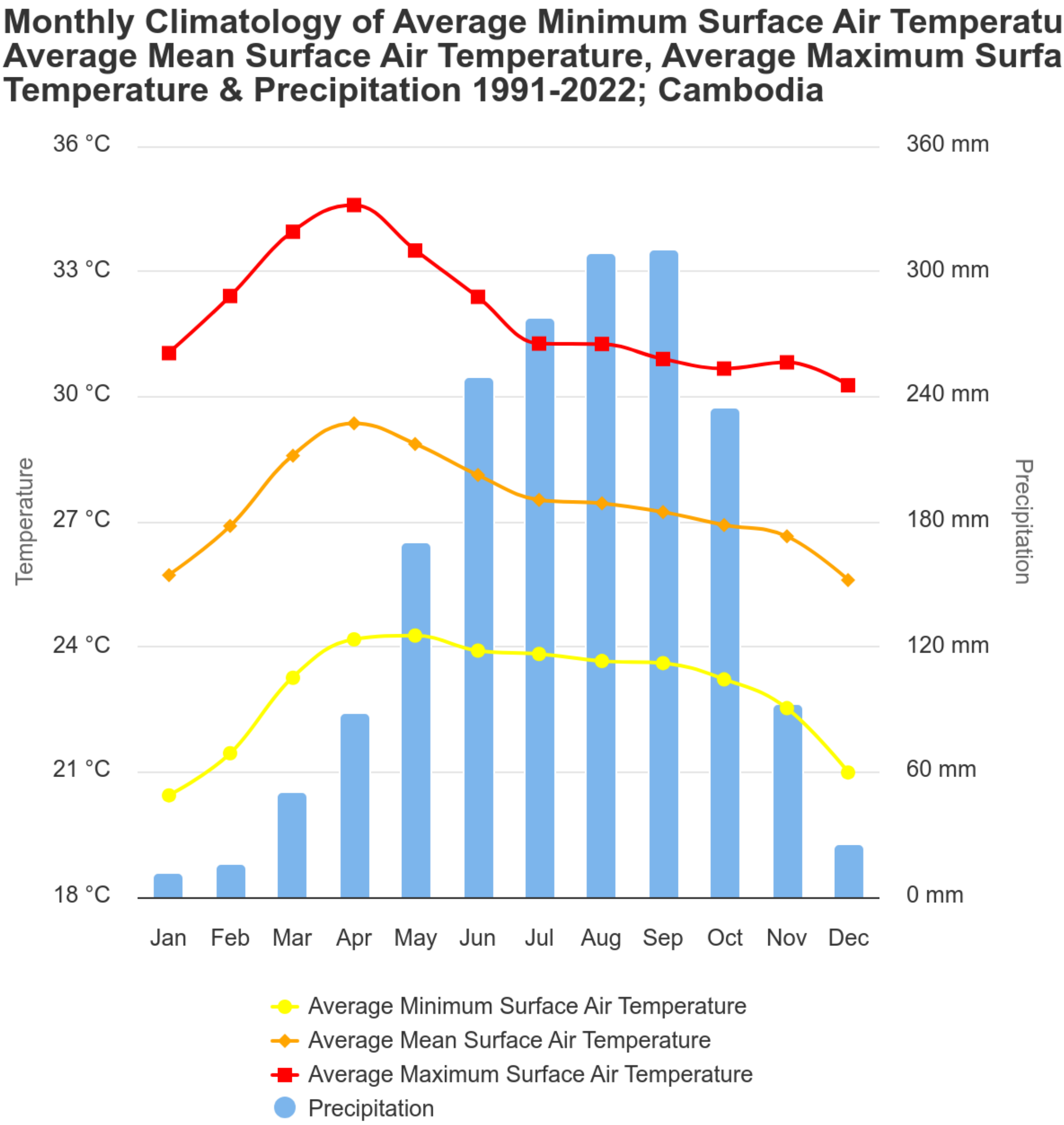


Figure II. 2: Monthly Climatology of Average Minimum Surface Air Temperature, Average Mean Surface Air Temperature, Average Maximum Surface Air Temperature & Precipitation 1991-2020; Cambodia

Source: World Bank, 2024

Inter-annual climate variations in Cambodia are influenced by phenomena such as the El Niño Southern Oscillation (ENSO), which affects the nature of monsoons in the region. El Niño events typically bring warmer and drier than average winter conditions across Southeast Asia, while La Niña episodes result in cooler than average conditions. These climate patterns significantly shape Cambodia's weather dynamics, impacting agriculture, water resources, and overall socio-economic activities. Despite these variations, Cambodia benefits from its geographical features, shielded from the direct impacts of tropical cyclones and typhoons by surrounding mountains and highlands, contributing to its overall climate resilience.

4. Natural Disasters

Natural disasters pose significant challenges to Cambodia, with storms, flooding, and droughts being the most prevalent and impactful occurrences. These disasters affect many people and incur substantial economic costs, exacerbating vulnerabilities and hindering development efforts. Climate change projections suggest that these events may worsen in the future, with more intense rainfall and violent storms during the wet season and drier dry seasons anticipated. Storms, often accompanied by lightning, pose significant risks to Cambodian communities. Strong winds and heavy rainfall can lead to the destruction of homes and infrastructure, causing injuries and fatalities. Lightning strikes, with Cambodia having one of the highest rates of lightning deaths globally, resulting in numerous casualties and property damage annually.

Drought, while less frequent than flooding, is equally damaging, mainly due to its prolonged effects on agriculture and water resources. Severe droughts, such as those experienced in 2002, 2003, 2004, 2006, and 2016, have caused widespread water shortages and crop failures, affecting millions nationwide. The 2016 drought, one of the most severe in decades, significantly impacted Cambodia's population, with millions directly affected by water scarcity and agricultural losses (ODC, 2016).

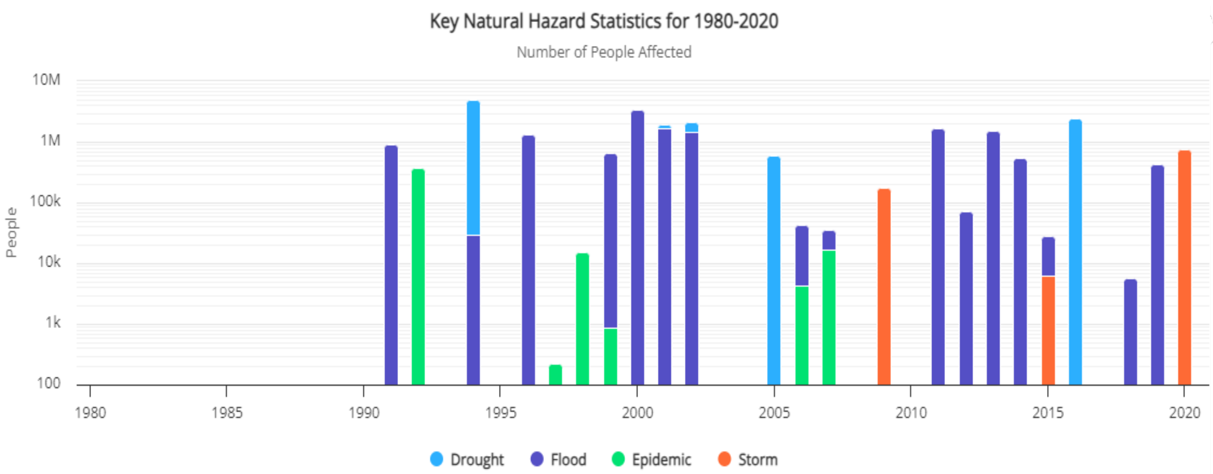


Figure II. 3:Natural disaster in Cambodia 1980-2020
Source: ODC, 2016

Flooding is a recurrent issue in Cambodia, particularly during the wet season from May to October. While localized flooding brings advantages such as improved soil moisture and fertility, severe floods can have devastating consequences. In 2013, flooding caused extensive damage across agriculture, infrastructure, and residential areas, resulting in significant economic losses and losses of lives. Infrastructure damage, including roads, water systems, and electricity distribution, further exacerbates the long-term impacts of flooding, disrupting essential services and impeding recovery efforts.

Despite government efforts to mainstream environmental protection and climate adaptation, climate change threatens Cambodia's development and increases hazards. According to future forecasts, the northeastern country will see less precipitation but more yearly rainfall. Sea level rise is predicted to cause increased flooding along the shoreline over the next 90 years. A decrease in rice yields is anticipated due to increased temperature, showing that climate change poses a severe danger to food security and safety. Low-lying farming fields would be subject to increasing flooding and saline intrusion (ODC, 2020).

Table II. 1: Flood occurrence in Cambodia from 1996-2019

Year	Number of Floods that Cause More than 5 Deaths (Major)	Number of Dead from Major Floods	Number of Houses Damaged or Destroyed by Major Storms
1996	6	155	2629
2000	14	252	1899
2001	1	5	0
2002	1	9	2
2003	1	7	0
2005	1	64	1035
2009	2	13	11
2011	9	68	117
2012	1	6	0
2013	3	168	1183
2014	1	12	124
2017	4	41	154
2018	1	1	137
2019	3	16	82
Grand Total	46	155	6180

Source: ODC, 2020

5. Population Profile

In 2020, the nation's population was 16.3 million, with forecasts indicating a growth to 17.3 million by 2024, 17.6 million by 2025, nearly 18.7 million by 2030, and 21 million by 2050 (NIS, 2021). Phnom Penh, the capital and largest city of Cambodia, with a population of approximately 2.4 million in 2020. Forecasts suggest it will attain approximately 2.5 million by 2024 and 2.7 million by 2030. The exponential annual growth rate in 2020 was roughly 1.6%, projected to decline to 1.4% by 2024 and 1.2% by 2030. In 2008, the population density was 75 individuals per square kilometer, increasing to 82 individuals per square kilometer in 2013, and reaching 87 individuals per square kilometer according to the GPCC 2019 statistics.

In 2019, population density across regions within the country exhibited significant variation. The Central Plain region recorded a relatively high population density of 305 persons per square kilometer, followed by the Tonle Sap region with 72 persons per square kilometer. The coastal and sea regions came next with 62 persons per square kilometer, whereas the plateau and mountains region had the lowest density at only 29 persons per square kilometer (NIS, 2021).

(a) **(b)**

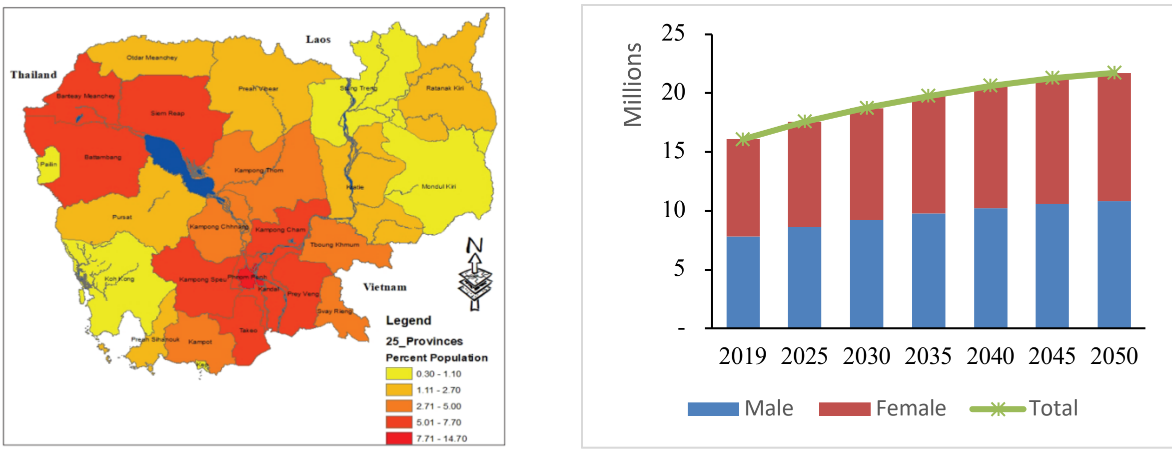


Figure II. 4: (a) Percentage distribution of the total population by province, Cambodia 2019, (b) Long term trend in Cambodia's population
Source: NIS, 2021

(a) **(b)**

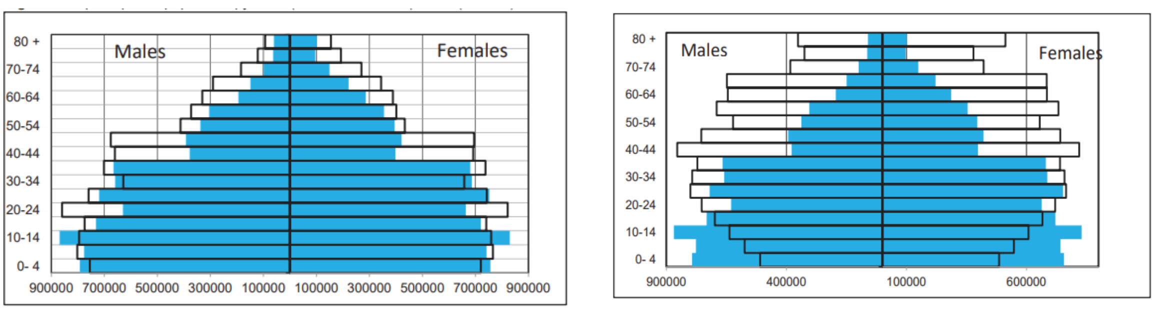


Figure II. 5: (a) Superimposed population pyramid (absolute numbers): 2019 (shaded) and 2030 (clear); (b) Superimposed population pyramid (absolute numbers): 2019 (shaded) and 2050 (clear)
Source: NIS, 2021

(a) **(b)**

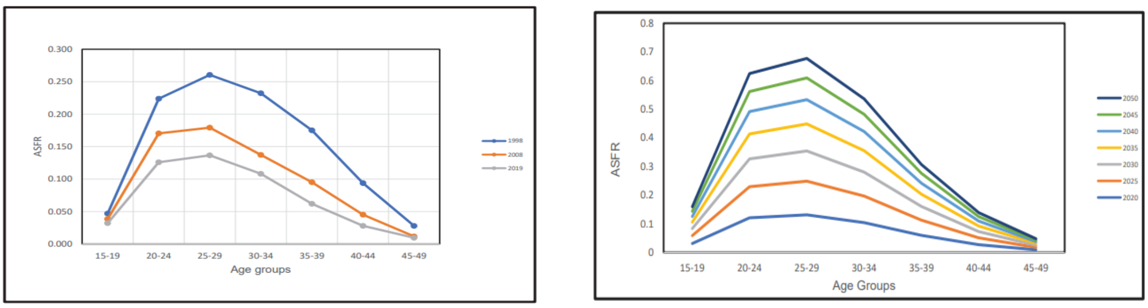


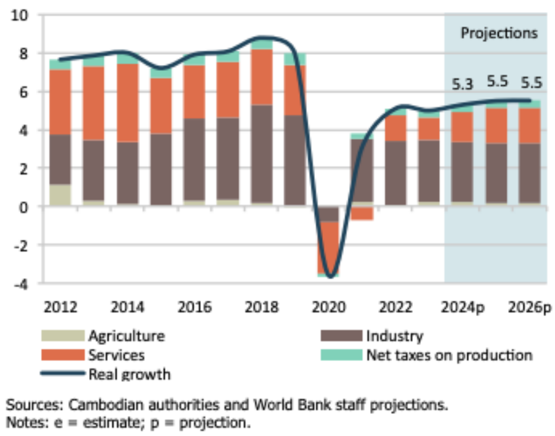
Figure II. 6: (a) Age-specific fertility rates according to the 1998, 2008 and 2019 censuses, (b) Projected ASFR, 2020 to 2050
Source: NIS, 2021

6. Economic Profile

In the ten years preceding the COVID-19 pandemic, Cambodia achieved an average annual growth rate of seven percent. The annual GDP demonstrated significant growth, averaging over 8% per year from 2000 to 2010 and approximately 7% since 2011. Following the onset of the COVID-19 pandemic, Cambodia's economy experienced a deceleration. The average annual growth rate decreased to 4.4% from 2017 to 2022. The World Bank projects a growth rate of 5.4% for this year, exceeding the growth recorded in the preceding three years. This indicates a possible recovery in economic activity relative to the decline observed in the immediate post-pandemic period (HAYATI, 2023). The International Monetary Fund (IMF) projects a 6.1 % change in Real GDP growth for 2024. The COVID-19 pandemic severely affected Cambodia's economy, mainly due to the collapse of tourism and a decline in demand for manufactured goods. In 2021, the economy faced setbacks due to community spread of the virus and subsequent lockdown measures. Consequently, Cambodia experienced a recession in 2020 and sluggish growth in 2021.

Significant changes were observed in sectoral contributions to GDP. The contribution of the agriculture sector to Cambodia's GDP decreased from 24.7% in 2016 to 22.7% in 2020, and further to 22.2% in 2022. The industry sector rose from 29.5% in 2016 to 34.6% in 2020, reaching 37.9% in 2022. The observed changes indicate a shift in Cambodia's economic structure, characterized by a reduced dependence on agriculture and an increasing focus on industrial activities[5].

(a)



(b)

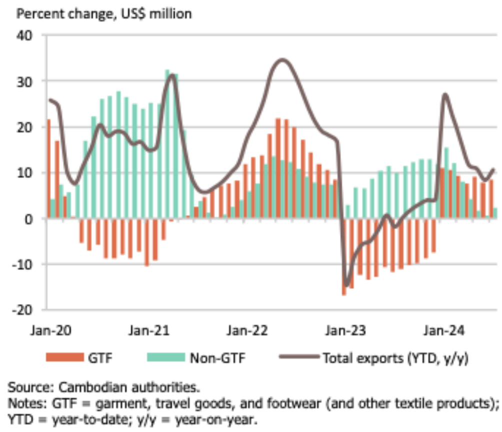


Figure II. 7: (a) Cambodia / Real GDP growth and sectoral contributions to real GDP growth. (b) Cambodia / Merchandise exports, levels and growth rate

Source: World Bank, 2024

5 Cambodia Economic Outlook https://thedocs.worldbank.org/en/doc/c6aceb75bed03729ef4ff9404dd7f125-0500012021/related/mpo-khm.pdf

7. Education Profile

The Royal Government of Cambodia has made significant strides in implementing the "Education for All" strategy, ensuring most Cambodian children have equitable access to a basic nine-year education. The first Education Strategic Plan (ESP) (2001-2005) aimed to enhance education quality and increase budget allocations for the sector. Subsequent updates, such as the ESP (2009-2013), focused on aligning education sector plans with legislative mandates and RGC policies. Moreover, the ESP (2014-2018)[6] was redesigned to establish a clear relationship between strategic frameworks, programs, activities, and resource allocation.

Table II. 2:Advancement within Cambodia's education sector

Items	Unit	2008/9	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Primary Schools (Grade 1-6)	Number	6,565	6,635	6,685	6,785	6,910	6,915	6,951	7,073
Net Enrolment Primary School	%	94.4	95	96	97	97	97.3	97.9	98.6
Lower Secondary Schools	Number	1,451	1,521	1,600	1,612	1,622	1,632	1,642	1,652
Net Enrolment Lower Secondary School	%	33.9	40	43	46	56.5	60.4	66.9	73.7
Upper Secondary Schools	Number	N/A	N/A	N/A	N/A	433	443	451	498
Net Enrolment Upper Secondary School	%	N/A	N/A	N/A	N/A	29.8	29.4	30.8	33.9
Technical High Schools	Number	N/A	N/A	N/A	N/A	4	4	5	5
Student Technical High Schools	Number	N/A	N/A	N/A	N/A	730	984	1,238	1,492
Literacy Rate (15-24 years)	%	87.5	88	89	90	91.5	92.5	93.5	94.5
Literacy Rate (15-45 years)	%	N/A	N/A	N/A	N/A	N/A	87.8	88.5	89.2

Source: TNC, 2022

The primary higher education institutions in Cambodia engaged in climate change research include the Royal University of Phnom Penh (RUPP), the Institute of Technology Cambodia (ITC), the Royal University of Agriculture (RUA), the Paññāsāstra University of Cambodia (PUC), and the Prek Leap National College of Agriculture (PNCA). These institutions explore various aspects of climate change, with some commonly researched focus:

Table II. 3: Research thematic area in areas of climate related topics.

Thematic areas	Research focus/topics
Water	▪ Water and food security. ▪ Water governance and climate change adaptation. ▪ Effects of forest restoration on water availability for smart agriculture: A Case Study of Cambodia (FRAWSA) funded by the Swedish government;
Agriculture	▪ Climate-smart agriculture. ▪ Farm conservation and sustainable use of cereals diversity. ▪ Economics of adaptation in the Agriculture sector. ▪ Impact of CC on the Agriculture sector. ▪ Study of CH4 emission from enteric fermentation using INVITRO SYSTEM.

6 Education Strategic Plan: https://planipolis.iiep.unesco.org/sites/default/files/ressources/cambodia_education_strategic_plan_2014-2018.pdf

	▪ Producing CH_4 gases using waste from vegetables, fruits, and animal fertilizer ▪ Module for GHG emission from animal raising. ▪ Scaling-up Sustainable Land Management (SLM) practices by smallholder farmers: ▪ Working with agricultural extension services to identify, assess, and disseminate SLM practices funded by the IFAD;
Environment /Forestry	▪ Rehabilitation of native species in Cambodia. ▪ Develop an allometric equation to calculate carbon stock in forests. ▪ Enhancing Climate Change Resilience of Rural Communities Living in Protected Areas in Cambodia funded by MoE/UNEP;
Energy	▪ Building Adaptive Capacity through the Scaling-up of Renewable Energy Technologies in Rural Cambodia (S-RET) funded by the IFAD. ▪ Promoting Green Mobility through Electric Motorcycles in Cambodia funded by the GGGI, and Strategic Program for Climate Resilience (SPCR) (2011-2023) funded by the ADB.
Disaster Risk Reduction (DRR) and Climate change	▪ Climate resilience and disaster risk reduction. ▪ Identification of natural hazards. ▪ Historical climate change, climate vulnerability, and climate change projection in Cambodia. ▪ Improving community livelihood through CC adaptation and mitigation. ▪ Impact of drought on rural livelihoods;
Cross-cutting	▪ Building capacity of government institutions to help farmers adapt to CC;

8. Sectoral progress

8.1. Energy sector

Cambodia has made significant strides in expanding its electricity supply and network, guided by comprehensive plans like the Energy Sector Development Plan (ESDP) and the Rural Electrification Master Plan (REMP). While the country heavily relies on imported petroleum products, it boasts abundant, yet largely untapped, renewable energy sources. Infrastructure improvements, like transmission lines and substations, have enhanced connectivity and operational efficiency. The development focus has been on constructing and operating various hydropower plants and a coal-fired power plant to increase capacity and coverage. However, challenges persist, particularly in seasonal energy production and the need to accelerate electrification efforts to meet ambitious goals. Biomass remains a dominant energy source, prompting initiatives to promote renewable energy types and improve efficiency. The potential of offshore oil and gas fields adds another dimension to Cambodia's energy landscape, promising significant economic, social, and environmental impacts. Despite a growing final energy consumption, renewable energy plays a substantial role, highlighting the importance of sustainable energy practices for Cambodia's future development.

8.1.1. Energy Production and Consumption

In 2015, the Royal Government of Cambodia (RGC) witnessed a significant surge in electricity consumers, with a reported increase of nearly 30% compared to 2014, totaling 1,859,205 consumers. The primary fuels utilized for electricity generation remain diesel and Heavy Fuel Oil (HFO), with biomass reserved for micro-generation installations and captive systems. Independent Power Producers (IPP) dominated the electricity production landscape in 2004, contributing 64% of the total output, while Electricité Du Cambodge (EDC) and the Ministry of Industry, Mines and Energy (MIME) supplied the remainder. By 2015, electricity generation soared by 46.79% compared to the previous year, as indicated by the Electricity Authority of Cambodia (EAC) report in 2016 (Cambodia, Cambodia. National Communication (NC). NC 3., 2022). **Table II.4** shows the energy output from IPPs and Consolidated licensees, categorized by generation type.

Table II. 4: Generation Facilities and Energy Sent-out by Generation Type in 2014 and 2015

No.	Type of Generation	Installed Capacity		Proportion of Installed Capacity (%) for 2015	Energy Sent out		Proportion of Energy Sent out (%) for 2015
		2014	2015		2014	2015	
1	Hydropower	929,430	929,700	56.1	1,851.60	2,159.64	48.11
2	Diesel/HFO	291,268	304,629	18.38	326.97	163.66	3.65
3	Biomass	22,640	19,945	1.2	16.79	38.15	0.85
4	Coal	268,000	403,000	24.32	863.02	2,127.82	47.4
	Total	**1,511,338**	**1,657,274**	**100**	**3,058.38**	**4,489.27**	**100**

Source: TNC, 2022

By 2013, Cambodia had made significant strides in its energy sector, with energy sources nearly meeting consumption demands. Annual electricity consumption per person surged from 139 kWh in 2008 to 268 kWh, marking an average yearly growth of approximately 14%. Notably, operationalizing various electrical networks between 2008 and 2013 led to a substantial increase, with 51% of all villages nationwide gaining access to electricity by 2013. However, challenges persist, including sustaining electricity production to match escalating demands, extending network coverage to remaining villages, and devising more equitable electricity tariffs for consumers. **Table II. 5** provides a snapshot of Annual Electricity Consumption and Transmission Line Network data from 2008 to 2016

Table II. 5: Annual Electricity Consumption and Transmission Line Network (2008-2016)

No.	Description	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016
1	Electricity generation	Million Kwh	1,858	1,882	2,164	2,489	2,862	4,350	5,219	6,263	7,516
2	Household consumers	1000 HH	487	561	645	741	853	1,126	1,328	1,528	1,665
3	Consumption per capita/year	Kwh	139	135	153	174	197	268	295	344	400
4	Transmission line network (22 KV)	Km	1,450	1,595	1,914	2,201	2,531	11,182	13,440	17,182	20,482
5	Transmission line network (115 KV)	Km	323	353	353	376	548	422	521	676	876
6	Transmission line network (230 KV)	Km	-	100	100	269	1,182	853	944	1,054	1,446

Source: TNC, 2022

8.1.2. GHG emissions for the energy sector

A baseline scenario was devised for three specific subsectors: energy industries, manufacturing industries, and construction and transport. Considering available resources, energy consumption from each source was assessed using the GDP growth rate, estimated at 10% from

2011 to 2030 and 6.4% from 2031 to 2050. Projections suggest that emissions will escalate to 33 million tons of CO2e by 2030 and surge further to 114.2 million tons of CO2e by 2050 (Cambodia, 2022). **Table II.6** shows the BAU development for the Energy Sector.

Table II. 6: GHE emission projection under BAU in Energy sector 2010-2050

Sector- Energy	Million tonnes of CO_2e				
Year	**2010**	**2020**	**2030**	**2040**	**2050**
Energy Industries	0.8	2.2	5.7	10.7	19.9
Manufacturing Industries and Construction	0.7	1.7	4.3	7.9	14.7
Transport	2.9	7.6	19.6	36.5	67.9
Other Sectors- Agriculture, Forestry & Fisheries	0.1	0.3	0.7	1.3	2.4
Other Sectors- Commercial and Institutional	0.1	0.3	0.8	1.5	2.7
Other Sectors- Residential	0.3	0.7	1.8	3.5	6.4
Total - BAU	**4.9**	**12.8**	**33.0**	**61.4**	**114.2**

Source: TNC, 2022

8.2. Industrial Processes and Product Use (IPPU)

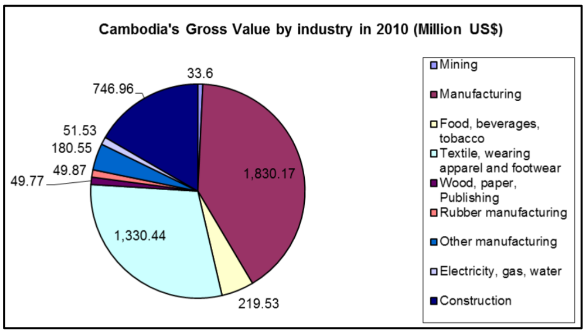
The industry sector in Cambodia has experienced remarkable growth over the past decade, primarily driven by export-oriented garment manufacturing. Its contribution to GDP surged from 12.7% in 1993 to 28.9% in 2004, boasting an impressive average annual growth rate exceeding 15%. Within the industry, textile, wearing apparel, and footwear emerged as the fastest-growing subsector, demonstrating an average annual increase of 41%. By 2004, these segments collectively accounted for 89% of the country's goods exports. However, despite its substantial economic impact, the industry sector employed only 8% of the labor force, significantly lower than the agriculture sector, which engaged 75% of the workforce.

In 2011, Cambodia's industrial sector surpassed 500,000 enterprises, generating over 1.6 million jobs, with over half a million in textiles, garments, and footwear alone. Legal overseas workers, numbering over 100,000, sent home more than $200 million annually in remittances. The Royal Government of Cambodia (RGC) responded by establishing the National Employment Agency (NEA) and an Employment Forum to aid job seekers and facilitate information exchange in the job market. This initiative coincided with efforts to raise the minimum wage in textile, garment, and footwear industries from $50 to $80 per month while encouraging additional monthly benefits averaging around $20 for workers. In 2010, Cambodia's industrial output totaled $4,492.4 million, with manufacturing contributing 41%, textiles, apparel, and footwear 30%, and construction 17%.

Between 2009 and 2016, the industrial sector, encompassing mining, manufacturing, electricity, gas, water, and construction, witnessed a substantial increase in investment, rising from US$ 1,011.7 million to US$ 2,517.3 million. Notably, the manufacturing sector, including the textile, apparel, and footwear sub-sector, commanded the most significant portion of this investment, totaling US$ 431.80 million in 2009 and escalating to US$ 1,150.37 million in

2016. The construction sub-sector closely followed, demanding $383.10 million in 2009 and surging to $840.85 million by 2016. In comparison, the electricity, gas, and water sub-sector received $142.71 million in 2009, which increased to $391.56 million by 2016. In 2008, manufacturing and garment industry outputs held significant economic importance, accounting for US$ 3,727.07 million and US$ 3,011.71 million, respectively. **Figure II 8 (a-b)** illustrates the economic significance of Cambodia's manufacturing and garment industry outputs.

(a)



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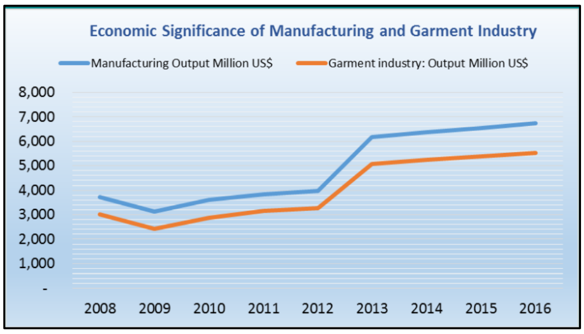


Figure II. 8: a) Cambodia's Gross Value by Industry in 2010, (b) Economic Significance of Manufacturing and Garment Industry Outputs
(Source: TNC, 2022)

8.2.1. GHG emissions for the IPPU sector

The Mineral industry emerged as the primary contributor to emissions in the IPPU sector, constituting 75% of the total emissions. The second-highest contributor (23%) stemmed from Product Use as Substitutes for Ozone-Depleting Substances (ODS). Emissions associated with cement manufacturing within the Mineral industry are anticipated to increase to 6.4 million tons of CO_2e by 2030, reflecting a 4% growth rate. This growth trajectory aligns with Cambodia's aim to achieve middle-income status by 2030, with growth expected to remain robust until 2035, driven by the expansion of the construction industry for infrastructure development. Subsequently, emissions from the cement industry are projected to decrease by -2% from 2035 to 2050. Similarly, the refrigeration and air conditioning industry are forecasted to experience an annual growth rate of 8.6% up to 2030 and 5.9% from 2030 to 2050, following the same assumptions as the cement industry. Based on these estimations, emissions are expected to reach 8.2 million tons of CO2e by 2030 and 11.6 million tons of CO2e by 2050. **Table II.7** shows the BAU development for the IPPU Sector.

Table II. 7: GHE emission estimation under BAU in IPPU 2010-20250

Sector- IPPU	**Million tonnes of CO_2e**				
Year	**2010**	**2020**	**2030**	**2040**	**2050**
Mineral Industry	0.4	3.9	6.4	6.3	6.2
Product uses as substitutes for ODS	0.1	0.6	1.3	2.4	4.2
Fuel and solvent base products	0.0	0.0	0.0	0.1	0.1
Other	0.0	0.2	0.4	0.6	1.2
Total-BAU	**0.5**	**4.7**	**8.2**	**9.4**	**11.6**

Source: TNC, 2023

8.3. Agriculture

8.3.1. Paddy and other cultivations

The agriculture sector in Cambodia is fundamental to stimulating economic growth. As of 2013, the total cultivated area for all crops exceeded 3 million hectares, with rice alone covering 2.5 million hectares, representing 90% of the whole agricultural area. From 2016 to 2023, the average paddy production increased from 3.10 tons per hectare to 3.51 tons. Simultaneously, total production increased from 8.78 million tons to 10.89 million tons.

Table II. 8: Area, Rice Production and Growth (2017-2023)

Description	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Total Cultivated Area	Million Ha	3.21	3.34	3.33	3.40	3.55	3.40	3.55
Wet Season	Million Ha	2.66	2.74	2.73	2.81	2.90	2.76	2.88
Dry Season	Million Ha	0.55	0.60	0.60	0.60	0.65	0.68	0.63
Total Harvested Area	Million Ha	3.19	3.25	3.26	3.27	3.50	3.30	3.51
Wet Season	Million Ha	2.64	2.65	2.67	2.68	2.85	2.66	2.84
Dry Season	Million Ha	0.55	0.59	0.59	0.59	0.65	0.63	0.63
Average Yield	Tons per ha	3.12	3.16	3.08	3.09	3.21	3.30	3.35
Wet Season	Tons per ha	2.87	2.93	2.82	2.83	2.96	3.05	3.09
Dry Season	Tons per ha	4.35	4.38	4.44	4.42	4.47	4.51	4.51
Total Production	Million tons	9.29	9.39	0.93	9.34	0.95	10.52	10.89
Wet Season	Million tons	7.14	7.27	7.14	7.17	7.64	2.47	2.68
Dry Season	Million tons	2.15	2.12	2.18	2.16	2.32	2.47	2.68

Source: MAFF, 2023

The cultivated areas for other horticulture and industrial crops, such as maize, cassava, mung beans, and soybeans, expanded significantly from 774,660 hectares in 2010 to 2,034,000 hectares in 2016. Production figures also rose, escalating from 9.93 million tons in 2011 to 10.85 million tons in 2012 (MAFF, 2023).

Table II. 9: Annual crop production from 2017-2021

Description	Unit	2017	2018	2019	2020	2021
Maize	000' ha	613.91	652.23	656.86	630.17	732.33
Red Corn	000' ha	206.08	215.04	200.03	154.59	125.01
Cassava	000' ha	684.07	652.24	656.87	663.93	732.33
Green bean	000' ha	50.42	37.86	26.08	18.88	25.10
Soybeans	000' ha	41.95	46.05	34.58	28.53	16.22
Sweet potatoes	000' ha	5.62	4.88	7.22	6.83	4.66
Vegetables	000' ha	48.75	57.02	57.26	69.86	-
Peanut	000' ha	1.44	1.20	0.926	0.8105	0.826
Sesame	000' ha	17.00	14.57	13.39	13.93	13.85
Sugar Cane	000' ha	19.71	20.10	17.02	12.48	46.92
Jute	000' ha	0.20	0.18	0.16	0.29	0.18
Tobacco	000' ha	6.86	5.74	5.18	5.18	4.45

8.3.2. Livestock

In 2012, the livestock and poultry sector accounted for 3.9% of Cambodia's GDP at current prices. From 2009 to 2014, approximately 1,814,000 families (56% of the total) participated in livestock and poultry farming. In 2014, the predominant livestock and poultry species among households were chickens, comprising around 64%, followed by ducks at 23% and cattle at 7%. The overall counts of Cattle, Buffalo, Swine, and Poultry were 2.47 million, 0.45 million, 1.37 million, and 29.23 million heads, respectively.

Table II. 10: Livestock production 2016-2023 (million heads)

Description	2016	2017	2018	2019	2020	2021	2022	2023
Cattle	2.90	2.97	2.93	2.78	2.84	2.97	3.03	3.05
Buffaloes	0.52	0.51	0.50	0.45	0.42	0.43	0.45	0.43
Pig/swine	2.37	3.07	2.75	2.19	2.52	3.02	3.43	3.58
Birds/poultry	28.69	36.24	38.17	40.40	48.06	53.42	58.15	59.35
Horse	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Sheep	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Goats	0.02	0.03	0.03	0.03	0.03	0.04	0.05	0.05
Total	34.51	42.83	44.38	45.84	53.89	59.89	65.12	66.48

Source: MAFF,2023

8.3.3. GHG emissions for the agriculture sector

In 2010, the TNC reported emissions from livestock and non-CO2 sources on land as 6,393.88 GgCO2e and 9,932.94 GgCO2e, respectively. The TNC constructed a Business As Usual (BAU) scenario encompassing five sub-sectors: rice farming, enteric fermentation, manure management, urea application, direct N2O emissions, and indirect N2O emissions from managed soils. Future emissions projections in the Business-As-Usual scenario were predicated on variables including population growth rate and per capita rice consumption, as well as the growth rates of cattle, pigs, and poultry concerning enteric fermentation and manure management, derived from data on meat consumption and demographic forecasts.

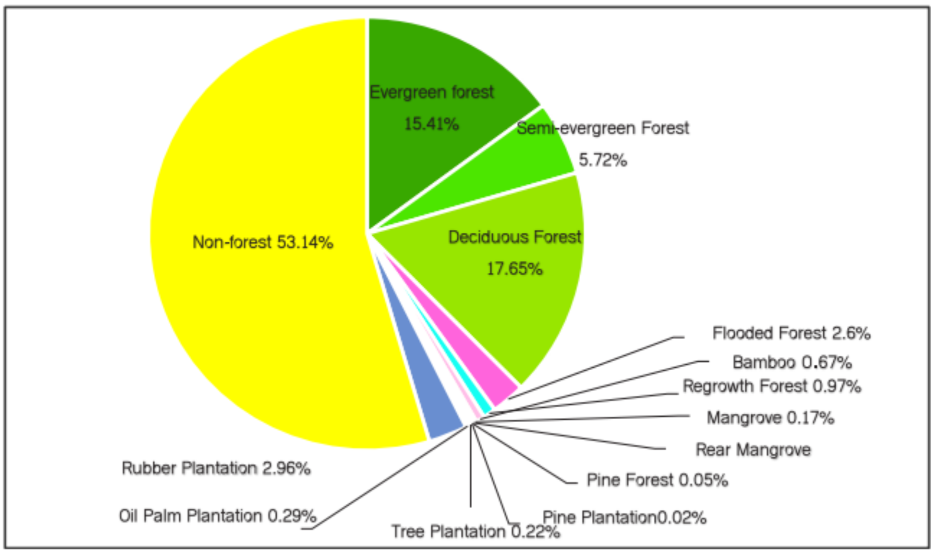
Table II. 11: BAU for the Agriculture Sector of agriculture sector from 2010-2050

Sector- Agriculture	Million tonnes of CO_2e				
Year	2010	2020	2030	2040	2050
Rice Cultivation	7.3	8.9	11.1	13.7	16.0
Livestock Emissions	7.0	6.5	7.7	8.6	9.6
N_2O Emissions from Managed Soils	1.9	2.2	3.0	3.6	4.3
Urea Application	0.1	0.2	0.2	0.3	0.3
Total - BAU	**16.3**	**17.8**	**22.0**	**26.2**	**30.2**

8.4. Forestry and Other Land Use

According to the Cambodia forest cover assessment 2018, the results show that forest land covers an area of 8.510.807 ha, equivalent to 46.86 % of the country's total land area (the results from the assessment included rubber plantation, palm oil plantation, and other perennial crops) as provided in the chart below. Since 1965, Cambodia has conducted eight assessments of its national forest cover. These assessments were conducted intermittently over 27 years, from 1965 to 1992/93, due to civil conflict that lasted nearly three decades, placing significant pressure on forest resources. Regular assessments resumed in 1993 and continued until 2014, with assessments conducted at an average interval of four years. With Cambodia's participation in the international community's REDD+ program, the importance of accurate forest cover data has increased significantly for natural resource management planning and supporting the monitoring and evaluation process for REDD+ implementation. Forest cover is now assessed every two years. According to **Figure II 9 (b)** below, the forest cover has declined by 26.18% from 1965 to 2018 compared to the overall country area. Several factors have contributed to this decline, including civil war, population growth, the expansion of agricultural land, and other significant drivers (MoE, 2023).

a)



b)

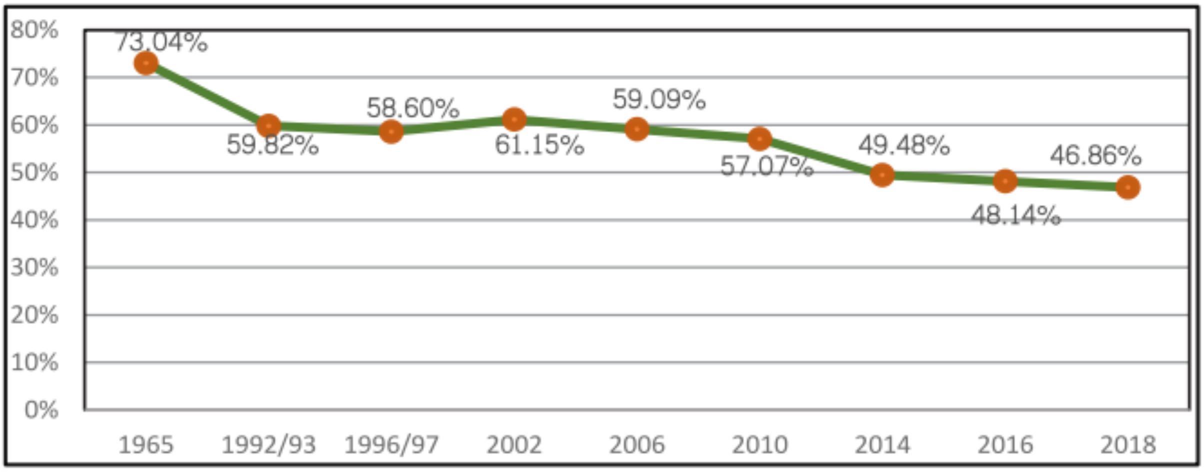


Figure II. 9 a) National land use cover of Cambodia 2018, b) The rate of variation in forest cover resources 1965 – 2018

Source: MOE, 2020

8.4.1. GHG emissions for the FOLU sector

Cambodia has produced numerous studies and national documents outlining various BAU scenarios for the FOLU sector in recent years. These assessments served as valuable references in developing BAU scenarios for the TNC assessment.

- The BAU Scenario 1 for the FOLU sector was developed based on Cambodia's TNC.
- The BAU scenario 2 for the FOLU sector was developed based on Cambodia's Updated Nationally Determined Contribution, 2020.
- The BAU scenario 3 for the FOLU sector was developed based on Cambodia's Long-Term Strategy for Carbon Neutrality, 2021

In BAU Scenario 1, activity data for the year 2010 was directly sourced from the TNC assessment. The projection of future forest cover was based on an assumed annual depletion rate of 0.5%, derived from historical data spanning 2000 to 2010 as per the TNC assessment. Conversely, BAU Scenario 2 considered a higher annual forest cover depletion rate of 2.02%. BAU Scenario 3 utilized activity data from the LTS4CN assessment, incorporating a 2.6% yearly emission decline from 2016 to 2050 within the same assessment.

Table II. 12: GHG emission project under BAU for FOLU from 2010-2050

Sector-FOLU	GHG Emissions (Million tCO_2e)					
Year	2010	2016	2020	2030	2040	2050
BAU Scenario 1 – TNC	19.9	19.9	19.9	19.9	19.9	19.9
BAU Scenario 2 – Updated NDC, 2020	-	76.3	76.3	76.3	0.0[6]	0.0[6]
BAU Scenario 3 – LTS4CN, 2021	-	51.4	46.5	34.2	28.1	21.2

Source: TNC, 2021

8.5. Waste

The Ministry of Environment (MoE) is responsible for overseeing and managing the waste sector in Cambodia. As per the MoE, waste generation at the national level was approximately estimated at 318 kg per capita per year, or a total of 4.96 million tons annually in 2012. The quantity of solid waste generated was estimated to be 2,672,019 tons per year, with a nationwide collection rate of 37%. In Cambodia, wastewater is left to oxidize in expansive holding ponds or lakes or directly discharged into waterways. Approximately 9% of Cambodian households are linked to sewage systems. The lake receives roughly 80% of the city's waste and sewage water and the untreated effluent from 3,000 small and large-scale industrial enterprises (Cambodia, 2022).

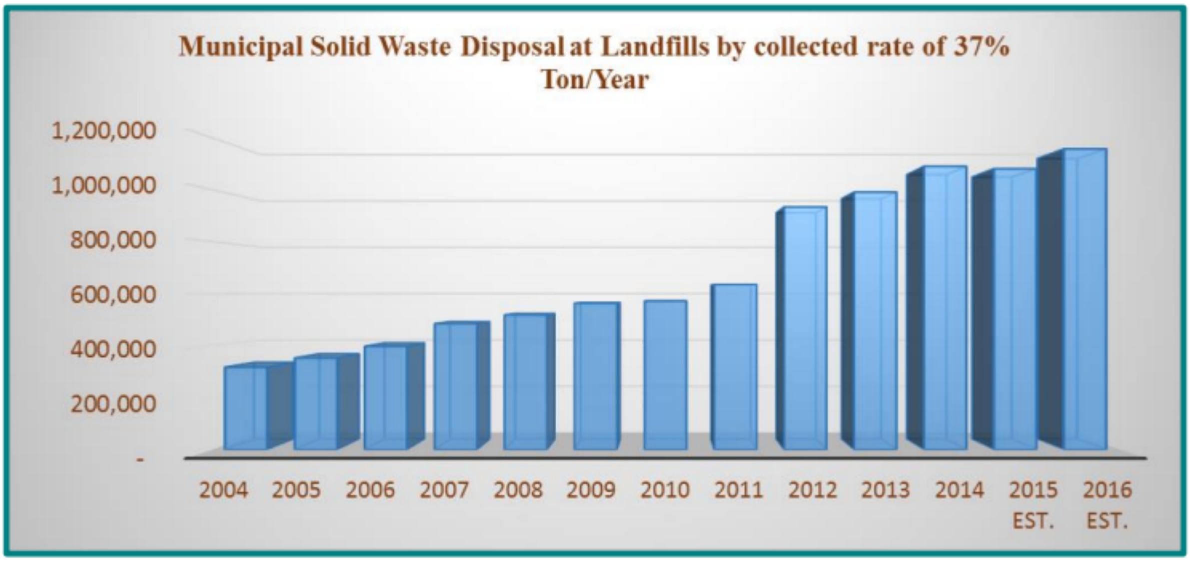


Figure II. 10: Municipal Solid Waste Disposal at Landfills from 2004-2016
Source: TNC, 2022

8.5.1. GHG emissions for the waste sector

The Third National Communication (TNC) of Cambodia has documented the emissions from the waste sector for 2010 across four sub-sectors (Cambodia, 2022):

- Solid waste disposal: 1,003.69 GgCO2e
- Biological treatment of waste: 12.98 GgCO2e
- Incineration and open burning: 324.77 GgCO2e
- Wastewater treatment and discharge: 522.53 GgCO2e

The TNC also outlines the projections for the Business-As-Usual (BAU) scenario for the waste sector. These projections are based on various factors, including (Cambodia, 2022):

- Biological treatment of waste: The population growth rate is 1.25% by 2030 and 0.76% by 2050.

- Solid waste disposal: Assumed to follow a similar growth rate of municipal solid waste generated per year as a comparable economic country in the region for solid waste.
- Incineration and open burning: The growth rate is expected to mirror the growth rate of solid waste disposal.
- Wastewater treatment and discharge: The growth rate is estimated at 0.96% from 2030 to 2050.

Table II. 13: GHG emission estimation under BAU in waste sector from 2010-2050

Sector- Waste	Million tonnes of CO_2e				
Year	2010	2020	2030	2040	2050
Solid Waste Disposal	1.0	2.2	2.6	3.0	3.6
Biological Treatment of Waste	0.01	0.01	0.02	0.02	0.02
Incineration and Open Burning	0.3	0.4	0.4	0.5	0.5
Wastewater Treatment and Discharge	0.5	0.5	0.6	0.7	0.8
Total-BAU	**1.8**	**3.2**	**3.7**	**4.2**	**4.9**

Source: TNC, 2022

9. Institutional arrangements in place to track progress made in implementing and achieving the NDC under Article 4

(paras. 61 and 62 of the MPGs)

Establishing a robust institutional framework is crucial for successfully implementing NDC tracking assessments. This framework guarantees the efficient functioning of NDC tracking assessments and streamlines the process of comprehensively collecting, analyzing, and reporting data. Previous institutional arrangements on Monitoring, Reporting, Verification (MRV) frameworks, such as those for the transport sector MRV and renewable energy MRV, have been considered in the development of the institutional framework for NDC tracking. Below, we detail the essential elements of the developed institutional arrangement.

9.1. National entity or national focal point

The National Climate Change Lead Agency is the focal point for the UNFCCC. It is entrusted with tasks such as validating results, supervising, and providing strategic oversight for the BTR assessment.

9.2. Organizational Structure

The institutional arrangement outlines a well-defined organizational structure with specified roles and responsibilities. This structure usually involves government entities, environmental agencies, research institutions, and pertinent stakeholders, ensuring a cohesive approach to NDC tracking assessments.

9.3. Legal Framework

A robust legal framework is put in place to mandate NDC tracking assessments, ensure adherence to reporting obligations, and execute emission reduction measures. This may entail enacting environmental legislation, regulations, and international accords to govern GHG monitoring, reporting, and verification procedures. The legal framework for the NDC tracking component of the BTR assessment is aligned with the legal framework of the GHGI assessment, considering established legal frameworks from previous MRV frameworks like the transport sector MRV framework and renewable energy MRV framework.

9.3.1. Capacity Building

Efforts are directed towards enhancing the capacity of relevant entities involved in NDC tracking assessments. Training programs, workshops, and technical assistance are provided to equip personnel with the necessary skills and expertise in data collection methodologies, emission reduction calculations, and NDC tracking techniques.

9.3.2. Data Management Systems

Robust data management systems are implemented to streamline emission reduction data collection, storage, and analysis. This may involve the development of centralized databases and quality assurance procedures to ensure the reliability and accuracy of the reported data.

9.3.3. Stakeholder Engagement

The institutional arrangement emphasizes active stakeholder engagement, including government agencies, industry associations, civil society organizations, and the public. Consultative processes are employed to solicit feedback, foster transparency, and promote inclusivity in decision-making regarding NDC tracking assessments.

9.3.4. Role and responsibilities

The role and responsibility of the NDC tracking in Cambodia has been defined as indicated in the **Table II.14** below.

Table II. 14: Defined roles and responsibilities for NDC tracking in Cambodia

Role	Responsibilities
National Climate Change Lead Agency	Ensure the validation of results, provide supervision, and maintain strategic oversight for NDC tracking processes. Establish quality standards and guide national climate actions toward achieving NDC commitments.
NDC Tracking Coordinator	Lead coordination efforts for international and national consultants involved in NDC tracking. Oversee project timelines, ensure

	efficient resource allocation, and monitor progress to meet reporting standards.
International NDC Tracking Evaluation Team	Perform accurate estimation of NDC emission reductions, implement rigorous quality control measures, compile and write the NDC tracking report, and provide targeted capacity-building support to national data compilers.
National NDC Tracking Evaluation Team	Collect relevant activity data, assist in the calculation of emission reduction estimates, and conduct quality assurance checks in alignment with the established QA/QC plan.
Data Provider	Supply necessary data for the NDC tracking process in a timely and accurate manner, ensuring data completeness and reliability.
Sectoral Stakeholders	Participate in quality assurance through consultation and validation workshops, offering sector-specific insights to support the accuracy and relevance of NDC tracking data.

Source: Author

Institutional arrangement for NDC tracking in Cambodia indicated in **Figure II.11**.

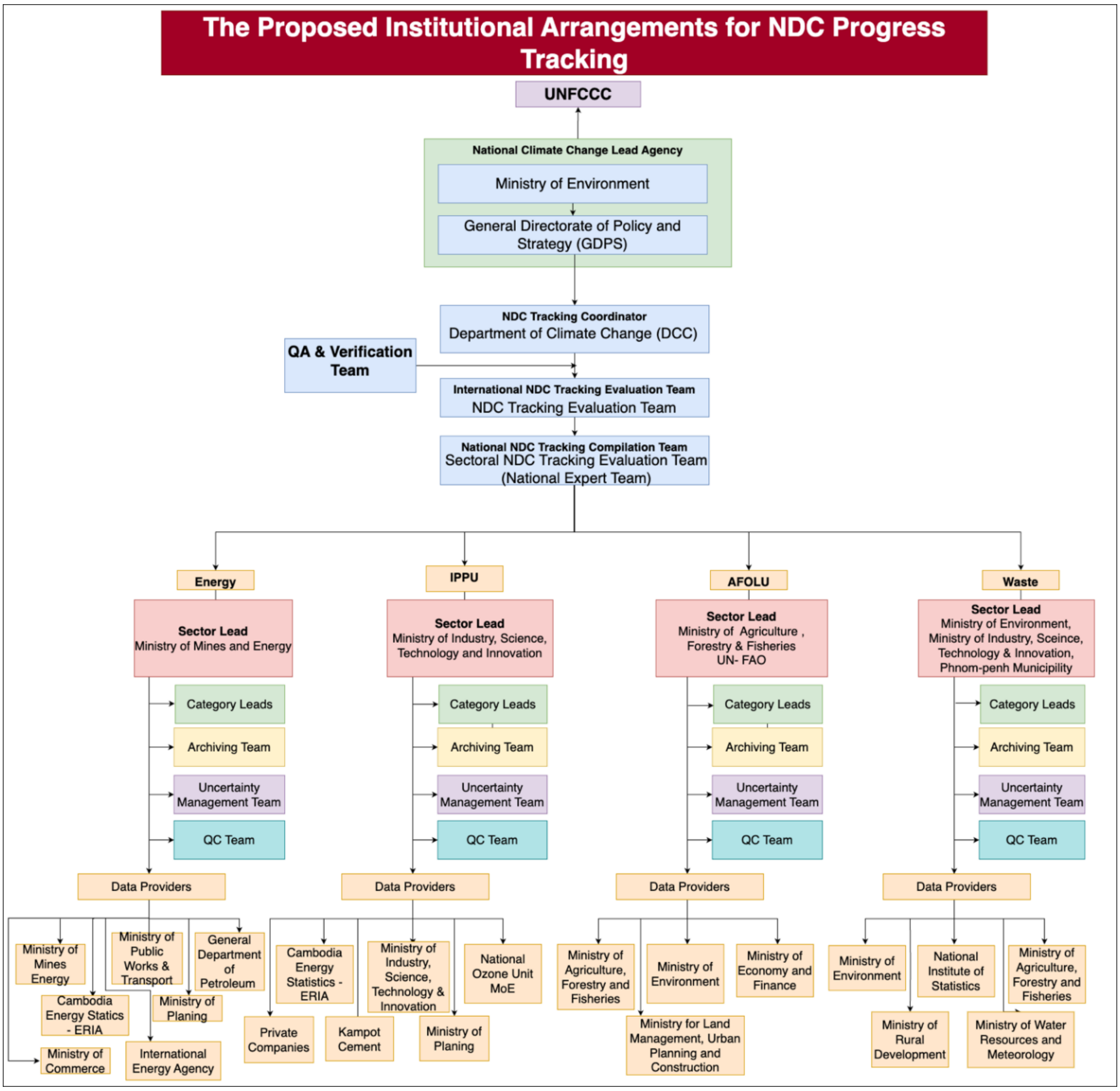


Figure II. 11: Institutional arrangement for NDC tracking in Cambodia
Source: Author

9.4. Sub-institutional arrangements for the Energy sector.

The diagram below illustrates the institutional arrangement for the energy sector, while the **Figure II.12** provides information related to this arrangement.

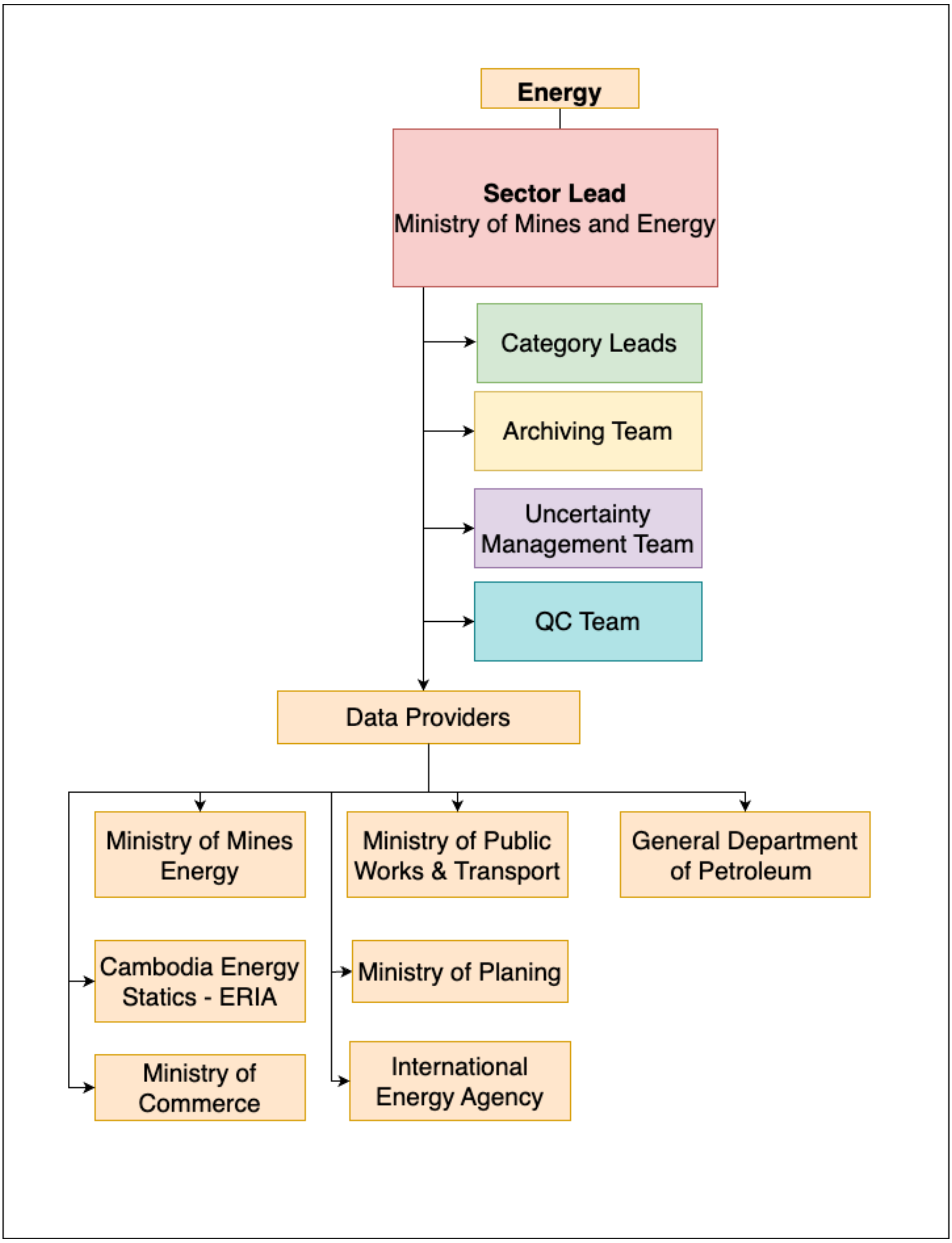


Figure II. 12: Sub-institutional arrangements for the Energy sector
Source: Author

10. Sub-institutional arrangements for the IPPU sector.

The diagram below illustrates the institutional arrangement for the IPPU sector, while the **Figure II.13** provides information related to this arrangement.

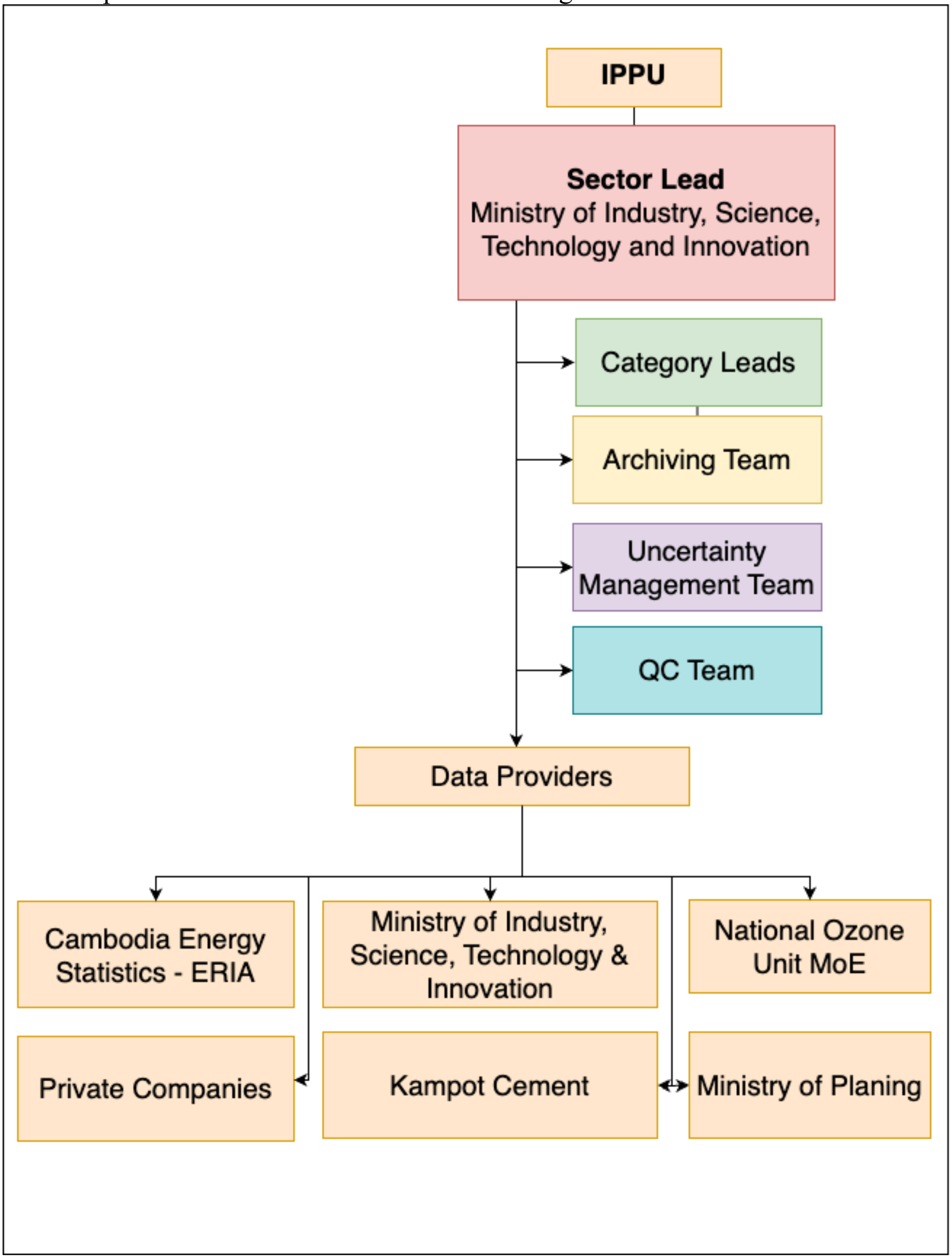


Figure II. 13: Sub-institutional arrangements for the IPPU sector

Source: Author

11. Sub-institutional arrangements for the AFOLU sector.

The diagram below illustrates the institutional arrangement for the IPPU sector, while the **Figure II.14** provides information related to this arrangement.

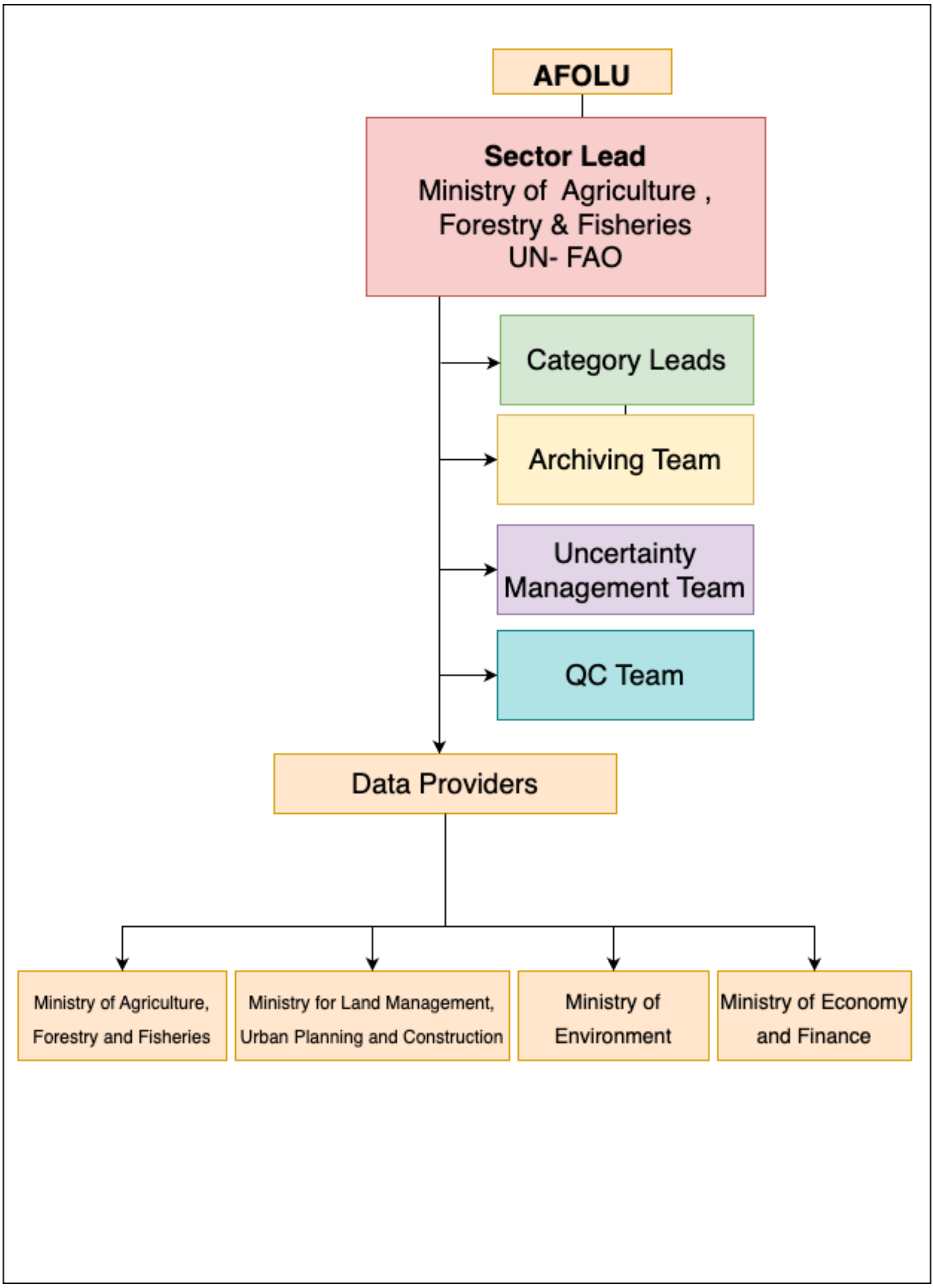


Figure II. 14: Sub-institutional arrangements for the AFOLU sector.
Source: Author

12. Sub-institutional arrangements for the Waste sector.

The diagram below illustrates the institutional arrangement for the waste sector, while the **Table II.15** provides information related to this arrangement.

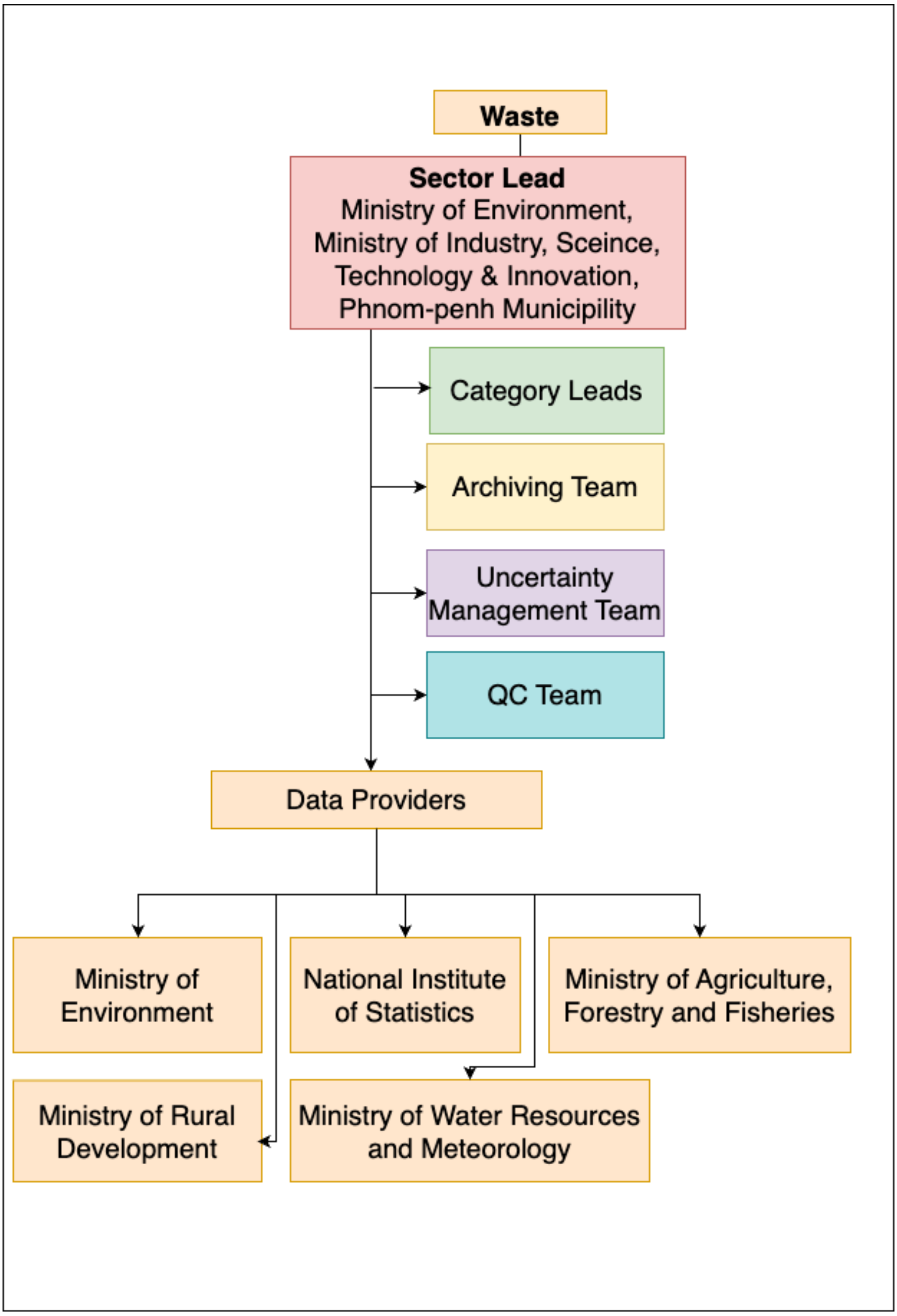


Figure II. 15:Sub-institutional arrangements for the Waste sector.
Source: Author

B. Description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates

(para. 64 of the MPGs)

The revised NDC for Cambodia demonstrates significant enhancements across various aspects. Firstly, it broadens its scope to encompass climate change mitigation objectives in agriculture and waste sectors, accompanied by detailed initiatives such as energy efficiency improvements. Additionally, it strongly emphasises adaptation, notably aiming to halve deforestation rates by 2030 in the Forestry and Land Use sector. Furthermore, Cambodia has heightened its targets for reducing GHG emissions across multiple sectors compared to its initial NDC in 2015. Lastly, there's a deliberate focus on gender equality and vulnerable groups to ensure their inclusion in adaptation and mitigation endeavours, alongside efforts to strengthen measurement, reporting, and verification (MRV) frameworks.

Furthermore, Cambodia has heightened its targets for reducing GHG emissions across multiple sectors compared to its initial NDC in 2015. Lastly, there's a deliberate focus on gender equality and vulnerable groups to ensure their inclusion in adaptation and mitigation endeavours, alongside efforts to strengthen measurement, reporting, and verification (MRV) frameworks.

Table II. 15: Cambodia's updated NDC

No	Mitigation Actions	Lead Ministry	Sector	Sectors in line with the GHG inventory assessment
1	Promote sustainable energy practices in manufacturing.	MISTI	Other Industries	IPPU sector
2	Urban Planning Tools for Climate Change Mitigation and the urban planning solution in three sub-cities	MLMUPC	Building residential	Energy sector
			Building commercial	Energy sector
3	Application of electrical equipment's labelling & MEPS (Lighting, Cooling & Equipment)	MME	Building residential	Energy sector
			Building commercial	Energy sector
4	Improvement of process performance of EE by the establishment of energy management /industries	MME	Other Industries	IPPU sector
			Building residential	Energy sector
			Building commercial	Energy sector
5	Public awareness campaigns, DTEBP-EE info centres	MME	Building residential	Energy sector
			Building commercial	Energy sector
6	Building codes and enforcement/certification for new buildings and those undergoing a major renovation	MME	Building commercial	Energy sector

7	Introduction of efficient electrical motors and boilers	MME	Building commercial	Energy sector
			Other Industries	IPPU sector
8	Improve sustainability of charcoal production through enforcement of regulations	MME	Building residential	Energy sector
9	Roadmap study on Integration of RE (Renewable Energy) resources.	MME	Energy generation	Energy sector
10	New sanitary landfills with LFG extraction and LFG extraction at the Dangkor Landfill	MoE	Waste -MSW	Waste sector
			Agriculture - land-related	AFOLU sector
11	Composting of biodegradable organic fraction of MSW supplemented with separation of organic waste (at source).	MoE	Agriculture - land-related	AFOLU sector
12	Production of Refuse-Derived Fuel (RDF) from either a) fresh MSW or b) old MSW mined from the Dangkor landfill.	MoE	Cement sector	IPPU sector
13	Implementation of National 3R strategy	MoE	Waste -MSW	Waste sector
14	Enhance maintenance and inspection of the vehicle (Piloting maintenance and emission inspections of vehicles)	MPWT	Passenger transport	Energy sector
15	Promote integrated public transport systems in main cities	MPWT	Passenger transport	Energy sector
16	Reducing GHG emissions through the off-grid street lightening of the rural municipality	NCDD	Building commercial	Energy sector
			Building residential	Energy sector
17	Bio-digesters construction (85% reduction compared to 2000) (Small size (2-3-4m^3)	MAFF	Building residential	Energy sector
			Waste -MSW	Waste sector
18	Bio-digesters construction (85% reduction compared to 2000) Medium size(6-8-10m^3)	MAFF	Energy generation	Energy sector
			Waste -MSW	Waste sector
19	Bio-digesters construction (85% reduction compared to 2000) Large size(>10m3)	MAFF	Energy generation	Energy sector
			Waste -MSW	Waste sector
20	Centralized recycling facility for industrial waste from the garment sector	MISTI	Waste -MSW	Waste sector
21	Climate-friendly cooling of public sector buildings	NCSD	Building commercial	Energy sector

22	Toward Battambang city to green city	NCDD	Building commercial & Residential	Energy sector
23	Shift long-distance freight movement from trucks to train	MPWT	Freight Transport	Energy sector
24	Emission management from factories	MoE	Other Industry	IPPU sector
25	Increasing the effectiveness and sustainability of agricultural land management techniques (Conservation Agriculture)	MAFF	Agriculture land-related	AFOLU sector
26	Organic input agriculture and bio-slurry; and deep placement fertilizer technology	MAFF	Agriculture land-related	AFOLU sector
28	Promote manure Management through compost making process to reduce carbon emissions	MAFF	Agriculture land-related	AFOLU sector
29	Better management of industrial wastewater in the food & beverage sector	MISTI	Wastewater	Waste sector
30	Implementation of National Cooling Action Plan	MLMUPC	Building commercial	Energy sector
31	Inclusion of performance requirements of Passive Cooling Systems in Building Energy Code of Cambodia	MLMUPC	Building commercial	Energy sector
32	Implementation of "passive cooling" measures in the cities (addressing urban heat island effect [UHIE]), public buildings, and commercial buildings.	MLMUPC	Building commercial	Energy sector
33	FOLU: Reduce 50% of historical emissions by 2030 - Improve management and monitoring of forest resources and forest land use - Strengthen implementation of sustainable forest management - Approaches to reduce deforestation, build capacity, and engage stakeholders	REDD+ Technical Secretariat (RTS)	FOLU	AFOLU sector

Understanding the country's overall BAU GHG emissions and mitigation targets is crucial when discussing the reference information for the identified indicators. According to Cambodia's updated NDC, the BAU emissions in 2016, including the FOLU sector, were approximately 125.1 million tCO_2e. The projected BAU emissions in 2030 are expected to reach 154.9 million tCO2e, including the FOLU sector (**Figure II.15)**. Additionally, the estimated emission reductions for the year 2030, including the FOLU sector, are 64.6 million tCO_2e **(Figure II. 16)**.

(a) **(b)**

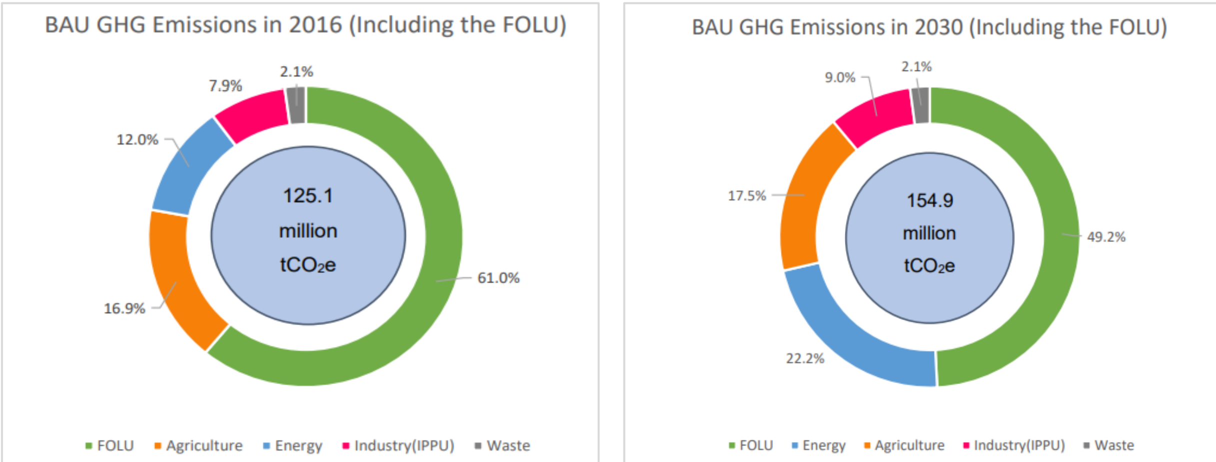


Figure II. 16: BAU GHG emissions for 2016 and 2030 (a) GHG emission in 2016 without FOLU and (a) GHG emission including FOLU in 2030

(a) **(b)**

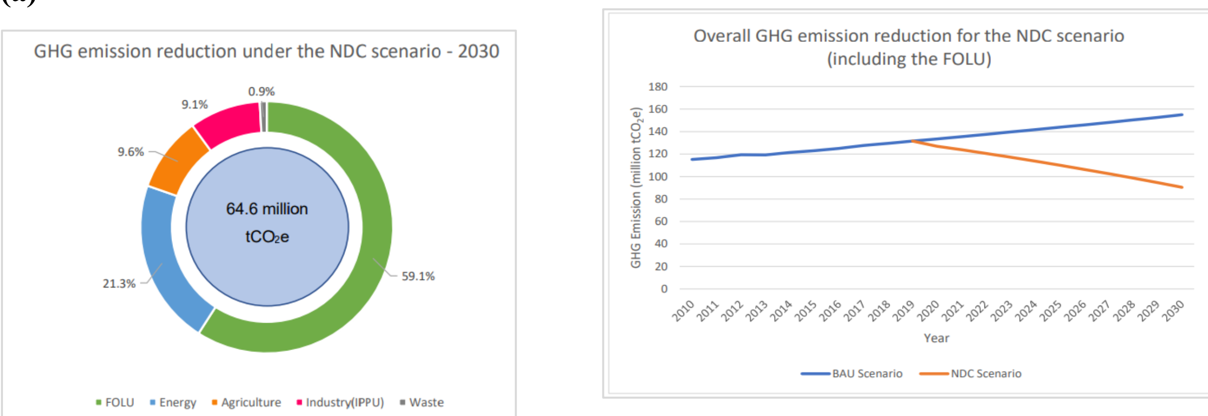


Figure II. 17: Mitigation target under Cambodia's updated NDC (a) GHG emission reduction under NDC scenario (b) GHG emission reduction under NDC scenario (Including FOLU).
Source: NDC, 2020

In consideration of the country's NDC target and in alignment with common tabular formats for the electronic reporting of the information necessary to track progress (UNFCCC, Decision 5/CMA.3, Annex II, 2022), the following **Table II.16** provides information on the indicators relevant to their reference points. As mentioned in the previous section, the indicators' data are provided according to the mitigation actions identified under the updated NDC in Cambodia. The years 2016 and 2020 are significant for selecting reference information, with 2016 being the base year for the NDC and 2020 marking the start of the NDC implementation period. Furthermore, this section also outlines the expected targets for 2025 and 2030 based on the information available in the updated NDC report. It is also important to note that the values for emission reductions and emissions related to mitigation actions are estimated using the PROSPECTS+ model for all sectors except the FOLU sector.

The BAU scenarios of the updated NDC cover various sectors, including energy, transport, waste, industry, agriculture, building, forestry, and other land use (FOLU), falling under Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), and waste sectors. The scenarios for electricity, transport, buildings, cement, other industries (excluding cement), agriculture, and waste were developed using the PROSPECT+ model, while the FOLU sector was established based on the REDD+ NDC assessment model by the REDD+ Technical Secretariat (RTS). GHG emissions and CO_2 removal estimates are sourced from the 2019 GHG Inventory Report and First Biennial Updated Report (Cambodia, Cambodia BUR, 2020) by the Government of Cambodia. Tier 1 methodologies from the IPCC 2006 Guidelines, alongside default emission factors and country-specific activity data from 1994 to 2016, were considered for the BAU assessment.

All projections of the NDC incorporated macroeconomic conditions, policy conditions, market conditions, and events in other sectors. A BAU scenario was developed for each sector by extrapolating past emission trends, interpolating to fill missing data in a sequence, and incorporating relevant influential factors such as GDP, population, and forestry growth rate.

Table II. 16: Summary of Cambodia's updated NDCs description.

Description of Cambodia's Updated NDC	
Target(s), including a description and the target type(s)	By 2030, a reduction in emissions of 41.7% is anticipated compared to the Business-As-Usual (BAU) scenario.
Target year(s) or period(s), and whether they are single-year or multi-year target(s)	2030
Reference point(s), level(s), baseline(s), base year(s) or starting point(s), and their respective value(s)	2016 BAU scenario: 213 million tCO_2e/year for the year 2030
Time frame(s) and/or periods for implementation	2020 - 2030
Scope and coverage, including, as relevant, sectors, categories, activities, sources and sinks, pools and gases	Geographies covered by the contribution: All national territories Scope of gases included in the contribution: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O) Sectors covered in the contribution: Energy sector, IPPU sector, Waste sector, AFOLU sector
Intention to use cooperative approaches that involve the use of internationally transferred mitigation outcomes under Article 6 towards NDCs	Not Available
Any updates or clarifications of previously reported information (e.g. recalculation of previously reported inventory data or greater	Not Available

detail on methodologies or use of cooperative approaches).	

C. Information necessary to track progress made in implementing and achieving nationally determined contributions under Article 4 of the Paris Agreement

(paras. 65-79 of the MPGs)

The methodology for tracking progress in implementing and achieving Cambodia's Nationally Determined Contribution (NDC) in the Biennial Transparency Report (BTR) assessment adheres to the guidelines outlined in the "Technical Handbook for Developing Country Parties on Preparing for the Implementation of the Enhanced Transparency Framework under the Paris Agreement," published by the UNFCCC. This approach is based on Decision 18/CMA.1 and the common tabular format for reporting under Decision 5/CMA.3, Annex II. Consequently, the NDC tracking section of the BTR has encompassed the following sub-topics:

1. National circumstances and institutional arrangements
2. Description of a Party's nationally determined contribution under Article 4 of the Paris Agreement, including updates
3. Information necessary to track progress made in implementing and achieving the nationally determined contribution under Article 4 of the Paris Agreement
4. Mitigation policies and measures, actions and plans, including those with mitigation co-benefits resulting from adaptation actions and economic diversification plans, related to implementing and achieving a nationally determined contribution under Article 4 of the Paris Agreement
5. Summary of greenhouse gas emissions and removals
6. Projections of greenhouse gas emissions and removals
7. Other information

According to **Figure II. 17**, components listed under each sub-topic are included in the Biennial Transparency Report (BTR), emphasizing sections denoted as "shall," which necessitate reporting by developing countries. Furthermore, in line with the GHG inventory archiving system, a robust, clear, and transparent data archiving system is upheld to track progress on NDCs in the context of the BTR assessment.

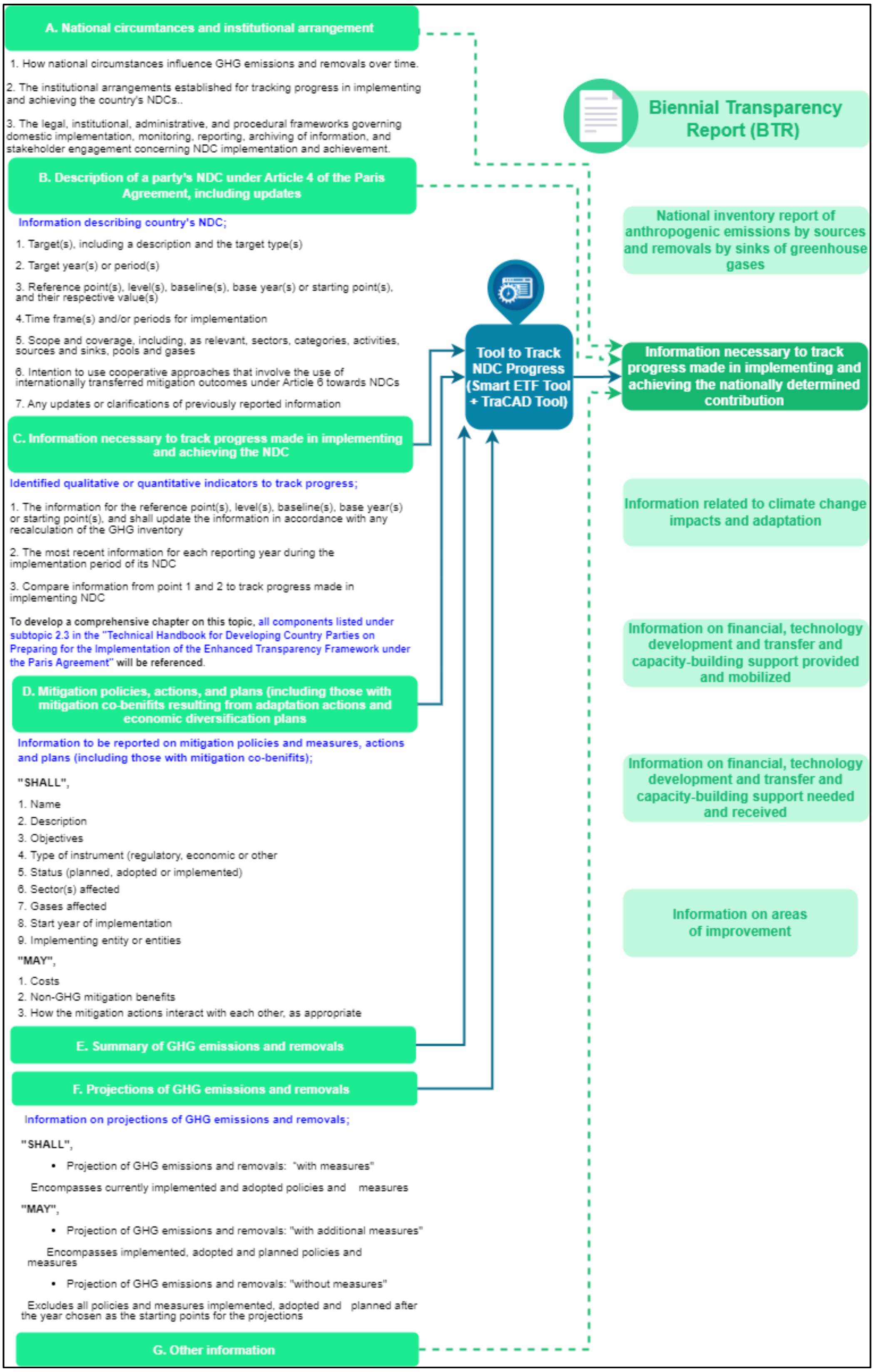


Figure II. 18: Overall procedure for tracking progress for implementing and achieving NDC in Cambodia

When completing the NDC progress tracking section of the report, we carefully consider the flexibility provisions granted to developing country Parties. These provisions allow for a more adaptable approach in tracking and reporting progress toward NDC commitments, acknowledging the unique challenges and resource constraints that developing countries may face. Thorough incorporating these flexibilities, we aim to ensure that the progress tracking reflects a fair and realistic assessment of each country's achievements, while also recognizing their efforts to enhance capacity, improve data quality, and advance sustainable development goals within their specific national contexts.

REFERENCE IN THE MPGS (ANNEX TO DECISION 18/CMA.1)	PROVISION IN THE MPGS	FLEXIBILITY PROVISION FOR THOSE DEVELOPING COUNTRY PARTIES THAT NEED IT IN THE LIGHT OF THEIR CAPACITIES
Paragraph 85 *Expected and achieved GHG emission reductions for PAMs*	Each Party shall provide, to the extent possible, estimates of expected and achieved GHG emission reductions of its PAMs	Instead encouraged to report such information
Paragraph 92 *GHG emission and removals projections*	Each Party shall report projections	Instead encouraged to report such projections
Paragraph 95 *Projections extension*	Projections shall begin from the most recent year in the Party's national inventory report and extend at least 15 years beyond the next year ending in zero or five	May extend their projections at least to the end point of their NDC
Paragraph 102 *Projections methodology or coverage*	See paragraphs 93 through 101 of the annex to decision 18/CMA.1	May report using a less detailed methodology or coverage

Figure II. 19: Flexibility provisions available to those developing country parties
Source: UNFCCC, 2023

Furthermore, in our assessment, we consider the flexibility provisions specified for the Common Reporting Tables (CRTs) and Common Tabular Formats (CTFs), as illustrated in the following figure. These provisions are designed to support developing countries by offering adjustments in the reporting of greenhouse gas inventories, mitigation actions, and financial support data, recognizing the varying capacities and resources available to different nations. By utilizing these flexibilities, we can more accurately assess progress while accommodating the technical and institutional challenges that developing countries may face in data collection, management, and reporting. This approach ensures that reporting under the CRTs and CTFs remains inclusive and fair, enabling a realistic and transparent comparison across countries while supporting continuous improvements in data quality and consistency over time.

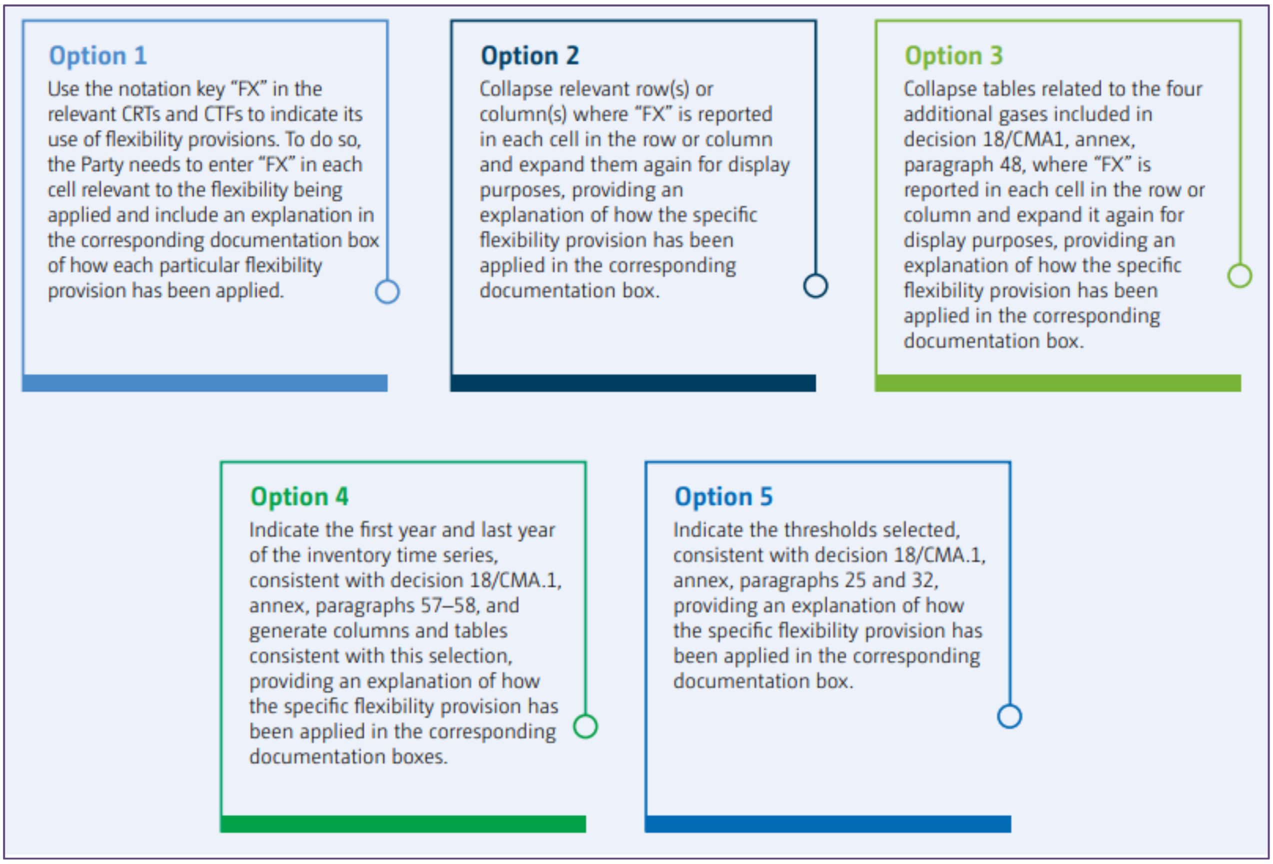


Figure II. 20: Flexibilities in the CRTs and CTFs,
Source: UNFCCC, 2023

13. Information to track progress made in implementing and achieving its NDC under Article 4

(paras. 71, 74, 75, 76, 77(d) of the MPGs)

Identifying indicators is crucial for monitoring progress towards implementing and fulfilling a country's NDC. As per available guidelines, these indicators can be either qualitative or quantitative measures and must be pertinent to the NDC objectives. According to the Modalities, Procedures, and Guidelines (MPG) for the transparency framework for action and support (UNFCCC, Decision 18/CMA.1, 2019), potential indicators that parties may opt for include net GHG emissions and removals, the percentage reduction of GHG intensity, relevant qualitative indicators for specific policies or measures, mitigation co-benefits of adaptation actions and/or economic diversification plans, or other metrics such as hectares of reforestation, percentage of renewable energy use or production, carbon neutrality, share of non-fossil fuel in primary energy consumption, and non-GHG related indicators.

Considering the proposed indicators outlined in Decision 18/CMA.1, paragraph 66, Cambodia has focused on the Net GHG emissions and removals for each sub-NDC. Additionally, qualitative indicators such as the mitigation co-benefits of adaptation actions have been observed. Other metrics, including hectares of reforestation and the percentage of renewable energy use or production, have also been considered for analysis in sub-NDCs. Moreover, gender equality has been analyzed for each sub-NDC in alignment with achieving the country's Sustainable

Development Goals (SDGs) rather than solely assessing emission reduction tracking for each sub-NDC.

Table II. 17: Implemented mitigation actions

No	Mitigation action	Sector	Indicators	Targets
1	Improvement of process performance of EE by establishment of energy management in buildings/industries	Energy and IPPU	Net GHG emissions and removals	0.1 MtCO2e/ year
			Energy use by SMEs	Reduce 10% in 2030
			Financial benefits	USD 60 million
			Job opportunities for women	30%
			Co-benefits	NA
			• Training of energy managers/ companies by DTEBP	
2	Building codes and enforcement/certification for new buildings and those undergoing major renovation	Energy	Electricity consumption	Reduce 10% in 2030
			• Energy demand in new buildings/ buildings undergoing major renovation	
			Financial benefits	USD 40 million
			• Job opportunities for women	30%
			Co-benefits	NA
			• Energy efficiency standards, laws and regulations concerning building energy codes are being elaborated and promulgated	
3	Roadmap study on Integration of renewable energy resources (solar, wind, hydro, biomass) into energy mix	Energy	Net GHG emissions and removals	NA
			Share of RE sources into the power mix	25% of RE source into power mix by 2030
			Financial benefits	USD 600,000
			Job opportunities for women	30%
			Co-benefits	
			Reduce imports of energy sources and increase clean energy	NA
4	New sanitary landfills with LFG extraction and LFG extraction at the Dangkor Landfill	Waste	Net GHG emissions and removals	1 MtCO2e or 1.12 MtCO2e in 2030 incase composting is implemented

	Potential for private sector engagement in financing, constructing, and operating sanitary landfill and LFG systems		Share of waste disposed at sanitary landfills with LFG extraction	LFG extraction, 50% by 2030
			Accrued income in the period of 2020-2030 for electricity sales	USD 69.8 million
			Accrued income in the period of 2020-2030 for carbon revenues	USD 25.97 million based on USD 5/carbon credit
			Co-benefits	NA
			Reduced fire hazard	
			Decrease risk of collapse	
			Odour control	
			Reduced health hazard	
			Energy for leachate evaporation	
			Prevention of surface and groundwater contamination from toxic waste	
			Components leachate capture and treatment	
			Employment creation	
5	Composting of biodegradable organic fraction of MSW supplemented with separation of organic waste (at source). This can be done at different stages in the waste management value chain, either at the household, community level or landfill site. The private sector can invest in and operate the composting facilities	Waste	Net GHG emissions and removals	Emission reduction of 0.5 MtCO2e/year by 2030
			A portion of the generated MSW is treated through composting	10% by 2030
			Sales of compost fertilizers	120 USD per tons
			Job opportunities for women	60% of people involved
			Co-benefits	NA
			Job creation	
			Reduced odour nuisance	
			Local organic fertilizer production	
			Less leachate leakage from landfill	
			4. Less landfill space is required, so cost-savings (but space required for composting)	
6	Implementation of National 3R strategy	Waste	Net GHG emissions and removals	Emission reduction of 0.42 MtCO2e/ year
			Amount of plastic waste generated and burned	NA
			Number of targeted cities and secondary towns	NA

			Share of women will be benefited	50% of women
			Co-benefits	
			Achieving a recycling process with an environmental and economic purpose contributes to the goal of the environment and sustainability	NA
7	Promote integrated public transport systems in main cities	Energy	Net GHG emissions and removals	NA
			Annual passenger volume on rail transport/ bus (passenger-km)	NA
			Share of interregional buses running on CNG% of tracks running on CNG	NA
8	Emission management from factories	IPPU	Net GHG emissions and removals	NA
			Number of factories targeted to monitor air quality	105 factories per year
			Share of factories to be licensed	90% factories
9	Increasing the effectiveness and sustainability of agricultural land management techniques (Conservation Agriculture)	AFOLU	Financial benefits	NA
			Net GHG emissions and removals from burned agriculture residue.	NA
			Job opportunities for women	NA
			Co-benefits	NA
			Sustainable land management	
			Reduce emissions from burned agriculture residue.	
			Protect soil from erosion	
10	Organic input agriculture and bio-slurry; and deep placement fertilizer technology	AFOLU	The number of provinces in which deep placement fertilizer technology is promoted.	10 provinces
			Job opportunities for women	NA
			Financial benefit	NA
			The number of provinces in which Organic input agriculture is promoted.	10 provinces
			Co-benefits	
			Reduce chemical fertilizer utilization	NA
			Contribute to mitigating greenhouse gases	
			Reduce production costs and pollution	

			Soil improvement	
11	Increase energy access to rural area	Energy	Net GHG emissions and removals (SHS)	
			Share of households/population with access to modern energy	
			Financial benefits	
			Job opportunities for women	
			Co-benefits	
			Local community has electricity 24 hours	
12	Diversification of household and community energy generation sources to reduce reliance on biomass as an energy sources	Energy	Net GHG emissions and removals	
13	E-mobility	Energy	Net GHG emissions and removals	
			Percent of bikes that are EV	
			Percent of cars that are EV	
			Number of electric vehicles	

D. Mitigation policies and measures, actions and plans, including those with mitigation co benefits resulting from adaptation actions and economic diversification plans, related to implementing and achieving a nationally determined contribution under Article4 of the Paris Agreement

(paras. 80–90 of the MPGs)

14. Introduction

Cambodia has established a comprehensive framework to address climate change and promote sustainable development through various policy structures and strategic plans. The country's Nationally Determined Contribution (NDC) emphasizes the Cambodia Climate Change Strategic Plan (CCCSP) 2014-2023 and its related Sectoral Action Plans. Key policies supporting these efforts include the Cambodia Sustainable Development Goals (SDGs) 2016-2030, which adapt global SDGs to Cambodia's context by adding 'Goal 18 of Demining'. Governance systems are set to evolve with milestones for 2020, 2025, and 2030, enhancing mitigation, adaptation, finance, and transparency mechanisms. The National Strategic Plan on Green Growth (NSPGG) 2013-2030 aims to transition Cambodia towards a green economy, while the Rectangular Strategy IV and the National Strategic Development Plan (NSDP) 2019-2023 focus on fostering socioeconomic development with integrated climate change indicators. The Circular Economy Strategy and Action Plan also outlines a roadmap for sustainable economic practices.

Other sectoral strategies, such as the National Protected Area Strategic Management Plan 2017-2031, the National REDD+ Strategy, and the National Environmental Strategy and Action Plan 2016-2023, further demonstrate Cambodia's commitment to environmental sustainability and climate resilience. Collectively, these initiatives reflect an overarching approach to mainstream climate action across all levels of governance and sectors of the economy (Cambodia, Cambodia’s Updated Nationally Determined Contribution, 2020). The implemented actions were collected from the NDC Explorer -2022 report developed by National Council for Sustainable Development, General Secretarial, Department of Climate Change and Ministry of Environment[7]. A list of implemented actions and their emission reduction from 2017 to 2023 are listed in table

7 https://ncsd.moe.gov.kh/ndc-tracking/measures/manage/report/?year=2022&full=true

Table II. 18: Implemented actions and their emission reductions - 2017 - 2023

Implemented climate actions	Emission Reduction tCO_2e						
	2017	2018	2019	2020	2021	2022	2023
With measures							
[1]. Energy-efficient practices	**1,196**	**1,289**	**1,381**	**1,490**	**1,582**	**1,681**	**1,785**
[2]. Promote integrated public transport systems in main cities	**185**	189	192	195	198	199	204
[3]. Establishment of a Cropping System for Growing Mung bean on Rainfed Lowland Paddy Fields after Wet Season	**577**	584	590	597	604	611	618
[4]. Enhancing Soil, Water, and Nutrient Management for Sustainable Rice Production and Optimized Yield	**NA**	NA	NA	NA	11,773	16,674	14,224
[5]. Organic-based farming for rice crops in Battambang of Preah Vihear province	**NA**	NA	NA	1	1	1	1
[6]. 10% COMPED in Battambang province is working on organic waste to make compost by 2030	**151**	232	304	390	489	600	721
[7]. New sanitary landfills with LFG extraction and LFG extraction at the Dangkor Landfill	**NA**	NA	NA	4,962	8,490	10,758	15,042

[8]. Building codes and enforcement/certification for new buildings and those undergoing major renovation	**26,475**	65,043	115,190	161,743	211,849	265,794	323,563
[9]. Roadmap study on Integration of renewable energy resources (solar, wind, hydro, biomass) into energy mix	**384,435**	747,315	1,087,736	1,440,479	1,798,909	2,132,449	2,501,541
[10]. Implementation of National 3R strategy	**NA**	NA	NA	NA	NA	9,527	13,421
[11]. Emission management from factories	**NA**	NA	29,455	30,348	31,241	32,133	32,669
Total "With Measures" (tCO_2e)	**413,019**	814,651	1,234,849	1,640,204	2,065,135	2,470,426	2,903,788
With Additional measures							
[1]. Increase energy access to rural area	**3,422**	3,765	4,141	4,555	5,010	5,512	6,063
[2]. Improvement of process performance of EE by the establishment of energy management in buildings/industries	**3,786**	4,163	4,580	5,037	5,539	6,093	6,702
[3]. E-mobility	**NA**	NA	NA	13	196	2,101	2,381
Total "with Additional measures" (tCO_2e)	**7,208**	7,928	8,720	9,605	10,745	13,707	15,145

E. Summary of greenhouse gas emission reduction from implemented actions

(para. 91 of the MPGs)

Greenhouse Gas Emission Reduction of the Energy Sector

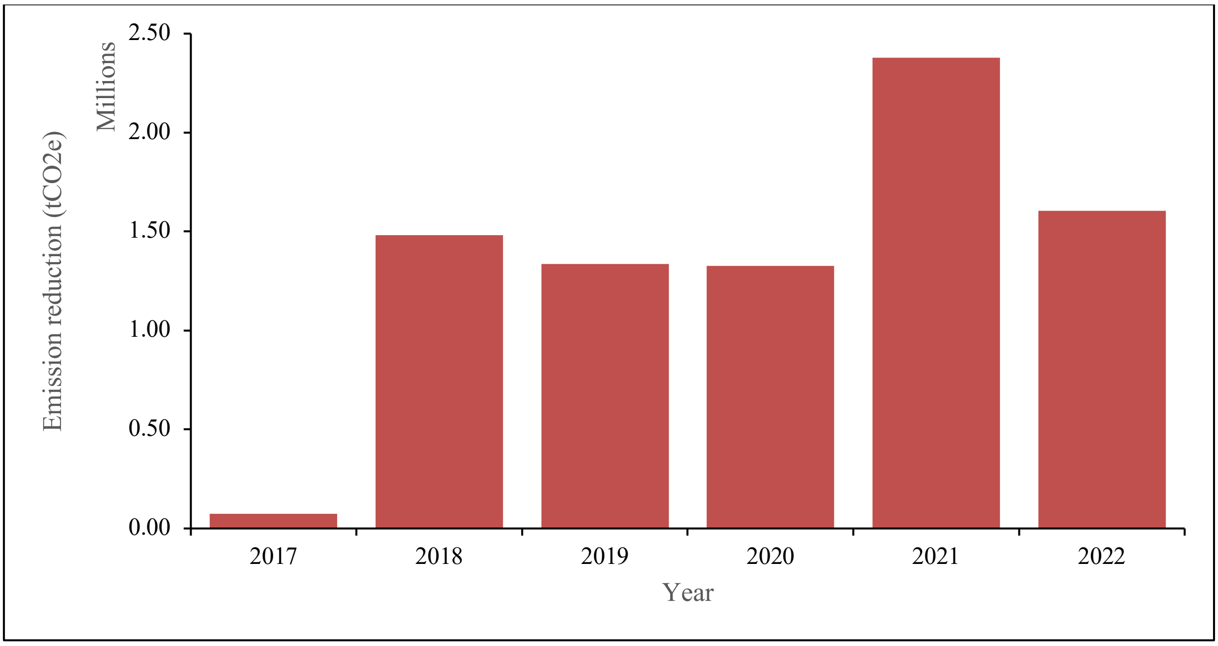


Figure II. 21: Greenhouse Gas Emission Reduction of Energy Sector from 2017-2023

Greenhouse Gas Emission Reduction of Waste Sector

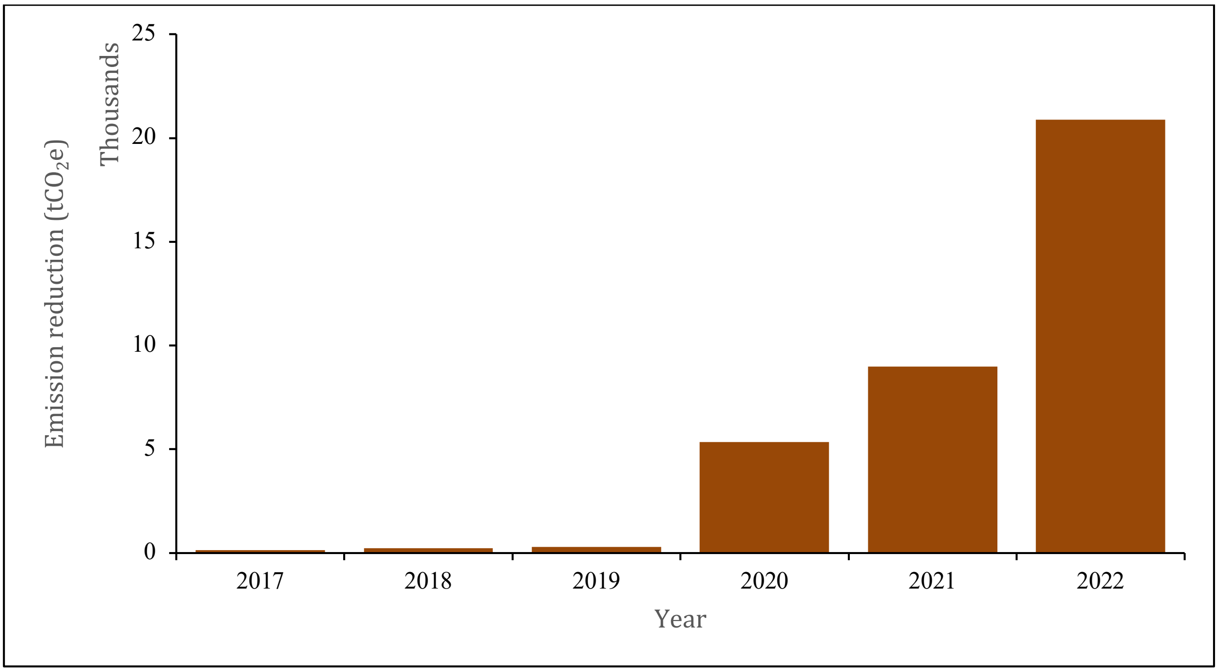


Figure II. 22: Greenhouse Gas Emission Reduction of Waste Sector from 2017-2023

Greenhouse Gas Emission Reduction of AFOLU Sector

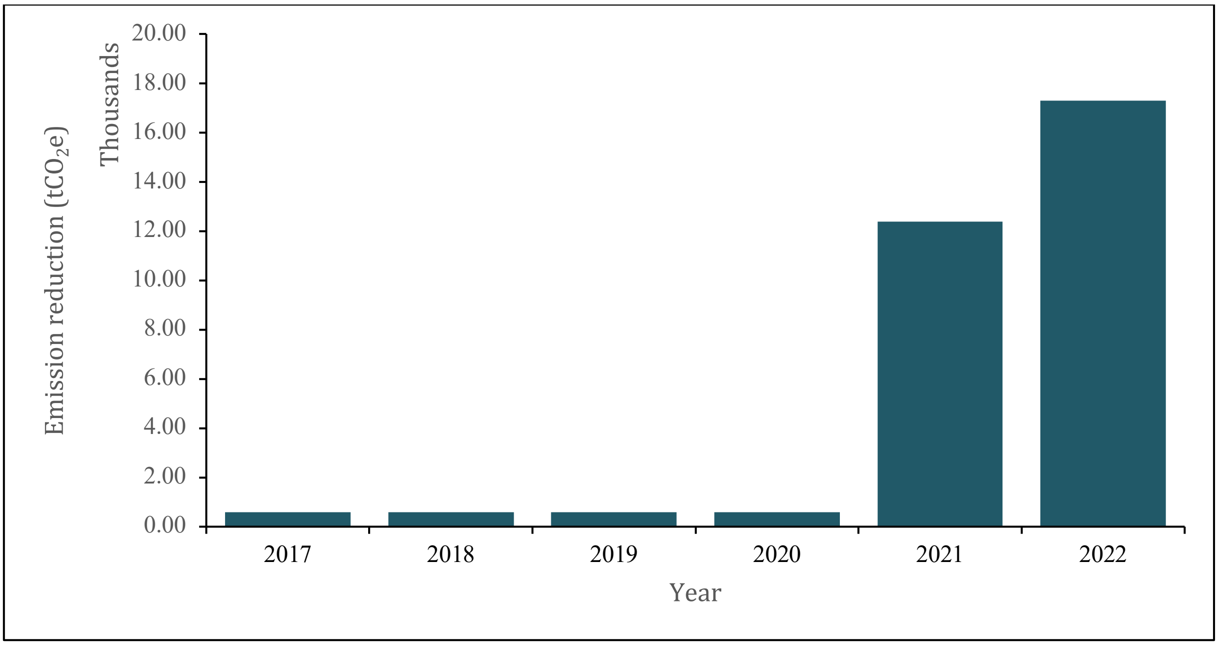


Figure II. 23: Greenhouse Gas Emission Reduction of AFOLU Sector from 2017-2023

F. Projections of greenhouse gas emissions and removals

(paras.92–102 of the MPGs)

15. Greenhouse gas emissions and removals for all sectors

The graph depicts hypothetical projections of greenhouse gas emissions and removals for all sectors from 2017 to 2030 under different scenarios.

- Without measures
- With measures
- With additional measures

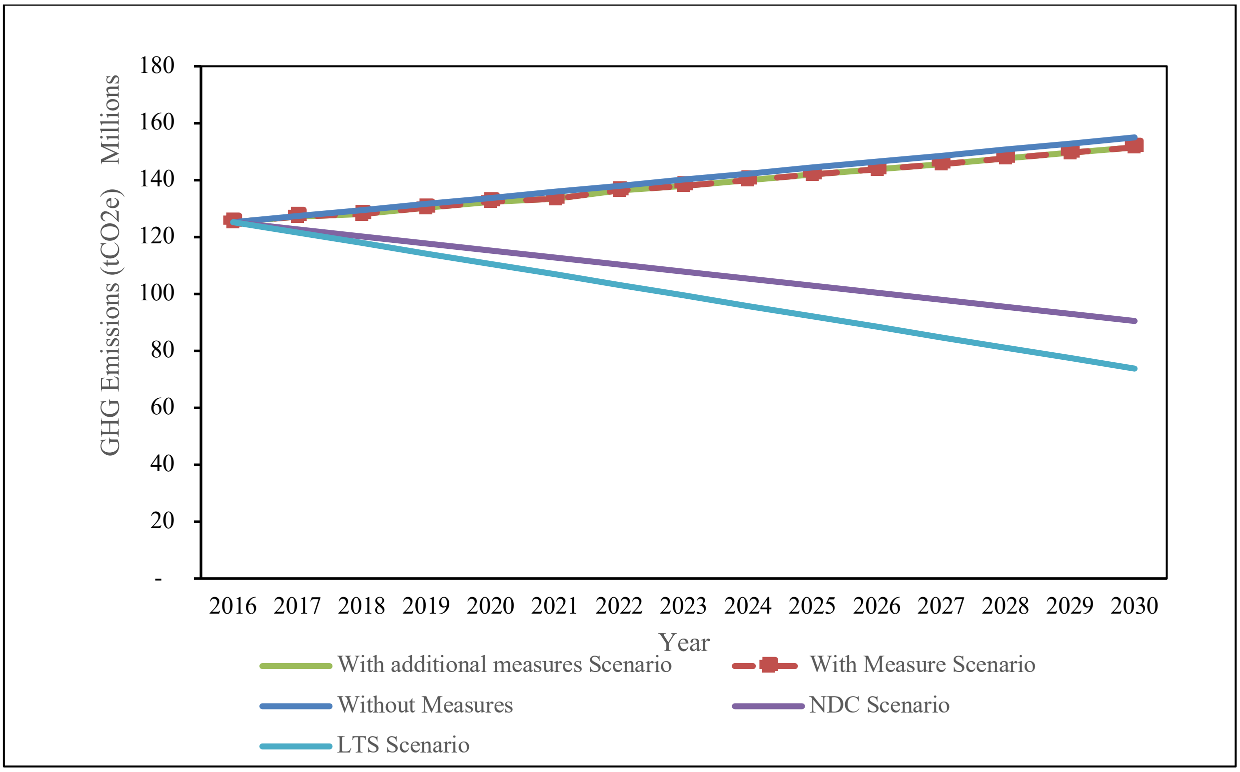


Figure II. 24: Projections of greenhouse gas emissions and removals under different scenarios

15.1. Projections of GHG Emissions in the Energy Sector

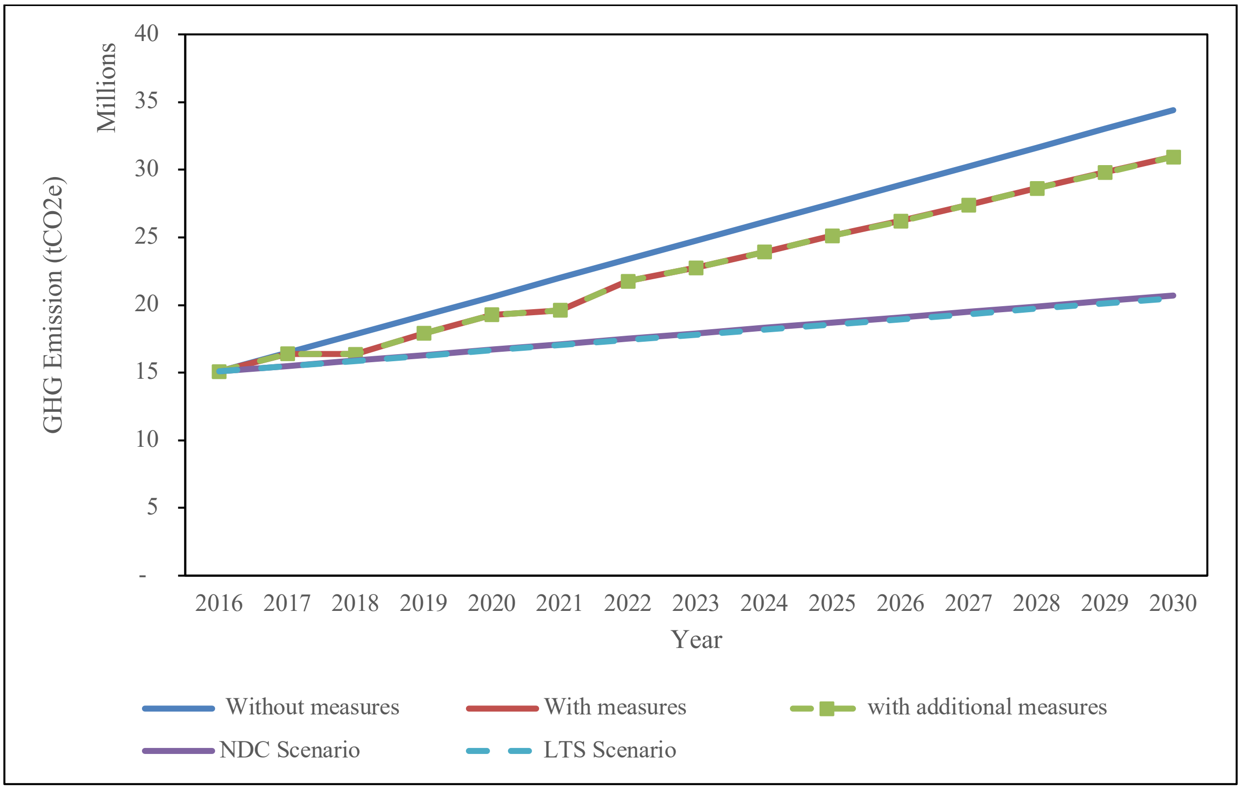


Figure II. 25: Projections of greenhouse gas emissions and removals under different scenarios- Energy sector

For the energy sector, the following implemented actions are covered under "with measures" and "with additional measures" scenarios.

- **“With measures” Scenario**
    1. M-111. Promote sustainable energy practices in manufacturing
    2. M-116. Promote integrated public transport systems in main cities
    3. M-90.b. Development of Energy Efficiency code for building
    4. M-105. Roadmap study on Integration of renewable energy resources (solar, wind, hydro, biomass) into energy mix
    5. M-136. Emission management from factories
    6. M-90.a. Development of Energy Efficiency roadmap for the building and construction sector

- **“With Additional measures” Scenario**
    1. Increase energy access to rural area
    2. Diversification of household and community energy generation sources to reduce reliance on biomass as an energy sources
    3. E-mobility

15.2. Projections of GHG Emissions in the Waste Sector

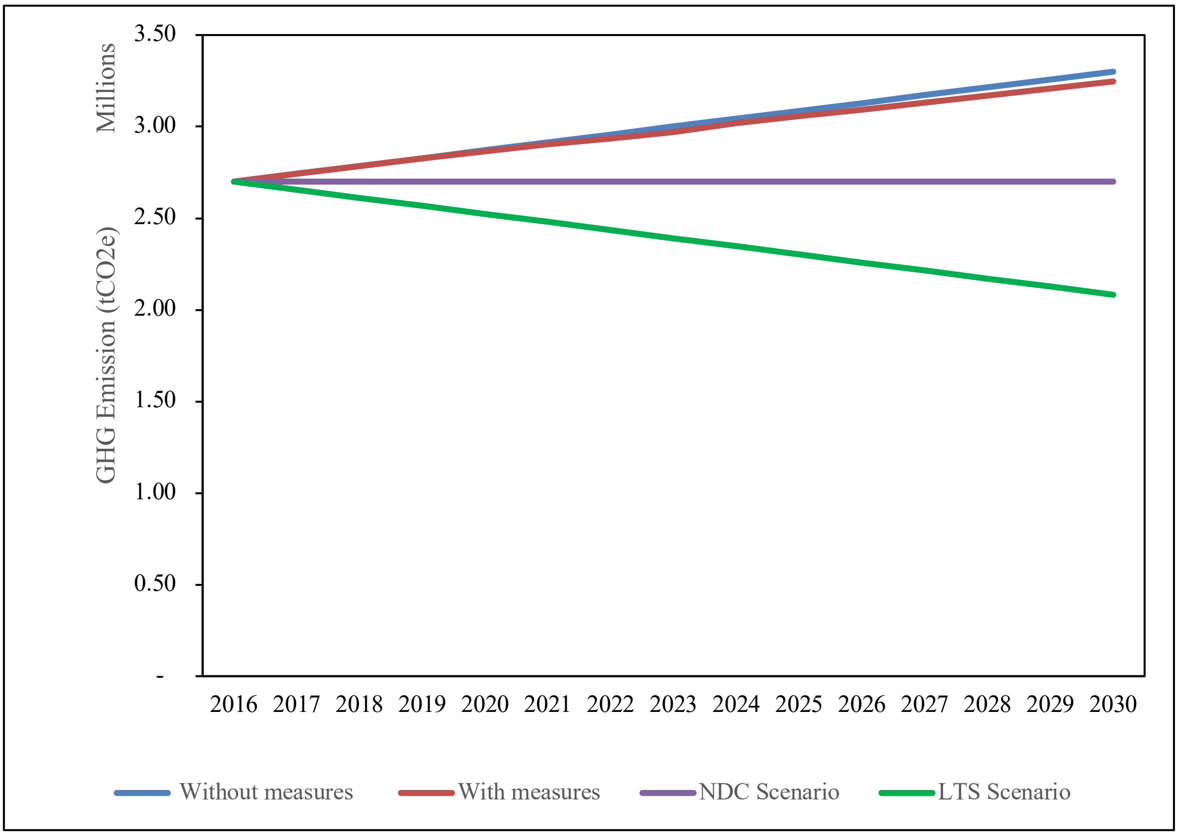


Figure II. 26: Projections of greenhouse gas emissions and removals under different scenarios- Waste sector

For the waste sector, the following implemented actions are covered under “with measures” and “with additional measures” scenarios.

- **“With measures” Scenario**
    1. M-93.a. 10% COMPED in Battambang province is working on organic waste to make compost by 2030
    2. M-92.a. LFG extraction at the Dangkor Landfill

3. M-95.a. Combatting marine plastic litter in Cambodia

15.3. Projections of GHG Emissions in the Agriculture Sector

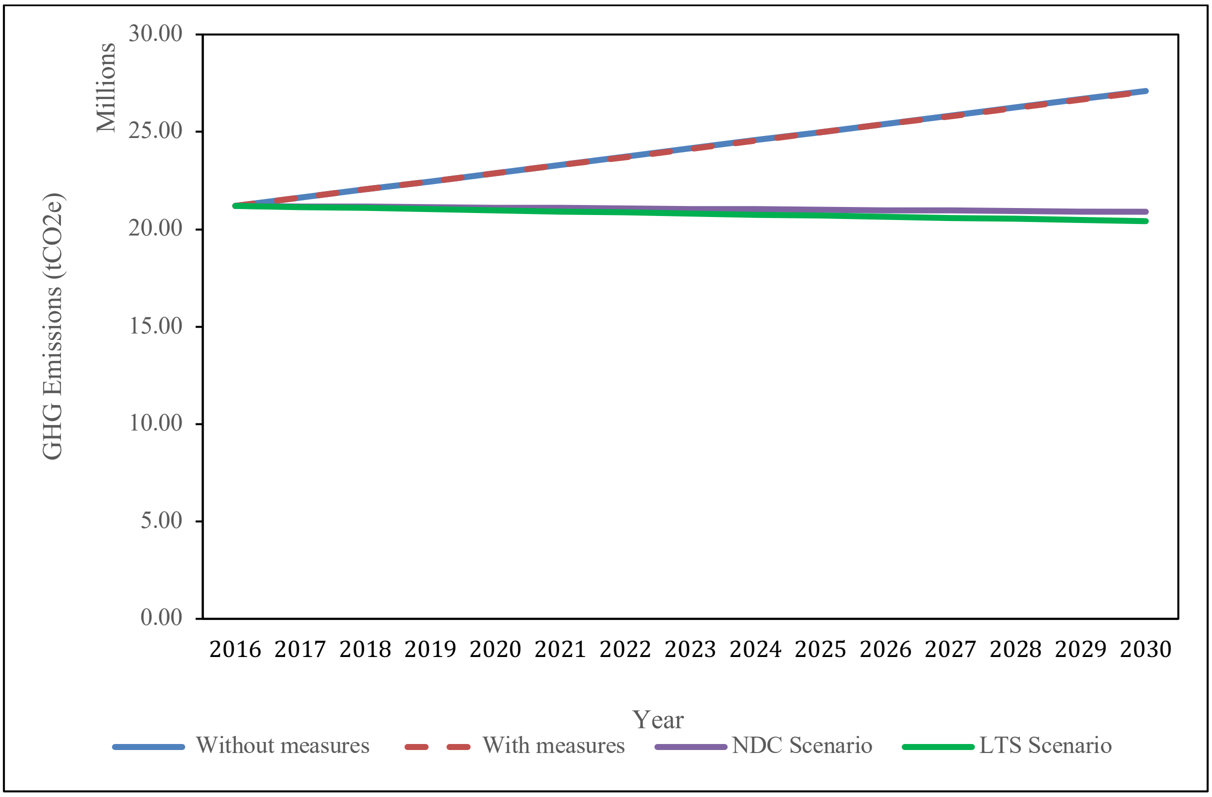


Figure II. 27: Projections of greenhouse gas emissions and removals under different scenarios- Agriculture sector

For the agriculture sector, the following implemented actions are covered under "with measures" and "with additional measures" scenarios.

- **"With measures" Scenario**
    1. M -122.a. Establishment of a Cropping System for Growing Mung bean on Rainfed Lowland Paddy Fields after Wet Season
    2. M -121. a. Enhancing Soil, Water, and Nutrient Management for Sustainable Rice Production and Optimized Yield
    3. M- 122.b. Organic-based farming for rice crops in Battambang of Preah Vihea province

15.4. Projections of GHG Emissions in the IPPU Sector

There are no implemented actions found for the IPPU sector from the NDC Explorer 2022 report.

15.5. Projections of GHG Emissions in the FOLU Sector

There are no implemented actions found for the FOLU sector from the NDC Explorer 2022 report.

Details of implemented actions are discussed in the **Table II. 19** below

“With measures” Scenario

Table II. 20: Roadmap study on Integration of renewable energy resources (solar, wind, hydro, biomass) into energy mix

Name of Action	Roadmap study on Integration of renewable energy resources (solar, wind, hydro, biomass) into energy mix						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	NA	NA	Ministry of Mines and Energy	CO_2	Cambodia	Energy
Description							
The "Roadmap Study on Integration of Renewable Energy Resources into Cambodia's Energy Mix" outlines strategic actions to incorporate solar, wind, hydro, and biomass energy into the country's energy system.							
Objective							
- To increase the contribution of renewable energy for electricity generation by 25 % by 2030 (solar, wind, hydro and biomass)							
Scope of the Action							
Integration of Renewable Energy Resources into Cambodia's Energy Mix							
Estimated Outcomes							
- Reduce emissions of carbon and other air pollutants. - Energy security. - Health security by reducing air pollution. - Reduce imports energy sources and increase clean energy							
Estimated GHG Emission Reductions	Not Available						
Methodologies and Assumptions	AMS-I.D.: Grid connected renewable electricity generation --- Version 15.0						

Parameter	Parameter type	Unit	2017	2018	2019	2020	2021	2022
• Quantity of net electricity generation supplied by the project plant/unit to the grid in year y	Baseline	GWh	0	106	2310	1689	1703	3273
• Combined margin CO2 emission factor for grid connected power generation in year y	Baseline	tCO_2e/MWh	0.5878	0.5878	0.5878	0.5878	0.5878	0.5878

Table II. 21: NDC 6: Building codes and enforcement/certification for new buildings and those undergoing a major renovation

Name of Action	Building codes and enforcement/certification for new buildings and those undergoing major renovation						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress			Ministry of Mines and Energy	CO_2	Cambodia	Energy
Description							
The mitigation action focusing on building codes and enforcement for new and renovated buildings in Cambodia aims to enhance energy efficiency within the construction sector. A key project under this initiative is the "Energy Efficiency Code of Building Technical Regulation," which sets standards for energy-saving measures in building design and construction. Effective implementation of this code, guided by the "Energy Efficiency in Buildings: Accelerating Low-carbon Development in Cambodia" policy brief and case study, targets substantial energy savings. By adhering to these regulations, buildings can achieve up to 25% reduction in energy demand by 2035, significantly contributing to the country's low-carbon development goals and sustainability[8]							
Objective							
[1]. To enhance energy efficiency in Cambodia's construction sector. By implementing the "Energy Efficiency Code of Building Technical Regulation," the goal is to reduce energy demand in buildings by up to 25% by 2035, thereby supporting low-carbon development and sustainability.							
Scope of the Action							
[1]. This includes setting energy performance standards, enforcing compliance, certifying buildings, integrating energy-efficient technologies, promoting renewable energy, and providing training. The action aims to reduce energy demand and greenhouse gas emissions, support sustainable development, and enhance climate resilience.							
Estimated Outcomes							
[1]. Energy Savings [2]. Reduced Greenhouse Gas Emissions. [3]. Improved Building Performance [4]. Enhanced Regulatory Compliance							
Estimated GHG Emission Reductions	Not Available						
Methodologies and Assumptions	AMS-II.E.: Energy efficiency and fuel switching measures for buildings --- Version 12.0						

Progress Indicators - 2017				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e			26475.36
Progress Indicators - 2018				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e			65042.61
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e			115190.07
Progress Indicators - 2020				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e			161742.47

8 https://www.undp.org/sites/g/files/zskgke326/files/migration/kh/UNDP2020_Energy-Efficiency-in-Building-Policy-Brief-Cambodia_ENG_Small.pdf, page:05

Progress Indicators - 2021									
Indicator		Unit	Baseline Scenario			Project Scenario			Final Outcome
Emission reduction		tCO_2e							211849.26
Progress Indicators - 2022									
Indicator		Unit	Baseline Scenario			Project Scenario			Final Outcome
Emission reduction		tCO_2e							265793.52
Progress Indicators - 2023									
Indicator		Unit	Baseline Scenario			Project Scenario			Final Outcome
Emission reduction		tCO_2e							323562.84
Emission reduction									
Parameter	Parameter type	Unit	2017	2018	2019	2020	2021	2022	2023
[1]. Electricity that would have been consumed by the baseline building unit j (MWh), determined as the average electricity consumed over the 3 years prior to the start date of the project activity[9]	Baseline	MWh	3021601.40	3711618.10	4382168.70	4614869.02	4835620.91	5055783.27	5275406.08
[2]. Electricity consumed by the project building unit j in year[10] y (MWh)	Project	MWh	2981843.48	3613943.93	4209188.35	4371981.17	4517487.95	4656642.48	4789513.41
[3]. Average technical transmission and distribution losses for consuming electricity from source k in year y	Baseline and Project	%	11.40%	11.40%	11.40%	11.40%	11.40%	11.40%	11.40%
[4]. Weighted average CO_2 emission factor of the sources k that supply electricity to the building unit j in year y (tCO_2/MWh), excluding renewable energy technologies. If there is no separate monitoring of electricity consumed from different sources or there are no plausible method of distinguishing between the sources, use the source with the lowest CO_2 emission factor[11]	Baseline	t CO2e/MWh	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Progress	2017 - 2023								
Emission reduction	323562.84								

9https://gggi.org/asia-low-carbon-building-transition-project-propelling-cambodias-shift-to-sustainable-buildings/#:~:text=In%202019%2C%20buildings%20encompassing%20the,compared%20to%20baseline%20in%202020.

10 https://www.undp.org/sites/g/files/zskgke326/files/migration/kh/UNDP2020_Energy-Efficiency-in-Building-Policy-Brief-Cambodia_ENG_Small.pdf, page:05

11 Microsoft Teams Chat Files - OneDrive (sharepoint.com)

Table II. 22: NDC 9: Roadmap study on Integration of RE (Renewable Energy) resources.

<table>
<tr><td>Name of Action</td><td colspan="7">Roadmap study on Integration of renewable energy resources (solar, wind, hydro, biomass) into energy mix</td></tr>
<tr><td>Type of Action</td><td>Status</td><td>Date of Commencement</td><td>Duration</td><td>Implementing Entity</td><td>GHG Coverage</td><td>Geographic coverage</td><td>Sectoral Scope</td></tr>
<tr><td>Mitigation action</td><td>In progress</td><td>NA</td><td>NA</td><td>Ministry of Mines and Energy</td><td>CO_2</td><td>Cambodia</td><td>Energy</td></tr>
<tr><td colspan="8">Description</td></tr>
<tr><td colspan="8">The "Roadmap Study on Integration of Renewable Energy Resources into Cambodia's Energy Mix" outlines strategic actions to incorporate solar, wind, hydro, and biomass energy into the country's energy system.</td></tr>
<tr><td colspan="8">Objective</td></tr>
<tr><td colspan="8">[1]. To increase the contribution of renewable energy for electricity generation by 25 % by 2030 (solar, wind, hydro and biomass)</td></tr>
<tr><td colspan="8">Scope of the Action</td></tr>
<tr><td colspan="8">[1]. Integration of Renewable Energy Resources into Cambodia's Energy Mix</td></tr>
<tr><td colspan="8">Estimated Outcomes</td></tr>
<tr><td colspan="8">[1]. Reduce emissions of carbon and other air pollutants.
[2]. Energy security.
[3]. Health security by reducing air pollution.
[4]. Reduce imports energy sources and increase clean energy</td></tr>
<tr><td colspan="4">Estimated GHG Emission Reductions</td><td colspan="4">NA</td></tr>
<tr><td colspan="4">Methodologies and Assumptions</td><td colspan="4">AMS-I.D.: Grid connected renewable electricity generation --- Version 15.0</td></tr>
<tr><td colspan="4">Progress Indicators - 2017</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Indicator</td><td>Unit</td><td>Baseline Scenario</td><td>Project Scenario</td><td>Final Outcome</td></tr>
<tr><td colspan="4">Emission reduction</td><td>tCO_2e</td><td>384,435.04</td><td>0</td><td>384,435.04</td></tr>
<tr><td colspan="4">Progress Indicators - 2018</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Indicator</td><td>Unit</td><td>Baseline Scenario</td><td>Project Scenario</td><td>Final Outcome</td></tr>
<tr><td colspan="4">Emission reduction</td><td>tCO_2e</td><td>747,315.39</td><td>0</td><td>747,315.39</td></tr>
<tr><td colspan="4">Progress Indicators - 2019</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Indicator</td><td>Unit</td><td>Baseline Scenario</td><td>Project Scenario</td><td>Final Outcome</td></tr>
<tr><td colspan="4">Emission reduction</td><td>tCO_2e</td><td>1,087,736.38</td><td>0</td><td>1,087,736.38</td></tr>
<tr><td colspan="4">Progress Indicators - 2020</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Indicator</td><td>Unit</td><td>Baseline Scenario</td><td>Project Scenario</td><td>Final Outcome</td></tr>
</table>

Emission reduction		tCO_2e	1,440,479.16				0	1,440,479.16	
Progress Indicators - 2021									
Indicator		Unit	Baseline Scenario				Project Scenario	Final Outcome	
Emission reduction		tCO_2e	1,798,909.04				0	1,798,909.04	
Progress Indicators - 2022									
Indicator		Unit	Baseline Scenario				Project Scenario	Final Outcome	
Emission reduction		tCO_2e	2,132,449.18				0	2,132,449.18	
Progress Indicators - 2023									
Indicator		Unit	Baseline Scenario				Project Scenario	Final Outcome	
Emission reduction		tCO_2e	2,501,540.77				0	2,501,540.77	
Emission reduction									
Parameter	Parameter type	Unit	2017	2018	2019	2020	2021	2022	2023
[1]. Quantity of net electricity generation supplied by the project plant/unit to the grid in year y[12]	Baseline	MWh	654,023.55	1,271,376.98	1,850,521.25	2,450,628.04	3,060,410.08	3,627,848.22	4,255,768.58
[2]. Combined margin CO2 emission factor for grid connected power generation in year y[13]	Baseline	t CO2e/MWh	0.59	0.59	0.59	0.59	0.59	0.59	0.59
Progress	2020 - 2023								
Emission reduction	10,092,864.96 t CO2e								

12 https://www.eria.org/RPR_FY2015_08.pdf page:11

13 IFI Default Grid Factors 2021 v3.1_unfccc.xlsx (live.com)

Table II. 23: NDC 10: New sanitary landfills with LFG extraction and LFG extraction at the Dangkor Landfill

Name of Action	LFG extraction at the Dangkor Landfill						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2020	4	Ministry of Environment (MoE)	CO_2, CH_4	Cambodia	Waste
Description							
In 2017, the Dangkor landfill site in Phnom Penh received an estimated 2,215 tons of municipal solid waste (MSW) per day. This waste contributed to approximately 7 gigagrams (Gg) of methane emissions. By 2030, it is projected that methane emissions from the landfill will increase to 12 Gg. Therefore, the target has been set to increase landfill gas (LFG) extraction by 50% from new sanitation landfills and the Dangkor landfill by 2030.							
Objective							
[1]. Reduces emissions by capturing landfill gas and destroying methane at Dangkor landfill							
Scope of the Action							
[1]. To captures and combusts methane from Dangkor landfill, which is used for the disposal of residues from human activities, including municipal and other solid wastes containing biodegradable organic matter.							
Estimated Outcomes							
[1]. Emission reduction from capturing landfill gas and destroying methane.							
Estimated GHG Emission Reductions	Not Available						
Methodologies and Assumptions	Methodology: UNFCCC- AMS-III.G.: Landfill methane recovery --- Version 10.0 Assumption: It was assumed that only the flaring process occurs in the mitigation action, without considering thermal, mechanical, or electricity generation methods.						

Progress Indicators - 2020				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	NA	NA	4,961.50
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	NA	NA	8,489.50
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	NA	NA	10,757.50
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	NA	NA	15,041.50

2023							
[1]. Oxidation factor[14]	Emission reduction			0.1	0.1	0.1	0.1
[2]. Density of methane at the temperature and pressure of the landfill gas in year[15]	Emission reduction	tons/ m3		0.000656	0.000656	0.000656	0.000656

14 https://cdm.unfccc.int/UserManagement/FileStorage/HN2W3BMY6RKUQOZDCVXS08F9LT1AI7

15 https://cdm.unfccc.int/methodologies/inputsconsmeth/MGM_methan

[3]. Methane content in landfill gas in year[16]	Emission reduction	m3CH4/m3LFG		0.5	0.5	0.5	0.5
[4]. Landfill gas destroyed via flaring[17]	Emission reduction	m3LFG		1,219,512.20	1,646,341.46	1,920,731.71	2,439,024.39
[5]. Methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year[18]	Emission reduction	tons CH4		0	0	0	0
[6]. Emission factor for electricity generation in year[19]	Emission reduction	tCO2/MWh		0.5878	0.5878	0.5878	0.5878
[7]. Average technical transmission and distribution losses for providing electricity in year [20]	Emission reduction	%		13	13	13	13
[8]. Quantity of electricity consumed by the project electricity consumption in year [21]	Emission reduction	MWh		435	435	435	435
[9]. Flare efficiency in the minute m[22]	Emission reduction	%		90	90	90	90
[10]. Mass flow of methane in the residual gas in the minute m[23]	Emission reduction	Kg/m		3.282	3.282	3.282	3.282
[11]. Global warming potential of methane valid for the commitment period[24]	Emission reduction	tCO2e/tCH4		28	28	28	28
Progress	2018 - 2023						
Emission reduction	15,041.50tCO_2e						
Indicator 2							

Table II. 24: NDC 11: Composting of biodegradable organic fraction of MSW supplemented with separation of organic waste

Name of Action	10% COMPED in Battambang province is working on the organic waste to make compost by 2030						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2009	15	Ministry of Environment	CO_2, CH_4	Cambodia	Waste
Description							

16 https://cdm.unfccc.int/UserManagement/FileStorage/9DJVMRIL5B6E7P243OY0S8QWHXGKCZ

17 Estimation based on the methane emission from solid waste in Dangkor landfill (https://ir3s.ifi.u-tokyo.ac.jp/3e-nexus/pdf/011817/session4-3_Siengheng.pdf). Assuming 5% of landfill gas (LFG) is recovered and flared in 2020, with a subsequent annual increase of 1%, the recovery

18 Assumption: Case 1: No requirement to destroy methane exists and no existing LFG capture system (https://cdm.unfccc.int/UserManagement/FileStorage/HEJ2MD41GB0PUZISL9FNTAYQV3875O)

19 Harmonized IFI Default Grid Factors 2021 v3.1

20**Invalid source specified.**

21 Based on similar project activities (https://cdm.unfccc.int/UserManagement/FileStorage/6OBF3GE4PKGZ573TASSJDZX28TIPCJ)

22 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v4.0.pdf

23 Based on similar studies: https://cdm.unfccc.int/UserManagement/FileStorage/6OBF3GE4PKGZ573TASSJDZX28TIPCJ

24 IPCC 5th assessment report

COMPED, a local NGO, operates a composting plant in one corner of the final disposal site in Battambang municipality. This plant was established in 2009 with the financial support of the Federal Ministry of Economic Cooperation and Development (BMZ) and the Thuringian-Cambodian Association (TKG) of Germany, and it continues to operate to this day. The amount of composted waste increased from 1.2 tons per day in 2014, to 1.5–2 tons per day in 2015, and further to 3.5 tons per day in 2017.										
Objective										
To prevent methane emissions into the atmosphere from municipal solid waste (MSW) that has already been deposited in a closed solid waste disposal site (SWDS) without methane recovery										
Scope of the Action										
Composting of Landfill Municipal Solid Waste (MSW) in Battambang Municipality										
Estimated Outcomes										
Reduction of methane emissions through the composting of partially decayed municipal solid waste.										
Estimated GHG Emission Reductions			Not Available							
Methodologies and Assumptions			Methodology: UNFCCC- AMS-III.AF.: Avoidance of methane emissions through excavating and composting of partially decayed municipal solid waste (MSW) --- Version 1.0 Assumption: • Emissions from oxygen consumption during the high-pressure aeration process are not applicable to the mitigation measures. • Differences between project emissions related to waste transport and electricity consumption are negligible compared to baseline emissions from the same sources.							
Progress Indicators - 2017										
Indicator			Unit		Baseline Scenario		Project Scenario		Final Outcome	
Emission reduction			tCO_2e		321.94		171.05		150.89	
Progress Indicators - 2018										
Indicator			Unit		Baseline Scenario		Project Scenario		Final Outcome	
Emission reduction			tCO_2e		439.71		207.84		231.87	
Progress Indicators - 2019										
Indicator			Unit		Baseline Scenario		Project Scenario		Final Outcome	
Emission reduction			tCO_2e		572.92		268.97		303.95	
Progress Indicators - 2020										
Indicator			Unit		Baseline Scenario		Project Scenario		Final Outcome	
Emission reduction			tCO_2e		720.09		330.10		390.00	
Progress Indicators - 2021										
Indicator			Unit		Baseline Scenario		Project Scenario		Final Outcome	
Emission reduction			tCO_2e		879.35		389.95		489.40	
Progress Indicators - 2022										
Indicator			Unit		Baseline Scenario		Project Scenario		Final Outcome	
Emission reduction			tCO_2e		1,049.27		449.16		600.11	
Progress Indicators - 2023										
Indicator			Unit		Baseline Scenario		Project Scenario		Final Outcome	
Emission reduction			tCO_2e		1,228.49		507.63		720.86	
Emission reduction										
Parameter	Parameter type	Unit	2017	2018	2019	2020	2021	2022	2023	

Model correction factor to account for model uncertainties for year[25]	Baseline		0.85	0.85	0.85	0.85	0.85	0.85	0.85
Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year[26]	Baseline		0	0	0	0	0	0	0
Global Warming Potential of methane[24]	Baseline		28	28	28	28	28	28	28
Oxidation factor[27]	Baseline		0.1	0.1	0.1	0.1	0.1	0.1	0.1
Methane correction factor for year (unmanaged solid waste disposal sites – deep)	Baseline		0.8	0.8	0.8	0.8	0.8	0.8	0.8
Decay rate of the excavated waste (MAT > 20°C; tropical, wet, >2a<10a)[28]	Baseline		0.1	0.1	0.1	0.1	0.1	0.1	0.1
Amount of non-inert waste separated and aerobically composted in year[29]	Baseline	tons	2009 | 74.50 2010 | 74.50 2011 | 95.90 2012 | 119.60 2013 | 146.00 2014 | 438.00 2015 | 730.00 2016 | 1,095.00 2017 | 1,277.50 2018 | 1,606.00 2019 | 1,894.40 2020 | 2,182.70 2021 | 2,465.00 2022 | 2,744.30 2023 | 3,020.10						

25 Humid/wet conditions **Invalid source specified.**

26 THE CASE OF BATTAMBANG CITY (**Invalid source specified.**

27**Invalid source specified.**

28**Invalid source specified.**

29 Estimated values are based on the amount of composted waste and landfill waste per day for the years 2014 to 2017, as provided in "The Case of Battambang City **Invalid source specified.**." For the subsequent years, values were estimated using the annual population of Battambang published in the Cambodia Population Projection 2020-2030 **Invalid source specified.**.

Annual average methane generation potential of the non-inert fraction of the partially decayed waste separated during the year[30]	Baseline	tons CH4/tons waste	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567
Quantity of compost i produced in year	Project	tons	72[26]	72[26]	146	220	293	365[31]	436
Average truck capacity for compost i transportation[32]	Project	tons/truck	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Average distance for compost i transportation[26]	Project	km/truck	6	6	6	6	6	6	6
CO2 emission factor from fuel use due to transportation [32]	Project	kgCO2/km	0.4856	0.4856	0.4856	0.4856	0.4856	0.4856	0.4856
Quantity of waste treated by composting in year[33]	Project	tons	1,277.5	1,606	1,894.35	2,182.7	2,465.03	2,744.32	3,020.12
Emission factor for composting of organic waste (Wet weight basis)[34]	Project	tons CH4/tons waste	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Progress			2018 - 2023						
Emission reduction			720.86 tCO_2e						

30 Estimated values are based on Equation 3.3 under SOLID WASTE DISPOSAL in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories **Invalid source specified.**. For the assessment, the following values were considered: DOCj for MSW Bulk - 0.17, DOCf - 0.5, F - 0.5, and the molecular weight ratio CH4/C.

31**Invalid source specified.**

32**Invalid source specified.**

33 Estimated based on the data given in THE CASE OF BATTAMBANG CITY (**Invalid source specified.**

34 **Invalid source specified.**

Table II. 25: NDC 13: Implementation of National 3R strategy

Name of Action	Combatting marine plastic litter in Cambodia supported by UNDP /Japan						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2021	03	Ministry of Environment (MoE)	CO_2e	Cambodia	Waste

Description
The project aims to prevent and reduce plastic pollution on land and in the ocean by promoting a 4R (Refuse, Reduce, Reuse, and Recycle) framework. Target provinces include Siem Reap (SRP), Sihanoukville (SHV), Phnom Penh (PNH), Kep, Kampot, and Koh Kong.
Objective
Reduction of production of HDPE, LDPE, PET, PVC and PP from virgin materials, thus reducing related energy consumption
Scope of the Action
Recovering and recycling materials from municipal solid waste (MSW) to process them into intermediate or finished products and displaces the production of virgin materials in dedicated facilities, thereby avoiding energy use.
Estimated Outcomes
Reduction in emissions through the recycling of plastic waste.

Estimated GHG Emission Reductions	Not Available
Methodologies and Assumptions	Methodology: UNFCCC- AMS-III.AJ.: Recovery and recycling of materials from solid wastes --- Version 9.0 Assumption: Assuming Cambodia contributes to virgin PET plastic production (20%), it is assumed they primarily use petroleum (diesel) as their energy source in the absence of natural gas.

Progress Indicators - 2021				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	5,101.84	37.52	5,064.32
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	9,597.29	70.58	9,526.71
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	13,520.86	99.43	13,421.43

Emission reduction							
Parameter	Parameter type	Unit			2021	2022	2023
Quantity of PET recycled in year[35]	Baseline	tons	-	-	76.9	144.66	203.8
Net to gross adjustment factor to cover degradation in material quality and material loss in the production process of the final product using the recycled material[36]	Baseline		-	-	0.75	0.75	0.75
Percentage of plastics produced in the host Country out of total plastic consumed in year[37]	Baseline	%	-	-	20	20	20

35 https://www.undp.org/cambodia/projects/combatting-marine-plastic-litter-cambodia

36 https://cdm.unfccc.int/UserManagement/FileStorage/WDFQ1I93T5S7J2EXHC84LOZUBPKM0G

37 Assumption in the absence of data

Percentage of imported plastics out of total plastic consumed in year[37]	Baseline	%			80	80	80
Specific electricity consumption in the production of virgin PET[3636]	Baseline	MWh/tons			1.11	1.11	1.11
Emission factor for the baseline electricity consumption for virgin plastic production in the host party[45]	Baseline	tCO2/MWh			0.5878	0.5878	0.5878
Specific fuel consumption for the production of virgin PET[36]	Baseline	GJ/tons			15	15	15
CO2 emission factor of the baseline fossil fuel (Petroleum – Diesel)[38]	Baseline	tCO2/GJ			0.0741	0.0741	0.0741
Emission factor for the baseline electricity consumption for the portion of plastic that is imported	Baseline	tCO2/MWh			0.24	0.24	0.24
CO2 emission factor for fossil fuel (Natural gas)[38]	Baseline	tCO2/GJ			0.0561	0.0561	0.0561
Quantity of PET recycled in year[35]	Project	tons			76.9	144.66	203.8
Specific electricity consumption for the recycling of PET[36]	Project	MWH/tons			0.83	0.83	0.83
Emission factor of the electric grid supplying electricity to the recycling facility in year y[1945]	Project	tCO2/MWh			0.5878	0.5878	0.5878
Progress	2018 - 2023						
Emission reduction	13,421.43 tCO_2e						

38**Invalid source specified. Invalid source specified.**

Table II. 26: NDC 15 - Promote integrated public transport systems in main cities

Name of Action	Promote integrated public transport systems in main cities						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2017	NA	Ministry of Public Works and Transport	CO_2	Cambodia	Transport

Description
This project aims to promote integrated public transport systems in major cities in Cambodia, transitioning passenger transport from existing modes to electric buses (e-buses).
Objective
1. To reduce greenhouse gas emissions and improve urban mobility by implementing an integrated public transport system using e-buses in main cities.
Scope of the Action
1. Integration of e-buses into the existing public transport infrastructure. 2. Development of necessary infrastructure to support e-bus operations, including charging stations and maintenance facilities.
Estimated Outcomes
1. Significant reduction in greenhouse gas emissions due to the shift from conventional transport modes to electric buses. 2. A more reliable and efficient public transport system, encouraging higher ridership and reducing traffic congestion. 3. Cost savings on fuel and maintenance due to the higher efficiency and lower operational costs of e-buses.

Estimated GHG Emission Reductions	Not Available
Methodologies and Assumptions	JICA - Transport / Modal Shift (Passenger)

Progress Indicators - 2017				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	262.99	77.65	185.34
Progress Indicators - 2018	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	266.22	77.65	188.57
Progress Indicators - 2019	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	269.25	77.65	191.60
Progress Indicators - 2020				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	272.39	77.65	194.74
Progress Indicators - 2021				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	275.58	77.65	197.93
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	277.04	77.65	199.39
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	281.84	77.65	204.19

Emission reduction								
Parameter	Parameter type	Unit	2017	2018	2019	2020	2021	2022	2023

[1]. CO_2 emission factor of transport mode - Bus	Baseline parameter	tCO_2/km	0.000804	0.000804	0.000804	0.000804	0.000804	0.000804	0.000804
[2]. Share of passengers by transport mode - Bus	Baseline parameter	%	39.31%	39.79%	40.25%	40.72%	41.19%	41.41%	42.13%
[3]. Average occupation rate of transport mode - Bus	Baseline parameter	passenger/vehicle	45	45	45	45	45	45	45
[4]. CO_2 emission factor of transport mode - Car	Baseline parameter	tCO_2/km	0.0001617	0.0001617	0.0001617	0.0001617	0.0001617	0.0001617	0.0001617
[5]. Share of passengers by transport mode - Car	Baseline parameter	%	18.44%	18.67%	18.88%	19.10%	19.32%	19.43%	19.76%
[6]. Average occupation rate of transport mode - Car	Baseline parameter	passenger/vehicle	4	4	4	4	4	4	4
[7]. Share of passengers by transport mode - Tuktuk	Baseline parameter	%	17.63%	17.63%	17.85%	18.05%	18.26%	18.47%	18.57%
[8]. CO_2 emission factor of transport mode - Tuktuk	Baseline parameter	tCO_2/km	0.0000693	0.0000693	0.0000693	0.0000693	0.0000693	0.0000693	0.0000693
[9]. Average occupation rate of transport mode - Tuktuk	Baseline parameter	passenger/vehicle	4	4	4	4	4	4	4
[10]. Electricity consumption associated with the operation of the transport mode - Electricity bus[39]	Project parameter	MWh/yr	124.1	124.1	124.1	124.1	124.1	124.1	124.1
[11]. CO_2 emission factor of the grid electricity - Electricity bus[40]	Project parameter	tCO_2/MWh	0.6257	0.6257	0.6257	0.6257	0.6257	0.6257	0.6257
[12]. Average trip distance of the passenger - Bus[41]	Project parameter	km	15,000	15,000	15,000	15,000	15,000	15,000	15,000
[13]. Number of passengers transported by the transport mode[42]	Project parameter	-	1000	1000	1000	1000	1000	1000	1000
Progress	2017 - 2023								
Emission reduction	1,361.77 tCO_2e								

39 https://www.sustainable-bus.com/news/electric-bus-range-electricity-consumption/

40 https://ncsd.moe.gov.kh/sites/default/files/phocadownload/Activities/CDM/grid%20emission%20factor-pp%20electricity%20cambodia-2011-summary-24-03-2011.pdf

41 Assumed for the calculation purpose.

42 https://www.phnompenhpost.com/international/hcm-city-operate-1st-electric-bus-services (Assumed that annual number of passengers were consistent throughout the years)

Table II. 27: NDC 24- Emission management from factories

Name of Action	Emission management from factories						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2019	NA	Ministry of Environment	CO_2	Cambodia	Energy
Description							
The updated NDC of the country aims to monitor air quality at 105 factories annually and issue air emission permits to 90 factories as part of the mitigation action, with the goal of licensing 90% of factories.							
Objective							
Encourage factories nationwide to reduce emissions through energy efficiency and other mitigation measures.							
Scope of the Action							
Energy efficiency measures, including savings of electricity and fuel, in new or existing factories							
Estimated Outcomes							
Reduce GHG emissions from energy efficiency measures, including savings of electricity and fuel							
Estimated GHG Emission Reductions	Not Available						
Methodologies and Assumptions	Methodology: UNFCCC- AMS-II.E.: Energy efficiency and fuel switching measures for buildings --- Version 12.0 Assumption: • Fuel switching measures are absent within the assessment years. • Fuel-saving measures are only applicable to coal consumption during the assessment years.						
Progress Indicators - 2019							
Indicator		Unit	Baseline Scenario	Project Scenario		Final Outcome	
Emission reduction		tCO_2e	NA	NA		29,455.34	
Progress Indicators - 2020							
Indicator		Unit	Baseline Scenario	Project Scenario		Final Outcome	
Emission reduction		tCO_2e	NA	NA		30,347.92	
Progress Indicators - 2021							
Indicator		Unit	Baseline Scenario	Project Scenario		Final Outcome	
Emission reduction		tCO_2e	NA	NA		31,240.51	
Progress Indicators - 2022							
Indicator		Unit	Baseline Scenario	Project Scenario		Final Outcome	
Emission reduction		tCO_2e	NA	NA		32,133.10	
Progress Indicators - 2023							
Indicator		Unit	Baseline Scenario	Project Scenario		Final Outcome	
Emission reduction		tCO_2e	NA	NA		32,668.65	
Emission reduction							
Parameter	Parameter type	Unit	2019	2020	2021	2022	2023

[1].	Electricity that would have been consumed by the baseline building units[43]	Emission reductions	MWh	59,558	61,363	63,168	64,972	66,055
[2].	Electricity that would have been consumed by the project building units[44]	Emission reductions	MWh	17,867	18,409	18,950	19,492	19,817
[3].	Weighted average CO_2 emission factor of the sources k that supply electricity to the building units[45]	Emission reductions	tCO_2/MWh	0.5878	0.5878	0.5878	0.5878	0.5878
[4].	Average technical transmission and distribution losses for consuming electricity[46]	Emission reductions	%	13	13	13	13	13
[5].	Energy content of the coal that would have been consumed by the baseline building units	Emission reductions	GJ	26,801.13	27,613.29	28,425.44	29,237.60	29,724.89
[6].	Energy content of the coal consumed by the project building units[47]	Emission reductions	GJ	13,400.57	13,806.64	14,212.72	14,618.80	14,862.45
[7].	Average CO2 emission factor of the different fuel types f that are consumed by the building units[48]	Emission reductions	tCO_2/GJ	0.0961	0.0961	0.0961	0.0961	0.0961
[8].	The number of factories to get license for emission management	Used to calculate energy consumption values for electricity and coal combustion	Factories	165[50]	170[50]	175[50]	180[49]	183[50]
Progress		2018 - 2023						
Emission reduction		32,668.65 tCO_2e						

43 Calculations were conducted based on the average annual electricity consumption of 360,958 kWh per factory, as reported in "Benchmarking Industrial Building Energy Performance." This figure was then multiplied by the number of factories with issued licenses up to the assessment year (Reference: **Invalid source specified. Invalid source specified.**).

44 In the absence of project-level electricity consumption data for the factories, it was assumed that 70% of the baseline electricity consumption was reduced during the project scenario. This assumption is based on the available Clean Development Mechanism (CDM) registered project activities under methodology AMS-II. E (https://cdm.unfccc.int/contest/Projects/projsearch.html)

45 Harmonized IFI Default Grid Factors 2021 v3.1

46 **Invalid source specified. Invalid source specified.**

47 In the absence of project-level coal consumption data for the factories, it was assumed that 50% of the coal consumption was reduced during the project scenario. This assumption is based on the available Clean Development Mechanism (CDM) registered project activities under methodology AMS-II. E (https://cdm.unfccc.int/contest/Projects/projsearch.html).

48**Invalid source specified. Invalid source specified.**

49 **Invalid source specified. Invalid source specified.**

50 The estimation was based on the GDP and the number of factories licensed in the year 2022.

Table II. 28: NDC 25- Increasing the effectiveness and sustainability of agricultural land management techniques (Conservation Agriculture)

Name of Action	Establishment of Cropping System for Growing Mungbean on Rainfed Lowland Paddy Field after Wet Season						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2017	NA	Ministry of Agriculture, Forestry and Fisheries (MAFF)	CO_2	Cambodia	Agriculture
Description							
Establishment of Cropping System for Growing Mungbean on Rainfed Lowland Paddy Fields after Wet Season (KOPIA)							
Objective							
Minimizing synthetic nitrogen fertilizers applied on Rainfed Lowland paddy fields by planting legumes after the wet season							
Scope of the Action							
Minimizing synthetic nitrogen fertilizer application							
Estimated Outcomes							
Reduce GHG emissions from synthetic nitrogen fertilizer application Reduce the cost of synthetic nitrogen fertilizer							

Estimated GHG Emission Reductions	Not Available
Methodologies and Assumptions	UNFCCC AMS-III.A.: Offsetting of synthetic nitrogen fertilizers by inoculant application in legumes-grass rotations on acidic soils on existing cropland --- Version 3.0

Progress Indicators - 2017				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	1729.6	1153.1	576.5
Progress Indicators - 2018	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	1750.8	1167.2	583.6
Progress Indicators - 2019	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	1770.8	1180.5	590.3
Progress Indicators - 2020				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	1791.4	1194.3	597.1
Progress Indicators - 2021				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	1812.4	1208.3	604.1
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	1831.9	1221.3	610.6
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	1853.6	1235.7	617.8

Emission reduction									
Parameter	Parameter type	Unit	2017	2018	2019	2020	2021	2022	2023

[1]. Emission factor to produce synthetic nitrogen fertilizer (Urea)[51]	Baseline	t CO_2/tons fertilizer	0.73	0.73	0.73	0.73	0.73	0.73	0.73
[2]. Area of land where legumes(I) cultivated in classified land area (j)[52]	Baseline	ha	15724.00	15917.00	16098.00	16286.00	16477.00	16655.00	16851.00
[3]. Average application rate of fertilizer (f) to rice (g) by farmer (i) in the classified area (j) [53]	Baseline	tons/ha	0.15	0.15	0.15	0.15	0.15	0.15	0.15
[4]. Amount of synthetic nitrogen fertilizer (f) applied to rice (g) in the project activity[53]	Project	tons	1572.37	1591.69	1609.82	1628.61	1647.69	1665.45	1685.11
[5]. Emission factor to produce synthetic nitrogen fertilizer (Urea)[51]	Project	t CO_2/tons fertilizer	0.73	0.73	0.73	0.73	0.73	0.73	0.73
Indicator 2									
Progress	2017 - 2023								
Emission reduction	4180.255 tCO_2e								

51 IPCC 2006 Guideline

52 MAFF Annual Report 2014-2015, 2015-2016 and forecast the available data for 2017 to 2023

53 https://www.mdpi.com/2073-4441/14/21/3539

Table II. 29: - Increasing the effectiveness and sustainability of agricultural land management techniques (Conservation Agriculture)

Name of Action	Enhancing Soil, Water, and Nutrient Management for Sustainable Rice Production and Optimized Yield						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2021	NA	Ministry of Agriculture, Forestry and Fisheries	CO_2	Cambodia	Agriculture
Description							
In 2022, Total areas 1980 ha with 865 farmer households in 3 provinces of Battambang, Kampong Thom, and Preah Vihear provinces cultivated under Conservation agriculture (CA) practices. CA technology has been realized as a practice that improves soil quality, soil health, and prevent soil erosion. CA main activities have been central to research based in Bos Khnor station (Kampong Cham province) for over 15 years. In recent years, there has been a collective effort (CASIC, Metkasekor, ASMC, WAT4CAM) to transfer CA technology to stakeholders, especially farmers. In 2021, the cultivated land under CA was 1398 ha with 703 farmer households in Battambang, Kampong Thom, and Preah Vihear provinces. We conducted CA training courses and hosted the visits of various visitors to Bos Khnor for 193 participants (25% were women).							
Objective							
1. To promote awareness of sustainable land management practice 2. Reduce GHG Emissions							
Scope of the Action							
Sustainable agricultural land management practices for rice cultivation							
Estimated Outcomes							
Reduce GHG emissions Enhancing Soil, Water, and Nutrient Management for Sustainable Rice Production Optimization of yield							
Estimated GHG Emission Reductions	Not Available						
Methodologies and Assumptions	VERRA- VM0017: Adoption of Sustainable Agricultural Land Management						

Progress Indicators - 2021				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	36,318.4	24,545.4	11,773.0
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	51,438.1	34,763.9	16,674.2
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	43,878.3	29,654.7	14,223.6

Emission reduction								
Parameter	Parameter type	Unit	2018	2019	2020	2021	2022	2023
[1]. Mass of synthetic fertilizer type i applied (urea)[54]	Baseline	tons in year t				209.7	297	168.90
[2]. Mass of organic fertilizer type j applied	Baseline	tons in year t				0	0	60.40[55]

54 NDC Explorer 2022
55 Assumptions

[3]. Emission Factor for emissions from N inputs[56]	Baseline	ton-N_2O-N (t-N input)$^{-1}$				0.01	0.01	0.01
[4]. Fraction that volatilizes as NH_3 and NO_X for synthetic fertilizers[56]	Baseline	dimensionless				0.1	0.1	0.1
[5]. Fraction that volatilizes as NH_3 and NO_X for organic fertilizers[56]	Baseline	dimensionless				0	0	0.2
[6]. Ratio of molecular weights of N_2O and N[57]	Baseline	ton-N_2O (t-N)$^{-1}$				1.57	1.57	1.57
[7]. Global Warming Potential for N_2O[58]	Baseline	kg-CO_2-e (kg-N2O)$^{-1}$				265	265	265
[8]. Nitrogen content of the synthetic fertilizer type i applied[59]	Baseline	g-N (100 g fertilizer)$^{-1}$				46	46	46
[9]. Nitrogen content of organic fertilizer type j applied[60]	Baseline	g-N (100 g fertilizer)$^{-1}$				0	0	2
[10]. Mass of crop residues burnt in year t[61]	Project	t CO_2e				2201.85	3118.50	1773.45
[11]. Mass of grassland residues burnt in year t	Project	tons				0	0	0
[12]. Global warming potential of CH_4[58]	Project	tons				28	28	28
[13]. Combustion factors that depend on vegetation type (Rice)[57]	Project	t CO_2e / t CH_4				0.8	0.8	0.8
Progress	2021 - 2023							
Emission reduction	42,670.8 tCO_2e							

56 https://fsapps.nwcg.gov/gtac/CourseDownloads/IP/Cambodia/FlashDrive/Supporting_Documentation/REDD/2006_IPCC_GHG_Inventories/V4_11_Ch11_N2O&CO2.pdf
57 https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-07-v1.pdf
58 IPCC 5th assessment report
59 https://ebrary.ifpri.org/digital/api/collection/p15738coll2/id/128917/download
60 FAO. (2005). "Fertilizer Use by Crop in Cambodia
61 "Rice Straw Management" by the Food and Agriculture Organization (FAO

Table II. 30: NDC 26- Organic input agriculture and bio-slurry; and deep placement fertilizer technology

Name of Action	Organic-based farming for rice crops in Battambang of Preah Vihear province						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2020	NA	Ministry of Agriculture, Forestry and Fisheries (MAFF)	CO_2	Cambodia	Agriculture
Description							
The organic-based farming has been introduced to farmers in Preah Vihear province since 2020 through WAT4CAM pilot activity by an introduction of cover crops (legumes) before rice cultivation in the land area of 28.6 ha with 49 farmers.							
Objective							
Minimizing synthetic nitrogen fertilizers applied to rice cultivation by planting cover crops							
Scope of the Action							
Minimizing synthetic nitrogen fertilizer application							
Estimated Outcomes							
Reduce GHG emissions from synthetic nitrogen fertilizer application Reduce the cost of synthetic nitrogen fertilizer							
Estimated GHG Emission Reductions			Not Available				
Methodologies and Assumptions			UNFCCC AMS-III.A.: Offsetting of synthetic nitrogen fertilizers by inoculant application in legumes-grass rotations on acidic soils on existing cropland --- Version 3.0				

Progress Indicators - 2020	Unit	Baseline Scenario	Project Scenario	Final Outcome
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	3.14	2.09	1.05
Progress Indicators - 2021				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	3.19	2.13	1.06
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	3.24	2.16	1.08
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	3.29	2.19	1.10

Emission reduction								
Parameter	Parameter type	Unit	2018	2019	2020	2021	2022	2023
[1]. Emission factor for the production of synthetic nitrogen fertilizer (Urea)[51]	Baseline	t CO_2/tons fertilizer			0.73333	0.73333	0.73333	0.73333
[2]. Area of land where Cover crops(I) cultivated in classified land area (j)[62]	Baseline	ha			28.60	6022.40	6087.30	6159.10
[3]. Average application rate of fertilizer (f) to rice (g) by farmer (i) in the classified area (j) [53]	Baseline	tons/ha			0.15	0.15	0.15	0.15

62 CCCA 2022 report

[4]. Amount of synthetic nitrogen fertilizer (f) applied to rice (g) in the project activity [53]	Project	tons			2.90	602.20	608.70	615.90
[5]. Emission factor to produce synthetic nitrogen fertilizer (Urea)[51]	Project	t CO_2/tons fertilizer			0.73	0.73	0.73	0.73
Progress	2018 - 2023							
Emission reduction	4.29 tCO_2e							

“With Additional measures” Scenario

Table II. 31: Non NDC 1 - Increase energy access to rural area

Name of Action	Increase energy access to rural area						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2017	NA	Ministry of Mines and Energy	CO_2	Cambodia	Energy
Description							
This project aims to increase energy access in rural areas of Cambodia by enhancing electricity availability.							
Objective							
To provide consistent and reliable electricity to rural communities, thereby improving living standards and economic opportunities.							
Scope of the Action							
The project involves extending the grid and constructing new mini grids to supply electricity to rural households and communities.							
Estimated Outcomes							
to achieve net GHG emission reductions, increase the share of households with access to modern energy, generate financial benefits, and create job opportunities for women, resulting in 24-hour electricity availability for local communities.							
Estimated GHG Emission Reductions	Not Available						
Methodologies and Assumptions	UNFCCC AMS-III.BB.: Electrification of communities through grid extension or construction of new mini-grids --- Version 3.0						

Progress Indicators - 2017				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	6,307.6	2,885.7	3,421.8
Progress Indicators - 2018	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	6,938.3	3,173.7	3,764.6
Progress Indicators - 2019	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	7,632.1	3,491.6	4,140.5
Progress Indicators - 2020				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	8,395.3	3,840.3	4,555.0
Progress Indicators - 2021				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	9,234.9	4,224.5	5,010.4
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	10,158.3	4,646.5	5,511.8
Indicator 2				
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	11,174.2	5,111.2	6,062.9

Emission reduction									
Parameter	Parameter type	Unit	2017	2018	2019	2020	2021	2022	2023

[1]. Annual electricity consumption of existing consumer x1 in year y[63]	Baseline parameter	MWh	2,776	3,053	3,359	3,695	4,064	4,471	4,918
[2]. Annual electricity consumption of existing consumer x2 in year y	Baseline parameter	MWh	2,917	3,208	3,529	3,882	4,270	4,697	5,167
[3]. Annual electricity consumption of existing consumer x3 in year y	Baseline parameter	MWh	2,192	2,411	2,652	2,917	3,209	3,530	3,883
[4]. Number of existing consumers receiving electricity from the project activity in year y	Baseline parameter	-	3	3	3	3	3	3	3
[5]. Baseline emissions factor for the mini grid[64]	Baseline parameter	tCO_2/MWh	0.8	0.8	0.8	0.8	0.8	0.8	0.8
[6]. Annual electricity consumption of household consumers not metered j in year y[65]	Baseline parameter	MWh	0.24	0.24	0.24	0.24	0.24	0.24	0.24
[7]. household consumers not metered (k = 1, 2, 3, …)	Baseline parameter	-	1	1	1	1	1	1	1
[8]. Number of household consumers not metered in year y	Baseline parameter	-	50	50	50	50	50	50	50
[9]. Total electricity delivered to all new and existing consumers	Project parameter	MWh	3	3	3	3	3	3	3
[10]. Emissions factor for the project electricity system in year y[66]	Project parameter	tCO_2/MWh	0.71	0.71	0.71	0.71	0.71	0.71	0.71
[11]. Transmission and distribution losses in the project electricity system[67]	Project parameter	%	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Indicator 2									
Progress	2017 - 2023								
Emission reduction	32,467.4 tCO_2e								

63 eria.org/uploads/media/Research-Project-Report/RPR-2022-08/Cambodia-Energy-Statistics-2019-2020.pdf (Assumed that every year there was 10% increase in consumption)

64 EB115_repan05_TOOL33_ver02.0 (unfccc.int)

65 World Bank Document

66 https://www.energy.gov.lk/ODSM/Carbon-Footprint.html

67 EB115_repan16_AMS-III.BB_ver03.0 (unfccc.int)

Table II. 32: Non-NDC 2 - Diversification of household and community energy generation sources to reduce reliance on biomass as an energy sources

Name of Action	Diversification of household and community energy generation sources to reduce reliance on biomass as an energy sources						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2017	NA	Ministry of Mines and Energy	CO_2	Cambodia	Energy
Description							
focuses on diversifying energy generation sources for households and communities in Cambodia to reduce reliance on biomass. The project scenario aims to increase electricity access through grid extension or the construction of new mini grids.							
Objective							
2. to provide reliable and sustainable electricity to rural households, reducing their dependence on biomass and improving overall energy security.							
Scope of the Action							
The project will: 3. Extend the electricity grid to rural areas. 4. Construct new mini grids to provide electricity to remote communities. 5. Target households that currently rely heavily on biomass for their energy needs.							
Estimated Outcomes							
1. More households will have access to reliable electricity, decreasing their reliance on biomass. 2. The shift from biomass to electricity will result in lower greenhouse gas emissions. 3. Enhanced access to electricity will improve living standards and provide new economic opportunities for rural communities.							
Estimated GHG Emission Reductions			Not Available				
Methodologies and Assumptions			UNFCCC AMS-III.BB.: Electrification of communities through grid extension or construction of new mini-grids --- Version 3.0				

Progress Indicators - 2017				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	6,672	2,885.7	3,786.2
Progress Indicators - 2018	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	7,336.8	3,173.7	4,163.1
Progress Indicators - 2019	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	8,071.2	3,491.6	4,579.5
Progress Indicators - 2020				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	8,877.6	3,840.3	5,037.2
Progress Indicators - 2021				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	9,763.2	4,224.5	5,538.7
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	10,740	4,646.5	6,093.4
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	11,812.8	5,111.2	6,701.5
Emission reduction				

Parameter	Parameter type	Unit	2017	2018	2019	2020	2021	2022	2023
[1]. Annual electricity consumption of existing consumer x1 in year y[68]	Baseline parameter	MWh	2,776	3,053	3,359	3,695	4,064	4,471	4,918
[2]. Number of existing consumers receiving electricity from the project activity in year y	Baseline parameter	-	3	3	3	3	3	3	3
[3]. Baseline emissions factor for the mini grid[69]	Baseline parameter	tCO_2/MWh	0.8	0.8	0.8	0.8	0.8	0.8	0.8
[4]. Annual electricity consumption of household consumers not metered j in year y[70]	Baseline parameter	MWh	0.24	0.24	0.24	0.24	0.24	0.24	0.24
[5]. household consumers not metered (k = 1, 2, 3, …)	Baseline parameter	-	1	1	1	1	1	1	1
[6]. Number of household consumers not metered in year y	Baseline parameter	-	50	50	50	50	50	50	50
[7]. Total electricity delivered to all new and existing consumers[71]	Project parameter	MWh	3,658	4,023	4,426	4,868	5,355	5,890	6,479
[8]. Emissions factor for the project electricity system in year y[72]	Project parameter	tCO_2/MWh	0.71	0.71	0.71	0.71	0.71	0.71	0.71
[9]. Transmission and distribution losses in the project electricity system[73]	Project parameter	%	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Progress	2017 - 2023								
Emission reduction	35,899.94 tCO_2e								

68 https://www.eria.org/uploads/media/Research-Project-Report/RPR-2022-08/Cambodia-Energy-Statistics-2019-2020.pdf (Assumed that every year there was 10% increase in consumption)

69 EB115_repan05_TOOL33_ver02.0 (unfccc.int)

70 World Bank Document

71 eria.org/uploads/media/Research-Project-Report/RPR-2022-08/Cambodia-Energy-Statistics-2019-2020.pdf

72 https://www.energy.gov.lk/ODSM/Carbon-Footprint.html

73 EB115_repan16_AMS-III.BB_ver03.0 (unfccc.int)

Table II. 33: Non NDC 03- E- Mobility

Name of Action	E-mobility						
Type of Action	Status	Date of Commencement	Duration	Implementing Entity	GHG Coverage	Geographic coverage	Sectoral Scope
Mitigation action	In progress	2020	NA	Ministry of Public Works and Transport	CO_2	Cambodia	Transport

Description
The Cambodian government is committed to reducing pollution using fuel-efficient vehicles and the switch to EVs — at least to 40 percent of the cars and urban buses and 70 percent of motorcycles by 2050.
Objective
1.To transition away from a market dominated by imported used gasoline and diesel-powered vehicles 2.Electrifying 70% of motorcycles and 40% of cars and urban buses by 2050 TO ACHIEVE GOALS OF CARBON NEUTRAL ECONOMY BY 2050 3.Mitigate the effects of climate change by reducing GHG emissions from motorbikes
Scope of the Action
Switch to electric vehicles and reduce GHG emissions
Estimated Outcomes
Reduce GHG emissions Increase energy efficiency using electric motors rather than the use of fuel-fired motors through transition from fossil fuels to clean energy

Estimated GHG Emission Reductions	Not Available
Methodologies and Assumptions	UNFCCC- AMS-III.C. Emission reduction by electric and hybrid vehicles

Progress Indicators - 2020				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	23.0	10.3	12.7
Progress Indicators - 2021				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	361.5	165.4	196.1
Progress Indicators - 2022				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	3,877.7	1,776.2	2,101.5
Progress Indicators - 2023				
Indicator	Unit	Baseline Scenario	Project Scenario	Final Outcome
Emission reduction	tCO_2e	4,547.1	2,166.3	2,380.8

Emission reduction								
Parameter	Parameter type	Unit	2018	2019	2020	2021	2022	2023
[1]. Specific fuel consumption - Tricycle - Petrol[74]	Baseline	g/km			80	80	80	80
[2]. Number of operational project vehicles - Tricycle - Petrol[75]	Baseline	-			2	34	369	756[76]
[3]. Specific fuel consumption - Motor Bicycle - Petrol[74]	Baseline	g/km			50	50	50	50

74 https://www.ccacoalition.org/projects/cambodia-implementing-improved-vehicle-emission-standards

75 https://www.b2b-cambodia.com/articles/can-cambodia-hit-its-ev-2050-targets/

76 https://www.khmertimeskh.com/501401710/ev-registrations-jump-to-1162-this-year/

[4]. Number of operational project vehicles - Motor Bicycle - Petrol[75]	Baseline	-			1	2	18	220[76]
[5]. Specific fuel consumption - Car - Petrol[74]	Baseline	g/km			150	150	150	150
[6]. Number of operational project vehicles - Car - Petrol[75]	Baseline	-			2	32	343	358
[7]. Annual average distance travelled Car -Petrol[77]	Baseline	Km			22,350	22,350	22,350	22,350
[8]. Annual average distance travelled Motor Bicycle - Petrol[77]	Baseline	km			4,140	4,140	4,140	4,140
[9]. Annual average distance travelled_Tricycle-Petrol[77]	Baseline	km			4,140	4,140	4,140	4,140
[10]. Net calorific value - Petrol	Baseline	J/g			4430	4430	4430	4430
[11]. CO_2 emission factor - Petrol	Baseline	gCO_2/J			0.000693	0.000693	0.000693	0.000693
[12]. Technology improvement factor[78]	Baseline	-			0.99	0.99	0.99	0.99
[13]. Number of operational project vehicles - Bicycle - Electricity[75]	Project	-			1	2	18	220
[14]. Average technical transmission and distribution losses - Bicycle - Electricity[79]	Project	%			0.25	25	25	25
[15]. Number of operational project vehicles - Tricycle - Electricity[75]	Project	-			2	34	369	756
[16]. Specific fuel consumption - Tricycle - Electricity[80]	Project	kWh/km			0.2	0.2	0.2	0.2
[17]. Specific fuel consumption - Car - Electricity[80]	Project	kWh/km			0.2	0.2	0.2	0.2
[18]. Number of operational project vehicles - Car - Electricity[75]	Project	-			2	32	343	358
[19]. Specific fuel consumption - - Bicycle - Electricity[80]	Project	kWh/km			0.02	0.02	0.02	0.02
[20]. CO_2 emission factor - Electricity[81]	Project	$kgCO_2/kWh$			0.7239	0.7239	0.7239	0.7239
[21]. Annual average distance travelled Car -Petrol	Project	km			22,350	22,350	22,350	22,350
[22]. Annual average distance travelled Motor Bicycle - Petrol	Project	km			4,140	4,140	4,140	4,140
[23]. Annual average distance travelled Tricycle-Petrol	Project	km			4,140	4,140	4,140	4,140
Progress	2020 - 2023							
Emission reduction	4,691.1 tCO_2e							

77 Rural Transporter- A survey of Transport businesses in Rural Cambodia

78 Default values in AMS IIIC methodology

79 https://techiescience.com/diesel-engine-brake-specific-fuel-consumption-bsfc/

80 https://techiescience.com/diesel-engine-brake-specific-fuel-consumption-bsfc/

81 https://data.opendevelopmentmekong.net/library_record/grid-emission-factors-in-cambodia

CTF Table 01: Description of selected indicators

Indicator	Information for the reference point(s)	level(s)	Baseline(s)	Base Year(s)	Update in accordance with any recalculation of the GHG inventory	Relation to NDC
GHG emission		Total BAU GHG emission 125.1 $MtCO_2e$ in 2016[82]	Total BAU GHG emission 154.9 $MtCO_2e$ in 2016[83]	2016	NA	Cambodia aims to reduce GHG emissions by 42% by 2030 against the business as usual (BAU) emissions as per the updated NDCs submitted to the UNFCCC in 2020[84]

82 https://unfccc.int/sites/default/files/NDC/2022-06/20201231_NDC_Update_Cambodia.pdf

83 https://unfccc.int/sites/default/files/NDC/2022-06/20201231_NDC_Update_Cambodia.pdf

84 https://climateactiontransparency.org/wp-content/uploads/2022/08/Cambodia-Transport_MRV_Tranport_Policy_Analysis-Deliverable-1.pdf#:~:text=Cambodia%20aims%20to%20reduce%20GHG.%2C%20Industry%2C%20and%20Waste%20sectors.

ETF Table 02: Definitions needed to understand Nationally Determined Contributions

	Definitions[a]
Definition needed to understand each indicator:	
Net GHG emissions and removals	Cambodia's updated NDC baseline scenario was used as the baseline scenario of the NDC tracking assessment. According to the NDC, the BAU assessment considered activity data from 1994 to 2006 and Tier 1 methodologies. The BAU projections until 2030 were generated by forecasting emissions calculated from 2000 to 2016 using PROSPECT+. Emission reductions from implemented mitigation actions were calculated for NDC tracking assessment based on UNFCCC CDM methodologies.
Other indicators	*Job opportunities for women/ Share of women will be benefited* This indicator explores the impact of each mitigation action on SDG 5: Gender Equality, which encourages equal rights for women. Information provided in the updated NDC report has been used to determine the progress related to this indicator. *Financial benefits* This indicator observes the financial benefits of implemented mitigation actions, such as financial gains from selling compost and reducing energy consumption. The progress has been compared with the expected targets outlined in the country's Updated NDC.
Any sector or category defined differently than in the national inventory report:	The updated NDC cover various sectors, including energy, transport, waste, industry, agriculture, building, forestry, and other land use (FOLU), falling under Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), and waste sectors. Energy Sector – Electricity, Transport and Buildings IPPU sector – Other industry and Cement Waste sector – Waste AFOLU - AFOLU
Definition needed to understand mitigation co-benefits of adaptation actions and/or economic diversification plans:	Not Applicable
Any other relevant definitions	Not Applicable

CTF Table 03: Methodologies and accounting approaches – consistency with Article 4, paragraphs 13 and 14 of the Paris Agreement

Description	Description or reference to the relevant section of the BTR
For the first NDC under Article 4: b	
Accounting approach	Historical GHG inventory: The reported estimates of emissions of GHGs and removals of CO_2 are based on data reported in the draft Second National Communication (SNC) developed by the Government of Cambodia. The GHG inventory used Tier 1 methodologies set out in the IPCC 1996 Guidelines, IPCC default emission factors and country specific activity data from 2000. Baseline GHG projections: In the energy sector, projections have been generated for the SNC using Long-range Energy Alternatives Planning (LEAP) modelling, using default emission factors and activity data from a wide range of sources. Projections for the land use, land use change and forestry (LULUCF) sector take into account forest and grassland conversions and land abandonment and are based on methodologies in the Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance. All projections took into account current macroeconomic conditions, policy conditions, market conditions and events in other sectors. Mitigation options: These were formulated based on previous needs analyses, experience from successful projects, pilot projects, feasibility studies, literature reviews and expert opinion
Consistency of accounting approach with Article 4, paragraphs 13 and 14 of the Paris Agreement	Cambodia's approach to accounting for its Nationally Determined Contributions (NDCs) under the Paris Agreement is consistent with Article 4, paragraphs 13 and 14, by ensuring transparency, accuracy, completeness, comparability, and consistency in tracking its greenhouse gas emissions and mitigation efforts. Cambodia has developed a robust Measurement, Reporting, and Verification (MRV) system to support its NDC tracking, which aligns with the principles of environmental integrity, transparency, accuracy, completeness, comparability, and consistency stipulated in Article 4. The country utilizes a comprehensive inventory of greenhouse gas emissions and removals, adopts standardized methodologies, and follows internationally recognized guidelines.
For the second and subsequent NDC under Article 4, and optionally for the first NDC under Article 4:c	
Consistency of reporting information referred to in chapter III.B and C of Annex to decision 18/CMA.1 with	Cambodia's second NDCs demonstrate consistency with the reporting information referred to in Chapter III.B and C of the Annex to decision 18/CMA.1 and decision 4/CMA.1. These decisions mandate comprehensive and transparent reporting of mitigation actions and outcomes. Cambodia has adhered to these requirements by detailing its greenhouse gas (GHG) inventory, including methodologies, data sources, and assumptions used,

decision 4/CMA.1	ensuring transparency and accuracy in reporting. The country also outlines its mitigation targets, policies, and measures, along with progress indicators and projections, thus aligning with the prescribed guidelines.
Accounting for anthropogenic emissions and removals in accordance with methodologies and common metrics assessed by the Intergovernmental Panel on Climate Change (IPCC) and adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement:	
Explain how the accounting for anthropogenic emissions and removals is in accordance with methodologies and common metrics assessed by the IPCC and in accordance with decision 18/CMA.1 {Annex II decision 4/CMA.1 para 1 (a)}	Cambodia's accounting for anthropogenic emissions and removals adheres to methodologies and common metrics assessed by the Intergovernmental Panel on Climate Change (IPCC) and is consistent with decision 18/CMA.1 and the Annex II of decision 4/CMA.1, paragraph 1 (a).
For Parties whose NDC cannot be accounted for using methodologies covered by IPCC guidelines, provide information on their own methodology used, including for NDC pursuant to Article 4, paragraph 6, of the Paris Agreement, if applicable {Annex II decision 4/CMA.1 para 1 (b)}	By applying internationally recognized methodologies; UNFCCC CDM, VERRA, and JICA
Provide information on how the Party has drawn on existing methods and guidance established under the Convention and its related legal instruments, as appropriate, if applicable {Annex II decision	Cambodia utilizes the IPCC Guidelines for National Greenhouse Gas Inventories, which are endorsed by the United Nations Framework Convention on Climate Change (UNFCCC)

4/CMA.1 para 1 (c)}	
Provide information on methodologies used to track progress arising from the implementation of policies and measures, as appropriate {Annex II decision 4/CMA.1 para 1 (d)}	• UNFCCC - AMS-I.D.: Grid connected renewable electricity generation --- Version 15.0 • UNFCCC- AMS-III.G.: Landfill methane recovery --- Version 10.0 • UNFCCC- AMS-III. AF.: Avoidance of methane emissions through excavating and composting of partially decayed municipal solid waste (MSW) --- Version 1.0 "AMS-III.AJ.: Recovery and recycling of materials from solid wastes --- Version 9.0 (PR- TraCAD) • UNFCCC- AMS-III.A.: Offsetting of synthetic nitrogen fertilizers by inoculant application in legumes-grass rotations on acidic soils on existing cropland --- Version 3.0 • VERRA- VM0017: Adoption of Sustainable Agricultural Land Management • UNFCCC- AMS-II.E.:Energy efficiency and fuel switching measures for buildings --- Version 12.0 • JICA - Transport / Modal Shift (Passenger): • UNFCCC- AMS-III.BB.: Electrification of communities through grid extension or construction of new mini-grids --- Version 3.0 • UNFCCC- AMS-III.C. Emission reduction by electric and hybrid vehicles
For Parties that decide to address emissions and subsequent removals from natural disturbances on managed lands, provide detailed information on the approach used and how it is consistent with relevant IPCC guidance, as appropriate, or indicate the relevant section of the national greenhouse gas inventory report containing that information Annex II decision 4/CMA.1 para 1 (e)	Cambodia employs an approach consistent with relevant IPCC guidance

For Parties that account for emissions and removals from harvested wood products, provide detailed information on which IPCC approach has been used to estimate emissions and removals {Annex II decision 4/CMA.1 para 1 (f)}	Cambodia estimates emissions and removals from harvested wood products (HWPs) using the first-order decay (FOD) approach as outlined in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
For Parties that address the effects of age-class structure in forests, provide detailed information on the approach used and how this is consistent with relevant IPCC guidance, as appropriate (para. 1(g) of annex II to decision 4/CMA.1, para. 75(d)(iii) of the MPGs)	Cambodia addresses the effects of age-class structure in forests by employing an approach consistent with relevant IPCC guidance. The country utilizes methodologies outlined in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, particularly focusing on forest management practices that consider age-class structures. This involves assessing how different age classes influence carbon stocks and dynamics, including carbon sequestration rates and emissions.
Ensuring methodological consistency, including on baselines, between the communication and implementation of NDCs:	
Explain how consistency has been maintained in scope and coverage, definitions, data sources, metrics, assumptions and methodological approaches including on baselines, between the communication and implementation of NDCs (para. 2(a) of annex II to decision 4/CMA.1)	Cambodia ensures methodological consistency, including on baselines, between the communication and implementation of its Nationally Determined Contributions (NDCs) by adhering to standardized approaches and guidelines outlined in the Paris Agreement and relevant IPCC methodologies. The country maintains consistency in scope and coverage by clearly defining the sectors and gases included in its NDCs and subsequent implementation plans. Definitions of terms related to emissions, removals, and mitigation actions are aligned with international standards to facilitate clear communication and accurate reporting. Data sources used for baseline establishment and progress tracking are transparently documented, ensuring reliability and comparability over time. Metrics such as greenhouse gas emissions reductions and carbon sequestration rates are consistently applied across reporting periods, supporting the assessment of progress towards NDC targets. Assumptions underlying projections and scenario analyses are disclosed, enabling stakeholders to understand the rationale behind policy decisions. Methodological approaches to establishing baselines, including the use of historical data and scenario modeling, are harmonized to ensure coherence between NDC communication and implementation phases. This comprehensive approach supports Cambodia's commitment to transparent and

	accountable climate action under the Paris Agreement framework.
Explain how consistency has been maintained between any GHG data and estimation methodologies used for accounting and the Party's GHG inventory, pursuant to Article 13, paragraph 7(a), of the Paris Agreement, if applicable (para. 2(b) of annex II to decision 4/CMA.1) and explain methodological inconsistencies with the Party's most recent national inventory report, if applicable (para. 76(c) of the MPGs)	Consistency between greenhouse gas (GHG) data and estimation methodologies used for accounting and the Party's GHG inventory under the Paris Agreement is ensured through rigorous adherence to established guidelines and methodologies, as specified in Article 13, paragraph 7(a). Cambodia maintains this consistency by regularly updating its national GHG inventory report using methodologies prescribed by the Intergovernmental Panel on Climate Change (IPCC) Guidelines.
Explain how overestimation or underestimation has been avoided for any projected emissions and removals used for accounting Annex II decision 4/CMA.1 para 2 (c)}	Cambodia avoids overestimation or underestimation of projected emissions and removals used for accounting by employing robust scenario analyses based on validated data and realistic assumptions. This approach ensures accuracy in forecasting trends and impacts of mitigation measures, contributing to reliable climate action planning and reporting under the Paris Agreement.
For Parties that apply technical changes to update reference points, reference levels or projections, the changes should reflect either of the following (para. 2(d) of annex II to decision 4/CMA.1):	
Changes in the Party's inventory {Annex II decision 4/CMA.1 para 2 (d)(i)}	Not applicable
Improvements in accuracy that maintain methodological consistency {Annex II decision	Improvements in accuracy that maintain methodological consistency under Annex II decision 4/CMA.1 para 2 (d)(ii) involve Cambodia's continuous refinement of data collection processes and the adoption of updated IPCC methodologies. By integrating new scientific findings and enhancing monitoring capabilities, Cambodia

4/CMA.1 para 2 (d)(ii)}	ensures that any adjustments to emission estimates are methodologically sound and consistently applied across reporting periods.
Explain how any methodological changes and technical updates made during the implementation of their NDC were transparently reported (para. 2(e) of annex II to decision 4/CMA.1)	Cambodia ensures transparency regarding any methodological changes and technical updates made during the implementation of their Nationally Determined Contributions (NDC) by documenting these changes in their official reporting channels.
Striving to include all categories of anthropogenic emissions or removals in the NDC and, once a source, sink or activity is included, continuing to include it (para. 3 of annex II to decision 4/CMA.1):	
Explain how all categories of anthropogenic emissions and removals corresponding to their NDC were accounted for (para. 3(a) of annex II to decision 4/CMA.1)	Cambodia ensures comprehensive accounting of all categories of anthropogenic emissions and removals corresponding to their NDC by systematically including data from sectors such as energy, agriculture, forestry, industrial processes, and waste management. This approach ensures consistency and completeness in reporting across all relevant sources, sinks, and activities, supporting accurate tracking of progress towards climate targets under the Paris Agreement.
Explain how Party is striving to include all categories of anthropogenic emissions and removals in its NDC, and, once a source, sink or activity is included, continue to include it (para. 3(b) of annex II to decision 4/CMA.1)	Cambodia strives to include all categories of anthropogenic emissions and removals in its NDC by regularly updating its inventory methodologies and data collection processes. Once a source, sink, or activity is included, Cambodia commits to ongoing monitoring and reporting to ensure continuity and completeness in its accounting framework, supporting comprehensive climate action planning and implementation under the Paris Agreement.
Provide an explanation of why any categories of anthropogenic emissions or removals are excluded (para. 4 of annex II to decision 4/CMA.1)	limited data availability, technical challenges in measurement and verification

Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of its NDC	
Provide information on any methodologies associated with any cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 (para. 75(f) of the MPGs)	Not Available
Provide information on how each cooperative approach promotes sustainable development, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	These approaches prioritize activities that contribute to sustainable development goals, such as enhancing energy efficiency, promoting renewable energy sources, and fostering resilient agricultural practices.
Provide information on how each cooperative approach ensures environmental integrity consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	These include rigorous methodologies for quantifying emissions reductions or removals exchanged through Internationally Transferred Mitigation Outcomes (ITMOs), ensuring that these outcomes represent real, measurable, additional, and permanent climate benefits. Cambodia implements transparent and accountable verification procedures to verify the authenticity and credibility of ITMO transactions, following established guidelines and standards. This approach safeguards against double counting and ensures that ITMOs contribute effectively to global climate mitigation efforts without compromising environmental integrity. By upholding these principles, Cambodia contributes to building trust and confidence in international cooperative mechanisms under Article 6 while supporting sustainable development objectives
Provide information on how each cooperative approach ensures transparency, including in governance, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	Each cooperative approach involving Cambodia ensures transparency, including in governance, by establishing clear rules and procedures for ITMO transactions, publicly disclosing relevant information, and engaging stakeholders in decision-making processes. This transparency enhances accountability and facilitates trust among participants, aligning with decisions adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) on Article 6.

Provide information on how each cooperative approach applies robust accounting to ensure, inter alia, the avoidance of double counting, consistent with decisions adopted by the CMA on Article 6 (para. 77(d)(iv) of the MPGs)	This includes verifying the authenticity of ITMOs through rigorous verification procedures and ensuring that each unit represents unique and additional climate benefits, in accordance with decisions adopted by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) on Article 6.
Any other information consistent with decisions adopted by the CMA on reporting under Article 6 (para. 77(d)(iii) of the MPGs)	Not available

CTF Table 04: Tracking progress made in implementing and achieving the NDC under Article 4 of the Paris Agreement

	Unit, as applicable	*Reference point(s), level(s), baseline(s), base year(s) or starting point(s), as appropriate (paras. 67 and 77(a)(i) of the MPGs)*	*Implementation period of the NDC covering information for previous reporting years, as applicable, and the most recent year, including the end year or end of period (paras. 68 and 77(a)(ii–iii) of the MPGs)*						*Target level[b]*	*Target year or period*	*Progress made towards the NDC, as determined by comparing the most recent information for each selected indicator, including for the end year or end of period, with the reference point(s), level(s), baseline(s), base year(s) or starting point(s) (paras. 69–70 of the MPGs)*
Indicator(s) selected to track progress of the NDC or portion of NDC under Article 4 of the Paris Agreement (paras. 65 and 77(a) of the MPGs):		2016	2017	2018	2019	2020	2021	2022			
GHG Emission reduction	%	% of Emission reduction against the business as usual (BAU) emissions	0.33%	0.63%	0.94%	1.23%	1.53%	1.80%	42%	2030	1.8% of GHG emission reduction by 2022 against the business as usual (BAU) emissions (BAU emission in 2023 – 140.1 Mt CO2e)
Where applicable, total GHG emissions and removals consistent with the coverage of the NDC (para. 77(b) of the MPGs)	Mt CO_2 equivalent	Total BAU GHG emission 125.1 MtCO2e in 2016 [1]	127.0	128.8	130.4	132.1	133.9	135.5	89.8	2030	
Contribution from the LULUCF sector for each year of the target	kt CO_2 equivalent		NA	NA	NA	NA	NA	NA			

period or target year, if not included in the inventory time series of total net GHG emissions and removals, as applicable (para. 77(c) of the MPGs)												
Each Party that participates in cooperative approaches that involve the use of ITMOs towards an NDC under Article 4 of the Paris Agreement, or authorizes the use of mitigation outcomes for international mitigation purposes other than achievement of the NDC, shall provide (para. 77(d) of the MPGs):												
If applicable, an indicative multi-year emissions trajectory, trajectories or budget for its NDC implementation period (para. 7(a)(i), annex to decision 2/CMA.3)	kt CO_2 equivalent		NA	NA	NA	NA	NA	NA				
If applicable, multi-year emissions trajectory, trajectories or budget for its NDC implementation period that is consistent with the NDC (para. 7(b), annex to decision 2/CMA.3)	Not applicable		NA	NA	NA	NA	NA	NA				
Annual anthropogenic emissions by sources and removals by sinks covered by its NDC or, where applicable, from the emission or sink categories as identified by the host Party pursuant to paragraph 10 of annex to decision 2/CMA.3 (para. 23(a), annex to decision	kt CO_2 equivalent		NA	NA	NA	NA	NA	NA				

2/CMA.3) (as part of para. 77 (d)(i) of the MPGs)											
Annual anthropogenic emissions by sources and removals by sinks covered by its NDC or, where applicable, from the portion of its NDC in accordance with paragraph 10, annex to decision 2/CMA.3 (para. 23(b), annex to decision 2/CMA.3)	kt CO_2 equivalent		NA	NA	NA	NA	NA	NA			
If applicable, annual level of the relevant non-GHG indicator that is being used by the Party to track progress towards the implementation and achievement of its NDC and was selected pursuant to paragraph 65, annex to decision 18/CMA.1 (para. 23(i), annex, decision 2/CMA.3)	Not applicable		NA	NA	NA	NA	NA	NA			
Annual quantity of ITMOs first transferred (para. 23(c), annex to decision 2/CMA.3) (para. 77(d)(ii) of the MPGs)	kt CO_2 equivalent		NA	NA	NA	NA	NA	NA			

CTF Table 05: Mitigation policies and measures, actions and plans, including those with mitigation co-benefits resulting from adaptation action and economic diversification plans, related to implementing and achieving a nationally determined contribution under Article 4 of the Paris Agreement

Name	Description	Objectives	Type of Instrument	Status	Sectors	Gases Affected	Start year	Implementing Entity	Estimate of GHG Emission Reduction ($t\ CO_2\ eq$)	
									Achieved	Expected
Establishment of Cropping System for Growing Mungbean on Rainfed Lowland Paddy Field after Wet Season	Establishment of Cropping System for Growing Mungbean on Rainfed Lowland Paddy Fields after Wet Season (KOPIA)	Minimizing synthetic nitrogen fertilizers applied on Rainfed Lowland paddy fields by planting legumes after the wet season	NA	In progress	Agriculture,	CO_2	2017	MAFF	617.87	NA
Increase energy access to rural area	This project aims to increase energy access in rural areas of Cambodia by enhancing electricity availability.	To provide consistent and reliable electricity to rural communities, thereby improving living standards and economic opportunities.	NA	In progress	Energy	CO_2	2017	MME	6,062.9	NA
Promote integrated public transport systems in main cities	This project aims to promote integrated public transport	To reduce greenhouse gas emissions and improve urban mobility by	NA	In progress	Energy	CO_2	2017	MPWT	204.19	NA

	systems in major cities in Cambodia, transitioning passenger transport from existing modes to electric buses (e-buses).	implementing an integrated public transport system using e-buses in main cities.								
Diversification of household and community energy generation sources to reduce reliance on biomass as an energy sources	focuses on diversifying energy generation sources for households and communities in Cambodia to reduce reliance on biomass. The project scenario aims to increase electricity access through grid extension or the construction of new mini grids.	to provide reliable and sustainable electricity to rural households, reducing their dependence on biomass and improving overall energy security.	NA	In progress	Energy	CO_2	2017	MME	6,701.5	NA
Building codes and enforcement/certification for new buildings and those undergoing major renovation	The mitigation action focusing on building codes and enforcement for new and renovated buildings in Cambodia aims	to enhance energy efficiency in Cambodia's construction sector. By implementing the "Energy Efficiency	NA	In progress	Energy	CO_2	2024	MME	323562.84	NA

	to enhance energy efficiency within the construction sector. A key project under this initiative is the "Energy Efficiency Code of Building Technical Regulation," which sets standards for energy-saving measures in building design and construction. Effective implementation of this code, guided by the "Energy Efficiency in Buildings: Accelerating Low-carbon Development in Cambodia" policy brief and case study, targets substantial energy savings. By adhering to	Code of Building Technical Regulation," the goal is to reduce energy demand in buildings by up to 25% by 2035, thereby supporting low-carbon development and sustainability.								

	these regulations, buildings can achieve up to 25% reduction in energy demand by 2035, significantly contributing to the country's low-carbon development goals and sustainability.									
Energy-efficient practices	The project scenario aims to reduce these emissions by implementing energy-efficient measures and adopting better energy management practices in both existing and new buildings/ industries.	1. To reduce energy consumption and greenhouse gas (GHG) emissions in the building and construction sector by establishing energy management practices and improving energy efficiency in both existing and new buildings. 2.Mitigate the effects of	NA	In progress	Energy	CO_2	2017	MME	1,785.3	NA

		climate change by reducing GHG emissions from buildings								
Roadmap study on Integration of renewable energy resources (solar, wind, hydro, biomass) into energy mix	The "Roadmap Study on Integration of Renewable Energy Resources into Cambodia's Energy Mix" outlines strategic actions to incorporate solar, wind, hydro, and biomass energy into the country's energy system.	To increase the contribution of renewable energy for electricity generation by 25 % by 2030 (solar, wind, hydro and biomass)	NA	In progress	Energy	CO_2	NA	MME	2,501,540.77	NA
Composting of biodegradable organic fraction of MSW supplemented with separation of organic waste (at source)	COMPED, a local NGO, operates a composting plant in one corner of the final disposal site in Battambang municipality. This plant was established in 2009 with the	To prevent methane emissions into the atmosphere from municipal solid waste (MSW) that has already been deposited in a closed solid	NA	In progress	Waste	CO_2	2009	MOE	720.86	NA

	financial support of the Federal Ministry of Economic Cooperation and Development (BMZ) and the Thuringian-Cambodian Association (TKG) of Germany, and it continues to operate to this day.The amount of composted waste increased from 1.2 tons per day in 2014, to 1.5–2 tons per day in 2015, and further to 3.5 tons per day in 2017	waste disposal site (SWDS) without methane recovery								
Enhancing Soil, Water, and Nutrient Management for Sustainable Rice Production and Optimized Yield	In 2022, Total areas 1980 ha with 865 farmer households in 3 provinces of Battambang, Kampong Thom, and Preah Vihear	To promote awareness of sustainable land management practice Reduce GHG Emissions	NA	In progress	Agriculture	CO_2	2021	MAFF	14,223.6	NA

	provinces cultivated under Conservation agriculture (CA) practices. CA technology has been realized as a practice that improves soil quality, soil health, and prevent soil erosion. CA main activities have been central to research based in Bos Khnor station (Kampong Cham province) for over 15 years. In recent years, there has been a collective effort (CASIC, Metkasekor, ASMC, WAT4CAM) to transfer CA technology to stakeholders, especially farmers.									

	In 2021, the cultivated land under CA was 1398 ha with 703 farmer households in Battambang, Kampong Thom, and Preah Vihear provinces. We conducted CA training courses and hosted the visits of various visitors to Bos Khnor for 193 participants (25% were women).									
Organic-based farming for rice crops in Battambang of Preah Vihear province	The organic-based farming has been introduced to farmers in Preah Vihear province since 2020 through WAT4CAM pilot activity by an introduction of cover crops (legumes) before rice cultivation in	Minimizing synthetic nitrogen fertilizers applied to rice cultivation by planting cover crops	NA	In progress	Agriculture	CO_2	2020	MAFF	1.10	NA

	the land area of 28.6 ha with 49 farmers.									
New sanitary landfills with LFG extraction and LFG extraction at the Dangkor Landfill	In 2017, the Dangkor landfill site in Phnom Penh received an estimated 2,215 tons of municipal solid waste (MSW) per day. This waste contributed to approximately 7 gigagrams (Gg) of methane emissions. By 2030, it is projected that methane emissions from the landfill will increase to 12 Gg. Therefore, the target has been set to increase landfill gas (LFG) extraction by 50% from new sanitation landfills and the Dangkor	Reduces emissions by capturing landfill gas and destroying methane at Dangkor landfill	NA	In progress	Agriculture	CO_2	2020	MoE	15,041.50	NA

	landfill by 2030.									
Implementation of National 3R strategy	The project aims to prevent and reduce plastic pollution on land and in the ocean by promoting a 4R (Refuse, Reduce, Reuse, and Recycle) framework. Target provinces include Siem Reap (SRP), Sihanoukville (SHV), Phnom Penh (PNH), Kep, Kampot, and Koh Kong.	Reduction of production of HDPE, LDPE, PET, PVC and PP from virgin materials, thus reducing related energy consumption	NA	In progress	Waste	CO_2	2021	MoE	13,421.43	NA
Emission management from factories	The updated NDC of the country aims to monitor air quality at 105 factories annually and issue air emission permits to 90 factories as part of the mitigation action, with the goal of	Encourage factories nationwide to reduce emissions through energy efficiency and other mitigation measures.	NA	In progress	Energy	CO_2	2019	MME	32,668.65	NA

	licensing 90% of factories.									
E-mobility	The Cambodian government is committed to reducing pollution using fuel-efficient vehicles and the switch to EVs — at least to 40 percent of the cars and urban buses and 70 percent of motorcycles by 2050.	1.To transition away from a market dominated by imported used gasoline and diesel-powered vehicles 2.Electrifying 70% of motorcycles and 40% of cars and urban buses by 2050 TO ACHIEVE GOALS OF CARBON NEUTRAL ECONOMY BY 2050 3.Mitigate the effects of climate change by reducing GHG emissions from motorbikes	NA	In progress	Energy	CO_2	2020	MME	2,380.8	NA

CTF Table 06: Summary of greenhouse gas emissions and removals in accordance with the common reporting table 10

A. *Emission trends*

GREENHOUSE GAS EMISSIONS AND REMOVALS	Reference year/period for NDC	Base year	1994	2000	2005	2010	2016	2017	2018	2019	2020	2021	2022	Change from 1994 (Base year) to latest reported year	Change from 2016 (Reference year) to latest reported year
	CO2 equivalents (kt)													%	%
CO_2 emissions without net CO_2 from LULUCF	10,287	1,880	1,880	2,289	2,799	5,517	10,287	11,841	12,862	15,863	18,106	18,066	18,543	886	80
CO_2 emissions with net CO_2 from LULUCF	37,805	25,200	25,200	25,610	26,120	115,155	37,805	39,360	40,380	15,863	18,106	18,066	18,543	-26	-51
CH_4 emissions without CH_4 from LULUCF	34,936	12,324	12,324	13,766	16,309	17,943	34,936	35,225	36,244	36,006	37,005	38,894	38,868	215	11
CH_4 emissions with CH_4 from LULUCF	34,936	12,324	12,324	13,766	16,309	17,943	34,936	35,225	36,244	36,006	37,005	38,894	38,868	215	11
N_2O emissions without N_2O from LULUCF	3,881	1,293	1,293	1,323	1,465	1,568	3,881	4,118	4,378	4,294	4,287	4,814	5,664	338	46
N_2O emissions with N_2O from LULUCF	3,881	1,293	1,293	1,323	1,465	1,568	3,881	4,118	4,378	4,294	4,287	4,814	5,664	338	46
HFCs	330	NO	NO	NO	6	104	330	328	305	286	274	259	248	NA	-25
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA
SF_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA
Total (without LULUCF)	**49,434**	**15,497**	**15,497**	**17,378**	**20,579**	**25,132**	**49,434**	**51,513**	**53,790**	**56,449**	**59,672**	**62,033**	**63,322**	**309**	**28**
Total (with LULUCF)	**76,952**	**38,817**	**38,817**	**40,698**	**43,900**	**134,770**	**76,952**	**79,031**	**81,309**	**56,449**	**59,672**	**62,033**	**63,322**	**63**	**-18**
Total (without LULUCF, with indirect)	**49,434**	**15,497**	**15,497**	**17,378**	**20,579**	**25,132**	**49,434**	**51,513**	**53,790**	**56,449**	**59,672**	**62,033**	**63,322**	**309**	**28**
Total (with LULUCF, with indirect)	**76,952**	**38,817**	**38,817**	**40,698**	**43,900**	**134,770**	**76,952**	**79,031**	**81,309**	**56,449**	**59,672**	**62,033**	**63,322**	**63**	**-18**
	10,287	1,880	1,880	2,289	2,799	5,517	10,287	11,841	12,862	15,863	18,106	18,066	18,543	886	80

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Reference year/period for NDC	Base year	1994	2000	2005	2010	2016	2017	2018	2019	2020	2021	2022	Change from 1994 (Base year) to latest reported year	Change from 2016 (Reference year) to latest reported year
	CO2 equivalents (kt)													%	%
1. Energy	9,073	2,172	2,172	2,526	3,059	5,405	9,073	10,492	11,338	14,131	14,470	13,943	14,875	585	64
2. Industrial processes and product use	1,858	4	4	6	12	515	1,858	2,019	2,179	2,343	4,187	4,665	4,210	110,407	127
3. Agriculture	36,644	12,238	12,238	13,560	16,081	17,729	36,644	37,018	38,141	37,656	38,493	40,748	41,440	239	13
4. Land use, land-use change and forestry	27,518	23,321	23,321	23,321	23,321	109,638	27,518	27,518	27,518	NE	NE	NE	NE	-100	-100
5. Waste	1,859	1,083	1,083	1,285	1,427	1,484	1,859	1,985	2,133	2,320	2,523	2,677	2,797	158	50
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NA	NA
Total (with LULUCF)	**76,952**	**38,817**	**38,817**	**40,698**	**43,900**	**134,770**	**76,952**	**79,031**	**81,309**	**56,449**	**59,672**	**62,033**	**63,322**	**63**	**-18**

CTF Table 7: Information on projections of greenhouse gas emissions and removals under a 'with measures' scenario

	Most recent year in the Party's national inventory report	*Projections of GHG emissions and removals*	
	(kt CO_2 eq)[c]	*(kt CO_2 eq)[c]*	
	2022	*2025*	*2030*
Sector[d]			
1. Energy	14,875	25,139	30,961
2. Industrial processes and product use	4,210	NE	NE
3. Agriculture	41,440	24,974	2,707
4. Land use, land-use change and forestry	NE	NE	NE
5. Waste	2,797	3,057	3,247
6. Other	NO	NE	NE
Other (specify)			
Indirect CO2			
Gas			
CO_2 emissions including net CO_2 from LULUCF	18,543	NE	NE
CO_2 emissions excluding net CO_2 from LULUCF	18,543	NE	NE
CH_4 emissions including CH_4 from LULUCF	38,868	NE	NE
CH_4 emissions excluding CH_4 from LULUCF	38,868	NE	NE
N_2O emissions including N_2O from LULUCF	5,664	NE	NE
N_2O emissions excluding N_2O from LULUCF	5,664	NE	NE
HFCs	248	NE	NE
PFCs	NO	NE	NE
SF_6	NO	NE	NE
NF_3	NO	NE	NE
Other (specify)	NO		
Unspecified mix of HFCs and PFCs	NO	NE	NE
Total with LULUCF	63,322	NE	NE
Total without LULUCF	63,322.44	NE	NE

CTF Table 08: Information on projections of greenhouse gas emissions and removals under a 'with additional measures' scenario

	Most recent year in the Party's national inventory report	Projections of GHG emissions and removals	
	(kt CO_2 eq)[c]	(kt CO_2 eq)[c]	
	2022	2025	2030
Sector[d]			
1. Energy	14,875	25,136	30,955
2. Industrial processes and product use	4,210	NE	NE
3. Agriculture	41,440	24,974	2,707
4. Land use, land-use change and forestry	NE	NE	NE
5. Waste	2,797	3,057	3,247
6. Other	NO	NE	NE
Other (specify)			
Indirect CO2			
Gas			
CO_2 emissions including net CO_2 from LULUCF	18,543	NE	NE
CO_2 emissions excluding net CO_2 from LULUCF	18,543	NE	NE
CH_4 emissions including CH_4 from LULUCF	38,868	NE	NE
CH_4 emissions excluding CH_4 from LULUCF	38,868	NE	NE
N_2O emissions including N_2O from LULUCF	5,664	NE	NE
N_2O emissions excluding N_2O from LULUCF	5,664	NE	NE
HFCs	248	NE	NE
PFCs	NO	NE	NE
SF_6	NO	NE	NE
NF_3	NO	NE	NE
Other (specify)	NO		
Unspecified mix of HFCs and PFCs	NO	NE	NE
Total with LULUCF	63,322	NE	NE
Total without LULUCF	63,322	NE	NE

CTF Table 09: Information on projections of greenhouse gas emissions and removals under a 'without measures' scenario

	Most recent year in the Party's national inventory report	*Projections of GHG emissions and removals*	
	(kt CO_2 eq)[c]	*(kt CO_2 eq)[c]*	
	2022	*2025*	*2030*
Sector[d]			
1. Energy	14,875	27,507	34,400
2. Industrial processes and product use	4,210	NE	NE
3. Agriculture	41,440	24,993	27,100
4. Land use, land-use change and forestry	NE	NE	NE
5. Waste	2,797	3,086	3,300
6. Other	NO	NE	NE
Other (specify)			
Indirect CO2			
Gas			
CO_2 emissions including net CO_2 from LULUCF	18,543	NE	NE
CO_2 emissions excluding net CO_2 from LULUCF	18,543	NE	NE
CH_4 emissions including CH_4 from LULUCF	38,868	NE	NE
CH_4 emissions excluding CH_4 from LULUCF	38,868	NE	NE
N_2O emissions including N_2O from LULUCF	5,664	NE	NE
N_2O emissions excluding N_2O from LULUCF	5,664	NE	NE
HFCs	248	NE	NE
PFCs	NO	NE	NE
SF_6	NO	NE	NE
NF_3	NO	NE	NE
Other (specify)	NO		
Unspecified mix of HFCs and PFCs	NO	NE	NE
Total with LULUCF	63,322	NE	NE
Total without LULUCF	63,322	NE	NE

CTF Table 10: Projections of key indicators

Key indicator(s) [c]	*Unit, as applicable*	*Most recent year in the Party's national inventory report, or the most recent year for which data are available*	*Projections of key indicators* [d]	
		2022	2025	2030
Total GHG emission reduction of the NDCs and non NDC measures	kt CO_2 equivalent	63,322	66,837	79,831

CTF Table 11: Key underlying assumption and parameters used for projection

Key underlying assumptions and parameters [c]	*Unit, as applicable*	*Most recent year in the Party's national inventory report, or the most recent year for which data are available*	*Projections of underlying assumption/parameters* [d]	
		2022	*2025*	*2030*
Population	Number	16,767,842	17,336,354	18,271,652

CTF Table 12: Information necessary to track progress on the implementation and achievement of the domestic policies and measures implemented to address the social and economic Consequences of response measures

NDC	Sectors and activities associated with the response measures	Social and economic consequences of the response measures	Challenges in and barriers to addressing the consequences	Actions to address the consequences
Building codes and enforcement/certification for new buildings and those undergoing a major renovation	The construction and urban development sectors are involved in implementing building codes and enforcement. Regulatory agencies ensure compliance with new standards for energy efficiency and sustainability in buildings undergoing renovation or new construction.	The construction and urban development sectors are involved in implementing building codes and enforcement. Regulatory agencies ensure compliance with new standards for energy efficiency and sustainability in buildings undergoing renovation or new construction.	High initial compliance costs, lack of awareness and expertise, and resistance from industry stakeholders can impede progress. Overcoming these barriers requires concerted efforts.	Providing subsidies or incentives, conducting awareness campaigns, and offering training programs can help. Developing partnerships with the private sector is also essential to foster a collaborative approach to green building practices.
Composting of biodegradable organic fraction of MSW supplemented with separation of organic waste (at source).	The waste management sector and agricultural sector benefit from composting initiatives. Activities include the separation of organic waste at the source and the composting process itself, which turns waste into valuable soil amendments.	The waste management sector and agricultural sector benefit from composting initiatives. Activities include the separation of organic waste at the source and the composting process itself, which turns waste into valuable soil amendments.	Public awareness and participation can be limited, and there are high initial setup costs. Operational challenges in waste segregation need to be addressed to ensure efficiency.	Public education campaigns, financial incentives for waste separation, and composting, along with partnerships with local communities and businesses, can enhance participation and effectiveness.
Implementation of National 3R strategy	The waste management, manufacturing, retail, and consumer sectors are key players. Activities include promoting waste reduction, encouraging the reuse of materials, and establishing robust recycling systems.	The waste management, manufacturing, retail, and consumer sectors are key players. Activities include promoting waste reduction, encouraging the reuse of materials, and establishing robust recycling systems.	Public resistance to changing habits, insufficient recycling infrastructure, and lack of market for recycled materials are major challenges.	Education and outreach programs can shift public perception. Investment in recycling infrastructure and development of market incentives for recycled products are crucial for

				overcoming these barriers.
Improvement of process performance of EE by the establishment of energy management in buildings/industries	The industrial sector, commercial buildings, and energy providers are involved. Activities focus on improving energy efficiency (EE) through advanced energy management systems and practices.	The industrial sector, commercial buildings, and energy providers are involved. Activities focus on improving energy efficiency (EE) through advanced energy management systems and practices.	High initial investments, lack of technical expertise, and resistance from industries are notable barriers. Addressing these requires strategic interventions.	Financial incentives, subsidies, training, and capacity-building initiatives can encourage adoption. Providing technical assistance programs can also help industries transition smoothly.
Increasing the effectiveness and sustainability of agricultural land management techniques (Conservation Agriculture)	The agricultural sector and rural development initiatives are key. Activities include adopting conservation agriculture practices that improve soil health and sustainability.	The agricultural sector and rural development initiatives are key. Activities include adopting conservation agriculture practices that improve soil health and sustainability.	Traditional farmers may resist change, and there is often a lack of knowledge and training. High initial costs for transitioning to new practices can also be a barrier.	Providing training and extension services, financial incentives for farmers, and supporting research and development of sustainable practices can facilitate adoption and overcome resistance.
New sanitary landfills with LFG extraction and LFG extraction at the Dangkor Landfill	The waste management and energy production sectors are involved. Activities focus on the development and operation of sanitary landfills equipped with landfill gas (LFG) extraction systems.	The waste management and energy production sectors are involved. Activities focus on the development and operation of sanitary landfills equipped with landfill gas (LFG) extraction systems.	High initial capital investment, technical challenges in gas extraction, and maintaining operational efficiency are significant barriers. Public acceptance and regulatory compliance also poses challenges.	Securing financial investments, providing technical training and support, and developing clear regulatory frameworks can address these challenges. Public awareness campaigns can also help gain community support.
Organic input agriculture and bio-slurry; and deep placement fertilizer technology	The agriculture sector is the primary focus, with activities including the use of organic inputs and bio-slurry from biogas production, and the adoption of deep placement fertilizer	The agriculture sector is the primary focus, with activities including the use of organic inputs and bio-slurry from biogas production, and the adoption of deep placement fertilizer	Challenges include the high initial costs of adopting new technologies, limited availability of organic inputs, and resistance	To address these challenges, it is crucial to provide financial incentives, subsidies, and training programs for farmers. Developing

	technology to enhance soil fertility and crop yield.	technology to enhance soil fertility and crop yield.	from farmers accustomed to traditional practices. There may also be a lack of awareness and technical knowledge about these methods.	robust supply chains for organic inputs and bio-slurry and conducting awareness campaigns to highlight the benefits of these practices can facilitate wider adoption.
Promote integrated public transport systems in main cities	The transportation and urban planning sectors are involved, focusing on developing and enhancing public transport infrastructure, such as buses, trains, and trams, in major cities to reduce traffic congestion and emissions.	The transportation and urban planning sectors are involved, focusing on developing and enhancing public transport infrastructure, such as buses, trains, and trams, in major cities to reduce traffic congestion and emissions.	Key challenges include high initial investment costs, coordination between various levels of government, and resistance from stakeholders invested in private transportation. Ensuring consistent service quality and maintaining infrastructure also present challenges.	Securing funding through public-private partnerships and government subsidies is crucial. Implementing strategic urban planning policies, enhancing coordination between government agencies, and conducting public awareness campaigns to promote the benefits of public transport can help overcome these barriers. Additionally, investing in modern, efficient public transport vehicles and infrastructure maintenance ensures long-term success.

Chapter 3:

Information related to climate change impacts and adaptation under Article 7 of the Paris Agreement

Under Paris Agreement

A. National Circumstances, Institutional Arrangements and Governance

(para. 106 of the MPGs)

1. National Circumstance

1.1. Country Snapshot

Cambodia, located in Southeast Asia, shares borders with Laos, Vietnam, and Thailand. The Mekong River feeds into the Tonle Sap Great Lake, providing the country with abundant aquatic resources and fertile land for agricultural production. The Tonle Sap is a vital natural resource, covering almost 10% of the nation's surface area during the peak of the Southwest Monsoon season and constituting the nation's primary protein source. Cambodia's topography includes the low-lying central plains of the Mekong, which are surrounded by mountainous and highland regions.

Cambodia is experiencing a rapid rate of urbanization (ADB, 2021). Despite significant progress, Cambodia remains one of the poorest countries in the region. In 2022, the Gross National Income (GNI) per capita was approximately US$1,700, making it the second lowest in Southeast Asia. This economic reality reflects ongoing challenges, including limited industrial diversification, rural poverty, and inadequate infrastructure. Additionally, while there have been improvements in areas such as education and healthcare, these advancements have not yet fully translated into substantial economic gains for a large portion of the population (ADB, 2024).

In 2019, approximately one-third of Cambodia's population lived on less than US$3.20 per day. Furthermore, 27% were moderately poor or at risk of falling back into poverty. This figure highlights the ongoing economic vulnerability faced by many Cambodians despite recent development efforts. The combination of low incomes and economic instability underscores the need for continued investment in social safety nets and inclusive economic policies to ensure sustainable development and poverty alleviation. However, the country has transformed from an agrarian economy into a market-driven economy led by industry and services which led to GDP growth of 7.6% between 1995 and 2019 (IMF, 2022) marking the significant progress to poise to graduate out of the United Nations' LDC category as early as 2027 and inspires in vision to upper middle-income country by 2030 and a high-income country in 2050.

While significant growth has been seen in the manufacturing and services sectors, agriculture remains a crucial part of Cambodia's economy. In 2019, agriculture contributed 22.02% of the GDP and employed 33.3% of the labor force. Despite its importance, the sector faces numerous challenges, including low productivity, competitiveness, diversification, and commercialization. Limited access to reliable agricultural inputs and financing hinders the adoption of mechanization and other modern agricultural technologies. Additionally, only 22% of the country's 4.5 million ha of arable land (including 3.2 million ha of cultivated rice area) are covered by 2,480 irrigation schemes (ADB, 2021a). Post-harvest handling and processing, including transportation, cold chain, storage, and processing facilities, as well as weak market accessibility and links, remain underdeveloped. These factors restrict the upscaling of agricultural production and require significant investment for improvement.

1.2. Climate Hazard

Cambodia has experienced multiple climate hazards and extreme events. Based on FAO report, floods have had significant negative impacts on infrastructure throughout floodplain areas, with annual losses from flooding estimated between US$100-170 million from 2010 to 2019. In addition, the severe droughts of 2018-2019 affected over 50,000 people and severely impacted almost 2 million ha of crops. Between 2000 and 2019, the country experienced numerous typhoons, resulting in the damage of nearly 30,000 homes and the destruction of 113,000 ha of crops.

According to the 2019 Inform Risk Index (**Table II 1**), Cambodia has a high risk of disaster, ranking 55 out of 191 countries, driven particularly by its exposure to flood hazard (World Bank, 2021). Cambodia has extremely high exposure to flooding (ranked joint 4th), including, riverine and flash flooding and has some limited exposure to tropical cyclones and their associated hazards and the country's drought exposure is slightly lower, but still is of significant concern, as highlighted by the severe drought of 2015–2017. Cambodia's overall ranking on the INFORM risk index is somewhat exacerbated by its lack of coping capacity and to a lesser extent by the vulnerability of the population. The section analyses climate change influences on the exposure component of climate risk in Cambodia.

Table III. 1: Select indicators from the INFORM 2019 Index for risk management in Cambodia

Flood (0-10)	Tropical cyclone (0-10	Drought (0-10)	Vulnerability (0-10)	Lack of coping capacity (0-10)	Overall informed Risk level (0-10)	Rank (1-191)
9.5 [4.5]	4.0 [1.7]	4.6[3.2]	3.9[3.6]	6.2 [4.5]	4.8 [3.8]	55

Source: (ADB, 2021)

Note: The global average scores are shown in the brackets. For sub-categories of risk (e.g. "flood"), higher scores reflect larger risks. Conversely, the most at-risk country is ranked first. The global average score is provided in brackets.

1.2.1. Drought

Drought is a naturally occurring phenomenon with a sluggish onset that starts slowly, builds up gradually, and sometimes has unnoticed impacts. Drought does affect life and property seriously, even though it doesn't happen as quickly as flooding. Drought can have varying consequences on communities based on their level of vulnerability. Frequent, severe, and lengthy droughts can have catastrophic cumulative effects (Hamid et al., 2023).

Two primary types of droughts may affect Cambodia are meteorological (usually associated with a precipitation deficit) and hydrological (usually associated with a deficit in surface and subsurface water flow, potentially originating in the region's wider river basins). Drought has a particularly negative effect on Cambodia's rural communities that depend on subsistence farming because of the correlation between reduced water availability and poorer productivity or yield—a result of both the lack of rainfall and the upstream damming of the Mekong River. In the whole country, large-scale artificial irrigation is not yet practical. At present Cambodia faces an annual median probability of severe meteorological drought of around 4% (WBG Climate Change Knowledge Portal (CCKP), 2021) as defined by a standardized precipitation evaporation index (SPEI) of less than −2. According to Naumann et al. (2018) provide a global overview of changes in drought conditions under different warming scenarios(Naumann et al., 2018). Projection for Southeast Asia indicate that there will be fewer droughts return periods. At lower global warming levels, this trend is less important, but as temperature hits 2-3°C, phenomena that currently only happen once every hundred years could return more frequently than once every fifty years. The chance of a drought in Cambodia between 2080 and 2099, as projected by the model ensemble under various emission trajectories, is displayed in **Figure II. 1**. Although there is still a great deal of uncertainty, every emissions pathway shows that the median annual probability will rise from 4% to 5-9%.

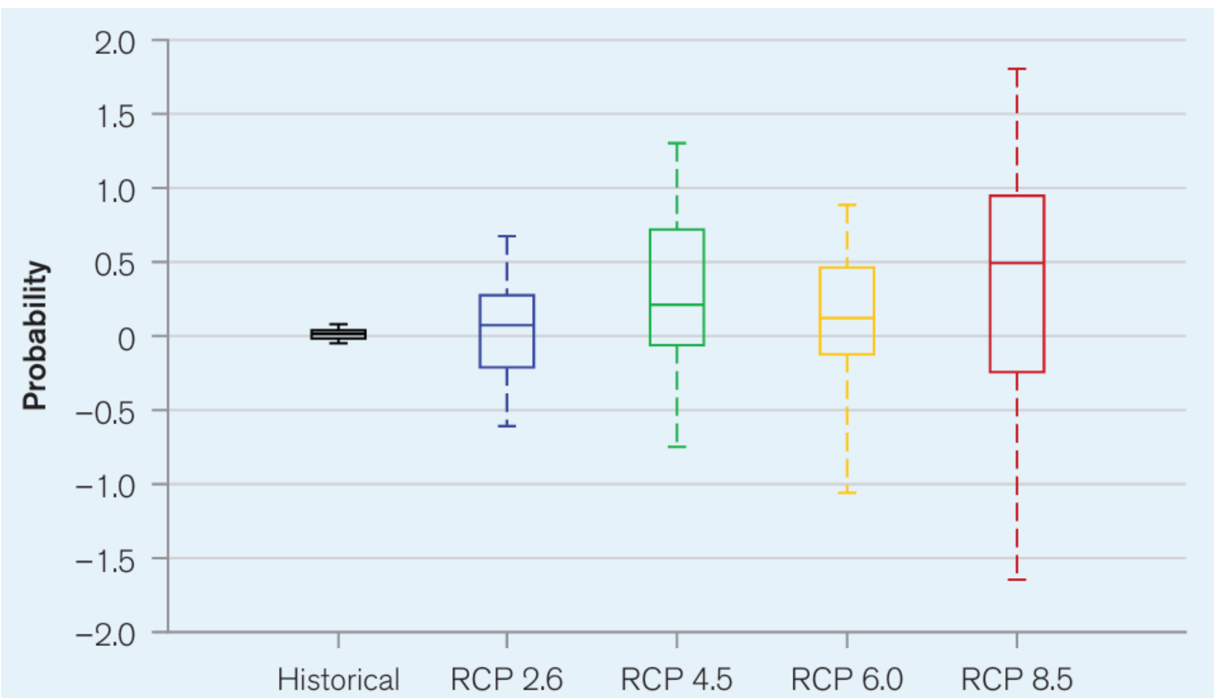


Figure III. 1: Boxplots showing the annual probability of experiencing a 'severe drought' in Cambodia (−2 SPEI Index) in 2080–2099 under four emissions pathways; Source: (WBG Climate Change Knowledge Portal (CCKP), 2021)

1.2.2. Flood

Flooding is a major hazard that threatens the country and has caused enormous deaths and destruction. The Mekong River, which originates in Laos and flows into central Cambodia's Great Tonlé Sap Lake, influences the level of flooding. A distinct kind of flooding is increasing in frequency due to upstream dam failures or unexpected water flows. The World Resources Institute's AQUEDUCT Global Flood Analyzer can be used to establish a baseline level of flood exposure, as of 2010 assuming protection for up to a 1 in 25-year event, the population annually affected by flooding in Cambodia is estimated at 90,000 people and expected annual urban damage is estimated at US$105 million. Economic development and climate change are both expected to increase these figures. Economic development and climate change are both expected to increase these projections can be expected to increase the annually affected population by 70,000 people, and urban damage by US$226 million under the RCP8.5 emissions pathway (AQUEDUCT Scenario B) in 2030 (WBG Climate Change Knowledge Portal (CCKP), 2021).

Almost all Asian countries will face more frequent extreme river flows even with reduced emissions routes that are compliant with the Paris Climate Agreement(Paltan et al., 2018). The fact is that, in most of South, Southeast, and East Asia, floods—which traditionally may have happened once every 100 years—may now happen once every five years or even once every 25 years. There is a strong correlation between the trend and the severity of precipitation according to this model. The increasing intensity of intense precipitation is correlated with the probability of surface flooding associated impacts include infrastructural damage in urban environments and landslide risk in rural areas. Around 4 million people, or 25% of the population, are affected when an extreme river flood strikes while another study conducted by the World Bank put the increase in the population exposed to flood by 2050 at 19% (Winsemius et al., 2015).

1.2.3. Heatwaves

Cambodia already experiences some of the highest temperatures in the world, with an estimated national average of 64 days per year when the maximum temperature exceeds 35°C. The current median probability of a heat wave (defined as a period of 3 or more days where the daily temperature is above the long-term 95th percentage of daily mean temperature) is around 3% (WBG Climate Change Knowledge Portal (CCKP), 2021). An increase in the frequency and intensity of heatwaves has been observed across recent decades that made a 29% contribution to the extreme temperatures experienced across Southeast Asia in April 2016, while ENSO contributed 49% (Thirumalai et al., 2017).

2. Institutional Arrangements and Governance

To ensure more efficient and effective work, especially in the context of climate change and sustainable development, the Royal Government of Cambodia (RGC) has established few units under umbrella with role and responsibility as following section:

2.1. National Council for Sustainable Development (NCSD)

In 2006, the RGC has established the National Climate Change Committee (NCCC) with a mandate to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans and programmes of the government. The NCCC was created as an inter-ministerial mechanism, cross-sectoral and multi-disciplinary in nature, to coordinate the tasks related to climate change and sustainable development response. In 2015, the RGC has established the National Council for Sustainable Development (NCSD). The Council is composed of high-level representatives (Secretaries and Under-Secretaries of State) of key government ministries and agencies, with the Prime Minister as its Honorary Chair and the Minister of Environment as its Chair. Council membership has increased covering a greater number of ministries and agencies, including provincial governors. The structure of the NCSD is illustrated in **Figure III. 2**.

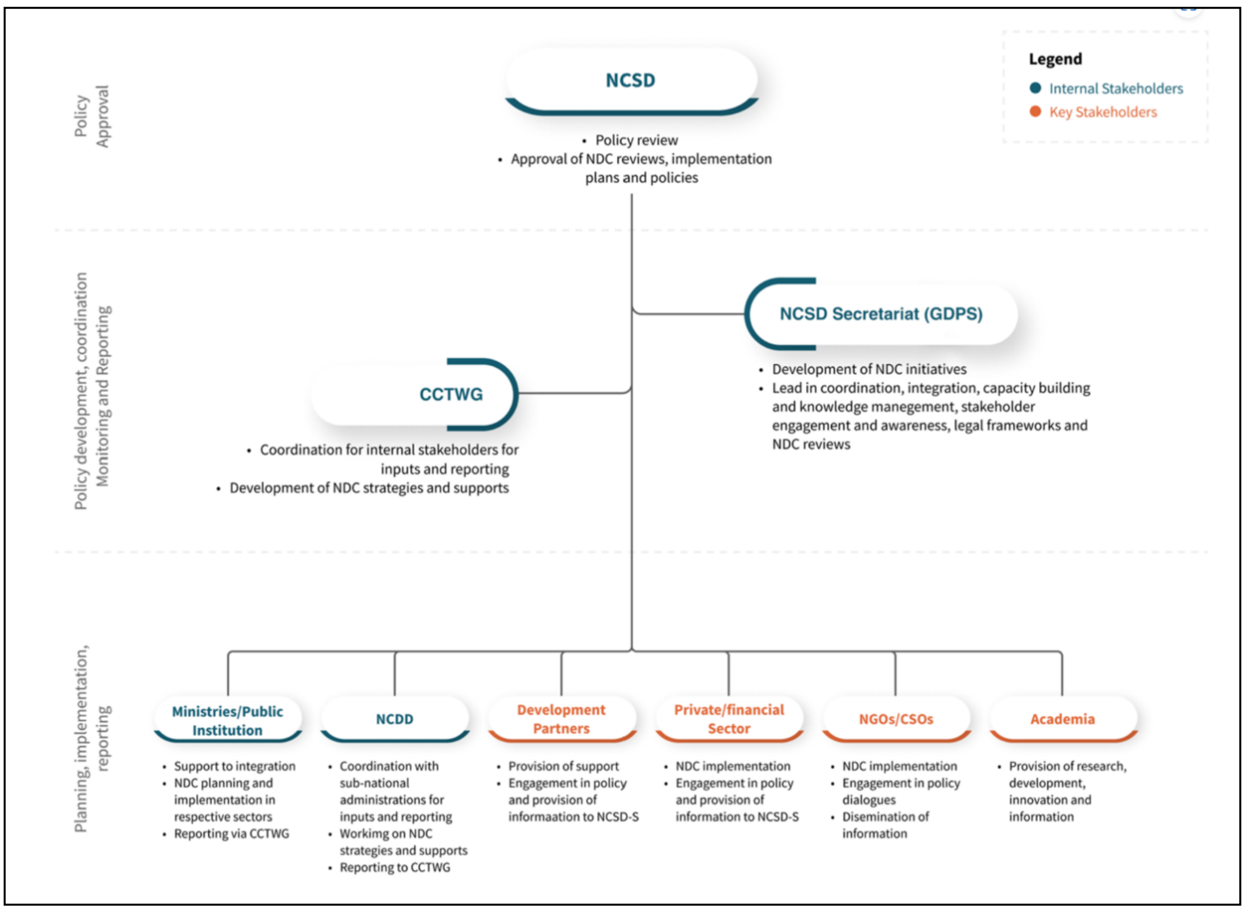


Figure III. 2: Climate change institutional arrangement in Cambodia

2.2. General Secretariat of the National Council for Sustainable Development (GSSD)

In 2003, the Cambodia Climate Change Office (CCCO) of the Ministry of Environment (MoE) was established to be responsible for wide-ranging climate change related activities, including climate change plans, policies, mitigate greenhouse gas (GHG) emissions, assessment of new technologies to adapt to the adverse effects of climate change and capacity building and awareness raising. In 2009, the RGC upgraded the status of the CCCO from office to Department of Climate Change (DCC) aiming to strengthening their climate change institutions. The DCC was subsequently included as one of the five Departments of the General Secretariat of the National Council for Sustainable Development in 2015. The DCC serves as secretariat of the CCTWG and convenes and coordinates the CCTWG to discuss key priority as following:

- Update and review of national institution indicators in the National Monitoring and Evaluation (M&E) Framework.
- Review of the Implementation of Cambodia's Climate Change Strategic Plan 2014-2023 (CCCSP), and
- Review Cambodia's Nationally Determined Contributions (NDC).

The NCSD plays important role to develop the national communications and Biennial Update Reports for submitting to UNFCCC. The NCSD provides the basis for institutional continuity at both the policy-making and technical levels, across a comprehensive range of government stakeholders.

2.3. Climate Change Technical Working Group

The NCSD has established a CCTWG which including representatives of the General Secretariat of the National Council for Sustainable Development (GSSD) and line ministries. The CCTWG is an integral part of the NCSD structure coordinated by the GSSD, and it facilitates the review, formulation, and implementation of policies, strategies, action plans, and programs to enhance climate change response and sustainable development related activities. The CCTWG's mandate and priority program is to support the NCSD for strengthening Cambodia's capacity to respond to climate change. The CCTWG is used to coordinate and facilitate the preparation and development of the BTR, BUR and other related reports to UNFCCC.

2.4. Institutional Arrangements for Compiling the GHG Inventory

The CCTWG has the overall responsibility for inventory preparation and plays important role for the inter-ministerial coordination needed for developing the national GHG emission inventory, especially for data gathering and validation purposes. The General Directorate of National

Protected Area (GDNPA), previously named The General Directorate of Administration for Nature Conservation and Protection (GDANCP) of the MoE in collaboration with the GSSD have developed the national greenhouse gas inventory in 2019. The institutional arrangement for the GHG inventory is illustrated in the **Figure III. 3** below.

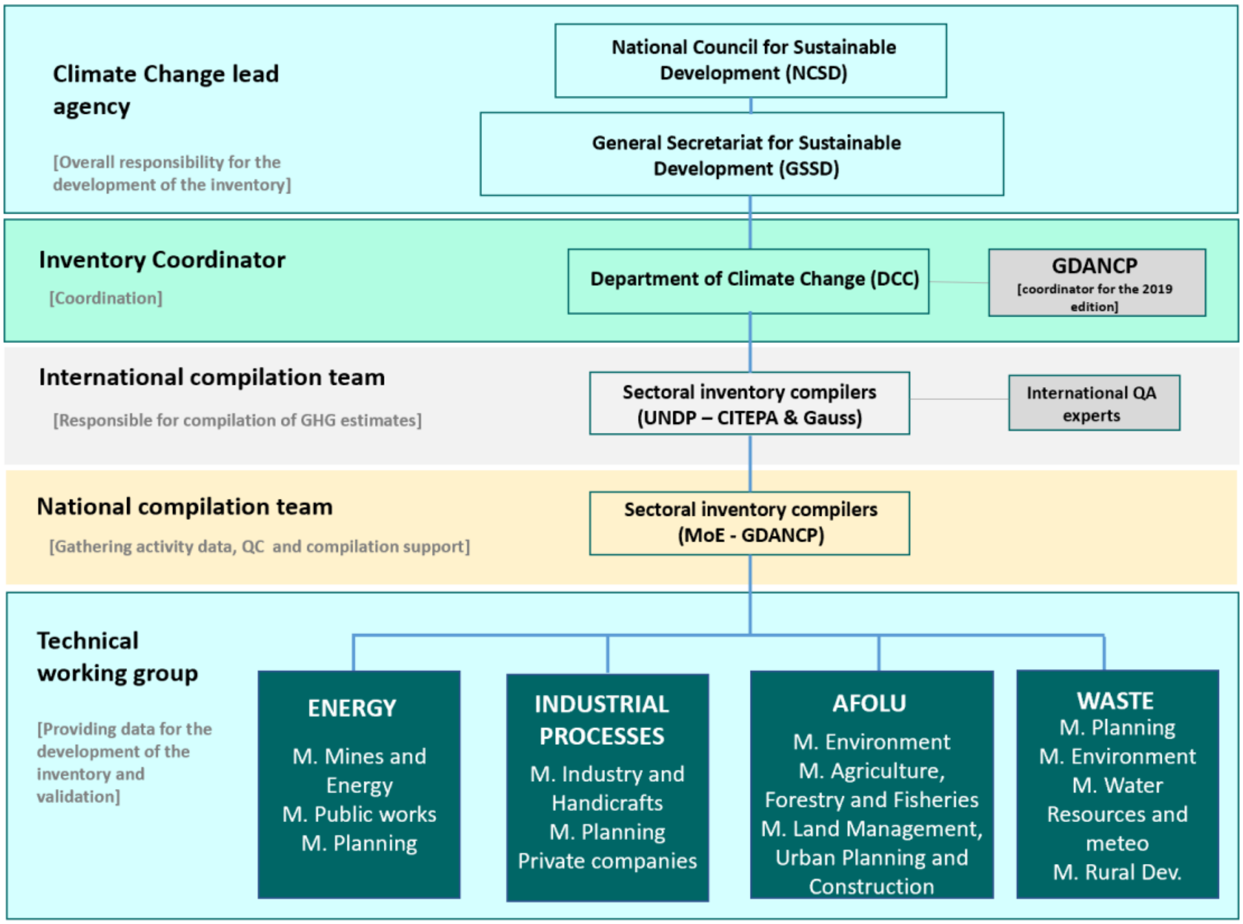


Figure III. 3: Institutional arrangement for the GHG inventory; Source: (MoE, 2020b)

The detailed roles and responsibilities for the inventory development include the following **Table II.2**.

Table III. 2: Roles and responsibilities for the development of the GHG inventory stakeholders

Role	Responsibility
Climate Change lead agency including NCSD and GSSD	Validate the results, supervision, and strategic oversight
Inventory coordinator including DCC and GDANCP	Coordinate and oversee the work of international and national consultants or experts
International compilation team including UNDP coordinator (CITEPA and Gauss) and international QA expert	Oversee the work of the international compilers and supports the coordination with the national inventory coordinator

International inventory compilers	Estimate the GHG emission inventory, perform quality control processes, write the inventory report, and provide capacity building to national compilers.
National inventory Compilers including MoE-GDANCP	Gathering activity data, supporting the compilation of GHG emissions estimates and perform quality checks in line with the quality assurance and quality control plan.
International QA experts	Carry out the quality assurance of the inventory, in line with the quality assurance and quality control plan.
Data providers	Provide the information available as needed for the development of the national GHG inventory.
Sectoral stakeholders	Carry out the quality assurance through consultation and validation workshops with relevant stakeholders.

Source: (MoE, 2020b)

2.5. Legal and Policy Frameworks and Relevant Regulation

2.5.1. Overarching Policy Structures

The RGC is committed to combating climate change and accelerating the transition to a climate-resilient, low-carbon sustainable mode of development. The MoE outlined several mechanisms and strategies that will support Cambodia's contribution to the prevention and reduction of climate change impacts addressed in the UN conference. During the 2023 United Nations Climate Change Conference or Conference of the Parties which known as COP28 of the UNFCCC and relevant summits, held in Dubai, the United Arab Emirates (UAE), from November 30 to December 12. COP28 was attended by the leaders of 196 countries, as well as prominent scientists, representatives of the UN, development partners, and civil society organizations, as well as observer countries and journalists. A total of almost 70,000 people took part. Cambodia and the other participating countries adopted a formal joint declaration on a sustainable food system, agricultural sustainability and resilience, and climate action. The joint proclamation is in line with the government's commitment to smart agriculture, reducing carbon emissions and sustainable development, to prevent and mitigate the effects of climate change more effectively. A further sign of Cambodia's new success on the international stage to strengthen and expand its excellent international relations and contribute to economic, social and political development. Cambodia is committed to seven key mechanisms and strategies, which were presented and discussed at COP28. They include the abolition of a 700MW coal-fired power plant project, which will be replaced with an LPG-powered one. Cambodia is also developing a new reservoir which will produce 1,000 megawatts of clean electricity before 2028. Through the MoE, the RGC intends to increase renewable energy, mostly through solar, hydropower and wind, to 70%. According to MoE 2023, Cambodia is also cleaning up through a plastic reduction campaign – which has already seen the participation of more than 3 million Cambodians and continues to grow – as well as the Green Cambodia strategy, which will plant at least one million new trees ach year, increasing forest cover by 60% by 2050. In addition, the MoE highlighted an end to the construction of coal-fired power plants in the country, along with the building of hydropower dams across the Mekong

River. Also, Cambodia's support and commitment to the Universal Declaration on Food Sustainability, Agriculture and Climate Change response activities, with a focus on priorities including improving the livelihoods of local communities, advocating for food security and nutritional well-being, expanding smart farming practices and low-carbon emissions strategies as key components of climate change adaptation and mitigation efforts.

As the effects of climate change increasingly challenge progress toward development goals, national-level frameworks that monitor and evaluate both adaptation and development are needed to allow developing countries to prioritize investment most effectively. The MoE is committed to combating climate change and accelerating the transition to a climate-resilient, low-carbon sustainable mode of development. The RGC has supported global efforts against climate change by being a Party to the UNFCCC since 1996. Cambodia adopted and ratified the Paris Agreement submitting an ambitious Intended NDC, showcasing progress in climate policy, and putting forward mitigation targets and adaptation actions consistent with national priorities. In 2015, Cambodia submitted its NDC to the UNFCCC, outlining its intended measures to mitigate greenhouse gas emissions, adapt to climate change, secure funding, and ensure reporting and assessment. Cambodia developed its NDC with the goal of reducing greenhouse gas emissions maximum of 27% by 2030 compared to the BAU level for the energy, industry, and waste sectors. Under the Land Use and Forestry sectors, Cambodia made a conditional commitment to increasing forest cover to 60% of the national land area by 2030, corresponding to the removal of 4.7tCO2eq./ha/year. The RGC has formulated and executed a variety of National Policies (describing its policy goals), Strategies (describing the necessary steps to achieve policy goals), and Action Plans (detailing the implementation of the strategies proposed). The Cambodia National Policy on Green Growth, the National Green Growth Strategy, National Strategic Development Plans, Sectoral Strategic Plans, the National Forest Program, and the National Environmental Strategy and Action Plan are meant to guide future development towards low-carbon and climate-resilient development and sustainable development. The Cambodia Climate Change Strategic Plan 2014-2023 has been developed in which 14 ministries and institutions have already produced sector-specific strategic plans and action plans that align with it. The country has made ambitious pledges in its NDC and adopted its LTS4CN that will see Cambodia be net-zero emissions by 2050. Delivering these commitments will require careful policy choices to mitigate transition risks and seize development opportunities. With its small size and reliance on trade and foreign direct investment (FDI), Cambodia is an open economy that will be greatly impacted by global changes in consumption and production patterns as well as the accelerated decarbonization of the global economy. This might present chances for export diversification, job creation, and growth with the correct policy decisions and a thriving private sector. In addition, there are several other sectoral policies and strategies, detailed action by actions, including the below:

- National Cooling Plan (draft)
- National REDD+ Strategy 2017 – 2021 (2017) and the National REDD+ Action and Investment Plan (2019) (**Figure III. 4**)

- National Energy Efficiency Policy (2022) (**Figure III. 5**)
- Strategic Planning Framework for Fisheries 2010 – 2019 (2010).

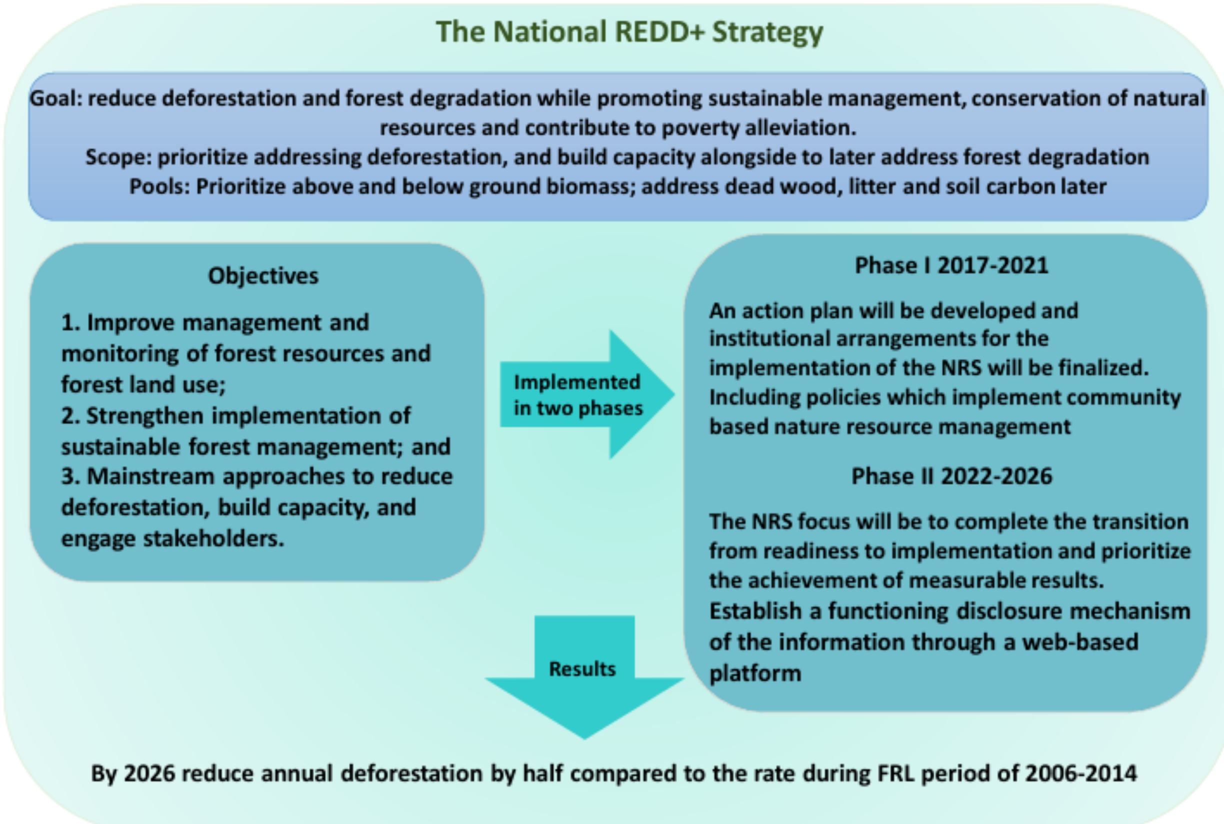


Figure III. 4: The Cambodian REDD+ Strategy; Source: (MoE, 2020a)

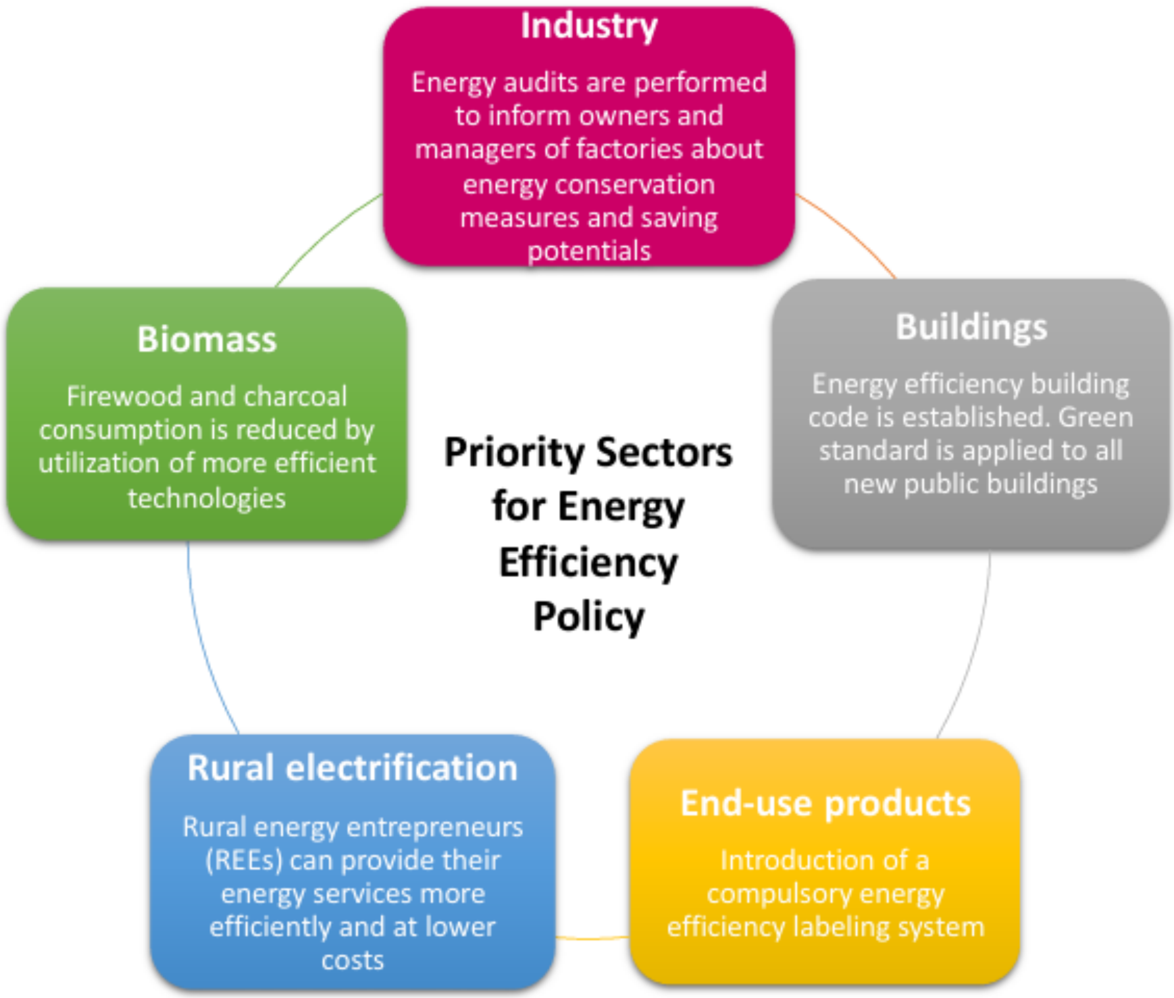


Figure III. 5: Priority sectors for energy efficiency policy; Source: (MoE, 2020a)

There are several key planning policies and strategies relevant to climate change adaptation and mitigation (**Table. II 3**). Cambodia is actively addressing the pressing issue of climate change through the implementation of strategic plans and highly committed activities. The section below provides an overview of the key planning documents policies and strategies relevant to climate change adaptation and mitigation.

Table III. 3: Key policies, strategic plan and frameworks on adaptation and mitigation

No.	Titles	Description: Relevance to climate action on adaptation and mitigation
1	Cambodian Sustainable Development Goals (SDGs) Framework 2016-2030	Cambodia SDGs have been developed, adapting the global SDGs to Cambodia's context by adding 'Goal 18 of Demining' and tailoring the indicators. Cambodia's SDG framework provides the overall direction for the achievement of the 17 global goals, and a breakdown into country-specific targets. Among further linkages to SDGs such as SDG2 (Zero Hunger) and SDG 15 (Life on Land), in particular "Cambodia sustainable development

		goal 13" Climate Action is relevant to Scaling Up Climate Ambition in Land Use and Agriculture (SCALA).
2	Rectangular Strategy IV	The rectangular strategy for growth, employment, equity and efficiency sets out an overall vision for the development of the country focused around four core elements. The plan is currently in its fourth phase. The priority area of the Rectangular Strategy IV is Inclusive and Sustainable Development, include 1) promotion of agriculture and rural development, 2) strengthening sustainable management of natural and cultural resources, 3) strengthening management of urbanization and 4) ensuring environment sustainability and readiness for climate change.
3	Pentagon Strategy, Phase 1	The strategy focuses on sustainable development. This strategy addresses the challenges and uncertainties of globalization, environmental sustainability, and climate change. The government pays particular attention to the promotion of the agricultural sector and rural development, including its linkage with the National Action Plan for Zero Hunger Challenge 2016-2025. While it continues similarly to "ensure environmental sustainability, and pre-emptive response to climate change" and "sustainable resource management of natural resources and culture" elements integrate with the government's key climate change policies.
4	Circular Strategy on Environment 2023-2028	The Strategy aims to turn the potential of the environmental sector into real benefits for the country and its people and promote the sustainable use of renewable energy in response to global climate change. The strategy serves as a roadmap, outlining priority actions to ensure environmental sustainability, integrity, climate change resilience, and the promotion of a green economy. Its goal is to realize the country's aspiration of transforming into a carbon-neutral country with 60% of forest cover by 2050.
5	National Strategic Development Plan 2019-2023	The National Strategic Development Plan (NSDP) 2019-2023 was developed and summarized the key achievements and challenges during the implementation of the National Strategic Development Plan 2014-2018, together with the macro-economic framework for NSDP 2019-2023. In addition, the NSDP outlines policies and priority actions for 2019-2023 that relevant ministry shall carry out, and presents estimated values, including expenses, resources and expenditure program. The NSDP also presents the framework for monitoring and evaluation for 2019-2023 phrase. The line ministries will be required to develop their sectoral development plans; and The NSDP outlines the roles of the MoE and NCSD to respond climate change, for instance promoting climate resilience and facilitate progress of building a society that release low carbon, develop and implement the NDC for the implementation of UNFCCC.

6	Cambodia's Updated Nationally Determined Contributions	The NDCs are a crucial component of Cambodia's climate action plan. It strengthens the country's aspirations towards a cleaner and greener economy and fulfils its obligations to better the lives of its citizens, particularly the most vulnerable people. These NDCs outline the country's commitments and goals in reducing greenhouse gas emissions, adapting to climate change impacts, and promoting sustainable development. Cambodia's NDCs are regularly updated to align with the evolving global climate agenda.
7	Code of Environment and Natural Resources	The Code provides a comprehensive framework for managing and protecting Cambodia's natural resources. This code emphasizes the importance of sustainable development and integrating climate change considerations into national policies and practices.
5	REDD+ National Strategy	The mission of the REDD+ Strategy is to strengthen the capacity of national and sub national institutions for effective implementation of policies, laws and regulations that will contribute to improved management of natural resources, forest lands, and biodiversity conservation. The goal of the strategy is to reduce deforestation and forest degradation, promote sustainable management and conservation, and contribute to poverty alleviation of local communities.
6	National Forest Programme	The overall National Forest Program Objective is "The forest resources provide optimum contribution to equitable macro-economic growth and poverty alleviation particularly in rural areas through conservation and sustainable forest management, with active participation of all stakeholders." Specifically, the Objective 2: Adapt to climate change and mitigate its effects on forest-based livelihood and the Objective 3: Macro land use planning that allows for holistic planning across sectors, jurisdictions and local government borders. The Objective 7: Ensure environmental protection and conservation of forest resources.
7	National Strategic Plan on Green Growth 2013-2030	Promote national economy with growth stability, reduction and prevention of environmental pollution, safe ecosystem, poverty reduction and promotion of public health service, educational quality, natural resources management and sustainable land use and water resources management to increase energy efficiency, ensuring food safety and glorify the national culture. The National Strategic Plan on Green Growth 2013-2030 (2013) was prepared to move Cambodia towards a green economy
8	Cambodia Climate Change Strategic Plan 2014 –2023	This is the first ever comprehensive national policy document responding to the climate change issues our nation facing. It builds synergies with existing government policies to ensure a strategic cohesion to address a wide range of climate change issues linked to adaptation, GHG mitigation, and low-carbon

		development. The vision is Cambodia towards a green, low carbon, climate resilient, equitable, sustainable and knowledge-based society. The mission is creating a national framework for engaging the public, the private sector, civil society organizations and development partners in a participatory process for responding to climate change to support sustainable development.
9	Cambodia's Climate Change Financing Framework (CCFF)	• Provides a first estimate of the economic case for the CC response in Cambodia (impacts of CC on economy / sectors) • Clarifies the contribution of each ministry to CC mitigation and adaptation and the resources currently used for this • Develops experience in identifying CC actions and mainstreaming • Climate Change into existing planning and budgeting systems. • Develops financing scenarios and defines more clearly the modalities that can be used for management of CC finance. • Identifies responsibilities of various agencies and related capacity development needs
10	National Strategic Plan on Green Growth 2013-2030	The RGC regards green growth as a win-win approach for sustainable economic growth moving towards a developed country in the future. to promote green growth, public health, quality of environment, people's livelihoods, and uphold of a national cultural identity
11	Climate Change Priorities Action Plans (CCPAPs)	15 ministries have prepared action plans aligned with CCCSP 2014-2023. Specifically, the MAFF climate change priorities action plan proposed priorities actions "promoting resilience in animal production and adaptation to climate change" and "Enhancing animal waste management and emission mitigation". At the same time, promoting reforestation and afforestation to increase carbon stock in the forestry sub sector. MAFF is updating its plan to design a CCPAP 2022-2030 with the support of SCALA
12	National Protected Area Strategic Management Plan (NPASMP) 2017-2031	The NPASMP is developed to guide the future planning and management of individual protected areas. Its mission is to achieve the most effective, efficient and equitable management of the national protected area system in the Royal Kingdom of Cambodia. One of the five goals is to strengthen protected area management effectiveness and working partnerships with government agencies, local authorities, conservation NGOs, and development partners.

13	Agricultural Strategic Development Plan (ASDP) 2019-2023	The ASDP has been established to reduce poverty, assure food security and safety through Cambodian agricultural modernization at faster speeds and with new scope approaches, to promote the development of agriculture and exportation of agricultural products, along with natural resource conservation in a sustainable manner. The vision for agriculture development is climate resilience. Cambodian agriculture must deal with natural disasters possible, with two main measures, 1) adaptation or resilience to climate change focusing on the production of seeds and crops which are adapted to the drought and flood, 2) mitigation of climate change impacts by enhancing activities related to the establishment of the planting system; climate tolerant livestock (modern farm system, water saving, heat and rain management). Cambodian agriculture will need to be developed in accordance with the principle of "green development", reducing environmental and socio-economic impacts, and maintaining a balance between "conservation" and "development".
14	National Adaptation Plan Financing Framework and Implementation Plan (2017) (NAPFFIP)	The main purpose of the NAPFFIP is to bring the National Adaptation Plan process in Cambodia closer to its execution and with a specific aim to increase the possibilities for Cambodia to access additional adaptation finance.
15	National Environment Strategy and Action Plan 2016-2023 (NESAP)	The NESAP is a roadmap for sustainable development in the Kingdom of Cambodia. It identifies priority policy tools and financing options for sustainable natural resource management and environmental protection. At the same time, the government has taken necessary measures to address and prevent natural resources degradation and ecological balance, which could affect the national ability to achieve sustainable development and the people's livelihoods, especially vulnerable groups such as women, children, elderly, indigenous minorities and disable people.
16	The National REDD+ Strategy 2017 – 2026	The National REDD+ Strategy 2017-2026 was also developed with a vision to contribute to national and global climate change mitigation through improving resources and forest land management and sustainable biodiversity conservation. The main mitigation instrument was developed. It provides a roadmap for the implementation of policies and measures addressing drivers of deforestation and forest degradation. It is an expression of the country´s continued commitment to sustainable forest resource management in an era of climate change.
17	The National Energy Efficiency Policy (2018-2035)	The policy was prepared in 2018 with two main goals: Improve the management and maintenance of existing infrastructure (e.g. buildings) and industrial processes (e.g. for the use of fuel wood) for increased energy efficiency and increase the transfer and

		adoption of energy-efficient technology (e.g. fuel-efficient vehicles and light bulbs) to reduce energy intensity. The policy is currently under review by the Office of the Council of Ministers.
18	Strategy on Environmentally Sustainable Transport Development (ESTD)	The ESTD was formulated to ensure stable economic growth and environmental sustainability.
19	Urban Transport Master Plan (UTMP)	The UTMP targeting 2035 to solve the current transport problems/issues and support the 2035 Urban Vision and Urban Structure, which will maintain the people-environment-friendly urban conditions and revitalize the urban activities in Phnom Penh City. Two important directions were included 1) to shift from a private-oriented urban transport system to a well-balanced system of public and private transport, and a combination of road, public transport and traffic management for improving the mobility of citizens; and 2) to materialize the urban potential of Phnom Penh City.
20	Waste Management Strategy and Action Plan 2018 - 2030	Its vision to Cambodia becomes clean and beautiful city and towns with improved public health, social security, and environmental quality by 2030.
21	The Agriculture Development Policy (ADP) 2022-2030	The ADP's ambition is 'to modernize the agriculture sector so it can become competitive, inclusive and resilient to climate change in a context of environmental sustainability', with the overall development goal being 'to increase agricultural growth with high competitiveness and inclusivity by providing high-quality products which result in food safety and nutrition, while taking into account sustainable management of land, water, forestry and fishery resources.'
22	Climate Change Priority Action Plan 2030 (CCPAP-2030) for Agriculture (draft)	The plan is considered a pathway to climate resilience in agriculture toward 2030. It aims to address key challenges and promote sustainable practices in agriculture to mitigate the impacts of climate change. The plan supports i) farmers in adopting sustainable techniques, such as agroforestry and precision agriculture, to mitigate the effects of climate change on crop yields and livestock production and ii) seeks to facilitate collaboration between farmers, researchers, development partners, private sectors and policymakers to ensure effective implementation and monitoring of climate interventions in the agricultural sector.

2.6. Stakeholder Roles and Responsibilities

The MoE was formalized as the country's focal point for the convention. In 2003 the Office of Climate Change was established within MoE with the following mandates: to promote climate change-related research, capacity-building, and awareness-raising; enhance cooperation with relevant organizations in implementing the climate change framework convention; and provide information to the government and assist them in preparing their position for the international negotiation. The MoE climate change strategic objectives, as reflected in the CCCSP, are to:

- Promote climate resilience through improving food, water and energy security,
- Reduce sectoral, regional, gender vulnerability and health risks to climate change impacts,
- Ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands, etc.), biodiversity, protected areas and cultural heritage sites,
- Promote low-carbon planning and technologies to support sustainable development,
- Improve capacity, knowledge and awareness for climate change responses,
- Promote adaptive social protection and participatory approaches in reducing loss and damage due to climate change,
- Strengthen institutions and coordination frameworks for national climate change responses and
- Strengthen collaboration and active participation in regional and global climate change processes.

In addition to fulfilling many other responsibilities, the NCSD serves as the UNFCCC's focal point. Coordination within the government, integration into planning and budgeting, capacity building, and general stakeholder involvement across all sectors have all benefited greatly from the work of the DCC/NCSD. To maintain balance in the social, cultural, environmental, and economic spheres within the Kingdom of Cambodia, the NCSD advocates for sustainable development. It also has a Secretariat (based at the Ministry of Environment) and an Executive Committee.

- **A General Secretariat** was established to support the operations of the NCSD and to coordinate the development of policies, strategic plans, action plans, and legal instruments concerning sustainable development, including the green economy, climate change, biodiversity conservation and biosafety, and science and technology.
- **The Department of Climate Change** is under the NCSD and has led technical efforts for climate change adaptation and mitigation response and reporting.
- **A Climate Change Technical Working Group** was established to facilitate and provide technical support to the NCSD in addressing climate change in the Kingdom of Cambodia. The TWG is key to governance and to ensure decision making and implementation by key line ministries.
- **Committees or Technical Working Groups** have been created in several line ministries to take on the coordination responsibilities for climate change actions within their respective sectors.

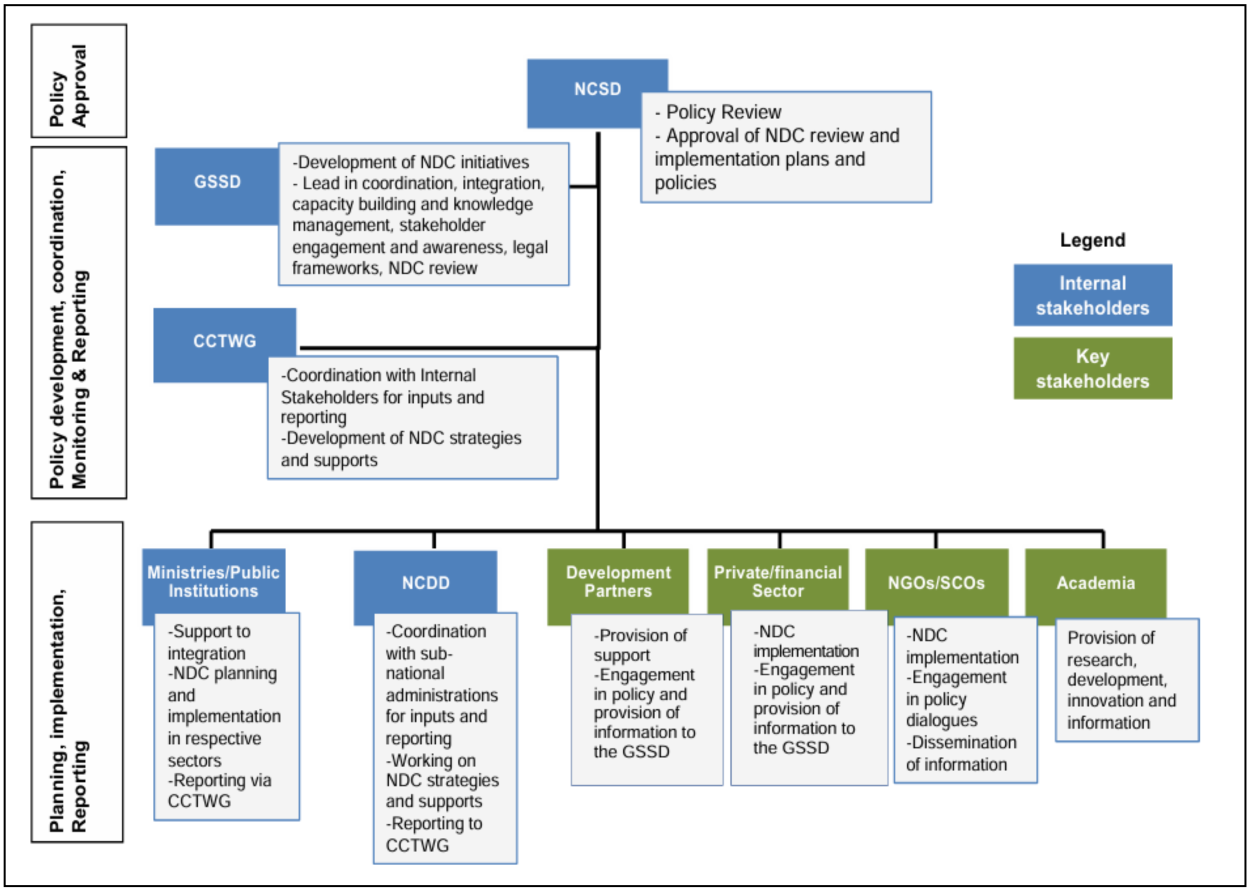


Figure III. 6: Stakeholder roles and responsibilities; Source: (MoE, 2019)

2.7. Priority Action Responses to Climate Change

Climate change policy in Cambodia has already advanced remarkably, particularly in terms of incorporating climate change into subnational and national planning. The Cambodian Government's coordinated strategy to tackle climate change is focused on adaptation, with a gradual increase in mitigation actions aligned with economic development goals. Cambodia has also made strong progress in developing and implementing monitoring and evaluation (M&E) frameworks, including for finance. The country has produced regular climate public expenditure reviews and improved climate finance tracking in her Official Development Assistance (ODA) database. The National M&E Framework for Climate Change Response has also been developed and future adaptation and mitigation efforts are anticipated to be supported by international donors and multilateral funds, as well as national contributions.

Cambodia prioritizes adjusting to the effects of climate change, both now and in the future. Cambodia is adamant that to be effective and to achieve national development goals, climate change adaptation measures must take an integrated, multi-sector approach. As a result, Cambodia has chosen many key initiatives, prioritizing those that have co-benefits related to mitigating the effects of climate change:

- Encouraging and enhancing communities' ability to adjust to climate change, particularly through community-based adaptation initiatives, and reestablishing the natural ecosystem system.
- Implementing management strategies to help protected areas adjust to climate change.
- Strengthening early warning systems and the distribution of climate information.
- Developing and rehabilitating the flood protection dike for agricultural and urban development.
- Expanding the use of permanent and mobile pumping stations to adapt to mini-droughts and encouraging groundwater research in response to climate risk and drought.
- Creating agricultural systems that are climate-proof so they can adjust to variations in water variability and increase crop yields.
- Enhancing climate-smart farming practices and constructing sea dikes to promote climate-resilient agriculture in coastal areas.
- Developing crop varieties that are adaptable to climate change and appropriate for Agro-ecological zones (AEZ).
- Promoting aquaculture production methods and practices that are adaptive to climate change.
- Repairing and renovating the current road infrastructure and ensuring it performs and is maintained effectively while considering the effects of climate change.
- Up scaling the Malaria Control Program toward pre-elimination status of malaria.
- Up-scaling of national programs to address the risk of acute respiratory infection, diarrheal disease, and cholera in disaster-prone areas. Including conducting surveillance and research on water-borne and food-borne diseases associated with climate change, and
- Strengthening technical and institutional capacity to conduct climate change impact assessments, climate change projections, and mainstreaming of climate change into sector and sub-sector development plans.

In additional, the RGC ratified the National Framework Convention on Climate Change in 1996 and, in 2013 undertook a high-level national policy dialogue on climate change, that led to the development of the Cambodia Climate Change Strategic Plan (CCCSP, 2014-2023) with 8 key objectives, namely:

- To promote climate resilience through improving food, water and energy security.
- To reduce sectoral, regional, gender vulnerability and health risks to climate change impacts.

- To ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands, etc.), biodiversity, protected areas and cultural heritage sites.
- To promote low-carbon planning and technologies to support sustainable development.
- To improve capacities, knowledge and awareness for climate change responses.
- To promote adaptive social protection and participatory approaches in reducing loss and damage due to climate change.
- To strengthen institutions and coordination frameworks for national climate change responses; and
- To strengthen collaboration and active participation in regional and global climate change processes.

The CCCSP sets out strategies and actions for different phases:

- **In the immediate term (2013-2014)**: establishing institutional and financial foundations for the CCCSP's implementation, creating frameworks and indicators for country M&E, and having line ministries create climate change action plans for the years 2014–2018
- **In the medium term (2013-2018)**: introduction of high-priority initiatives, accrediting the Adaptation Fund and Green Climate Fund, and concentrating first on adaptation and then gradually increasing mitigation measures
- **In the long term (2019-2023)**: Although research and education will be prioritized, scaling up successful initiatives and continuing to mainstream climate change into national and subnational programs will be the key goals.

A summary of the CCCSP's climate change-related plans and policies is given in **Table III. 4.**

Table III. 4: INDC planning and implementation processes and link to existing climate change strategies and plans

Priority actions	Existing climate change strategy and plan
Adaptation	
Promoting and improving the adaptive capacity of communities and restoring the natural ecology system to respond to climate change	Implementation of Climate Change Action Plan for Environment and Protected Areas (2014-2018)
Implementing measures of management and protection of areas to adapt to climate change	Implementation of Climate Change Action Plan for Environment and Protected Areas (2014-2018)
Strengthening climate information and early warning systems	Implementation of Climate Change Action Plan for Water Resources and Meteorology (2014-2018)
Developing and rehabilitating the flood protection dike for agricultural/urban development	Implementation of Climate Change Action Plan for Water Resources and Meteorology (2014-2018)

Increasing the use of mobile pumping stations and permanent stations in responding to mini-droughts, and promoting groundwater research in response to drought and climate risk	Implementation of Climate Change Action Plan for Water Resources and Meteorology (2014-2018)
Developing climate-proof tertiary-community irrigation to enhance the yields from agricultural production of paddy fields	Implementation of Climate Change Action Plan for Rural Development (2014-2018)
Promoting the climate resilience of agriculture through building sea dikes in coastal areas and scaling-up of climate-smart farming systems	Implementation of Climate Change Action Plan for Water Resources and Meteorology (2014-2018); and Climate Change Action Plan for Agriculture, Forestry and Fisheries (2014-2018)
Developing crop varieties suitable to Agro-Ecological Zones (AEZ) and resilient to climate change (include coastal zones)	Implementation of Climate Change Action Plan for Agriculture, Forestry and Fisheries (2014-2018)
Promoting aquaculture production systems and practices that are adaptive to climate change	Implementation of Climate Change Action Plan for Agriculture, Forestry and Fisheries (2014-2018)
Repairing and rehabilitating existing road infrastructure and ensuring effective operation and maintenance, considering climate change impacts	Implementation of Climate Change Action Plan for Public Works and Transport (2014-2018)

Source: (INDC, 2015)

2.8. Prioritized Adaptation Actions

The 2023–2028 RGC Pentagonal Strategy Phase 1, in contrast to the 2050 vision and 2030 milestones, delineates the fundamental initiatives that shall be executed over the subsequent five years to effectuate a transformation of Cambodia into a high-income economy by 2050. The strategy identifies five Key Priorities for this strategy, namely people, road, water, electricity, and technology which are clearly reflected in the Strategic Pentagons in the whole structure of the strategy "strategic approach," Under this Pentagonal strategy, the government pays particular attention to the promotion of the agricultural sector and rural development, including its linkage with the National Action Plan for Zero Hunger Challenge 2016-2025. While it continues similarly to “ensure environmental sustainability, and pre-emptive response to climate change” and “sustainable resource management of natural resources and culture” elements integrate with the government’s key climate change policies.

The approach is built upon the subsequent principles: Employment, Equity, Efficiency, and Sustainability. Building the Foundation Towards Realizing the Cambodia Vision 2050, which serves as the socio-economic policy agenda, through the operationalization of the following five strategic objectives to effectively implement the "Political Platform":

1. Ensuring crisis-resilient economic growth of around 7% per year on average.
2. Creating more jobs, both quantity and quality, for Cambodian people, especially for the youth.
3. Achieving the poverty reduction target of 10% and continuing to keep the poverty rate to a minimum level.
4. Continuing to strengthen governance capacity and improve the quality of public institutions, both national and sub-national, to ensure efficiency of public services, continue to strengthen private sector governance, and continue to promote a favorable environment for business, investment, and trade.
5. Ensuring sustainable socio-economic development and building resilience to climate change.

The National Policy and Strategic Plan on Green Growth 2013-2030 (MoE, 2013) formulated with key directions on green investment and green job creation, green economy development in balance with environment, green environment and natural resource management, and good governance on green growth. National Council of Green Growth and the General Secretariat of the NCGG are a mechanism for the preparation of policy, national strategic plan, programs and action plans on green growth to mobilize the resources including the national budget and the other sources including private sector and ODA. However, it is absent the amount of budget projected to achieve the long- term commitment of the policy.

The Circular Strategy on Environment is designed as a circle, with a core strategy in the center and three strategies on the outside. The central strategy revolves around three key angles: enhancing policy, establishing digital administration, and broadening extension. These three elements include being **CLEAN**, which has three angles: controlling pollution, modernizing pollution measurement systems, and improving environmental impact assessment. The second strategy: going **GREEN** has three angles: intensifying tree planting movement, ensuring sustainable management of protected areas, and enhancing local communities' livelihood. Lastly, the third strategy: being **SUSTAINABLE** has another three angles: applying compliance, expanding cooperation and strengthening coordination. Specific target for climate action and forest management:

- Distribute at least 1 million saplings per year to the public for free for tree planting.
- Develop a reforestation management plan in the deforested areas within the Protected Areas to reach 60% forest cover by 2050.

Cambodia Updated Nationally Determined Contribution (NDC) - Cambodia ratified the Paris Agreement 6 February 2017. The NDC was submitted to the UNFCCC, aimed to reduce emission by half in 2030 within the Forest Other Land Uses (FOLU) sector while increasingly ambitious to improve the climate resilience economy by 2030. The estimated emissions reduction with the FOLU by 2030 under the NDC scenario will be approximately 64.6 million tCO_2e/year (41.7% reduction of which 59.1% is from the FOLU) (MoE, 2020a). In addition to that 86 Adaptation actions were submitted from line ministries consisted of 17 actions within agriculture, 02 in coastal areas, 02 actions in energy, 05 actions in human health, 01 action in industry, 07 actions in infrastructure including roads, buildings and urban land use planning, 07 actions in livelihood, poverty and biodiversity, 03 actions in tourism and 06 in water resource management. The demand of finance is remaining high which will be relying on national and international funding support of which over US$ 5.8 billion is required for all mitigation and US$2 billion to improve national resilience through multiple climate adaptation prioritized actions. Amongst the proposed budget, there is a highest projection cost for improving national resilience infrastructure, agriculture and water resources management.

Long-Term Strategy for Carbon Neutrality (LTS4CN) - Cambodia has also increased its ambitious toward to Carbon Neutrality by 2050. To achieve such a high target, the Forest and Other Land Uses (FOLU) sector has not only been considered as one of the sectors that completely stop the emission but also accelerate to sequester more Carbon dioxide. The FOLU sector is projected to sequester 50 megatons of carbon dioxide equivalent ($MtCO_2e$) by 2050 as such, Cambodia must completely stop deforestation by 2045. On the other hand, 1.6 million ha of the areas must be restored, promote agroforestry, enforce sustainable forest management and fully implement the REDD+ Action Investment Plan. The LTS4CN is projected to the direct economic benefits from LTS4CN actions would deliver 157,000 jobs by 2050 and generate 449,000 jobs in 2050 when jobs from wider mitigation and adaptation benefits are added which are 145% more than routine investment. The strategy is expected to grow more than US$11 billions of net benefit in 2050 which is accounting for 7.5% of the projected GDP. It is also projected about US$ 5 billion benefit for the public private sector investment and further around US$ 1 billion in adaptation co-benefit. National REDD+ Action Investment Plan - Cambodia is a signatory to the UNFCCC and has been engaged into REDD+ negotiations from the onset. The objective of REDD+ is to incentivize developing countries to reduce emissions from deforestation & forest degradation, and foster the conservation, sustainable management of forests and enhancement of forest carbon stocks. Conservation of remaining natural forests and enhancement of forest carbon stocks. The transformation effects arose from REDD+ AIP is to 1) Enhancement of sustainable local livelihoods through communities' empowerment; 2) REDD+ implementation through inter-sectoral coordination and stakeholders' engagement at national and subnational levels. The NRS and its AIP are closely built on the PFSP, the NPASMP and the SPFCM, ensuring essential synergies and addressing gaps. Implementation of the AIP is expected to lead to full implementation of the NPASMP and the PFSP, and to contribute significantly to the implementation of the SPFCM. To achieve this, the investment plan project cost around US$154 million which mainly depend on the national budget allocation, private and the international funding, which is date, only three REDD+ projects are under implementation, and one is under the pipeline. The project contributed to reducing more than 20 $MtCO_2e$ from 2013-2017 (RTS, 2021). Cambodia's Climate Change Strategic Plan (CCCSP) 2014-2023 – Coordinated by the Ministry of Environment, The CCCSP was formulated to address the various dimensions of climate impacts acting across the country in an integrated and strategic way. The strategy was designed around three phases of implementation, commencing in 2013 (MoE, 2013).

Table III. 5: Climate change prioritized actions in CCCSP

Immediate Term (2013-2014)	Medium term (2014-2018)	Long-term goal (2019-2023)
Institutional and financial development of climate change action plans (CCAP) by line ministries (in the case of MAFF it is called the CCPAP) and development	Implementation of the strategic arrangements in Phase 1 which focus areas: • Adaptation, • Knowledge management, • Mainstreaming climate change (both mitigation and adaption) across the sectors at different levels, • Operationalization of M&E systems • Launching climate prioritized actions across the climate strategic framework, and associated Climate Change Action Plans developed by line ministries, and, • Expansion of accreditation of the Green Climate Fund (GCF).	Focus on research, learning and scaling-up success to national and sub-national programmes to meet its 8 strategic objectives • Promote climate resilience through improving food, water, and energy security. • Reduce sectoral, regional, gender vulnerability and health risks to climate change impacts. • Ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands, etc.), biodiversity, protected areas, and cultural heritage sites. • Promote low-carbon planning and technologies to

		support sustainable development. • Improve capacities, knowledge, and awareness for climate change responses. • Promote adaptive social protection and participatory approaches in reducing loss and damage due to climate change. • Strengthen institutions and coordination frameworks for national climate change responses; and • Strengthen collaboration and active participation in regional and global climate change processes.

Interactions at the sectoral level: relevant line ministries developed Climate Change Strategic Plans under the framework of the CCCSP. Climate Change Action Plans (CCAPs) were then developed to operationalize these strategies. The climate data shows that 15 ministries have developed their CCAPs. Within these a total of 171 climate actions are identified - 7% of them mitigation-oriented and 93% with an adaptation focus. However, only a handful of the action plans have been allocated resources and have managed to be implemented. 148 actions identified in the CCAPs have not been implemented and remain largely unfunded (NCSD, 2017)

The National Adaptation Plan (NAP) process focuses on strengthening and improving the integration of existing climate strategies, approaches and practices. Following on from the NAPA, which highlighted and attempted to address immediate climate-related issues in the short-term, the NAP aims to reduce climate vulnerability and build adaptive resilience in the medium- to long-term. Actions identified under line-ministries' CCAPs, Cambodia's Initial and Second National

Communication and NDCs are key inputs to the NAP (NCSD, 2017). Suggested actions for NAP in agriculture, forestry, and fisheries (from the NAP Stocktaking Report, 2015) include:

- Land-use modeling and vulnerability mapping for important agricultural production (e.g., rubber, livestock, forestry and fisheries)
- Capacity building
- Scaling up resilient farming systems and community resilience
- Promote marginalized groups and women participation to climate change adaptation and mitigation strategy
- Enhance knowledge management related to climate change adaptation and promote innovation that is needs-based.
- Creating sample 'climate smart' villages.

Table III.6 summarizes the proposed adaptation actions subdivided by sectors and the corresponding lead ministry.

Table III. 6: Priority adaptation actions

No	Adaptation action	Sector / Subsector	Ministry/ Institutions
1	Towards an Agroecological transition in the uplands of Battambang	Agriculture	**NCDD**
2	Development of Rice crops for increased production, improved quality safety; harvesting and post-harvesting technique and Agro-business enhancement	Agriculture	**MAFF**
3	Development of Horticulture and other food crops for increased production, improved quality-safety; harvesting, and post-harvest technique and Agro-business enhancement	Agriculture	**MAFF**
4	Development of Industry crops for increase in production, improved quality-safety; harvesting and post-harvesting technique and Agro-business enhancement	Agriculture	**MAFF**
5	Improvement of support services and capacity building to crop production resilient to climate change by promoting research, trials, and up-scaling climate-smart farming systems that increase resilience to CC and extreme weather events	Agriculture	**MAFF**
6	Building climate change resilience on cassava production and processing	Agriculture	**MAFF**
7	Research for the development and enhancement of agricultural productivity, quality, and transfer through strengthening of crop variety conservation and new crop variety release responding to the impacts of climate change	Agriculture	**MAFF**

8	Development of new technologies and increased yields by using new crop varieties which adapt to climate change	Agriculture	**MAFF**
9	Development of rubber clone varieties suitable for AEZ and resilient to climate change	Agriculture	**MAFF**
10	Enhancing institutional and capacity development on climate change impact, vulnerability assessment, adaption measures and mitigation related to rubber sector	Agriculture	**MAFF**
11	Improvement of animal breeding technology in Cambodia through AI which can adapt to climate change	Agriculture	**MAFF**
12	Promotion of research capacities on animal genetics, animal breeding and animal feed is strengthened to adapt to climate change	Agriculture	**MAFF**
13	Strengthening capacities for risk prevention and reduction, effective emergency preparedness and response at all levels; enhancing livestock and disease-related early warning systems, and integrating disaster risk reduction and climate change adaptation measures into recovery and rehabilitation initiatives in the livestock sector	Agriculture	**MAFF**
14	Promoting aquaculture production systems and practices that are more adaptive to climate change	Agriculture	**MAFF**
15	Promoting climate resilience in the capture fisheries sector	Agriculture	**MAFF**
16	Scaled up climate-resilient agricultural production through increased access to solar irrigation systems and other climate-resilient practices	Agriculture	**NCDD**
17	Developing a training manual and providing training on approaches for the development of climate-smart and sustainable livelihood for rural poor people	Agriculture	**MRD**
18	Protection, risk mitigation, and resilience building from marine pollution particularly caused by activities on land including marine pollution from waste and aquaculture activities.	Coastal zones	**MoE**
19	Effective management and protection of ecological systems of marine and coastal zones to avoid adverse impacts from various factors, build their resilience, and restore their functions for productive and healthy oceans	Coastal zones	**MoE**
20	Conduct climate risk analysis for the existing electricity infrastructures and provide recommendations	Energy	**MME**

21	Climate-proofing existing and future solar/hydropower infrastructure	Energy	**MME**
22	Enable effective decision-making for health interventions through the generation of information and improved surveillance or early-warning systems	Human health	**MOH**
23	Enhance climate resilience in health service delivery	Human health	**MOH**
24	Strengthen and provide capacity building of technical guidelines for diagnosis, detection, control, prevention, and treatment of vector-borne and water-borne diseases, injuries and other food poisoning illnesses arising from climate change	Human health	**MOH**
25	Conduct water sanitation and hygiene (WASH) assessments on climate change and develop planning for communities and health facilities.	Human health	**MOH**
26	Strengthen institutional capacities to effectively integrate climate risks and adaptation options in health sector planning and implementation	Human health	**MOH**
27	Heat stress adaptation for industrial production	Industry	**MISTI**
28	Integrating climate change response measures into the construction design for buildings and for rural housing (use of modern integration of technology)	Infrastructure Buildings	**MLMUPC**
29	Develop resilient infrastructure of school buildings in response to climate change	Infrastructure Buildings	**MOEYS**
30	Implement climate change and disaster resilient construction and infrastructure standards including for public sector and community-focused buildings covering public health, education, WASH, etc.	Infrastructure Buildings	**NCDM**
31	• Prepare spatial planning (city/district/municipality) guidelines at all levels for climate change adaptation • Integrating climate change response measures to the commune land use planning	Infrastructure Land use planning	**MLMUPC**
32	Integrating climate change response measures to the policy of social land concession (SLC) and its procedures	Infrastructure Land use planning	**MLMUPC**
33	Prepare modality of standardized green spaces for urban planning or new sub-cities to address the vulnerability of urbanization.	Infrastructure Land use planning	**MLMUPC**

34	Vulnerability assessment towards the development of climate change strategic plans to respond to the impacts on land, housings, coastal management, and building due to climate change	Infrastructure Land use planning	**MLMUPC**
35	Promote the land use Planning Tools for urban houses and building construction adaptive to climate change benefits the low-income and homeless people	Infrastructure Land use planning	**MLMUPC**
36	Promote proper low-cost shelters for low-income households resilient to climate change, practically around social land concession	Infrastructure Land use planning	**MLMUPC**
37	Development of building code with mainstreaming climate change into building designs	Infrastructure Land use planning	**MLMUPC**
38	Mainstream climate change response measures for coastal development planning against seawater intrusion, seawater rise and seasonal storm destruction, and rising temperature	Infrastructure Land use planning	**MLMUPC**
39	Strengthening Climate Resilient Cities	Infrastructure Land use planning	**NCDD**
40	Develop national road construction and maintenance design standards for national and provincial roads, considering climate change impacts, including developing an M&E framework for climate-proofing and low-carbon technology roads	Infrastructure Roads	**MPWT**
41	Repair and rehabilitate existing road infrastructure and ensure effective operation and maintenance systems, considering climate change impact	Infrastructure Roads	**MPWT**
42	Rural road rehabilitation and improvement for climate change resilience	Infrastructure Roads	**MRD**
43	Develop and annually update national and subnational multi-hazard and climate risk assessments, including the identification of the most vulnerable communities	Livelihoods, poverty and biodiversity	**NCDM**
44	National end-to-end early warning systems with focus on effective dissemination to populations at risk	Livelihoods, poverty and biodiversity	**NCDM**
45	Implement community–based disaster and climate risk management programs	Livelihoods, Poverty and biodiversity	**NCDM**
46	Building resilience of biodiversity conservation and restoration to adapt to climate change	Livelihoods, poverty and biodiversity	**MoE**

47	Integrated village development	Livelihoods, Poverty and biodiversity	**MRD**
48	Strengthen flood resiliency capacity of communities around Lake Tonle Sap (access to clean water, off-grid renewable energy and waste management)	Livelihoods, poverty and biodiversity	**NCDD**
49	Building climate-resilient livelihood and public infrastructures in social land concession for vulnerable communities	Livelihoods, Poverty and biodiversity	**NCDD**
50	Provide capacity building and support for climate change innovation at the provincial along the Tonle Sap River	Tourism	**MOT**
51	Raising public awareness of climate change innovation at all levels	Tourism	**MOT**
52	Practicing smart agriculture in the tourism sector	Tourism	**MOT**
53	Establish an automated nation-wide hydro met monitoring network and data transmission program, including the collection of climate and hydrological data	Water resources	**MOWRAM**
54	Establish a centralized and standardized approach to climate-resilient water management	Water resources	**MOWRAM**
55	Establish a national climate and flood warning system, including a service center and flood emergency response plans	Water resources	**MOWRAM**
56	Integrated Groundwater Management in Cambodia	Water resources	**NCDD**
57	Establish nationally standardized best-practice systems for irrigation	Water resources	**MOWRAM**
58	**Resilient and Adaptive rural water supply and sanitation construction**	**Water resources**	**MRD**

Source:(MoE, 2020a)

B. Impacts, Risks, and Vulnerabilities

(para. 107 of the MPGs)

3. Climate Observation and Trends

Cambodia’s tropical monsoon climate with high temperatures is characterized by a rainy season and a dry season and influenced by El Niño Southern Oscillation (ENSO) and La Niña. The rainy season lasts from May-October with south-westerly winds ushering in clouds and moisture that account for anywhere between 80%–90% of the country’s annual precipitation, and a dry season lasts from November, is associated with the northeast Monsoon, which brings cooler air from

November to March, and then hotter air in April and early May. There is little seasonal temperature variation.

According to the most recent climatology, 1991–2020, Cambodia has a tropical climate with high temperatures and two distinct seasons: the rainy season, driven by the monsoon, lasts from May to October. During this time, clouds and moisture are brought in by south-westerly winds, and this season accounts for 80% to 90% of the country's annual precipitation. The dry season (November–April) with cooler temperatures, especially between November and January (World Bank, 2021). Average temperatures are relatively uniform across the country with the highest temperatures occurring in the early summer, just before the start of the rainy season, when highs frequently reach 32°C and remain between 25°C–27°C throughout the rest of the year. The wet season arrives with the summer monsoon which extends from May through November and brings the heaviest rain to the northwest and southeast with annual average rainfall is typically 1,400–2,000 mm with higher rates in the coastal and highland areas and lower rates in another inland region (**Figure III.7**). The El Niño Southern Oscillation affects the region's monsoon patterns, causing interannual fluctuations in the climate. Southeast Asia often experiences higher and drier winter temperatures during El Nino occurrences, whereas La Niña episodes bring lower temperatures than usual. The observed spatial variation for temperature and precipitation across Cambodia show in **Figure III.8**.

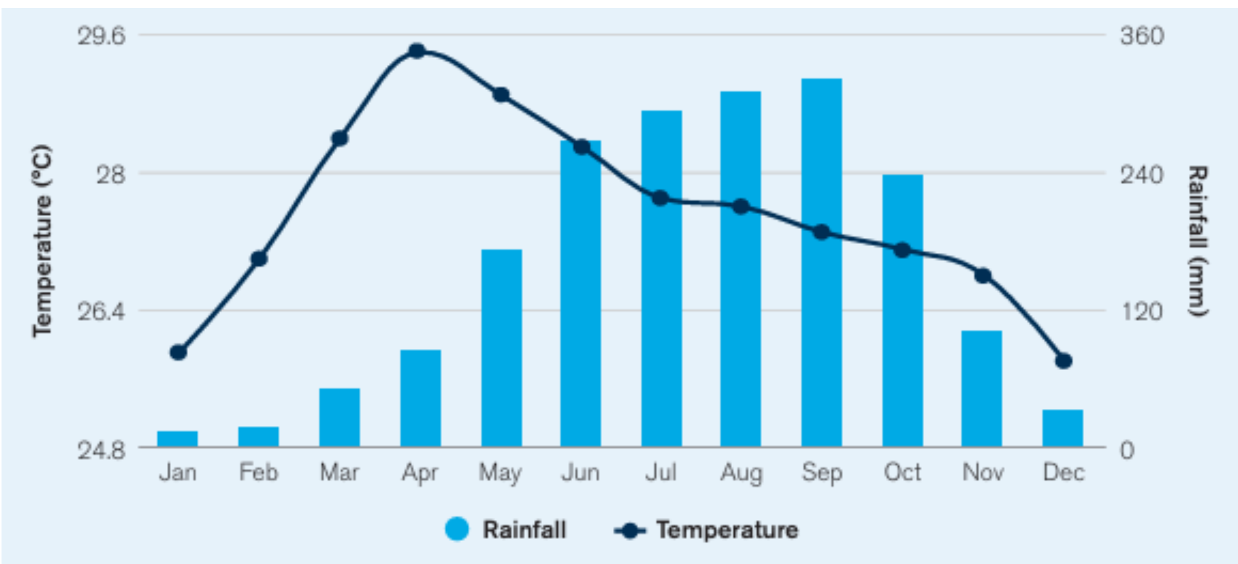


Figure III. 7: Average monthly temperature and rainfall in Cambodia (1991–2020); Source: (WBG Climate Change Knowledge Portal (CCKP), 2021)

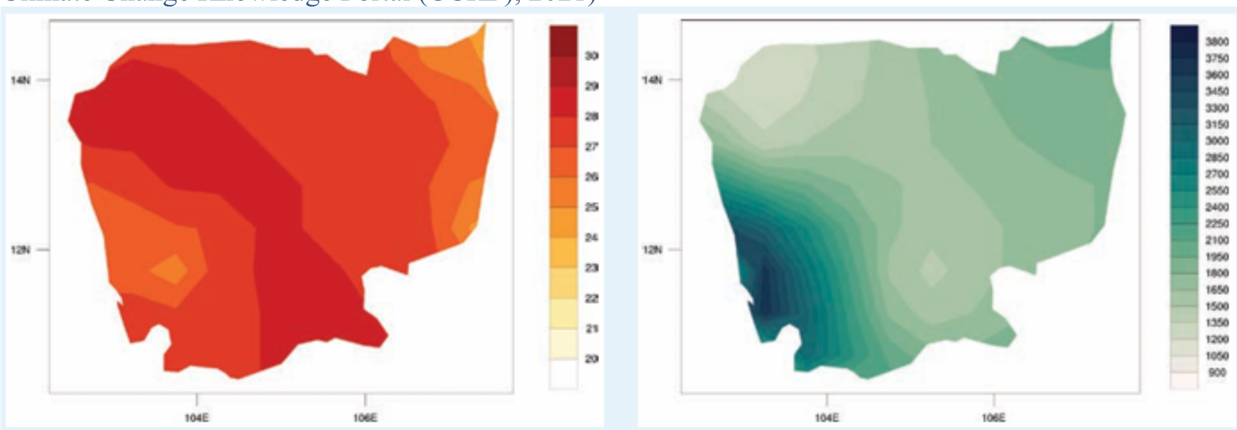


Figure III. 8: Annual mean temperature (°C) (left), and annual mean rainfall (mm) (right) in Cambodia over the period 1991–2020; Source: (WBG Climate Change Knowledge Portal (CCKP), 2021)

3.1.1. Temperature

In the year period of 1971-2020, Cambodia's average mean temperature increased by 0.29°C per decade, while average maximum temperatures increased 0.32°C per decade over the same period. The northeastern province of Ratanakiri recorded the highest annual average mean temperature increase per decade (0.33°C). The northeastern province of Mondulkiri recorded the highest average minimum temperature increase per decade (0.35°C). The north central plains (Banteay Meanchey, Battambang, Kampong Thom, Kampong Chhnang) recorded the highest maximum temperature increases per decade (0.35°C). By comparison, the lowest significant temperature increases over this period occurred along the southwest coast and northwest plains. Kep (southwest coast) observed a 0.21°C mean increase per decade and 0.22°C maximum increase per decade, while Otdar Meanchey (northwest plains) observed a 0.22°C minimum increase per decade. Winter months exhibited the greatest seasonal mean, minimum, and maximum increases in temperature per decade, with changes approaching or exceeding 0.40°C in central and eastern provinces. During winter months, Battambang (northwest) recorded an average mean temperature increase of 0.42°C per decade, followed by Kampong Cham and Phnom Penh (central plains, 0.41°C and 0.40°C per decade, respectively)(World Bank, 2024). During winter months, Battambang also recorded an average maximum temperature increase of 0.39°C per decade. Tboung Khmum recorded a minimum temperature increase of 0.44°C per decade during winter months. Observed number of tropical nights (T-min >20°C) from 1971–2020 significantly increased 6.06 nights per decade nationally (World Bank, 2024). The number of 'hot days' in the country has increased over the last century, by as much as 46 days per year(ADB, 2021b; WBG Climate Change Knowledge Portal (CCKP), 2021).

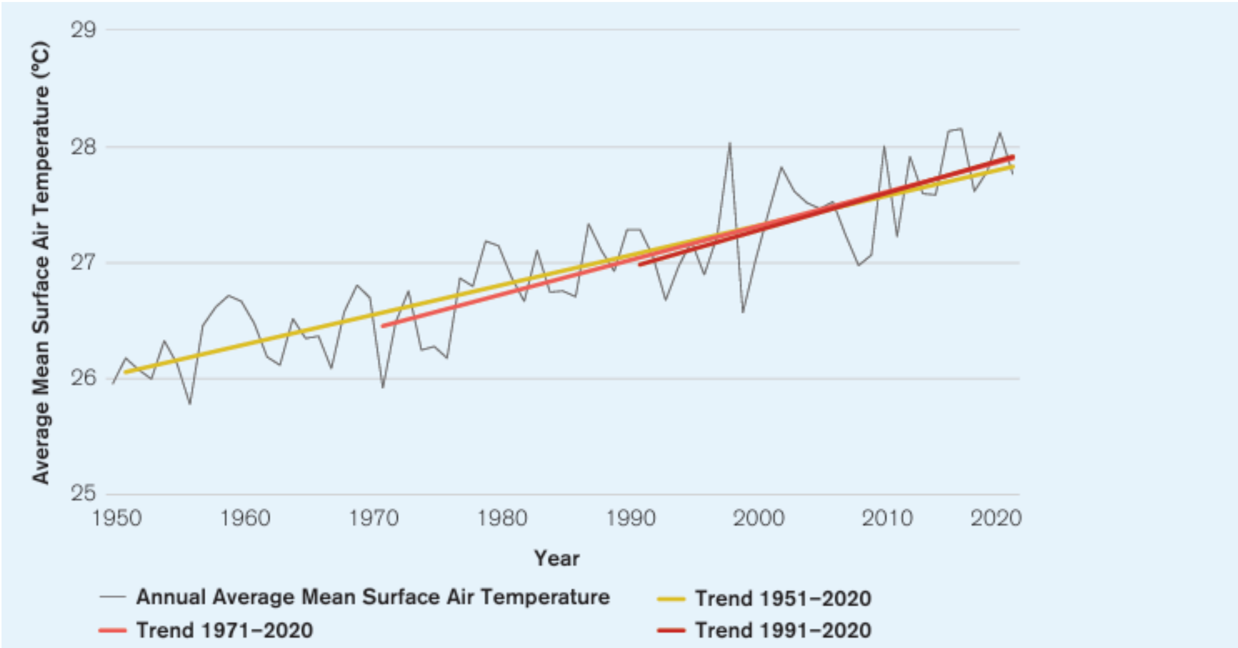


Figure III. 9: Average Annual Mean Temperature Trends Nationally per Decade, 1951–2020, Source: (World Bank, 2024)

Noted: Significantly positive trendlines over the 30-year, 50-year, and 70-year climatologies indicate a steadily rising rate of mean temperature increases, from an increase of 0.25°C per decade between 1951–2020 (yellow line) to an increase of 0.33°C per decade between 1991–2020 (red line)

3.1.2. Precipitation

Over the 50 years of 1971–2020, Cambodia experienced seasonally varied and significant decreases in precipitation per decade across its central and eastern provinces but significant increases per decade across some western provinces (see **Figure III.10).** The central province of Kampong Thom and the eastern province of Ratanakiri observed the largest total decreases in precipitation per decade (− 44.71 mm and − 43.44 mm, respectively), with the strongest effects during summer wet monsoon months. Provinces encompassing the eastern slopes of the western highlands, including Takeo, Kampot, Kampong Speu, and Battambang observed little annual change in precipitation per decade, with small increases during spring months and the greatest drying during fall months. In contrast, several western provinces observed significant precipitation increases over the same period, especially during spring months. Pailin in the western highlands observed the largest annual increase per decade (+17.95 mm), followed by Koh Kong along the western coast (+8.02 mm) (World Bank, 2024).Average annual rainfall could be as low as 1,400 mm in the central lowlands and as high as 4,000 mm near the Cardamom mountains and nearby coastal areas in the southwest. The country's eastern plains receive approximately 2,000 to 2,600 mm of rainfall annually and may exceed those amounts in the mountainous areas in the Northeast (USAID, 2019b). While rainfall was observed to increase in some areas since the 1960s, no statistically significant changes were detected over the 20th century, either in terms of annual rainfall or extreme events. However, precipitation variability is linked to the El Niño Southern Oscillation phenomenon, with years of strong El Niño correlated with years of moderate and severe drought over the 20th century (ADB, 2021b; WBG Climate Change Knowledge Portal (CCKP), 2021).

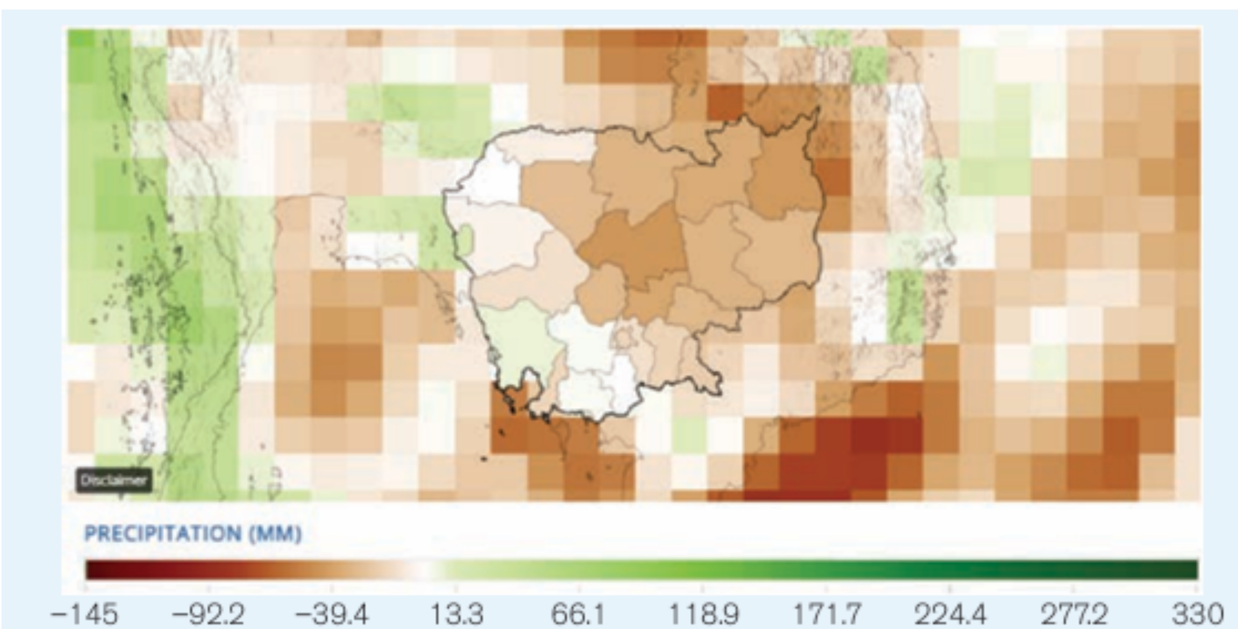


Figure III. 10: Observed Precipitation Trend per Decade (1971–2020) Annually; Source:(World Bank, 2024)

Noted: significant decreases in most of the country except in parts of the western and southern provinces

3.2. Climate Change Projection

Climate projections are computer-based simulations that use complex mathematical models to estimate how various aspects of the earth's climate, such as temperature, precipitation, and sea level, may change in the future under different scenarios of greenhouse gas emissions and other factors. These projections provide a range of possible outcomes rather than precise predictions due to the inherent complexities and uncertainties of the climate system. They are used by scientists, policymakers and stakeholders to assess climate change impacts, plan for adaptation and inform decision-making in various sectors. The most widely used projections are the RCPs issued by the Intergovernmental Panel on Climate Change (IPCC), which outline different possible future pathways of greenhouse gas emissions and concentrations.

The Shared Socioeconomic Pathways (SSPs) are a set of scenarios that complement the RCPs. While the RCPs focus on greenhouse gas emissions and concentrations, the SSPs provide narratives and projections of socioeconomic factors that influence future emissions and societal development, such as population growth, economic development, energy use and land use. They provide a framework to examine how different societal choices and policy decisions can shape greenhouse gas emissions and climate outcomes.

3.2.1. Temperature

Analysis of dynamically downscaled climate models shows the deviation in the future from the historical baseline (1950–2014). Mean temperature is expected to increase consistently from the historical baseline in the northern regions. Tmin will increase to a larger degree under SSP5.8.5, up to 32 °C in the far future period, with high agreement between global climate models. These projections underscore the significant impacts of climate change, particularly in northern latitudes where the rise in mean temperature is most pronounced. The robust agreement among global climate models enhances the reliability of these predictions, indicating a clear trend towards higher temperatures. Consequently, this warming trend under SSP5.8.5 scenario emphasizes the urgent need for adaptive measures and policies to mitigate the adverse effects of climate change on ecosystems, human health, and infrastructure.

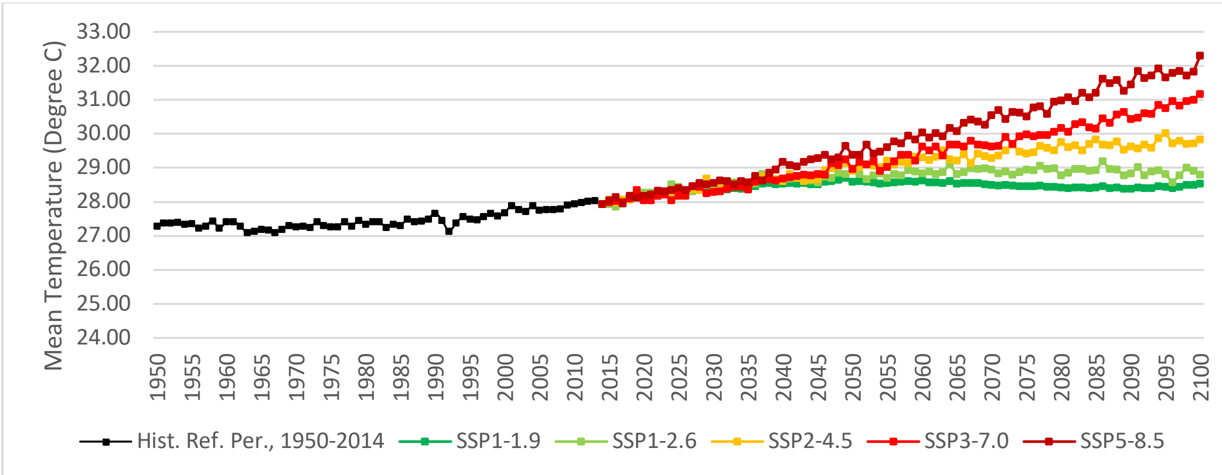
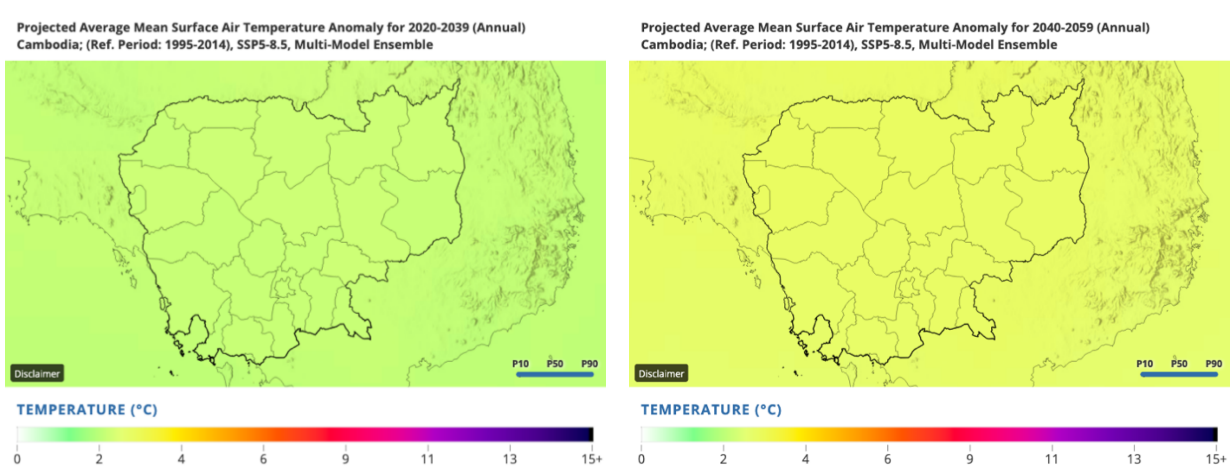


Figure III. 11:Projected average mean surface air temperature in Cambodia (Ref. 1950-2014), Multiple-Model Ensemble; Source: (World Bank, 2024)

By 2050, or likely earlier, the annual temperature is expected to increase by 1.0 °C under both SSP scenarios. While the projection for RCP4.5 suggests a moderate increase to 2.5°C by 2099, the SSP2-4.5 scenario indicates a dramatic rise of up to 4.5°C by the end of the century. **Figure III 12** depicts the nationwide spatial distribution of these climate change projections for the short-term (2026-2050) and long-term (2075-2099) timeframes. The northern regions of the country are likely to experience a greater increase in average annual temperature, particularly under the SSP5-8.5 scenario. In the short term, by 2050, the average annual temperature is projected to increase by 2.5°C in the north and around 1.1°C in the south, with little difference between the two scenarios. However, the long-term projections show a significant rise in average annual temperature, ranging from 1.5°C to 3.5°C, with lower increases in the south. By 2099, under the SSP5-8.5 scenario, temperatures are expected to rise sharply, ranging between 3.5°C and 4.5°C across the country.

(a) **(b)**



(c) (d)

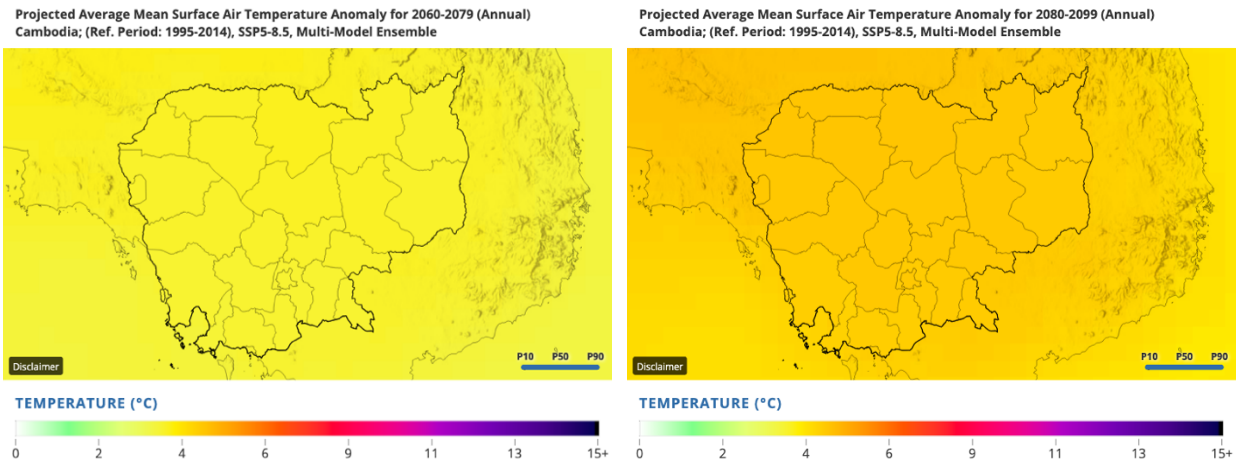


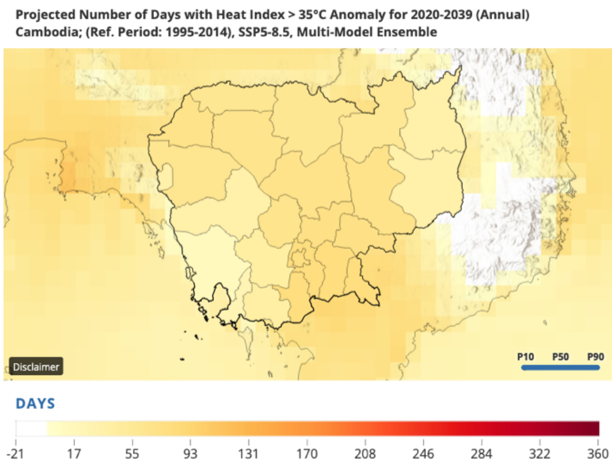
Figure III. 12: Projected Average Mean Surface Air Temperature Anomaly for Cambodia (Ref. period 1995-2014).

Noted: a) projected annual temperature for 2020-2039, b) projected annual temperature for 2060-2079, c) projected annual temperature for 2060-2079, d) projected annual temperature for 2080-2099, SSP5-8.5, Multi-Model Ensemble

The number of days with temperatures exceeding 35°C also increases significantly in both the medium and far future, with more pronounced increases observed under SSP5-8.5 compared to SSP1-2.6. Geographically, the southwestern and northeastern regions of the country experience the highest number of days with maximum temperatures above 35°C. Under the worst-case scenario (SSP5-8.5), the number of days with temperatures above 35°C will increase by more than 170 days on average by the end of the century (2070–2099). In contrast, this increase will be much lower, averaging between 20 to 40 days, under SSP1-2.6.

These projections emphasize the stark differences between the scenarios and underscore the severe implications of higher emissions pathways. The substantial rise in extremely hot days under SSP5-8.5 could lead to increased heat-related health issues, strain on water resources, and significant impacts on agriculture and energy demand. Conversely, the more moderate increase under SSP1-2.6 illustrates the potential benefits of stringent climate mitigation efforts.

(a)



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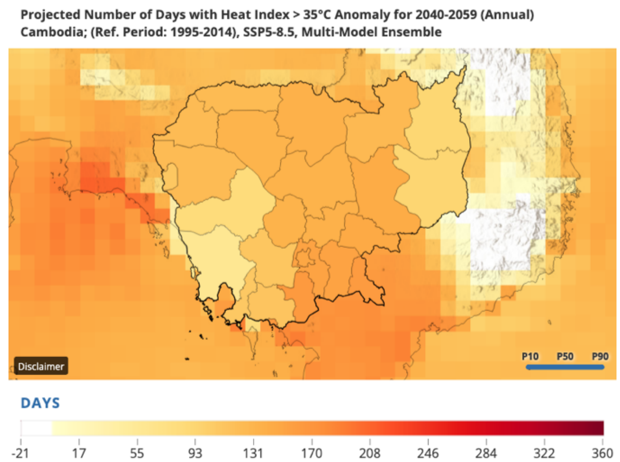

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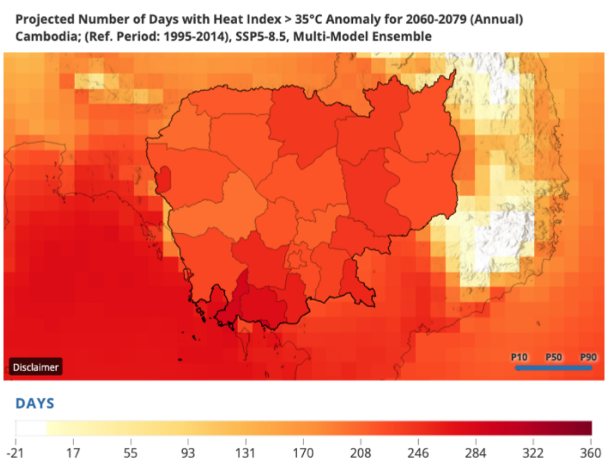

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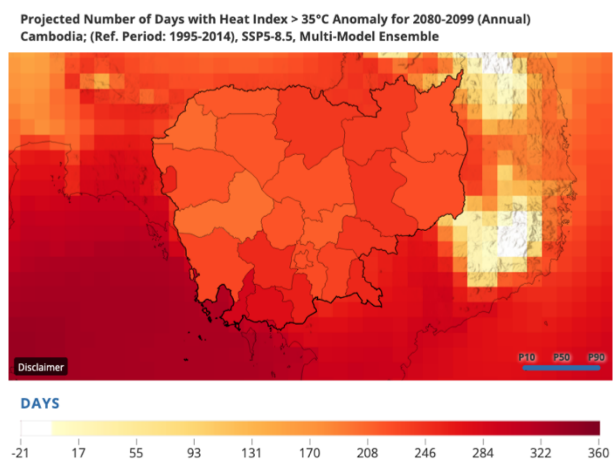


Figure III. 13: Projected Average Mean Surface Air Temperature Anomaly for Cambodia (Ref. period 1995-2014)

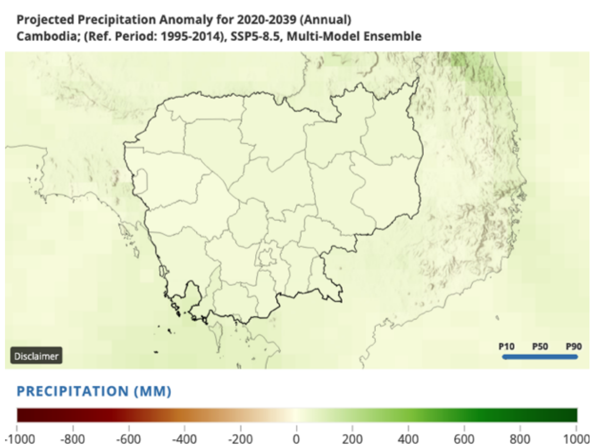
Noted: a) Projected Number of Days with Heat Index >35 C for 2020-2039, b) Projected Number of Days with Heat Index >35 C for 2040-2059, c) Projected Number of Days with Heat Index >35 C for 2060-2079, d) Projected Number of Days with Heat Index >35 C for 2080-2099, SSP5-8.5, Multi-Model Ensemble

3.2.2. Precipitation

Although there is significant variability in the precipitation projections for Cambodia, most estimates suggest a decrease in mean annual rainfall (0–200 mm) in the near future (2010–2039), particularly along the coastline. However, by the end of the century (2071–2099) and under the SSP5-8.5 scenario, an increase in precipitation is predicted, amounting to 10–20% of the average annual rainfall. Considering that the average annual rainfall in central Cambodia is approximately 2,000 mm, this translates to an increase of 200–400 mm.

This variability in precipitation patterns underscores the complexity of climate change impacts on regional hydrology. The initial decrease in rainfall along the coast may exacerbate water scarcity issues, affect agricultural productivity, and increase the vulnerability of coastal communities to drought. On the other hand, the projected increase in rainfall by the end of the century, particularly under SSP5-8.5, could lead to heightened flood risks, changes in river flow regimes, and challenges in water management. Given these projections, it is crucial for Cambodia to enhance adaptive strategies that address both extremes of the precipitation spectrum. Enhancing water storage and conservation infrastructure, improving flood management systems, and adopting sustainable agricultural practices will be essential to mitigate the impacts of changing rainfall patterns. Additionally, integrated water resource management plans should be developed to ensure the resilience of water supply systems and the protection of vulnerable communities against both droughts and floods.

(a)



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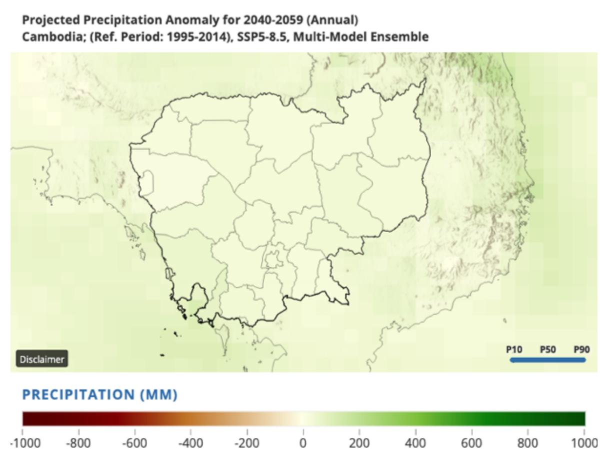

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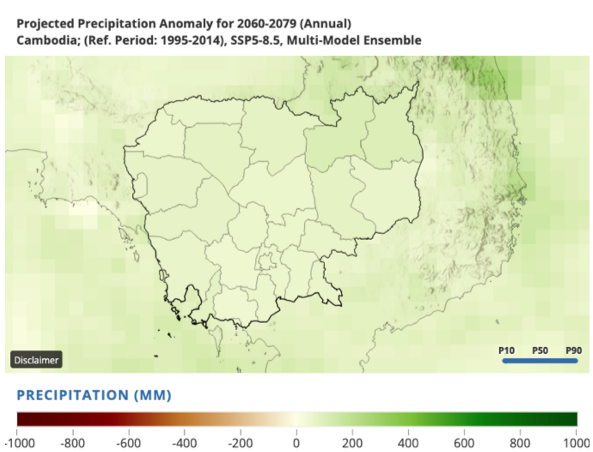

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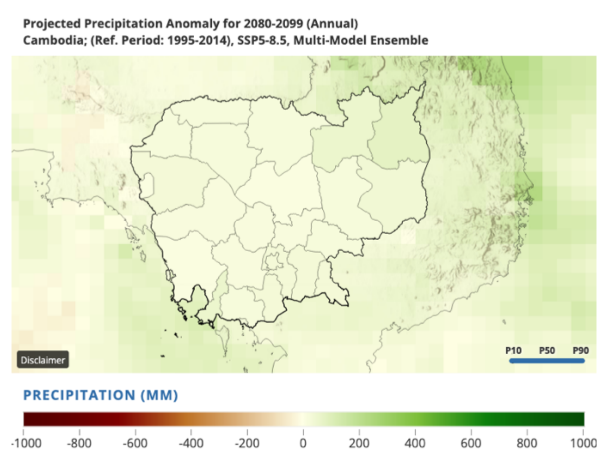


Figure III. 14: Projected Average Mean Surface Air Temperature Anomaly for Cambodia (Ref. period 1995-2014)

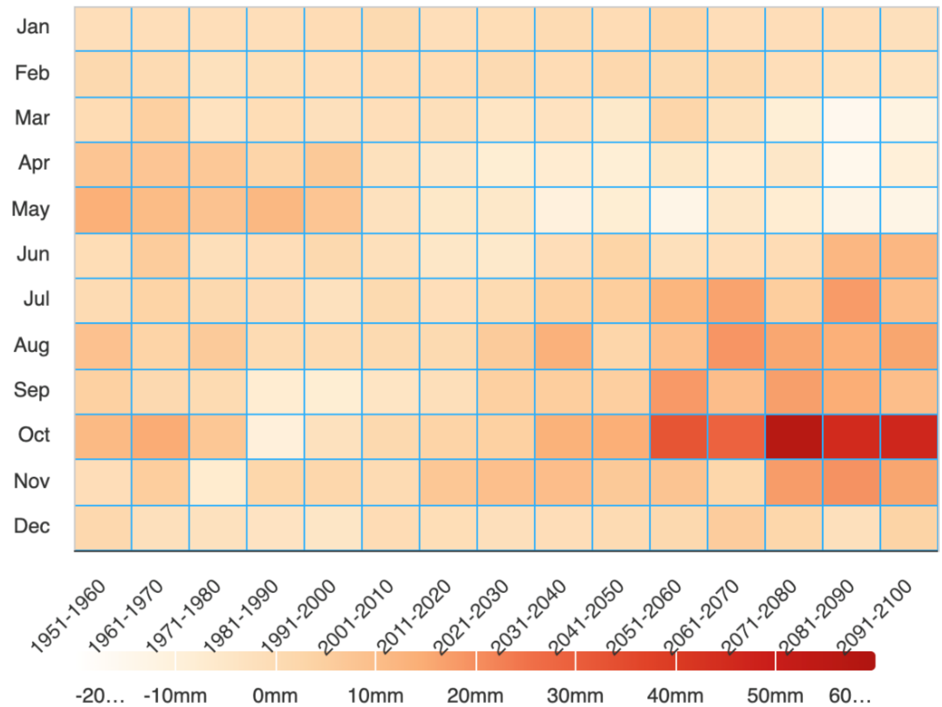
Noted: a) Projected Precipitation for 2020-2039, b) Projected Precipitation for 2040-2059, c) Projected Precipitation for 2060-2079, d) Projected Precipitation for 2080-2099, SSP5-8.5, Multi-Model Ensemble.

As most agricultural producers in Cambodia rely on rain-fed production during the wet season, **Figure III. 15** illustrates changes in cumulative precipitation from May to October and deviations from the historical average. The analysis indicates the rainy season is expected to shorten, potentially with larger rainfall events over shorter time periods. The scenarios projected to decrease precipitation in wet season along the coastline in the future, with some pockets of increased rainfall in central regions. This trend is particularly pronounced under the SSP5-8.5 scenario, especially in October and November.

These changes in wet season precipitation patterns have significant implications for agriculture, which is heavily dependent on consistent and adequate rainfall. A decrease in precipitation along the coastline could lead to reduced water availability for crops, negatively impacting yields and threatening food security. Conversely, the increase in precipitation in some central regions could benefit agricultural production but may also pose risks of waterlogging and flooding.

Under the SSP5-8.5 scenario, the shifts in rainfall patterns during the crucial months of October and November highlight the need for adaptive agricultural practices. Strategies such as developing drought-resistant crop varieties, improving irrigation infrastructure, and adopting soil moisture conservation techniques will be essential to cope with the changing climate. Furthermore, effective water management policies and early warning systems for extreme weather events can help mitigate the risks associated with both reduced and increased precipitation, ensuring the sustainability and resilience of agricultural production in Cambodia.

(a)



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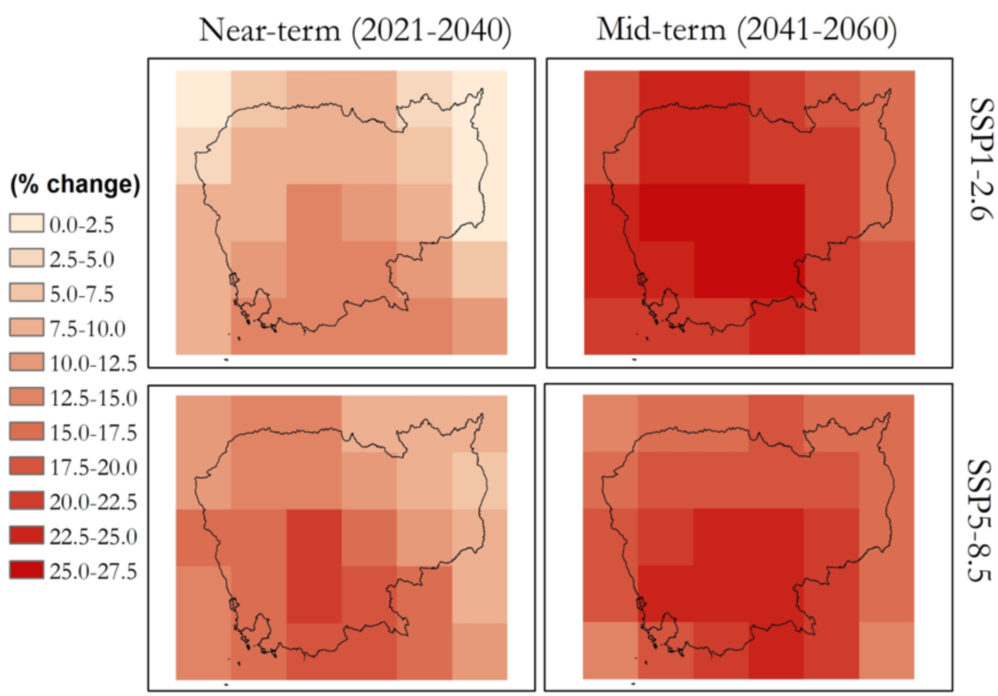


Figure III. 15: Projected precipitation Anomaly (Ref. Period: 1995-2014), SSP5-8.5, Multi-Model Ensemble

Noted: a) Projected precipitation Anomaly Cambodia, b) percentage change in six-month Standardized Precipitation Index (CMIP6 data) for SSP1-2.6 and SSP5-8.5 in the near term (2021–2040) and mid-term (2041–2060) relative to the baseline period (1981–2010)

C. Adaptation Priorities and Barriers

(para. 108 of the MPGs)

4. Key National Strategies, Policies, and Plans Related to Adaptation

The updated NDC, TNC, and LTST4CN review highlighted the priorities and adaptation action in each sectors/sub-sectors in the line-ministries. **Table III. 7** below summarized the key prioritized adaptation actions and measures by sectors which were prioritized by line institutions/ministries and sector, according to the Updated NDC.

Table III. 7: Summary key prioritized adaptation actions and measures by sectors

No.	Priories adaptation action	Sector/sub sector	Ministry	Reference
1	Towards an Agroecological transition in the uplands of Battambang	Agriculture	MAFF	Updated NDC
2	Development of Rice crops for increase production, improved quality-safety; harvesting and post harvesting technique and agro-business enhancement	Agriculture/ crop	MAFF	Updated NDC
3	Development of Horticulture and other food crops for increase production, improved quality-safety; harvesting and post harvesting technique and agro-business enhancement	Agriculture/ crop	MAFF	Updated NDC
4	Development of Industry crops for increase in production, improved quality-safety, harvesting and post harvesting technique and agro-business enhancement	Agriculture/ crop	MAFF	Updated NDC
5	Improvement of support services and capacity building to crop production resilient to climate change by promoting research, trials and up-scaling climate-smart farming systems that increase resilience to CC and extreme weather events	Agriculture/ crop	MAFF	Updated NDC
6	Building climate change resilience on cassava production and processing	Agriculture/ crop	MAFF	Updated NDC
7	Research for the development and enhancement of agricultural productivity, quality, and transfer through strengthening of crop variety conservation and new crop variety release responding to the impacts of climate change	Agriculture/ crop	MAFF	Updated NDC
8	Development of new technologies and increased yields by using new crop varieties which adapt to climate change	Agriculture/ crop	MAFF	Updated NDC

9	Development of rubber clone varieties suitable for AEZ and resilient to climate change	Agriculture/ rubber	MAFF	Updated NDC
10	Enhancing institutional and capacity development on climate change impact, vulnerability assessment, adaption measures and mitigation related to rubber sector	Agriculture/ rubber	MAFF	Updated NDC
11	Improvement of animal breeding technology in Cambodia through AI which can adapt to climate change	Agriculture/ livestock	MAFF	Updated NDC
12	Promotion of research capacities on animal genetic, animal breeding, and animal feed is strengthened to adapt to climate change	Agriculture/ livestock	MAFF	Updated NDC
13	Strengthening capacities for risk prevention and reduction, effective emergency preparedness and response at all levels; enhancing livestock and disease-related early warning system, and integrating disaster risk reduction and climate change adaptation measures into recovery and rehabilitation initiatives in the livestock sector	Agriculture/ livestock	MAFF	Updated NDC
14	Promoting aquaculture production systems and practices that are more adaptive to climate change	Agriculture/ fishery	MAFF	Updated NDC
15	Promoting climate resilience in the capture fisheries sector	Agriculture/ fishery	MAFF	Updated NDC
16	Scaled up climate-resilient agricultural production through increased access to solar irrigation systems and other climate-resilient practice	Agriculture	MAFF	Updated NDC
17	Direct seeding practices	Agriculture	MAFF	LTST4CN
18	Reduced exposure to climate related extremes and slow onset events affecting agriculture and dependent livelihoods.	Agriculture	MAFF	LTST4CN
19	Support in suppressing opportunistic agricultural pests and invasive species favored by higher temperature and humidity due to climate change.	Agriculture	MAFF	LTST4CN
20	Introduction of innovative sustainable techniques in crop rotation to strengthen their life cycle, reducing the use of chemicals, water consumption and soil erosion	Agriculture	MAFF	LTST4CN

21	Increased crop breeding for greater heat and water tolerance as well as food security	Agriculture	MAFF	LTST4CN
22	Drought preparedness increases adaptive capacity for water management	Agriculture	MAFF	LTST4CN
23	Promotion of organic fertilizers	Agriculture	MAFF	LTST4CN
24	Increased soil fertility, which can help farmers deal with increased temperatures and climate variability	Agriculture	MAFF	LTST4CN
25	Improved crop yields through using compost fertilizer	Agriculture	MAFF	LTST4CN
26	Alternate wetting and drying practices	Agriculture	MAFF	LTS4CN
27	Maintaining groundwater and surface water quality and quantity	Agriculture/ fishery	MAFF	LTS4CN
28	Seasonal and annual weather prediction and forecast for agriculture	Agriculture	MAFF	TNC
29	Sustainable water use management: sprinkler irrigation, drip irrigation, solar and windmill water pump, rainwater harvesting, crop water requirement planning, deficit irrigation	Agriculture	MAFF	TNC
30	Integrated soil management: sloping agriculture land technology, slow-forming terraces, conservation tillage, integrated nutrient management, compost making, soil senility management, vetiver and soil stabilization grasses, live staking, mulching	Agriculture	MAFF	TNC
31	Sustainable crop management: crop diversification and new varieties, new varieties from biotechnology, ecological /integrated pest management, seed and grain storage, system of rice intensification, alternate wetting and drying rice irrigation,	Agriculture	MAFF	TNC
32	Sustainable farming and livelihood systems: irrigated rice fish system, mix farming system, agroforestry	Agriculture/ crop/fishery	MAFF	TNC
33	Capacity building and development for community-based agriculture extension, farmer field schools, forestry user groups, water user associations, community-based seed systems	Agriculture/ cross- cutting	MAFF	TNC

34	Increasing the use of mobile pumping stations and permanent stations in responding to mini droughts	Agriculture	MAFF	TNC
35	Developing crop varieties suitable to Agro-Ecological Zones (AEZ) and resilient to climate change (include coastal zone)	Agriculture	MAFF	TNC
36	climate-smart farming systems	Agriculture	MAFF	TNC
37	Developing climate-proof tertiary-community irrigation to enhance the yields from agricultural production of paddy fields	Agriculture/	MAFF	TNC
38	Participatory action research in inland small-scale fisheries co management and wetlands conservation	Agriculture/ fishery	MAFF	TNC
39	Enhancing the productivity of rice field fisheries through the protection of dry season habitats for fish	Agriculture/ fishery	MAFF	TNC
40	Aquaculture producers will have to avoid overfeeding and overstocking fish and monitor the water temperature	Agriculture/ fishery	MAFF	TNC
41	Grow/re-grow forests and the flooded forest, mangrove	Agriculture/ fishery	MAFF	TNC
42	Fish species should be screened, and better-adapted species selected, or strains could be developed that are physiologically more tolerant to the changing environment	Agriculture/ fishery	MAFF	TNC
43	Promoting aquaculture production systems and practices that are adaptive to climate change	Agriculture/ fishery	MAFF	TNC
44	Promote conservation and management of fisheries and aquaculture in a sustainable way	Agriculture/ fishery	MAFF	CCCSP
45	Enhance community fisheries management	Agriculture/ fishery	MAFF	CCCSP
46	Promote the development and improved efficiency of fisheries sector management	Agriculture/ fishery	MAFF	CCCSP
47	Improved feed quality fodder management	Agriculture/ livestock	MAFF	LTS4CN/TNC
48	Feed additives for cattle	Agriculture/ livestock	MAFF	LTS4CN
49	Reduced heat stress and animal mortality	Agriculture/ livestock	MAFF	LTS4CN
50	Improved sow condition management	Agriculture/ livestock	MAFF	TNC

51	Biosecurity and vaccinations for animal health	Agriculture/ livestock	MAFF	TNC
52	Developing a training manual and providing training on approaches for development of climate-smart and sustainable livelihood to rural poor people	Cross-cutting	MRD	Updated NDC
53	Protection, risk mitigation, and resilience building from marine pollution particularly caused by activities on land including marine pollution from waste and aquaculture activities.	Coastal zones	MoE	Updated NDC
54	Effective management and protection of ecological systems of marine and costal zones to avoid adverse impacts from various factors, build their resilience and restore its functions for productive and healthy oceans	Coastal zones	MoE	Updated NDC
55	Mainstream climate change response measures into coastal development planning against sea water intrusion, sea water rise and seasonal storm destruction, and rising temperature	Coastal zone	MoE	Updated NDC
56	Promoting climate resilient agriculture in coastal areas through building sea dikes and scaling-up of	Coastal zone	MoE	TNC
57	Conduct climate risk analysis for the existing electricity infrastructures and provide recommendations	Energy	MME	Updated NDC
58	Climate proofing existing and future solar/hydropower infrastructure	Energy	MME	Updated NDC
59	Promote sustainable energy practices in manufacturing	Energy	MME	NDC
60	Increase energy access to rural area for local community	Energy	MME	NDC
61	Incorporate renewable energy resources (solar, wind, hydro, biomass) into energy mix to reduce imports energy sources and increase clean energy	Energy	MME	NDC/LTS4 CN
62	Climate-friendly cooling of public sector buildings	Energy	MME	LTS4CN/N DC
63	Fuel switching to electricity for cooking	Energy	MME	LTS4CN
64	Increase in solar, hydro, biomass and other renewables to 35% of the generation mix by 2050, of which 12% is from solar	Energy	MME	LTS4CN

65	Wind/solar water pumping	Energy	MME	TNC
66	Solar home system/ Solar lantern	Energy	MME	TNC
67	Enable effective decision-making for health interventions through generation of information and improved surveillance or early-warning systems	Human health	MoH	Updated NDC
68	Enhance climate resilience in health service delivery	Human health	MoH	Updated NDC
69	Strengthen and provide capacity building of technical guidelines for diagnosis, detection, control, prevention and treatment of vector-borne and water-borne diseases, injuries and other food poisoning illnesses arising from climate change	Human health	MoH	Updated NDC
70	Conduct water sanitation and hygiene (WASH) assessments on climate change and develop planning for communities and health facilities.	Human health	MoH	Updated NDC
71	Strengthen institutional capacities to effectively integrate climate risks and adaptation options in health sector planning and implementation	Human health	MoH	Updated NDC
72	Heat stress adaptation for industrial production	IPPU	MISTI	Updated NDC
73	Increase energy efficiency and pollution management in latex and rubber wood processing to increase environmentally friendly and income	IPPU	MISTI	Updated NDC
74	Using several products for clinker substitution, such as coal ash power, would reduce waste and land needed for disposal	IPPU	MISTI	LTS4CN/TNC
75	Promoting the use of locally available mineral resources contributes to energy efficiency in buildings given thermal mass, fire resistance and durability	IPPU	MISTI	LTS4CN
76	Introduce alternatives for cement production by using alternative raw materials whose availability	IPPU	MISTI	TNC
77	Integrating climate change response measures onto the construction design for buildings and for rural housing (use of modern integration of technology)	Infrastructure /Buildings	MLMUPC	Updated NDC
78	Develop resilient infrastructure of school buildings in response to climate change	Infrastructure /Building	MLMUPC	Updated NDC

79	Implement climate change and disaster resilient construction and infrastructure standards including for public sector and community-focused buildings covering public health, education, WASH etc.	Cross-cutting /Infrastructure/Building/ Health	NCDM	Updated NDC
80	Prepare spatial planning(city/district/municipality) guidelines at all levels for climate change adaptation	FOLU	MLMUPC	Updated NDC
81	Integrating climate change response measures to the commune land use planning	FOLU	MLMUPC	Updated NDC
82	Integrating climate change response measures to the policy of social land concession (SLC) and its procedures	FOLU	MLMUPC	Updated NDC
83	Prepare modality of standardized green spaces for urban planning or new sub-cities to address vulnerability of urbanization	FOLU	MLMUPC	Updated NDC
84	Vulnerability assessment towards the development of climate change strategic plans to respond to the impacts on land, housings, coastal management and building due to climate change	FOLU	MLMUPC	Updated NDC
85	Promote Land Use Planning Tools for urban houses and building construction adaptive to climate change benefits to the low-income and homeless people	FOLU	MLMUPC	Updated NDC
86	Promote proper low-cost shelters for low-income households resilient to climate change, practically in social land concession	FOLU	MLMUPC	Updated NDC
87	Development of building code with mainstreaming climate change into building designs	FOLU	MLMUPC	Updated NDC
88	Strengthening Climate Resilient Cities	FOLU	MLMUPC	Updated NDC
89	Tree seedlings distribute to public and local community to contribute forest cover, promote forestry communities' livelihoods and cultural	FOLU	MLMUPC	Updated NDC
90	Building resilience of biodiversity conservation and restoration to adapt to climate change	FOLU	MLMUPC	Updated NDC
91	Increased species composition (e.g., the mix of hardwood and softwood species),	FOLU	MLMUPC	LTS4CN

	age structure and harvest regime, and reduction of species emigration and extinctions			
92	Improved forest management and protection and the development of sustainable ecosystem services, which can result in avoided deforestation or reforestation	FOLU	MLMUPC	LTS4CN
93	Reducing the deforestation rate by 50% in 2030 and stopping deforestation by 2045	FOLU	MLMUPC	LTS4CN/TNC
94	Agroforestry and commercial tree plantation	FOLU	MLMUPC	LTS4CN
95	Full implementation of the REDD+ Investment Plan by 2050	FOLU	MLMUPC	LTS4CN/ TNC
96	Promoting and improving the adaptive capacity of communities, especially through community-based adaptation actions, and restoring the natural ecology system to respond to climate change	FOLU	MLMUPC	TNC
97	Strengthen implementation of sustainable forest management	FOLU	MLMUPC	TNC
98	Improve management and monitoring of forest resources and forest land use	FOLU	MLMUPC	TNC
99	Promote electrical vehicles	Transport	MPWT	TNC
100	Rail for freight and passengers	Transport	MPWT	LTS4CN/TNC
101	Increased use of public transportation	Transport	MPWT	LTS4CN/TNC
102	Develop national road construction and maintenance design standards for national and provincial roads, considering climate change impacts, including developing an M&E framework for climate proofing and low-carbon technology roads	Transport	MPWT	Updated NDC
103	Repair and rehabilitate existing road infrastructure and ensure effective operation and maintenance systems, considering climate change impact	Transport	MPWT	Updated NDC
104	Rural road rehabilitation and improvement for climate change resilience	Transport	MPWT	Updated NDC
105	Develop and annually update national and subnational multi- hazard and climate risk assessments, including the identification of the most vulnerable communities	Cross-cutting / Livelihoods, poverty and biodiversity	NCDM	Updated NDC

106	National end-to-end early warning systems with focus on effective dissemination to populations at risk	Cross-cutting / Livelihoods, poverty and biodiversity	NCDM	Updated NDC
107	Implement community–based disaster and climate risk management programs	Cross-cutting / Livelihoods, poverty and biodiversity	NCDM	Updated NDC
108	Building resilience of biodiversity conservation and restoration to adapt to climate change	Cross-cutting / Livelihoods, poverty and biodiversity	MoE	Updated NDC
109	Integrated village development	Cross-cutting / Livelihoods, poverty and biodiversity	MoE	Updated NDC
110	Strengthen flood resiliency capacity of communities around lake Tonle Sap (access to clean water, off grid renewable energy and waste management)	Cross-cutting / Livelihoods, poverty and biodiversity	NCDD	Updated NDC
111	Building climate resilient livelihood and public infrastructures in social land concession for vulnerable communities	Cross-cutting / Livelihoods, poverty and biodiversity	NCDD	Updated NDC
112	Provide capacity building and supports for climate change innovation at the provincial along Tonle Sap River	Cross-cutting / Tourism	MOT	Updated NDC
113	Raising public awareness on climate change innovation at all levels	Cross-cutting / Tourism	MOT	Updated NDC
114	Practicing smart agriculture in tourism sector	Agriculture/ Tourism	MOT	Updated NDC
115	Establish an automated nation-wide hydromet monitoring network and data transmission program, including the collection of climate and hydrological data	Water resources	MOWRAM	Updated NDC
116	Establish a centralized and standardized approach to climate-resilient water management	Water resources	MOWRAM	Updated NDC
117	Establish a national climate and flood warning system, including a service center and flood emergency response plans	Water resources	MOWRAM	Updated NDC
118	Integrated groundwater management in Cambodia	Water resources	NCDD	Updated NDC
119	Establish nationally standardized best-practice systems for irrigation	Water resources	MOWRAM	Updated NDC

120	Developing and rehabilitating the flood protection dike for agricultural and urban development	Water resources/ agriculture	MOWRAM	TNC
121	Resilient and Adaptive rural water supply and sanitation construction	Cross-cutting /water resources	MRD	Updated NDC
122	Bio-digesters construction	Waste	MoE	NDC/ LTS4CN
123	Composting of biodegradable organic waste	Waste	MoE	NDC/ LTS4CN/TNC
124	Implementation of National 3R strategy	Waste	MoE	NDC/TNC
125	Centralized recycling facility for industrial waste from the garment sector	Waste	MoE	NDC/TNC
126	Solid waste disposal management	Waste	MoE	LTS4CN
127	Biological treatment of solid waste to composting for fertilizer and soil improvement	Waste	MoE	LTS4CN/TNC
128	Incineration and open burning of waste for improved soil conditions in areas degraded by climate change	Waste	MoE	LTS4CN
129	Wastewater treatment and discharge management	Waste	MoE	LTS4CN
130	Better management of industrial wastewater in the food & beverage industries	Waste	MoE	TNC
131	Strengthen institutional capacities at national and sub-national levels to integrate gender responsiveness in climate change adaptation policies, plans, programming, including gender sensitive budgeting	Gender	MOWA	NDC
132	Enhance coordination and implementing accountability mechanisms to reduce climate change vulnerabilities of disadvantaged women and other marginalized groups such as ethnic minority women and men, People with Disabilities (PWD), youth, and the elderly	Gender	MOWA	NDC
133	Enhance monitoring and evaluation systems of sectoral ministries to track gender outcomes in climate change initiatives with a particular focus on collecting and managing sex-disaggregated data, gender indicators and budgeting,	Gender	MOWA	NDC

	outcome-based reporting and the dissemination and up-scaling of the gender and climate change adaptation related knowledge generated.			
134	Develop technical guidelines for Gender mainstreaming in NDC process	Gender	MOWA	NDC
135	Market supply chain of rural women entrepreneurs resilient to climate change	Gender	MOWA	NDC
136	Capacity Development for GCCC members and sectoral ministries on Gender analysis, gender responsive budgeting and NDC	Gender	MOWA	NDC

Source: (MoE, 2020b)

4.1.1. Challenges, Constraints and Barriers

Cambodia is an LDC, thus the government has demonstrated a commitment as well as the political will to seriously and comprehensively to addressing climate change and to mainstreaming climate change adaptation into governance at the national, sectoral, and subnational levels to build institutions and utilize science-based solutions to address climate change. The current challenges for the country is facing to cope with climate change is due to a combination of rapid development relatively high dependance on climate sensitive sectors including agriculture, forestry, fisheries, land, and water resources in particular weak adaptive capacity (limited human resources, instructional capacity, and finance), limited disaster risk management capabilities, poor infrastructure, and inadequate risk governance at all levels exacerbate the country's vulnerability to climate variability and change. However, Cambodia has been facing many constraints and gaps for the implementation of climate change impacts because of limited financial support, technology transfer, and institutional and human capacity.

The vulnerability and adaptation assessment in the SNC identified a number of constraints include:

- Climatic risk and climate modelling in national and sectoral plans is still limited in Cambodia, in mainstreaming adaptation to the negative impacts of climate change into national development planning.
- Insufficient relevant data and information to conduct an assessment for immediate climate
- change adaptation action in Cambodia under the conditions of increased likelihood of floods and droughts.
- Limited research conducted for related sectoral impact to climate change.
- There has been limited analysis of the wider impacts of disasters on macroeconomic or budgetary performance or on their wider socio-economic consequences, including on progress in poverty reduction.

- There is a shortage of capable technical experts and financial resources for running impact
- Assessments and adaptation measure development models.

Furthermore, the assessment conducted by the NDC and TNC found some barriers for implement of adaptation options and measures such as limited technical capacity, knowledge and skill, limited inter-ministerial and institutional coordination, limited financial and technical support for implementation and investment as well lack of technology transfer and low adaptive capacity among stockholders and farmers.

In term of human resources, Cambodia remains limited experts and researchers in climate vulnerability assessment and adaptation measures, climate change and energy, climate agronomists, climate economists, etc. Furthermore, it has been observed that systematic coordination among related agencies remains limited to address climate change.

Cambodia still faces financial constraints to ensure effective implementation of the proposed adaptation and mitigation options. Climate change financing remains a key barrier in Cambodia although a lot of key milestones have been achieved including the formulation of relevant national and sectoral policies and action plans. Development partners remain the biggest source of funds for climate change responses in Cambodia.

Cambodia recognizes the necessity of technology development, transfer, and diffusion in promoting resilience to climate change as well as reducing GHG emissions. The Technology Needs Assessment (TNA) and Technology Action Plans (TAP) for climate change adaptation technologies was conducted in 2013, focused only two sectors, water sector and coastal zone (MoE, 2013 a). Thus, the development of technology needs assessment and technology transfer for other climate change vulnerable sector should be taken in to account for agriculture sector that about 80% of rural livelihood are depending on its sector.

Under support from Cambodia Climate Change Alliance (CCCA), 15 government's ministries have developed their own Climate Change Action Plans, which proposed of 171 climate actions projects related to adaptation measures about 93% and mitigation about 7%. The MoE, MAFF and MOWRAM have, together, proposed 62 adaptation and mitigation projects, but only 12 of these (or 19%) were in operation by 2016. These ministries face similar challenges in implementing their climate change projects: Financial constraints; limited human capacity; a lack of reliable and comprehensive data sets and research; and a lack of technology transfer and awareness. An overview of barriers and opportunities is shown in the **Table III. 3** below, with elaborations provided in the following sections (NCDDS, 2019).

As Cambodia is committed to address climate change at national and global level, the government of Cambodia look forward cooperate and working with all partners to address the gaps and barriers in term of financing, capacity building, and technology transfer in order achieve the ambitious vision set out in the NDC and LTS4CN.

Table III. 8: Barriers and opportunities for sub-national implement climate change adaptation

Category	Barriers	Opportunities
Policy and institutional aspects	Scope for improved interagency coordination of CCA initiatives Inadequate land use planning and management	Strong political support for the D&D process Scope for improved, site-specific disaster preparedness and contingency planning Scope for improved CCA in urban areas
Information and knowledge base	High time-and-space variability of rainfall and stream flow Sea level and land subsidence are not systematically monitored	• Detailed high-resolution satellite data readily available new hydro-meteorological data portals in an advanced state of implementation • Manuals, guidelines and reference documents are readily available (see Appendix B).

Capacity and skills	• A remaining need exists for sub-national consolidation of CCA and DRR mainstreaming • EIA and climate screening modalities exist but are not consolidated	• Recent comprehensive training programs have been conducted for subnational practitioners • A clear scope for improved extension services, based on sharing of existing (but fragmented) expertise
Financial/economic constraints	Current commune- and district-level budgets can cover urgent infrastructural maintenance only – there is no room for pro-active development	• Substantially increased budget allocations have been announced • Various targeted CCA financing options are available • Scope for cost recovery Scope for private sector collaboration
Technology	Tools and modalities for identification, scoping and design optimization exist but are not well consolidated	Several related development initiatives are in progress
Social aspects	Good public awareness of climate-related pressures and concerns, but limited awareness of adaptation options	• Scope for expanded community-based cultivation, forestry and irrigation scheme operation, including knowledge sharing and dissemination of 'success stories' • Scope for expanded access to microcredit and crop insurance • Scope for strengthened interaction with the academic community and the NGOs/ CSOs

4.1.2. Barriers and Arrangements to Lift Barriers at the Local Level and for Specific Sectors

The updated-NDC review identified the need for capacity building to leave the barrier identified at the local level and specific sectors including the NDC implementation, especially for the NCSD/DCC, CCTWG, and sectoral (and sub-national) TWGs. In addition, it is required each ministry to submit its own capacity building requirements. The barriers and capacity needs for the

NDC implementation as submitted by each ministry and identified in the NDC review, the tackling of which will require strong international support are0 summarizes in the following Table III.9.

Table III. 9: Barriers and capacity needs

Ministries	Barriers	Capacity needs
MISTI	• Technical capacity • Finance • Regulatory framework • Inter-ministerial cooperation • Participation from private sector (factory owners and workers) • Labour skill • Data from factories • Equipment	• Financial support • Human resource training • Support from top management
MLMUPC	• Finance (budget for activity implementation) • Climate change information toolkit and capacity • Data systems to monitor and evaluate the impacts of climate change interventions	• Capacity on climate change (otherwise MLMUPC has full technical capacity) • Support to strengthen the CCTWG of MLMUPC Capacity support for technical staff of the four General Department within MLMUPC as well as horizontal (line agencies) and vertical actors (sub-national government) in carrying out the activities.
MME	• Lack of regulatory framework • Limited capacity for data collection and monitoring • Lack of data management system • Lack of integrated decision support system	• Human and institutional capacity building • Financial support • Capacity on mainstreaming climate change into energy infrastructure planning and development • Integrated decision support system for integration of climate data (from various ministries) to support resilient energy infrastructure
MoE	• Climate model expertise • Concept note and proposal development • Data management and reporting	As coordinator for the NDC implementation, the MOE would be expected to build its own capacity and the one of the line ministries in several areas, including: • Coordination and integration • Capacity building and knowledge management

		• Stakeholder engagement • Mitigation and adaptation including: - Environmental, social, economic impact assessment - ESS and gender implementation - Sectoral knowledge and best practices - GHG measurement and accounting - Vulnerability assessment - Policy development and appraisal • MRV/Transparency including: - GHG measurement and accounting - Negotiations skills - Public financial management - Database development
MoEYS	• As coordinator for the NDC implementation, the • Finance • Concept note development • Technical capacity	• Concept and case studies on climate change, DRR, climate emergency, response planning • Data collection and monitoring systems • Integration of climate change into school curriculum and teacher training curriculum, • M&E framework and systems for Education • Management Information System (EMIS) and climate change.
MoH	• Finance for climate change infrastructure and innovation • Human resources • Gender involvement • Technical support	• Technical and financial support from external sources both for policy development, infrastructure and behavior change communication and awareness raising
MoINF	• Finance • Technical • Human resources on climate change and environment	• Cooperation from stakeholders and expert ministries is crucial
MoP	• Finance • Capacity • Technical Assistance	• MoP has the capacity to guide sectoral ministries to implement their activities • Capacity building is necessary for all staff (by sector) on climate change

		• MoP and NCSD need capacity to assist in mainstreaming climate change in development plan. Being the key ministry to coordinate finance to the sectors, MoP might also require support in the following areas: • Financial and technology needs assessments • Financial modelling and cost benefit analysis • Business case and project concept note writing • Financial and investment terminology • Understanding of the constraints and requirements of investors • Accreditation and access to climate finance • Environmental, Social Safeguards (ESS) and gender
MoT	• Finance • Technical • Human resources on climate change and environment	• Cooperation from stakeholders and expert ministries is crucial
MoWRAM	• Finance • Capacity of staff • Needs assessment - particularly on technology • Data/information centres	• Technical support and cooperation from the private sector are required
MPWT	• Finance • Human resource (capacity building) • Research and development	• Capacity on climate change to be built for implementation and access to finance
MRD	• Finance • Human resources	• Outsourcing some services to firms on project design and quality assurance • For the implementation of the Government budget, MRD have enough capacity to deliver
NCDD	• Capacity of implementers and NCDD • Finance	• Existing capacity is not yet sufficient for implementation. Climate change is still new

	• Policy (at the national level)	• Human Resources are dedicated mostly for decentralisation and de-concentration, as reflected in the upcoming NCDD Strategy for 2021-2030
NCDM	• Resource person • Finance from development partners (governmental budget is limited) • Policy/standards (for example private engagement in DRM)	• NCDM would be able to deliver with technical and finance support
MOWA	• Capacity building to better understand the concept of gender and gender analysis, • M&E • Finance • Coordination (institutional arrangements)	• Resource person needs • Technical support • Gender safeguards mitigation measures implementation
MAFF	• Human resources • Finance • AFOLU GHG data • Technology	• Capacity building on Enhance Transparency Framework (ETF) and Management Information System(s) (MIS) • Technical support to establish and operate a tracking system for the NDC, CSDG and other relevant climate change strategies • Technical support for improving activity data and emission factor

Source: (NCSD, 2019)

D. Adaptation Strategies, Policies, Plans, Goals and Actions to Integrate Adaptation into National Policies and Strategies

(para. 109 of the MPGs)

In response to climate change impacts, it required high commitment from the national relevant stakeholders in order to frame the adaptation policy and planning framework included in various national documents, such as the NAP, the adaptation component of the NDC, sectoral policies, and other planning documents that include adaptation-related issues, should be provided by reporting on the strategies, plans, policies, goals, and actions in place for adaptation. The Paris Agreement acknowledges that adaptation is essential to the global efforts to climate change. The most important aspects of the Paris Agreement are outlined in Article 7 regarding the collective and national elements of action. Although the ETF seems to be more in line with the national dimension of action, it interacts with collective processes under the Paris Agreement, such as the global goal on adaptation (GGA) (Article 7, para. 1). Linking national adaptation measures with the GGA, as defined in paragraph 1 of Article 7 of the Paris Agreement, should receive particular emphasis when developing the overall planning narrative, which comprises "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring an adequate adaptation response in the context of the temperature goal referred to in Article 2". Cambodia is among the countries most at risk to the impact of climate change. The geographical incidence of extreme weather events such as windstorm, droughts, and floods, and while floods affect lowland areas, the geographical distribution of droughts is widespread. Managing environment and climate change has become another challenge for sustainability of Cambodia's economic growth and social development due to the pressure from population growth, urbanization, expansion and intensification of agriculture as well as transport, energy and other sectors. Having ratified the UNFCCC in 1995 and the Kyoto Protocol in 2002, associated with the Copenhagen Accord in 2010, and ratified the Paris Agreement on Climate Change in 2016, Cambodia has actively participated in the international community's effort to address climate-related issues. There some national key strategies, policies, plans related to adaptation which were prepare and developed for national implementation and submitted to the UNFCCC as list below:

The Initial National Communication to the UNFCCC (INC) (2002): The INC Communication has been prepared to fulfil Cambodia's commitments to the Convention. It contains the necessary information about the country's major sources of greenhouse gas emissions and sinks, vulnerability and adaptation options, together with the necessary mitigation measures that Cambodia has implemented, and will continue to implement, to adapt to climate change impacts and to further contribute to global efforts to reduce greenhouse gas emissions. The vulnerability assessment and adaptation focused on sector for agriculture, forest, human health, and coastal zone.

National Adaptation Programme of Action (NAPA) (2006): The main goal of the Cambodian NAPA is to provide a framework to guide the coordination and implementation of adaptation initiatives through a participatory approach, and to build synergies with other relevant environment and development programmes. NAPA identified 20 priority projects to address the urgent and immediate needs and concerns of people at the grassroots level for adaptation to the adverse effects of climate change in key sectors such as agriculture, water resources, coastal zone and human health.

The National Strategic Development Plan 2006-2010 (NSDP) (2006): Stress the need to improve agricultural productivity through the expansion of irrigation and the management of water resources to reduce vulnerability to natural disasters.

National Strategic Development Plan (NSDP) 2009-2013, and 2014-2018 recognizes environmental sustainability and climate change as major challenges to Cambodia's economic growth and social development.

The National Forest Programme 2010-2029: The NFP defines Cambodia's objectives for sustainable management and conservation of the forests. It encourages multi-purpose tree plantations to be established in watersheds to assure soil and water conservation. It defines that the participating communities have the right to sell or use forest timber for construction, and fuel wood, and non-timber forest products in balance with multiple benefits from biodiversity and environmental conservation. The NFP constitutes the main national framework for the sustainable management of the forestry sector in Cambodia. The overall objective of the NFP is stated as follows: the forest resources provide an optimum contribution to equitable macroeconomic growth and poverty alleviation particularly in rural areas through conservation and sustainable forest management, with the active participation of all stakeholders. The NFP identifies nine strategic objectives and out of them, Strategic Direction for Objective 2 is to reduce the impacts of climate change through financial mechanisms such as Reducing Emissions from Deforestation and Forest Degradation (REDD) and the Clean Development Mechanisms (CDM). The strategy calls for a flexible approach to carbon markets as they were more fully mature.

The Technology Needs Assessment and Technology Action Plans for Climate Change Adaptation (2013): The objective of the document was for listing of climate change technologies focus on Technology Action Plans (TAPs) which set targets to be achieved in technology transfer, diffusion and adoption, analyses barriers to technology transfer, and articulates a framework and action plan for overcoming these barriers.

National Strategic Plan on Green Growth 2013-2030: National policy and strategic plan for green growth (2013-2030) promotes Cambodia economy towards the green economy, focusing on effective use of natural resources, environmental sustainability, green jobs, green technologies, green finance, green credit, and green investment. The strategy needs to improve green growth by focusing on strategic direction includes (i) Green Investment and Green Jobs Creation; (ii) Green Economy Management in balance with environment; (iii) Blue Economy Development with Sustainability; (iv) Green Environment and Natural Resource Management; (v) Human Resource Development and Green Education; (vi) Effective Green Technology Management; (vii)

Promotion of a Green Social Safety System; (viii) Uphold and Protection of Green Cultural Heritage and National Identity; and (ix) Good Governance on Green Growth. Several legal instruments for the green growth implementation and intensifying efforts to reduce the impact of climate change by strengthening adaptation capacity and resiliency to climate change.

The National Action Plan for Disaster Risk Reduction (NAP-DRR) 2014-2018: integrated ways to reduce risk from hazards through sustainable, innovative, and realistic strategies with stronger partnerships among all stakeholders. The NAP-DRR consisted of five strategic components including consolidate and further enhance capacity of disaster management institutions at national, sub-national, and local community levels; enhancing risk assessment and improving early warning systems; development and use of innovation and knowledge to build resilience; reduction of the underlying causes of risks; and enhancing emergency response and recovery capabilities at all levels.

Strategic Programme for Climate Resilience (SPCR): The SPCR emphasizes two streams to promote climate resilience.The first stream is to build knowledge about climate change impacts in Cambodia and how to mainstream climate resilience into agriculture, water resources and transport and urban infrastructure. The second stream is to invest in applying new skills, techniques, technology, and engineering practices for climate resilience.

The Climate Change Strategic Plan 2014–2023 (CCCSP) (2013) was set up a vison for Cambodia develops towards a green, low-carbon, climate-resilient, equitable, sustainable and knowledge-based society, a mission by reading a national framework for engaging the public, private sector, civil society organizations and development partners in a participatory process for responding to climate change to support sustainable development, and 3 goals, (i) Reducing vulnerability to climate change impacts of people, in particular the most vulnerable, and critical systems (natural and societal), (ii) Shifting towards a green development path by promoting low-carbon development and Technologies, and (iii) Promoting public awareness and participation in climate change response actions. To achieve the vision, mission and goals, the Royal Government of Cambodia (RGC) has identified eight strategic objectives include (1)Promote climate resilience through improving food, water and energy security, (2) Reduce sectoral, regional, gender vulnerability and health risks to climate change impacts, (3) Ensure climate resilience of critical ecosystems (Tonle Sap Lake, Mekong River, coastal ecosystems, highlands, etc.), biodiversity, protected areas and cultural heritage sites, (4) Promote low-carbon planning and technologies to support sustainable development, (5) Improve capacities, knowledge and awareness for climate change responses, (6) Promote adaptive social protection and participatory approaches in reducing loss and damage due to climate change, (7) Strengthen institutions and coordination frameworks for national climate change responses, and (8) Strengthen collaboration and active participation in regional and global climate change processes.

Climate Change Priorities Action Plans (CCPAPs): 15 ministries have prepared action plans aligned with CCCSP 2014-2023. Specifically, the MAFF climate change priorities action plan proposed priorities actions "promoting resilience in animal production and adaptation to climate change" and "Enhancing animal waste management and emission mitigation". At the same time, promoting reforestation and afforestation to increase carbon stock in the forestry sub sector. MAFF is updating its plan to design a Climate Change Priority Action Plan (CCPAP) 2022-2030.

Gender and Climate Change Action Plan 2014-2018: The plan is developed by the Ministry of Women's Affairs following the Cambodia Climate Change Strategic Plan (CCCSP). The Ministry of Women's Affairs (MoWA) will actively address the following priority areas: 1. strengthening institutional capacity and cross-sectoral coordination with a focus on women's role in climate change adaptation and mitigation. 2. improving capacity, knowledge and awareness on women's role in climate change adaptation and mitigation. 3. reducing vulnerabilities to climate change impacts of disadvantaged women and other groups. 4. reducing GHG emissions by introducing climate friendly, low carbon economic activities for women.

The Second National Communication to the UNFCCC (SNC) (2015): The SNC Communication has been prepared to fulfil Cambodia's commitments to the Convention. It contains the necessary information about the country's major sources of greenhouse gas emissions and sinks, vulnerability and adaptation options, together with the necessary mitigation measures that Cambodia has implemented, and will continue to implement, to adapt to climate change impacts and to further contribute to global efforts to reduce greenhouse gas emissions. The vulnerability assessment and adaptation focused on sector for agriculture, forestry, human health, and coastal zone.

Cambodia National Environment Strategy and Action Plan (2016-2023): The National Environment Strategy and Action Plan (NESAP) 2016-2023 is developed in pursuant to Article 59 of the Constitution of the Kingdom of Cambodia, which mandates to the Royal Government of Cambodia (RGC) to manage and protect its environment and natural resources and requires the RGC to prepare management plans for these vital natural resources. It is also developed in accordance with the 1996 Law on Environmental Protection and Natural Resource Management. The NESAP 2016-2023 strategic goal is to leverage in-depth reform and modernization of the management and conservation of environment and natural resources through well-planned and executed actions for improving resources use efficiency and productivity, sustainable financing mechanism, and reducing waste and pollution and improving human health and well-being. The NESAP goals are articulated around four strategic objectives: i) to strengthen cross-sectoral collaboration and relevant legal instruments and guidelines to improve coordination, regulation, and delivery functions for sustainable development outcomes. ii) to improve resources, use efficiency for healthy environment and social well-being, while increasing business competitiveness and incentivizing technological innovation. iii) to develop and implement financing mechanisms, benefit sharing schemes and fund mobilization plans for investing in the modernization of the management and conservation of environment and natural resources. iv) to raise public awareness, build individual and institutional capacities, promote technology transfer and strengthen the application of monitoring science and technology to improve the management and conservation of environment and natural resources.

National Adaptation Plan Process in Cambodia (2017): This document aims at strengthening ongoing climate change adaptation processes through cross-sectoral programming and implementation at the national and sub-national level and pools them under one roof, and identified several key priorities for consideration and further implementation such as (1) Inter-sectoral coordinated implementation: opportunities for coordinated implementation include capacity development on climate change adaptation and financing at the national level, development and implementation of data management systems, etc., (2). Data systems and analyses: harmonization/standardization of data processing, modelling, projections, vulnerability assessments, and the use of geographic information systems, and (3). Capacity development and vertical mainstreaming linking national and sub-national levels: support measures such as capacity development, advisory services, upscaling mechanisms and enhanced ownership at the local level.

Cambodia National Adaptation Plan Financing Framework and Implementation Plan (2017): The main purpose of this document is to bring the NAP process in Cambodia closer to its execution with a specific aim to increase the possibilities for Cambodia to access additional adaptation finance.

Intended Nationally Determined Contribution (INDC) (2017): This INDC subjected to revisions to meet national circumstances as the country continues along its development pathway included both adaptation and mitigation actions based on national circumstances.

National REDD+ Strategy (2017-2026) (2017): The Cambodia REDD+ Strategy creates incentives to protect, better manage and wisely use the forest resources. The mission of the REDD+ Strategy is to strengthen the capacity of national and sub national institutions for effective implementation of policies, laws and regulations that will contribute to improved management of natural resources, forest lands, and biodiversity conservation. The goal of the strategy is to reduce deforestation and forest degradation, promote sustainable management and conservation, and contribute to poverty alleviation of local communities. The Royal Government of Cambodia has a clear vision that REDD+ is the national mechanism that provides an opportunity to support the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Environment, and relevant stakeholders, including local communities and indigenous peoples in their efforts to sustainably manage forest resources in the country.

Cambodia National Adaptation Plan Communication Strategy (2018): The main objective of the strategy is to "influence key stakeholders to be proactive players on the implementation adaptation actions, as prioritized in Cambodia's Climate Change Response, thus helping to mobilize resources and scale up implementation, as well as increase knowledge".

Agricultural Strategic Development Plan 2019-2023: The vision for agriculture development is climate resilience. Cambodian agriculture must deal with natural disasters possible, with two main measures, 1) adaptation or resilience to climate change focusing on the production of seeds and crops which are adapted to the drought and flood, 2) mitigation of climate change impacts by enhancing activities related to the establishment of the planting system; climate tolerant livestock (modern farm system, water saving, heat and rain management). Cambodian agriculture will need to be developed in accordance with the principle of "green development", reducing environmental and socio-economic impacts, and maintaining a balance between "conservation" and "development".

Mainstreaming Gender into Agriculture Climate Change Adaptation (CCA) Investments: Guidance Manual for Policy Makers and Practitioners (2018): Gender mainstreaming guidance is expressed in three levels of implementation: the document analyses gender gaps and needs at the policy level, identifies gender-response and gender balance at the program level, and verifies gender indicators at the beneficiary's level.

Rectangular Strategy phase IV (2019-2023): The Rectangular Strategy phase IV recognized climate change as a challenge and integrated climate change in its 4th pillar "Sustainable and Inclusive Development", under the 4th angle "Ensuring Environmental Sustainability and Preemptive Response to Climate Change, and called for development and implementation of integrated water resource management to expand water supply in response to demand, minimize risks caused by flood and drought, and ensure long-term water security.

Updated Nationally Determined Contribution (NDC Updated) (2020): The updated NDC prioritized 58 adaptation actions in agriculture, the coastal zones, energy, human health, industry, infrastructure, livelihoods, tourism, combating poverty, protecting biodiversity, and water resources. In addition, 32 actions for the mitigation target cover energy, waste, industry, transport, agriculture, building and the FOLU sectors.

Long-Term Strategy for Carbon Neutrality (LTS4CN) (2021): Cambodia also published their "Long-Term Strategy for Carbon Neutrality 2050 (LTS4CN)," in December 2020. With the submission of this policy, the country is the second least developed nation. Its main sectors for decarbonization were 1) FOLU, 2) energy, and 3) agriculture of the existing NDC goals. This plan is strategically aligned with nationally evolving climate priorities and commitments. Additionally, Cambodia's NDC set adaptation commitments across nine major sectors and various national ministries, considering its high dependency on climate-sensitive sectors like agriculture, water resources, forestry, fisheries, and tourism. The government's Second National Communication to the UNFCCC (NC2) from 2016 and its Third National Communication to the UNFCCC (NC3) in 2022 provide more details on these initiatives. The LTS4CN largely builds on the RGC’s existing commitments and proposes a trajectory it considers to be consistent with the updated NDC. The LTS4CN suggests that carbon neutrality by 2050 can be achieved through continued efforts to address forest sustainability and land use; decarbonize the power sector and pursue higher energy efficiency; and promote low-carbon agriculture, transport, industrial processes, and waste management.

The National Agriculture Development Policy 2022-2030 (2022): with the main objective to increase agricultural gross value-added by 3% per annum by providing broad guidance for the sector implementation to line ministries, development partners, and private sector. It defines four main areas and thematic policies for intervention including (1) Modernizing and commercializing the agricultural value chain, (2) Public and private investments in the agricultural sector, (3) Growing sustainable and increasing resilience to climate change, and (4) Institutional reforms and cross-cutting issues. MAFF’s strategy, outlined in the 2022-2030 National Agricultural Development Policy (ADP), is aligned with the 2050 vision and the aim for Cambodia to be an upper-middle-income country by 2030. In line with this, the ADP’s ambition is ‘to modernise the agriculture sector so it can become competitive, inclusive and resilient to climate change in a context of environmental sustainability’, with the overall development goal being ’to increase agricultural growth with high competitiveness and inclusivity by providing high-quality products which result in food safety and nutrition, while taking into account sustainable management of land, water, forestry and fishery resources.

The Third National Communication to the UNFCCC (TNC) (2022): The TNC Communication has been prepared to fulfil Cambodia’s commitments to the Convention. It contains the necessary information about the country’s major sources of greenhouse gas emissions and sinks, vulnerability and adaptation options, together with the necessary mitigation measures that Cambodia has implemented, and will continue to implement, to adapt to climate change impacts and to further contribute to global efforts to reduce greenhouse gas emissions. The vulnerability assessment and adaptation focused on key sectors included agriculture, forestry, and fisheries; water resource; human health; coastal zone; and gross cutting issues of gender.

The Pentagonal Strategy (2023): outlines five strategic goals: 1) Human capital development, 2) Economic diversification and competitiveness enhancement, 3) development of private sector and employment, 4) resilient, sustainable, and inclusive development, and 5) development of digital economy and society. In the Strategy Phase I (2024-2028) Cambodia seeks to ensure crisis-resilient economic growth of approximately 7% year-on-year on average, create more jobs, reduce the poverty rate to below 10% of the population, strengthen governance and improve public institutions to deliver public services and promote private sector investment, and to build resilience to climate change. Under this Pentagonal strategy, the government pays particular attention to the promotion of the agricultural sector and rural development, including its linkage with the National Action Plan for Zero Hunger Challenge 2016–2025. The current state of agriculture is a key sector, but it suffers from low productivity. To modernize agriculture, the strategy considers the following recommendations for modern techniques and technology: Promote the use of modern irrigation, high-yield seeds, and pest management. To implement, key activities must be in place: i) provide subsidies for the adoption of modern agricultural technologies; ii) establish extension services to educate farmers on modern practices; and iii) facilitate access to credit for smallholder farmers to invest in technology.

5. Progress on Implementation of Adaptation

5.1. Progress of Adaptation Strategy

The National Strategy for Plan on Green Growth for 2013–2030 and the NAP are connected, with a focus on inclusive development, greening investments, technology, and jobs, as well as good governance and sustainability education[85]. As Cambodia aimed to achieve the status of middle-income country by 2030, in term of NAP, the strategy emphasizes efforts to improve understanding of climate change impacts, address sea-level rise and coastal erosion and the need to ensure the effective reduction of disaster risks (IISD, 2018). Despite the efforts, climate budgeting lacks coordination, with 148 of 171 actions from CCCAPs remaining unfunded in its Sectoral Climate Change Strategic Plans (SCCSPs). One of the first nations to conduct a Climate Public Expenditure and Institutional Review (CPEIR) in response to the experience of worsening climate change consequences, Cambodia assisted in strengthening national capacities for cost-benefit evaluations related to climate change. To provide integrated finance and transparent budgeting, the Department of Climate Change created the National Adaptation Plan Financing Framework and Implementation Plan (NAPFFIP). More people are realizing that good monitoring of climate change adaption measures, national ownership, and political leadership are necessary for sustainable financing.

In 2017, Cambodia filed its first NDC to the UNFCCC. The document outlined the country's plans to mitigate climate change and reduce greenhouse gas emissions, as well as its budget tracking and climate financing initiatives. The key sectors identified within the NDC for adaptation include forestry, fisheries, water, human health, agriculture, and infrastructure (MoE, 2015). It also outlines multiple priority actions, including community-based adaptation, ecosystem restoration

85 National Council on Green Growth (2012). Cambodia National Strategic Plan on Green Growth 2013-2030. Retrieved from: https://www.greengrowthknowledge.org/national-documents/cambodia-national-strategic-plan-green-growth-2013-2030

and support to protected areas, flood protection, climate-resilient agriculture, combating water-borne and food-borne diseases, and mainstreaming of climate action.

Building on its initial (2002) and the second national communication (2015), Cambodia's NAP process has advanced steadily. Now, it expands upon the NSDP, the CCCSP, the CCCAPs, SCCAPs, NAPFFIP, and subnational climate mainstreaming programs. According to Cambodia, the CCCSP was its first NAP (see also NAP timeline and process). An expansion of these initiatives was the NAPFFIP, which offered a thorough analysis of the national and international climate adaptation finance landscape, established a standard procedure and approach for climate finance, identified sources and needs for funding, integrated adaptation into budgeting, and listed 40 key actions for the NAP process. Here are some key relevant policies and strategies:

- Cambodia's Initial National Communication to UNFCCC (2002)
- National Strategic for Plan on Green Growth for 2013-2030 (2012)
- Cambodia Climate Change Strategic Plan 2014–2023 (2013)
- Sectoral Climate Change Strategic Plans (2014 and 2015)
- Cambodia's Climate Change Action Plans (2014-2016)
- National Adaptation Plan Financing Framework and Implementation Plan (2014)
- Cambodia's National Adaptation Plan Process Stocktaking Report (2014)
- Cambodia's Second National Communication to UNFCCC (2016)
- Cambodia's Nationally Determined Contribution (2017)
- Cambodia National Adaptation Plan Financing Framework and Implementation Plan (2017)
- National Adaptation Plan Process in Cambodia (2017)
- Rectangular Strategy phase IV (2019-2023)
- Updated Nationally Determined Contribution (NDC) (2020)
- Long-Term Strategy for Carbon Neutrality (LTS4CN) (2021)
- Cambodia's Third National Communication to the UNFCCC (TNC) (2022)
- The Pentagonal Strategy (2023)
- Environmental and Natural Resources Code 2023.

5.2. Ambitious targets and policy planning, but some gaps in Implementation

The RGC's climate change regulatory framework is guided by an abundance of strategic plans and policy documents. The nation's comprehensive framework for climate policy as of January 2023 is the Cambodia Climate Change Strategic Plan (CCCSP) 2014–2023, which is in line with the objectives of RS–IV and the National Strategic Development Plan 2019–2023. To improve their own climate responsiveness at the subnational level, certain line ministries have concurrently, and with support from CCCSP, produced frameworks known as sectoral climate change strategy plans and climate change action plans.

Cambodia's key climate adaptation strategy documents and legal instruments include the updated NDC, the National Adaptation Plan, and the National Action Plan for Disaster Risk Reduction. The nine sectors that comprise the amended NDC's 86 adaptation activities cover important domains like infrastructure, energy, and agriculture. Along with medium- and long-term suggestions for climate change adaptation, the National Adaptation Plan Financing Framework and Implementation Plan lists forty short-term priority climate change measures. The government's main plan for disaster resilience is the National Action Plan for Disaster Risk Reduction 2019–2023, which emphasizes the need for better policy guidelines regarding the building of resilient public infrastructure and the mainstreaming of disaster risk reduction and climate change adaptation into line ministries' planning and development processes. The country's disaster risk management (DRM) landscape saw a major turning point in 2015 when the Law on Disaster Management was passed, expanding the concept of DRM to include pre-disaster, during disaster, and post-disaster situations.

5.3. Information on Implementation of Supported Adaptation Measures

Adaptation actions in the country to date have been mostly implemented through a variety of country-specific, tailored projects. Examples (non-exhaustive) include:

- Reducing the Vulnerability of Cambodian Rural Livelihoods through Enhanced sub-national Climate Change Planning and Execution of Priority Actions (2015-2020)
- Strengthening Climate Information and Early Warning Systems to Support Climate-Resilient Development in Cambodia (2015-2020):
- Scaling Up Climate Ambition in Land Use and Agriculture through NDC and NAPs (SCALA) Programme (2021-2025)
- Towards an Agroecological transition in the uplands of Battambang
- Early Warning System (EWS 1294) for risk prevention and reduction
- Enhancing Climate Resilient on Water Management and Agricultural Practice in Cambodia
- Public-Social-Private Partnerships for Ecologically-Sound Agriculture and Resilient Livelihood in Northern Tonle Sap Basin (PEARL) – FP199
- TCP/RAS/3903-Strengthening capacity of policy makers to mobilize investment for resilient and low emission agri-food systems in Asia under Article 6 of the UNFCCC Paris Agreement
- GCP/CMB/045/LDF-Promoting Climate-Resilient Livelihoods in Rice-Based Communities in the Tonle Sap Region

5.4. Effectiveness of Adaptation Measures Applied

Climate adaptation refers to changes in processes, practices, and structures to moderate potential damage or benefit from opportunities associated with climate change (UNFCCC, 2022). Although adaptation measures can never fully offset the wide-ranging impacts of climate change, they can attenuate many of the negative effects. Country Climate and Development Report (CCDR) by the World Bank identifies a range of measures that both the government and private entities could take to lower the impacts of climate change, evaluates the macroeconomic consequences of a select number of feasible adaptation options to incorporate into the macroeconomic modeling frameworks. These include the advantages of constructing flood-resistant infrastructure, risk-aware land-use planning, more irrigation, and cooling techniques to save indoor workers' health. These measures could reduce the impacts of climate change on GDP by 52–66%. In the CGE model GDP losses in 2050 could be reduced from 3% to 1% (a 66 %reduction) in the low scenario or from 9.4% to 4.9% (a 52% reduction) in the high scenario. In the MINDSET model, GDP losses in 2050 are very similar, declining from 9.1% to 5.0% (a 55% reduction) (**Figure III.16**).

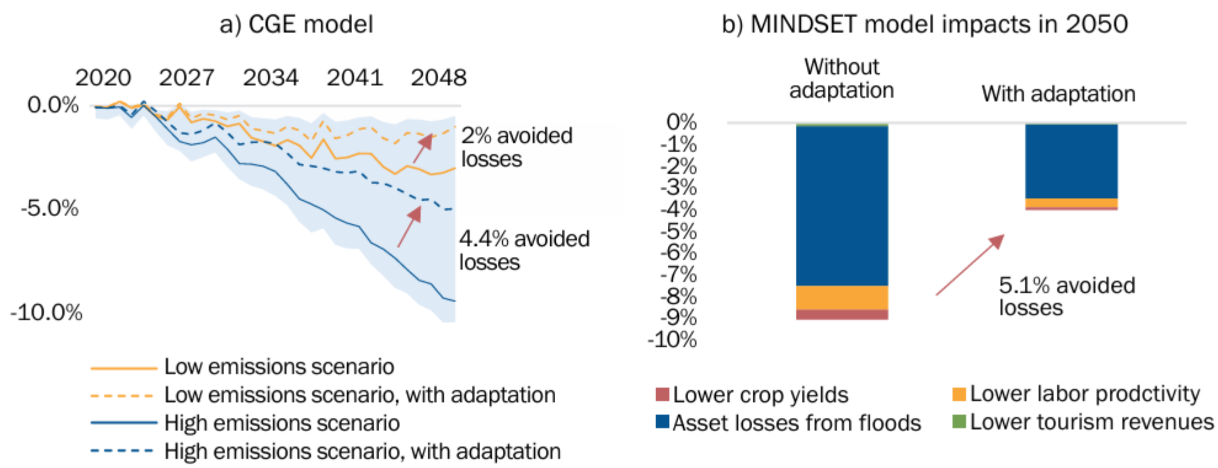


Figure III. 16: Adaptation measures could at least halve the GDP loss from climate change Impacts of climate change on GDP relative to a no-climate change baseline, with and without adaptation (%)
Source: (World Bank, 2023)

Note: Without considering adaptation measures, Panels a) and b) show asset losses from floods, the effects of heat on labor productivity, the effects of climate change on tourism, and the effects of climate change on crop yield losses in agriculture. In panel a), asset losses are the average. In panel b), asset losses are based on losses from a 1 in 10-year flood, excluding supply chain effects. Adaptation measures include risk-informed land-use planning, resilient transport infrastructure, climate-smart agriculture, and air conditioning.

Private sector adaption expenditures could be stimulated by government-led adaptation measures with significant positive externalities and public benefit components, such as knowledge about spatial climate hazards and emergency preparedness plans. Policies that address further flaws in the market that have an impact on how the economy functions may also encourage private adaptation. For instance, farmers' ability to invest in and adopt new crops that are better suited to the changing environment is frequently hampered by restrictions on the credit market. Since the private sector does not fully absorb risks, the government can also enact laws that help prevent underinvestment in adaptation and excessive risk-taking by the sector. Better building rules, required insurance, and land use planning that forbids building in flood zones are a few examples.

E. Progress on implementation of adaptation

(paras. 110–111 of the MPGs)

6. Climate Vulnerability and adaptation measure

The geographical incidence of extreme weather events such as droughts and floods vary, and while floods affect lowlands areas, the geographical distribution of droughts is widespread. The central plains' seasonal flooding provides certain benefits, but in the past ten years, the frequency of major floods has increased. Storms occur more frequently between August and November, with the highest frequency in October. The impacts of climate change on the Cambodian people and key economic sectors are likely to become increasingly significant. Cambodia has developed a specific Vulnerability Index (VI) to be able to track annually the percentage and number of communes scoring as highly vulnerable or quite vulnerable to three main types of climate hazards: floods, storms, drought. According to a series of vulnerability assessments carried out in 2016, 17.5% of Cambodia's communes were highly vulnerable (i.e. 288 communes) and 27.28% (449 communes) were quite vulnerable to multiple climate change hazards.

The rising severity of the climate crisis has been increasingly apparent in recent decades. Extreme weather conditions, such as an ongoing increase in Earth's temperature and protracted periods of both rain and drought, are characteristics of the disaster. Greenhouse gas emissions, part of a larger process of environmental degradation, contribute to harmful levels of air pollutants, such as particulate matter. Though their effects on health are frequently researched separately from one another, the effects of extreme temperature, precipitation, and air quality on health outcomes, including the spread of disease and long-term consequences, have been investigated for a few countries in the scientific literature.

The frequency and intensity of extreme weather events will probably rise due to climate change, which will also have an impact on human capital and health. The Intergovernmental Panel on Climate Change (IPCC) has released a report that emphasizes that average temperatures are bound to rise countrywide even under the 2°C scenario (IPCC, 2023). The predicted changes in temperature and precipitation patterns that accompany this warming trend increase the probability of either drought or periods of extreme precipitation (IPCC, 2021).Governments and health organizations worldwide are becoming increasingly concerned about the rising health costs brought on by climate change. Researchers and policymakers must generate localized evidence of weather-related health impacts and evaluate the effectiveness of adaption measures as adverse circumstances persist and intensify.

An increase in the average annual rainfall is anticipated, especially during the rainy season (Thoeun, 2015). Extreme weather conditions are likely to have an impact on the frequency and spread of a number of diseases, especially water-borne illnesses like diarrhea (Davies et al., 2014). Despite having a meager 0.14% share in global greenhouse gas (GHG) emissions in 2019, Cambodia's GHG emissions increased at an average annual pace of 8% between 2010 and 2019 (World Bank, 2023b). the extreme weather events and climate change are two major drivers of water-borne disease outbreaks in Asia and elsewhere in the world and diarrhea remains a leading cause of death from natural disasters globally, particularly in low-income countries (Davies et al., 2014). The high baseline disease burden and pre-existing risk factors for water-borne illnesses in Cambodia suggest that the additional burden of extreme weather events predicted by climate change would probably provide a significant health challenge to this developing country. Quantitative and qualitative data of the floods, droughts and typhoons in Cambodia from 1991–2023 were collated (**Table III. 10**).

Table III. 10: A summary of the impacts of extreme weather events (floods, droughts and typhoons) in Cambodia from 1991–2023

Year	Event (Month/s)	No. of province affected	Impacts
1991	Flood (August)	10	• 100 people died, 900,000 people affected • 243,000 ha agricultural land affected, US$150,000,000 estimated damages
1994	Drought (June)		• 5,000,000 people affected, US$100,000,000 estimated damages
	Flood (July)	6	• 506 people killed, 12,000 people displaced
1996	Flood (September)	10	• 59 people killed, 1,372,410 people affected • 30,577 ha agricultural land affected, 584,693 people affected by food shortage • US$1,500,000 estimated damages
1997	Typhoon (November)	1	• 23 people killed, 200 people missing
1997–1998	Drought ("Late 1997–Early 1998")		• Food shortages mid-year
1999	Flood (July–August)	7	• 4 people killed, 535,904 people affected, 8100 people displaced, 7000 homes affected • 17,732 ha agricultural land affected, US$500,000 estimated damages

	Flood (November)	6	• 25,847 families affected; 3561 homes affected • 9990 ha tares agricultural land affected
2000	Flood (July–November)	22	• 347 people killed (80% children), 3,448,629 people affected, 387,000 people displaced • 325,043 homes affected • 421,569 ha agricultural land affected • US$156,655,500 estimated damages
2001	Drought ("Most of the year")	12	• 530,844 people affected by food shortage
	Flood (August–October)	18	• 62 people died (70% children), 2,121,952 people affected, 508,666 people displaced • 201,371 ha agricultural land affected, 945,665 people affected by food shortage • US$16,900,000 estimated damages, (total 2001 drought & flood: US$36,000,000) • Increase in diarrheal disease
2002	Drought (January–August)	24	• 2,660,000 people affected, 30,000 forced migrations • 246,643 ha agricultural land affected, 1,000,000 people affected by food shortage • US$38,000,000 estimated damages
	Flood (August)	6	• 29 people killed, 1,470,000 people affected, 450,000 people displaced • 2731 ha agricultural land affected, 470,000 people affected by food shortage • US$100,000 estimated damages
2004–2005	Drought (October 2004–April 2005)	14	• 2,000,000 people affected, 1,000,000 people affected by food shortage • 520,000 ha of agricultural land affected US$21,000,000 estimated damages
2006	Tropical Storm Prapiroon, Flood (August–September)	9	• 13 people killed, 33,000 people displaced, 263 houses affected • 17,515 ha of agricultural land affected
2007	Flood (June)	1	• NA
	Tropical Storm Pabuk, Flood (August)	8	• 5 people killed, 160,000 people affected • 8000 ha agricultural land affected • US$1,000,000 estimated damages
2008	Flood (August)	1	• NA
	Drought (September)	1	• NA

2009	Drought (August)	7	• 79,000 ha agricultural land affected
	Typhoon Ketsana, Flood (September–October)	14	• 43 people killed, 67 people injured, 180,000 people affected, 6210 families displaced • 10,000 homes affected • 57,000 ha agricultural land affected: 48,000 families affected by food shortage • US$131,996,415 estimated damages • Increase in diarrheal disease
	Typhoon Mirinae (November)	1	• 2 people killed, 4 people injured
2009–2010	Drought (November 2009–July 2010)		• NA
	Flood (October–November)	8	• 8 people killed, 5 people injured, 9726 families affected • 33,096 houses affected • 18,527 ha agricultural land affected • US$70,000,000 estimated damages
2011	Flood (August–November)	18	• 247 people killed, 23 people injured, 1,640,023 people affected, 214,000 people displaced, 270,371 houses affected • 423,449 ha agricultural land affected, 15% households severely food insecure • US$521,000,000 estimated damages • Increase in diarrheal disease
2012	Tropical Storm Pakhar (March–April)	1	• 5 people injured • 145 houses affected
	Drought (July–August)	14	• 146,140 ha agricultural land affected
	Flood (September–October)	8	• 27 people killed, 14,322 families affected, 4057 families displaced • 12,274 houses affected; 16,510 ha agricultural land affected
	Tropical Storm Gaemi (October)	7	• NA
2013	Flood (August)	4	• 13 people killed, 2592 families affected, 450 families displaced, 230 houses affected • 20,000 ha agricultural land affected
	Flood, Typhoon Usagi, Tropical Storm Krosa	21	• 188 people killed, 29 people injured, 1,735,828 people affected, 144,044 people displaced • 240,195 houses affected

	(September–October)		• 384,846 ha agricultural land affected • US$1,000,000,000 estimated damages • Increase in diarrhea disease
2015	Flood, Tropical cyclone	18	• The effects of El Niño at least 50% of districts affected. • 18 provinces were severely affected, and 2.5 million people were affected. • There was significant crop damage and low water supplies which affected many poor communities who depend on precipitation fed water supplies for irrigation. • Health centers also reported increased cases of illnesses.
2016	Lightning and Storms	4	• Storm destroyed 1,997 houses and damaged the roofs of 8,147 houses. • There were 21 deaths and 193 injuries. • Lightning strikes killed 108 people, injured 105 more, killed 40 cattle and damaged 9 houses,
2018	Flood	6	• In July after heavy storms, 25,000 people in northern parts of Cambodia were evacuated and approximately 26 people died in this flooding • Lightning caused over 90 casualties including more than 50 human deaths and 50 cattle and destroyed more than 2,000 houses.
2019	Flood	4	• Approximately affected 94,000 households, displaced 11,500 households, and 16 people died in 4 provinces Tbong Khmum, Kampong Cham, Kratie, and Stung Treng
2020	Tropical cyclone	19	• There were 42 fatalities after more than 2 million people were exposed to flooding with some 800,000 people directly affected and 14,300 households evacuated. • In sum, an estimated 388,000 people needed immediate humanitarian assistance. More than 161,500 houses were damaged across 19 provinces with the worst affected being Battambang, Banteay Meanchey, Pursat, Kampong Speu, and Kampong Thom
2022	flood	14	• Heavy rains in September and October caused flooding in 14 provinces. An estimated 85,482

			households in Kampong Thom, Battambang, Banteay Meanchey, Pursat, Preah Vihear, Siem Reap, Tbong Khmum, Kratie, Stung Treng, Oddar Meanchey, Kampong Chhnang, Mondulkiri, Kampong Cham, and Kampong Speu were affected. Fourteen people died in Banteay Meanchey, and 1 person was killed in Oddar Meanchey. Some 33,165 homes, 29 health centers, and 280 schools were damaged, and significant impact on roads and agricultural production.
2023	Flood	17	• From July through September 2023, heavy rains affected 40,942 households in 17 provinces. 1,920 households evacuated, and 3 people were killed. The worst-affected provinces were Kampong Thom, Battambang, Pursat, and Siem Reap. Rural roads and nearly 33,000 ha of agricultural land were flooded and damaged.
2023	Lightning Strikes	4	• In 2023, 84 people were killed and 59 were injured; 107 head of cattle were killed, and 16 houses were damaged. The provinces with the most lightning strikes were Battambang, Siem Reap, Kratie, and Kampong Thom

Source: (Davies et al., 2015; Hamid et al., 2023; MoE, 2022 and CFE-DM, 2024)

7. Climate vulnerability index

7.1. Commune vulnerability index

The vulnerability to climate change at the commune level was assessed using the nationwide commune statistics from 2017, in conjunction with a comprehensive review of relevant documents, expert judgment, and the recommended methodological approaches and guidelines from the United Nations Framework Convention on Climate Change (UNFCCC). The assessment incorporated eight key indicators: (i) education level by age groups, (ii) primary occupation types, (iii) household assets and facilities, (iv) remoteness, (v) source of drinking water, (vi) sanitation facilities, (vii) dependency ratio, and (viii) frequency of occurrence of extreme climate events. These indicators were aggregated to evaluate vulnerability in accordance with the established vulnerability framework, which considers sensitivity, exposure, and adaptive capacity as its core components.

This comprehensive assessment provides a detailed overview of the status of climate change vulnerability at the commune administrative level, categorized into five scales of the Vulnerability Index: Least, Less, Quite, and High. The results of this evaluation are illustrated in **Figures III .17**, offering a visual representation of the varying degrees of vulnerability across different communes. These findings are crucial for informing targeted climate adaptation strategies and policies aimed at reducing vulnerability and enhancing resilience at the local level. Compared to the baseline, in 2014, the Commune Vulnerability Index highlighted significant progress. The number of communes that are less and quite vulnerable has dramatically decreased over time; however, the communes that are highly vulnerable to climate extreme events remain almost the same as during the baseline period. This suggests a need to expand investment in adaptation actions, particularly in areas that remain highly vulnerable. By targeting these high-risk areas, resources can be more effectively allocated to reduce vulnerability and enhance resilience against climate-related impacts. Additionally, continuous monitoring and assessment are essential to track progress and adjust strategies accordingly to ensure all communes can achieve lower vulnerability levels over time.

The assessment indicated that 47% of the communes in Cambodia fall into the "least to most vulnerable" categories, suggesting a significant proportion of communes are at varying levels of vulnerability. Specifically, 19% of the communes are classified as "quite vulnerable," indicating a moderate level of risk. Additionally, 17% of the communes are categorized as "less vulnerable," and another 17% as "least vulnerable," showing lower levels of vulnerability to climate change impacts.

The illustration of the vulnerability of various provinces and communes to storms. Notably, the index reveals that over 50% of the provinces are less vulnerable to storms, with some being among the least vulnerable. However, the areas surrounding the Tonle Sap Basin are considered highly vulnerable to storm impacts.

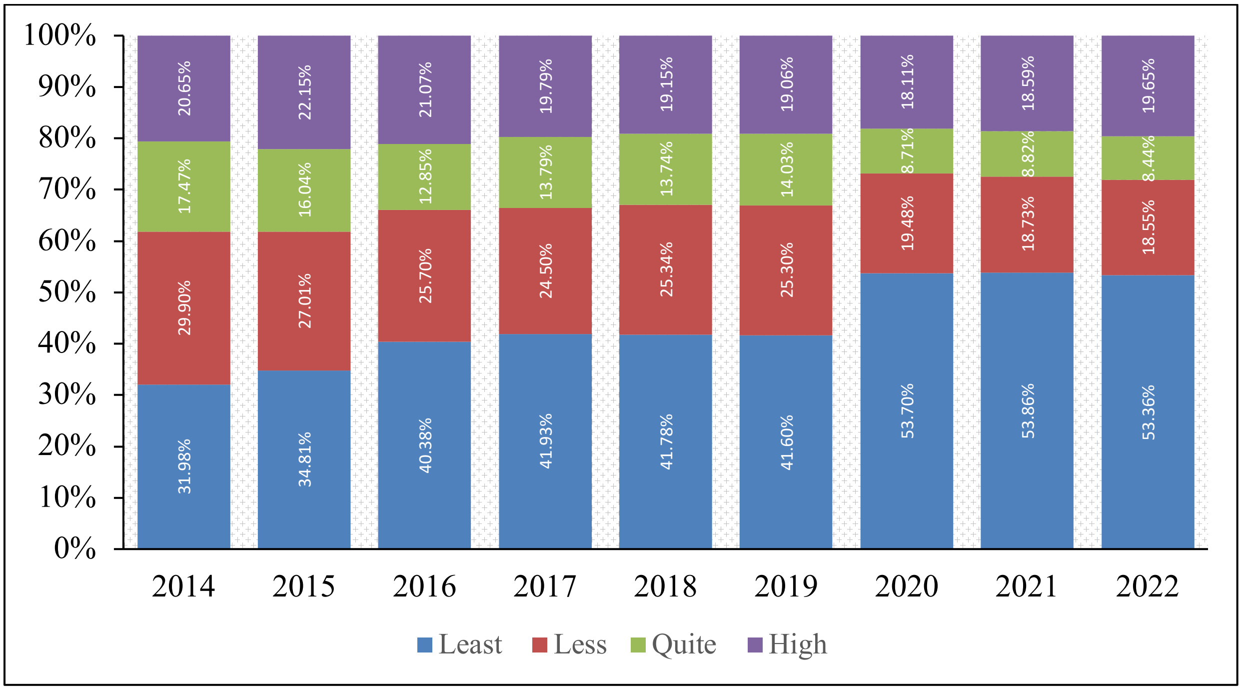


Figure III. 17:Commune vulnerability index 2017-2022; Source: (MoE, 2024)

7.2. Spatial distribution of vulnerability Index

Oddar Meanchey and Preah Vihear are the most vulnerable provinces to flooding and drought in the region. These areas are particularly susceptible due to their geographic and climatic conditions, which make them prone to extreme weather events. The recurring floods and droughts not only disrupt the lives of the local population but also significantly impact agriculture, infrastructure, and the overall economy. In addition, Stung Treng is the least vulnerable province to storms, however, it is highly vulnerable to droughts.

While the province-level rankings provide a holistic overview of vulnerability to climate change at a national level, it is important to recognize that the commune-level vulnerability to different hazard types varies significantly. For instance, a significant percentage of communes in some provinces are less vulnerable to storms. Kampong Chhnang and Preah Vihear are the most vulnerable provinces to storms, with Kampong Chhnang having a higher overall Storm Vulnerability Index (VI) score. Meanwhile, Banteay Meanchey has a higher percentage of communes vulnerable to storms in Categories 1 (Highly vulnerable) and 2 (Quite vulnerable), nearly 3.13% and 37.50% respectively (**Figure III 18-20**). This distribution highlights the diverse levels of vulnerability across the country, emphasizing the need for enhancing adaptation strategies to address the specific needs of each commune. The detailed breakdown of these categories is essential for policymakers and stakeholders to prioritize resources and efforts in the most affected areas, ensuring that interventions are both effective and equitable. This emphasizes the need for focused disaster preparedness and mitigation strategies in the Tonle Sap Basin to enhance resilience and reduce storm-related risks. The data provides a critical understanding of regional disparities in vulnerability, guiding resource allocation and policymaking to protect the most at-risk communities.

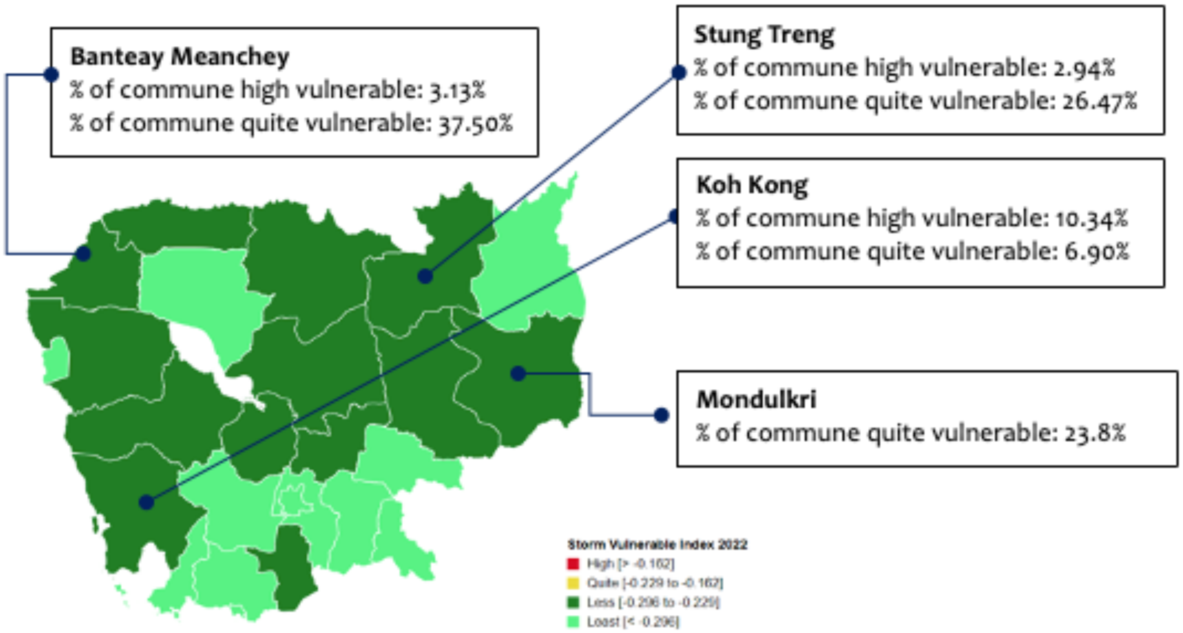


Figure III. 18: Storm vulnerable index 2022
Source: (MoE, 2024)

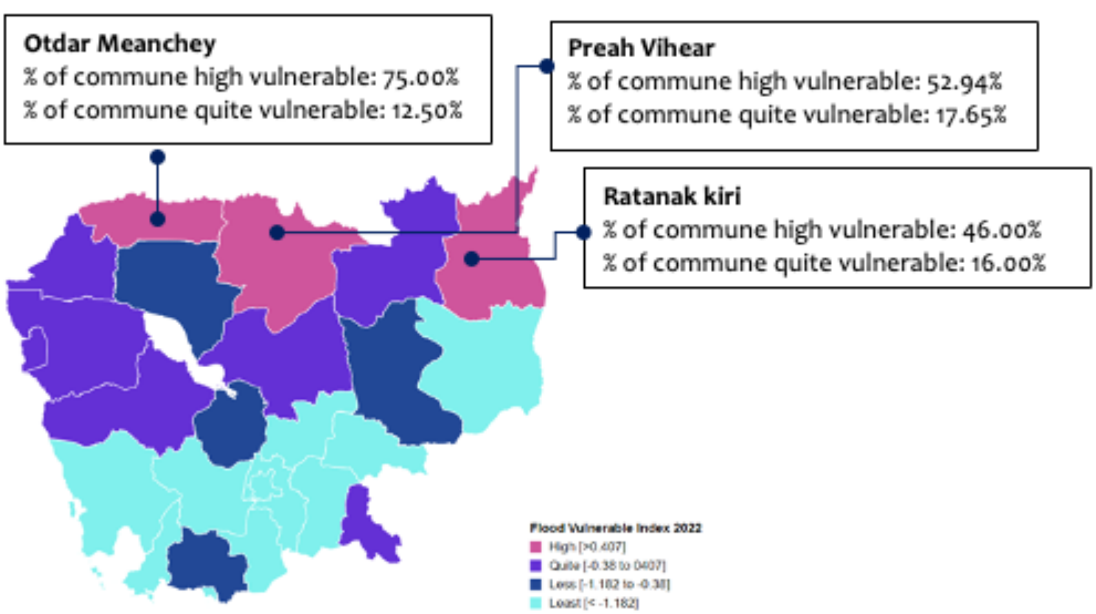


Figure III. 19: Flood Vulnerable Index 2022
Source: (MoE, 2024)

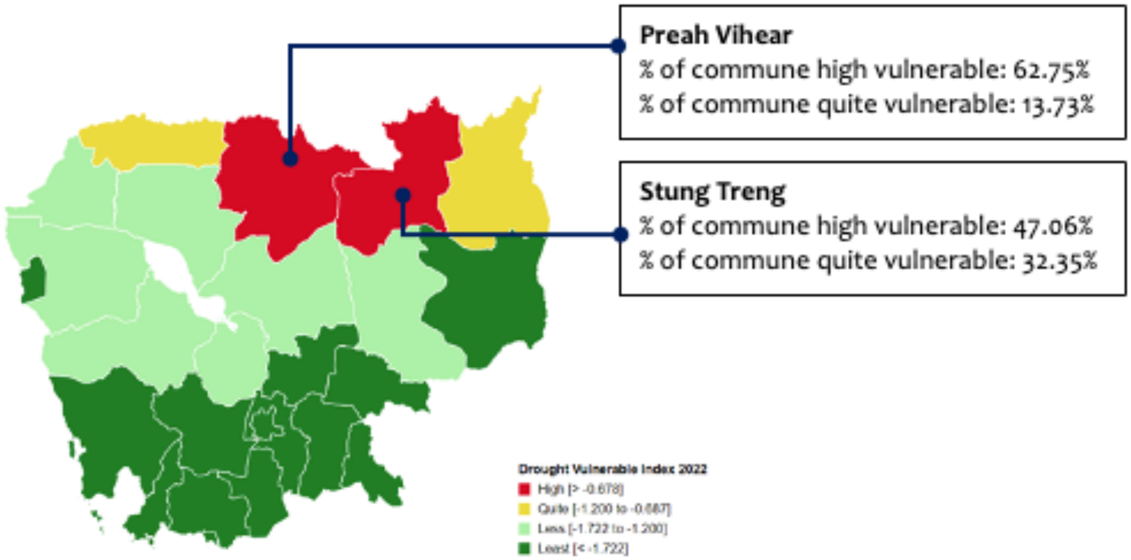


Figure III. 20: Drought vulnerability Index 2022
Source: (MoE, 2024)

7.3. Overview the adaptation progress in. Agriculture sector

Tracking impact indicators in agriculture relies heavily on the statistical data maintained by the Ministry of Agriculture, Forestry, and Fisheries (MAFF). Key indicators include yield per ha of crops and the number of livestock heads etc. The analysis presented in **Figure III 21** (a-f) highlights the key commodities identified by MAFF as essential for monitoring agricultural performance and productivity. As indicated in the M&E framework, rainfall is considered an influential factor in agricultural performance. Analyzing the correlation between rainfall and yield compared to the baseline data from 2015, we observe slight increases in the production of all five commodities despite variations in rainfall (IIED, 2016). However, cassava production has significantly decreased, which is associated with factors such as poor planting materials, soil degradation, and inadequate management practices. While multiple factors influence rice yield, the observed results are a positive sign. If climate change interventions in the agriculture sector are effective, we would expect rice yield rates to remain stable or improve over time. The figures illustrate the trends and changes in production over time, providing insights into the successes and challenges within the sector.

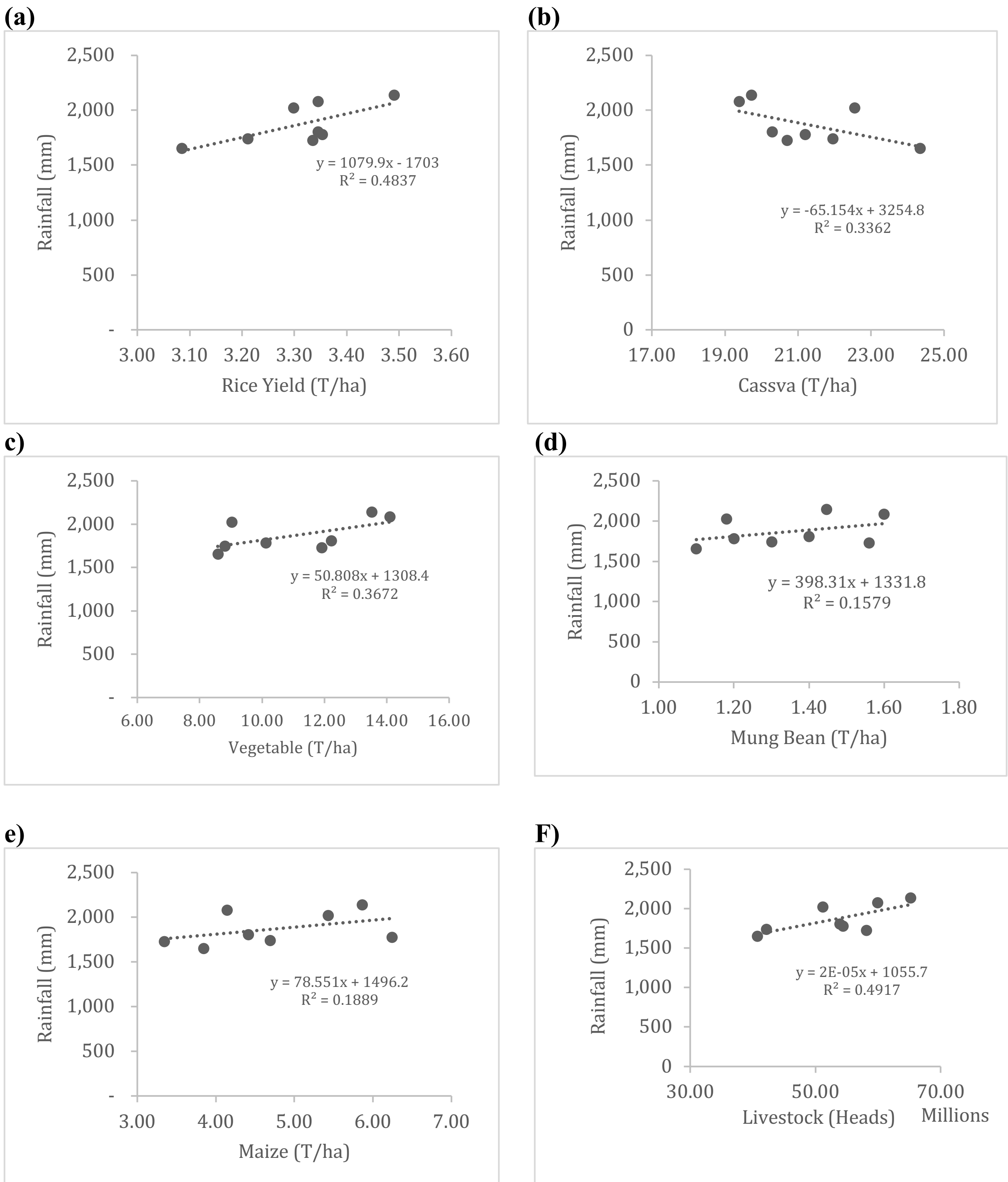


Figure III. 21: Tracking impact indicator in agriculture sector a) rice (ton per ha), b) cassava (ton per ha), c) Vegetable (ton per ha), d) Mungbean (ton per ha), e) Maize (ton per ha, and f) livestock (head of animal)

Source: (MAFF, 2024, MOWRAM, 2018)

8. Adaptation measure on specific sectors

Cambodia is classified as one of the most climate-vulnerable countries worldwide due to its strategic location, substantial reliance on agriculture, and insufficient adaptive capabilities. The country's shortage of human, financial, and technical resources exacerbates these issues.

8.1. Agriculture

The agriculture sector is extremely vulnerable to rising temperatures, altered rainfall patterns, and extreme weather events including floods, droughts, cyclones, and rising sea levels in coastal regions. Climate change is projected to cause longer and dryer dry seasons and shorter rainy seasons. According to some sources, farmers are already frequently facing floods and droughts, which lower agricultural yields and threaten food security. Agriculture is not only a source of livelihood for many people, but it is also crucial for food security. The agriculture sector shared to Cambodia's GDP in 2021 accounted for 24.4% at current prices, including sub-sector crop production 57.4%, fishery 24.4%, livestock 11.4%, forest 7.4%, and rubber 5.7% (MAFF, 2021).

8.1.1. Rice Crop

Rice is the predominant crop and a staple of rural diets, average yields between 2013 and 2017 were 9.7 million metric tons; production accounted for more than 80% of all cultivated land in the country; consumption accounted for roughly 68% of daily caloric intake in rural communities. Simultaneously, cassava has gained popularity; between 2002 and 2012, production climbed by nearly 7.5 million tons (USAID, 2019a).

The agriculture sector is particularly vulnerable to the impacts of climate change due to the following threats it faces:

- Extreme weather events, storms, droughts, and floods will occur more frequently in many areas of Cambodia.
- Significant changes in seasonal rainfall patterns are predicted to occur, resulting in prolonged dry seasons and shorter, more severe wet seasons.
- In the medium and long terms, higher average temperatures and rates of evapotranspiration are anticipated. A just 1°C rise can result in a 10% decrease in yields.
- Increased water demand as higher temperatures induces higher evapotranspiration.
- Extended growth cycles, warmer winters, faster pathogen growth, and more weed competition between plants because of elevated CO_2 levels have all contributed to an increase in the prevalence of pests and diseases.
- Effect of increased CO_2 on fertilization: plants may respond by growing more vegetatively, though this will depend on the species and type of plant.
- Sea level rise and saline water intrusion will reduce viable crop areas in the Mekong Delta.

In Cambodia, drought is recorded based on damage to areas of rice production caused by a lack of water. Damage to paddy rice caused by flood and drought is recorded in the MAFF's Agricultural Statistics, especially since 1994. However, data was compiled on damage by drought and flood from various sources mainly data before 1994. In total, drought caused 1.09 million ha of damage and flood caused twice between 1984 and 2018 (UNDP, 2019, **Figure III.22**). Changes in the rainy season's timing could significantly negatively influence rice harvests even though adaption techniques remain unidentified. According to one study, rainy-season loss of productivity might reach 9.9% and dry-season yield losses of 7.7% by 2050, respectively, if farmers do not ensure optimal timing, cultivar, and fertilizer use in the face of shifting climatic circumstances. alterations in the timing, frequency, and/or intensity of precipitation can notably affect the poorest farmers in Cambodia, who usually do not have irrigation because most the country's rice fields are rain-fed, with only 20% being irrigated. Prolonged droughts in 2004 and 2005 affected nearly 30% of agricultural land in Cambodia and caused a 14% decrease in rice yields. Projections suggest more frequent flooding in and around the Tonle Sap as well as in the floodplain zones of the Mekong, which could increase agricultural losses already estimated at US$100-170 million per year. Changing climatic conditions further expose crop production to increased outbreaks in agricultural pests and diseases. Prolonged droughts in 2004 and 2005 affected nearly 30 %of agricultural land in Cambodia and caused a 14% decrease in rice yields. Projections suggest more frequent flooding in and around the Tonle Sap as well as in the floodplain zones of the Mekong, which could increase agricultural losses already estimated at US$100-170 million per year. Changing climatic conditions further expose crop production to increased outbreaks in agricultural pests and diseases (USAID, 2019).

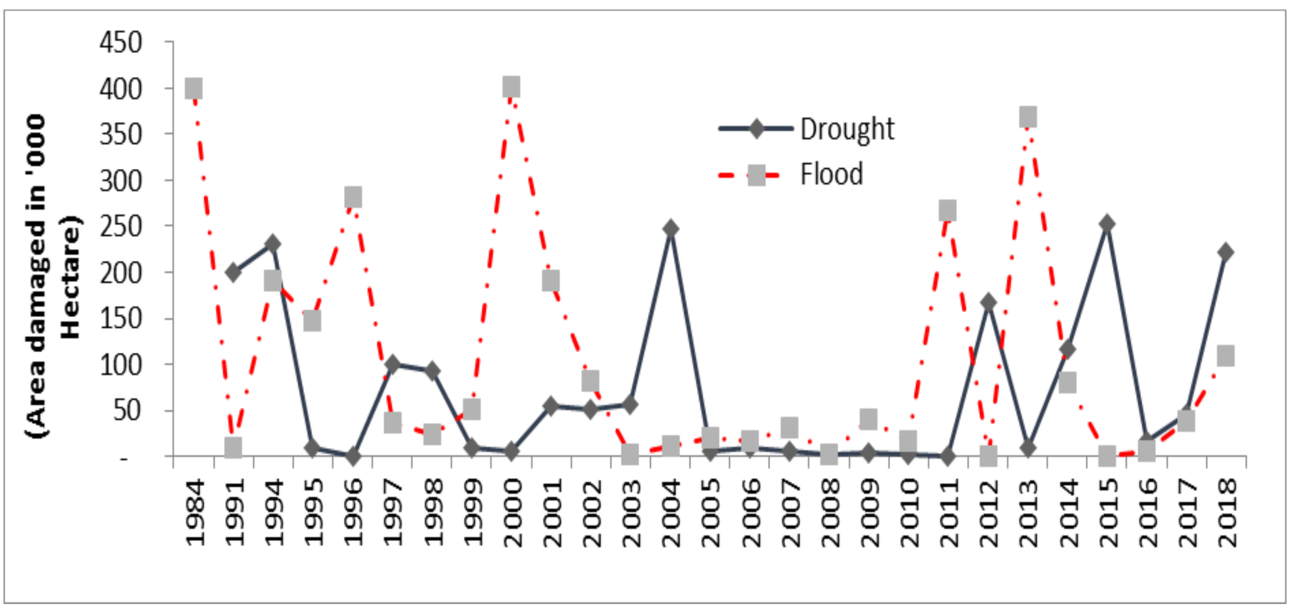


Figure III. 22: Flood and drought damage by paddy rice areas in Cambodia, 1984-2018

8.1.2. Adaptation options and measures in rice/crop production

According to Cambodia's Second National Communication submitted to UNFCCC in 2015, has proposed some adaptation measures and activities for rice production that suitable for implementation. In the short term should focus efforts on increasing its capacity to cope with current climate risks through the improvement of climate risk management and community livelihood, including:

- Increasing the capacity to use climate information, such as the use of climate forecast information, in setting up better cropping strategies and agribusiness activities
- Implementing adaptation measures that also contribute to emission reduction, such as the introduction of technology that increases water use efficiency via the System of Rice Intensification (SRI)
- Creating additional sources of income for communities from co-benefits of mitigation activities, such as generating carbon credits from reforestation or the use of manure and biomass waste (e.g. biogas for cooking and biomass energy in rice mills, composting, etc.).

In the long-term efforts will be directed at increasing the resilience of the agriculture system to future climate risks through the revitalization of long-term policies and planning that consider climate change, including:

- Institutionalizing the use of climate information in agriculture management and development.
- Prioritizing structural intervention programmes (where and when a particular intervention should be in place to minimize the impact of increasing climate risk, such as constructing dams or irrigation schemes).
- Expanding agriculture areas to regions with lower climate risk.
- Creating climate insurance for vulnerable communities.
- Generating more varieties resistant to drought, flood, and high salinity.
- Developing and implementing long-term research on climate modeling, mitigation, and adaptation technologies.

In the CCCSP 2014-2023 emphasized strategies responding to climate change adaptation and mitigation co-benefit for crop production including:

- Increase capacity to identify climate-induced opportunities in agricultural production systems, ecosystems, and nature protected areas
- Agricultural diversification (e.g. crops, livestock, etc.)
- Increase in productivity (e.g. crops, fisheries, livestock, forestry, etc.)

- Opportunity for new crop varieties
- Watershed and ecosystem management
- Strengthen the capacity of local farmers, especially FWUC members, on the selection of less-water crop varieties, and the planning of a less-water crop system for climate change adaptation
- Promote the use of appropriate technologies on livestock and crop production for vulnerable farmers.

For adaptation of crop production, Cambodia's NDC, LTS4CN, and TNC have identified some adaptation options and measures that are suitable for implementation in Cambodia as listed in **Table III.11.**

Table III. 11: Summary of key adaptation measures and actions for rice/crop production from NDC, LTS4CN, and TNC

NDC	LTST4CN	TNC
Adaptation measures for rice/crops		
Improved new management approach in agroecosystem of the uplands Battambang	Improvement in agriculture productivity	Seasonal and annual weather prediction and forecast
Enhancement of rice crop management for increased productivity, quality safety, harvesting and post-harvesting technique, and agro-business	Conservation of biodiversity and ecosystem services	Sustainable water use management: sprinkler irrigation, drip irrigation, solar and windmill water pump, rainwater harvesting, crop water requirement planning, deficit irrigation
Development of Horticulture and other food crops	Direct seeding practices	Integrated soil management: sloping agriculture land technology, slow-forming terraces, conservation tillage, integrated nutrient management, compost making, soil senility management, vetiver and soil stabilization grasses, live staking, mulching
Development of Industry crops for increased production, improved quality-safety, harvesting and post-harvesting technique, and agro-business	Reduced exposure to climate related extremes and slow onset events affecting agriculture and dependent livelihoods.	Sustainable crop management: crop diversification and new varieties, new varieties from biotechnology, ecological/ integrated pest management, seed and grain storage, the system of rice intensification, alternate wetting and drying rice irrigation.

Improvement of support services and capacity building to crop production resilient to climate change by promoting research, trials, and up-scaling climate-smart farming systems	Support in suppressing opportunistic agricultural pests and invasive species favored by higher temperature and humidity due to climate change.	Sustainable farming and livelihood systems: irrigated rice fish system, mix farming system, agroforestry
Research for the development and enhancement of agricultural productivity, quality, and transfer through strengthening of crop variety conservation and new crop variety release responding to climate change impacts	Introduction of innovative sustainable techniques in crop rotation to strengthen their life cycle, reducing the use of chemicals, water consumption and soil erosion	Capacity building and development for community-based agriculture extension, farmer field schools, forestry user groups, water user associations, community-based seed systems
Building climate change resilience on cassava production and processing	Increased crop breeding for greater heat and water tolerance as well as food security	Increasing the use of mobile pumping stations and permanent stations in responding to mini droughts, and promoting groundwater research response to drought and climate risk
Development of new technologies and increased yields by using new crop varieties which adapt to climate change	Drought preparedness increases adaptive capacity for water management	Strengthening early warning systems and climate information dissemination
Scaled up climate-resilient agricultural production through increased access to solar irrigation systems and other climate-resilient practices	Enable more consistent stream flows that can deliver irrigation water	Developing crop varieties suitable to Agro-Ecological Zones (AEZ) and resilient to climate change (include coastal zone)
Practicing smart agriculture in the tourism sector	Potential for scaled-up climate-resilient agricultural production through increased access to solar irrigation systems and other climate-resilient practices.	Promoting climate resilient agriculture in coastal areas through building sea dikes and scaling-up of climate-smart farming systems

Promote climate-friendly Agri-business value chain	Promotion of organic fertilizers	Developing climate-proof tertiary-community irrigation to enhance crop yields and production
Increasing resilience to climate change and natural disasters, and improving resilience facilities, tools, and technologies	Increased soil fertility, which can help farmers deal with increased temperatures and climate variability	Developing and rehabilitating the flood protection dike for agricultural and urban development
	Improved crop yields by using composting fertilizer	
	Alternate wetting and drying practices	

8.2. Fisheries

Climate change is expected to significantly impact inland fisheries in Cambodia. The inland capture fisheries of Cambodia are among the most productive globally, providing the main source of protein, especially in rural diets, accounting for approximately 61% of a household's animal protein intake. The average annual fish consumption per person is estimated at 63 kg (MoE, 2022). About 12% of GDP comes from this industry, which is especially significant for rural livelihoods where fishing generates more than 50% of total income. About 98% of people who live in the floodplains of the Tonle Sap are involved in some form of fishing activity and the fishery there alone contributes 7% of the country's GDP.

Changes in fishery production are likely to have the greatest impact on the people most dependent on fisheries, whose poverty, marginalization and lack of livelihood alternatives leave them ill-equipped to cope (WorldFish Center, 2007). However, a combination of climatic stressors, such as increased precipitation during the rainy season and decreased precipitation during the dry season, may cause hydrological changes in the Tonle Sap and Mekong River Basins, which might have a variety of effects on fisheries, both beneficial and detrimental.

Fisheries and food security are particularly vulnerable to the impacts of climate change due to the following threats:

- Increased temperatures decreased production and diversity of species found in fisheries
- Drought, Habitat degradation or loss for fish, other aquatic animals, and aquatic plants and wetland lost
- Increased rainfall and flash floods; Unpredictably of water levels
- Extreme weather events; Loss of fishing infrastructure
- Sea-level rise; Reduced freshwater availability

For example, the Tonle Sap region experienced a record-breaking El Niño in 2016, which resulted in heat waves, drought, and low water levels. It also fostered an unprecedented spread of wildfires in the region, affecting an estimated 640,000 ha—approximately a third of the flooded forest area—impacted. Projected sea level rise causes an extra threat to wetland habitats and freshwater quality while rising salinities may negatively influence the health of mangrove or freshwater ecosystems, which may reduce the quantity and/or quality of nutrients needed to support fisheries. Lastly, the fishing infrastructure in Cambodia may be further threatened by extreme weather events that destroy equipment used and owned by rural households (FAO, 2018).

8.2.1. Adaptation options and measures in Fishery and aquaculture

Fisheries must be taken into consideration in adaptation planning to ensure that adaptation measures in other sectors, such as irrigation and hydroelectric projects, do not inadvertently undermine fishery sustainability. Building fisher communities' capacity to adapt to immediate environmental change, partly by diversifying livelihoods and improving access to natural resources, goes together with improving their long-term capacity to adapt to climate change. As fisheries and aquaculture can compensate for other adaptation problems, such as the loss of low-lying farmland, conserving wild fisheries and enhancing aquaculture should be considered twin strategies of adaptation to climate change (WorldFish Center, 2007).

In the CCCSP 2014-2023 emphasized strategies responding to climate change for adaptation and mitigation co-benefit in fishery production including:

- Enhance capacity on climate change understanding (fisheries sector)
- Promote conservation and management of fisheries and aquaculture in a sustainable way
- Promote the development and improved efficiency of fisheries sector management
- Enhance community fisheries management
- Promote human resource development essential to contribute to adaptation and the reduction of impacts on fisheries resources.

For the adaptation of the fishery and aquaculture sector, Cambodia’s NDC, LTS4CN, and TNC have identified some adaptation options and measures that are suitable for implementation in Cambodia as listed **in Table III.12**.

Table III. 12: Summary of key adaptation options and measures for the fishery and aquaculture sector from NDC, LTS4CN, and TNC

NDC	LTST4CN	TNC
Adaptation measures for Fishery/Aquaculture		
Promoting aquaculture production systems and practices that are more adaptive to climate change	Avoiding biotic disturbances such as the spread of pests and pathogens on crops that	Enhancing the productivity of rice field fisheries through the protection of dry season habitats for fish

	will lead to water pollution	
Promoting climate resilience in the capture fisheries sector	Improved forest management and protection and the development of sustainable ecosystem services in particular mangrove and flooded forest	Participatory action research in inland small-scale fisheries co-management and wetlands conservation
Effective management and protection of ecological systems of marine and coastal zones to avoid adverse impacts from various factors, build their resilience, and restore their functions for productive and healthy oceans	Conserving water in natural systems to alleviate the effect of droughts	Low input, cost-effective, and nutrition-sensitive small-scale and medium enterprise models for aquaculture production and business enterprise models
Early warning systems on climate change vulnerable and impacts	Ecosystem protection through the restoration of natural habitats affected by climate change; restored hydrological balance in river basins	Climate-Smart Agriculture technologies and practices
Implement community–based disaster and climate risk management programs	Maintaining groundwater and surface water quality and quantity	Adapt by making ponds for conservation, making conservation areas
Establish a centralized and standardized approach to climate- resilient water management	Solid waste and wastewater proper management (collection, disposal and discharge)	Aquaculture producers will have to avoid overfeeding and overstocking fish and monitor the water temperature
		Build capacity for problem-solving
		Create and improve livelihood options; diversify livelihoods
		Extend/promote understanding of climate change
		Grow/re-grow forests and the flooded forest
		Dig ponds, rehabilitate canals, make conservation areas
		Build networks and provide information on climate change
		Species should be screened, and better-adapted species selected, or strains could be

		developed that are physiologically more tolerant to the changing environment
		Promoting aquaculture production systems and practices that are adaptive to climate change

8.3. Livestock

Livestock is another priority sub-sector contributing to job creation, securing food nutrition, economic growth and poverty reduction. It has accounted for over 11% of the total agricultural production for the last five years since 2014 (MAFF, 2018b). Cattle provide most of the agricultural draught, manure for fertilizing crops and constitute essential household assets. The private sector has taken the lead in livestock production by acquiring improved breeds of animals, providing improved animal feed, and processing facilities, reducing animal diseases through vaccinations and encouraging the government for livestock production. Raising livestock and poultry was the second most important agricultural activity undertaken by agricultural households following crop cultivation. Therefore, Livestock played a key role in supporting livelihoods and providing income in rural households (MoE, 2022). According to the FAO, the average meat consumption in Cambodia is 17.59 kg per capita per year, including 5 kg of beef and buffalo meat, 9.29 kg of pork, 3.3 kg of poultry, and another animal meat (MAFF, 2018a).

In General notification in the last five years (2015-2020), livestock raising by household farmers has declined from 80% in 2015 to 65% in 2020, oppositely the commercial raising farms have been increased up to 35% in 2020. The challenges in livestock production in Cambodia still remain critically including (1) high costs production especially animal feeds (about 70% of total production cost) and medical treatment,(2) lack of good quality of breeds for chicken, pig, and cattle, (3) lack of financial investment to expansion the production, (4) facing infectiousdiseases and zoonotic disease, (5) limited of extension services to encourage farmer for livestock raising at household level for income generation, (6) inadequate supply high quality animal feeds with suitable cost from domestic factories or encourage farmers to produce their animal feeds by themselves (RGC, 2022).

Livestock is very much sensitive to the increased temperature. Bos indicus sp. Cattle, for example, are comfortable in high temperatures, as high as 38°C before any notable effects on production, but the temperatures above 38°C may lead to heightened stress, reducing immunity and feed intake, and likely exacerbated by work. For pigs, the thresholds are very much dependent on management and breed systems, but the optimal production can typically be achieved between 20°C and 30°C. Young piglets are most susceptible to low temperatures, but bigger piglets are better able to cope, thus improved sow condition management is a possible means of building resilience to temperature changes. For poultry, the optimal temperatures are always approximately between 25°C and 30°C until a week or so of age. The importance is that the biggest production losses occur with sudden changes; they can better cope with temperature extremes if the change is gradual as such sudden temperature shocks can be catastrophic, particularly the intensive units. Significantly, the likelihood of disease transmission will be affected by changes in temperature affecting pathogen ecology (MoE, 2022).

Changes in rainfall patterns will substantially affect livestock units through feed and animal health issues. Also, changes in the availability, quality, and price of feeds are fundamental to all livestock production systems. For intensive monogastric units, feed costs typically account for 65 to 80% of production costs, while a current key constraint to most extensive smallholder systems in the region is under- nutrition. Furthermore, pathogens will likely be affected in terms of viability outside hosts and rates of proliferation by humidity levels and, importantly, the quality and quantity of vector breeding sites. Wetter periods typically increase the likelihood of disease transmission through fomites, increasing the importance of employing effective biosecurity measures. Therefore, the livestock sub-sector is highly vulnerable to the projected rising temperature and shifting rainfall patterns that affect climate change.

8.3.1. Adaptation options and measures in Livestock

For livestock adaptation options and measures should be focused more on using appropriate technologies, research and development (climate resilient breeding), development biogas for energy, livestock wastes for agriculture production, livestock nutrition, health, diseases protection, housing, and market access. There are five broad strategies to improve livestock development and increase resilience to climate change include improving nutrition, disease resistance, housing, production planning and off take, and access to markets. The conclusion of adaptation strategy for livestock relates to nutrition, animal health, and markets. The focus needs to be on improving animal nutrition among smallholder low-input systems, particularly bovines, reducing disease risks for all livestock systems by increasing disease resilience and minimizing disease challenges, and increasing smallholder access to and information on input, services, and product markets (ICEM, 2013).

In the CCCSP 2014-2023 launched strategies responding to climate change for adaptation and mitigation co-benefit in livestock production including:

- Develop capacity on using appropriate technologies that do not affect public health
- Promote human resource development essential to contribute to adaptation and the reduction of impacts on livestock
- Improve the use of new technologies on livestock by vulnerable farmers
- Promote renewable energy (biomass and biogas) consumption, efficiency, and proper agriculture technology usage.

For the adaptation of livestock production, Cambodia's NDC, LTS4CN, and TNC have identified some adaptation options and measures that are suitable for implementation in Cambodia as listed in **Table III.13**.

Table III. 13: Summary of key adaptation measures and actions for the livestock sector in NDC, LTS4CN, and TNC

NDC	LTST4CN	TNC
Adaptation measures for livestock		
Improvement of animal breeding technology in Cambodia through AI which can adapt to climate change	Improved feed quality fodder management	Improve feed quality and fodder management
Promotion of research capacities on animal genetic, animal breeding, and animal feed is strengthened to adapt to climate change	Feed additives for cattle	Improved sow condition management
Strengthening capacities for risk prevention and reduction, effective emergency preparedness and response at all levels; enhancing livestock and disease-related early warning system, and integrating disaster risk reduction and climate change adaptation measures	Reduced heat stress and animal mortality	Biosecurity and vaccinations for animal health

8.4. Forestry and Other Land Use (FOLU)

The forest sector contributes to sustainable development, improves local livelihoods, poverty reduction, and environmental sustainability it can regulate climate change mitigation and adaptation. Forests, for instance, limit the negative effects of droughts and floods and are a sink for carbon emissions.

Cambodia's forests cover was approximately 73% of the country's territory in 1960 declined to 61% in 2002, 57% in 2010, and 48.14% in 2016 (including rubber plantation, palm oil plantation, and other perennial crops), which divided into eight groups forests cover classification: evergreen, semi-evergreen, deciduous, other forests, wood and shrubland, evergreen, wood and shrubland dry, bamboo, and non-forests (MoE 2020, 2022).

Scientific predictions of climate change for Cambodia suggest that forests will be affected by changes in temperature, precipitation, and shifts in the seasons. A longer dry period might reduce forest productivity and increase the risk of fire. If forests are being logged, there exists a risk that it will take longer for them to regenerate. With increased risk of fire, forests are at risk of turning into shrub or unproductive lands. The implications of climate change on forests go much further, it could be(1) Given the importance of forests in rural livelihoods, any loss of productive forests, as well as of biodiversity, will lead to loss of income or livelihood options for forest-dependent communities, (2) Exposing forests to longer dry periods might reduce forest productivity and biodiversity, and will also lead to a typical insect growth cycles, which can further affect agriculture and forests, (3) Temperature increases and shifts in the seasons can increase the risk of fire reducing forests to shrub or unproductive lands, (4) The integrity of forest cover is intimately linked with maintenance of freshwater supplies, soil cover and quality, and is believed by local farmers to attract rainfall, and (5) The loss of forest may lead to more consequences such as storms, soil erosion and landslides (UNDP, 2011).

According to the study conducted by Cambodia's SNC, the impact of climate change on the forestry sector was evaluated based on the soil-climate zone. The change in soil-climate zone due to climate change will have a direct impact on forest productivity. A projected depletion of soil moisture due to climate change would most likely cause teak productivity to decline by about 6%, while the productivity of moist deciduous forests could decline by about 17%. The analysis showed that under current climate (the baseline), the soil water regimes of lowland forests vary considerably. Half of all lowland forests have a soil water deficit for a period of between four and six months, 35% for a period of six to eight months and 4% for more than eight months. High altitude forests (more than 500 m) are typically exposed to a shorter water deficit period (less than six months). Deciduous and evergreen broadleaf forests dominate Cambodia's forests. Forestland is mostly located in low elevations (<500 m above sea level), with only a small percentage at high altitudes - 9% at an elevation of between 500 m and 1000 m above sea level and about 2% at an elevation of more than 1000 m above sea level.

8.5. Water Resources

The Mekong River Basin system's overall flood-pulse dynamic is responsible for covering almost 86% of Cambodia with water during the rainy season. The Tonle Sap Lake, the largest freshwater lake in Southeast Asia, is essential to Cambodia's water resources. It is severely threatened by a variety of non-climate stressors, including overfishing, deforestation, and the building of dams throughout the Mekong Basin, as well as by prolonged droughts, irregular rainfall patterns, and storms. When combined, these stressors may cause changes in the water's flow. Monsoon-related rainfall increases seem likely, while rising temperatures and extended droughts are also expected to cause evapotranspiration to rise and surface water availability to reduce. Water quality may also deteriorate as a function of increased sedimentation due to forest loss (from non-climate stressors and increased temperatures) and increased flooding.

Climate change will affect the water cycle, bringing shifts in the timing, duration and intensity of rainfall patterns and seasons, changing the hydrology of major rivers and tributaries as well as groundwater recharge, and consequently, altering the quantity, quality, availability, and distribution of water (TKK and SEA START RC, 2009). There are many studies predict various climate change impacts on water resources in Cambodia including:

- Climate change is likely to significantly alter the Mekong River hydrological regime, upon which inland fisheries and agriculture depend,
- Changes in seasonal distribution of rainfall, with drier and longer dry seasons, and shorter, more intense wet seasons,
- Increased volume and intensity of wet season rainfall, leading to increased floods and a marginal decrease in dry season rainfall,
- Reduced flow of the Mekong and its tributaries in the dry season and increased flow in the rainy season,
- Higher drought risks in most of Cambodia's agricultural areas because of future climate change from 2025 to 2050,
- Increased temperatures, with corresponding increases in evapotranspiration,
- Increased frequency and intensity of extreme events, such as floods and droughts.

The main implications of the impact of climate change on the water sector are potentially exacerbated by the current condition of watersheds, catchments and floodplains that affect the runoff and recharge of groundwater, as well as by water resource development plans. Further degradation of catchments, watersheds, and flood plains will lead to additional pressures on the ecosystems. For Cambodia to deal with climate change across different sectors, it also will need to address the management of water resources and the ecosystems on which water itself depends. The same kinds of multi-scale, integrated, participatory approaches that are ingredients of integrated water resources management (IWRM) will be urgently needed for agriculture, fisheries and forestry (UNDP, 2011a).

8.5.1. Adaptation practices and measures for water sector

In the context of the Mekong River Commission (MRC), adaptation measures to climate change can be classified into two main groups, policy-based and vulnerability-based adaptation measures (MRC, 2018). The policy-based measures refer to the measures generally dealing with improving the 'enabling environment' or framework conditions for climate change adaptation, targeting to the policy, legal and institutional settings, financial and information systems and capacity building. The vulnerability-based measures are associated with the technical and infrastructure measures generally dealing with the expected water resources and socio- economic vulnerability.

According to the NAPA, CCCSP 2014-2023, and water resource climate change strategic plan 2013-2017 of Ministry of Water Resources and Meteorology, specified adaptation options and measures for water resources in Cambodia as below:

- Build foundations for river water use and control

- Raise specific awareness for private companies in adapted climate change development.
- Establish flood prevention measures in the riskier regions such as populated areas and potential agriculture sites.
- Encourage private companies in low carbon development and sustainable development.
- Deliver more mandates on water resources management to sub-national levels.
- Build capacity in water resources management and uses of modern weather technologies at sub-national levels.
- Develop a long-term plan of national water control to prepare for possible heavy rain casualties caused by abnormal climate variability.
- Build a flood warning system.
- Take measures against negative impacts on water resources from urban development such as stream flow reduction, worse water quality, and drainage systems.
- Prepare water use, considering the drought.
- Build stabilized irrigation systems addressing reduced precipitation caused by climate change.
- Develop groundwater preservation plans and restriction regulations.
- Shore up functions of the river environment, including ecological system preservation and water-familiar functions.
- Conduct research on what matters most in water resources concerning the impacts of climate change.
- Prioritize climate change coping activities on sustainable water resources development and management; and
- Rehabilitate the canals along Cambodia-Vietnam borderlines.

8.6. Human Health

Climate change can impact human health directly and indirectly. In terms of direct impacts, an increase in the frequency and/or intensity of extreme weather events may result in death, injury, psychological disorders, and damage to public health infrastructure. The indirect health impacts of climate change include changes in the geographical range and incidence of vector-borne diseases, infectious diseases, malnutrition, and hunger because of ecosystem disturbance. Furthermore, sea level rise may displace populations and cause damage to infrastructure leading to increased susceptibility to infectious diseases and psychological disorders. Many infectious diseases, such as malaria, dengue fever, diarrhea, and other water- and food-borne diseases are influenced by climate change (GSSD, 2015).

The recent progress in Cambodia's health situation is at risk due to rising temperatures, higher precipitation, and an increase in extreme weather events such as tropical storms, droughts, and more frequent flooding. Health sector reforms focused on extending physical health infrastructure, expanding health financing, and increasing access to services beginning in the 1990s helped strengthen the health sector and, in turn, health outcomes. Between 2000 and 2014, infant mortality in Cambodia decreased by 74% (from 95 deaths to 24.6 deaths per 1000 live births), while from 2005 to 2014 maternal mortality rates decreased by 64%, dropping from 472 deaths to 170 deaths per 100,000 live births (Center for Excellence in Disaster Management, 2017).

Even though Cambodia has come a long way in offering comprehensive health services, there are still numerous issues, and they could get worse because of the negative effects of the climate. Rising temperatures are projected to increase heat-related conditions for vulnerable populations, including the elderly, pregnant or expecting women, young children, and infants, and deforestation is likely to lead to higher temperatures in cleared areas. The combination of climate stressors impacted urban health infrastructure, municipal waste management systems, and water supply infrastructure, all of which could adversely affect health outcomes. These impacts could also increase the incidence of water and vector-borne diseases, such as malaria and dengue. Longer and drier dry seasons also significantly reduce safe drinking water availability, which is already a serious issue in Cambodia.

Human health is particularly vulnerable to the impacts of climate change due to the following threats:

- The increased temperatures caused increased heat stress resulting in in illness or injury such as heat stroke, exhaustion, cramps, or rashes.
- More intense and/or frequent weather events; More intense and/or frequent weather events and Decreased nutrition and food security
- Increased and prolonged droughts; Damage to health infrastructure and Limited drinking water supply
- Increased rainfall and flooding; Decreased water quality impacting health, sanitation and hygiene

Health issues in relation to climate change impacts are of particular attention due to the country's highly vulnerable conditions such as poverty, malnutrition, flood-prone areas, and limitations of public health services, governance, and technology. The major health issues found in Cambodia are connected to climate-related threats such as flooding, temperature rise, flash flooding, and landslides, including heat stress, vector-borne disease, water-borne disease, injury, and death. Furthermore, increased temperatures are projected to increase heat-related conditions and affect directly to the hight vulnerable group of people particularly the elderly, pregnant or expecting women, young children, as well as infants. Health infrastructure, such as hospitals, clinics, and cold chain storage facilities, may also be impacted by the increasing temperatures, heavy rains, and subsequent flooding, thus impacting overall patient care. In addition, higher temperatures and variable precipitation accelerate microbial growth, transmission and virulence, can lead to changes in the seasonal and geographic distribution of vector-borne and water-borne disease (MoE, 2020). Since the 1990s, Cambodia has made impressive progress in malaria control and elimination. Adult men aged 15-49 years face the highest malaria risk, and they accounted for 81% of all malaria cases reported in 2020 (WHO 2024). While malaria is caused by five species of the Plasmodium parasite, a large majority of malaria cases in Cambodia are caused by Plasmodium falciparum, which is commonly resistant to antimalarial drugs. The Royal Government of Cambodia (RGC) committed to eliminating P. falciparum by 2023 and to eliminating other Plasmodium species by 2025, through the launch of an innovative and targeted approach for the "last mile" of malaria elimination, alongside the WHO. This approach consists of an all-of-society effort targeting endemic hotspots in five provinces Kampong Speu, Kratie, Mondulkiri, Ratanakiri, and Stung Treng, where partners implement interventions such as mosquito net distribution, house-to-house screening, targeted drug administration, and Intermittent Preventive Treatment for travelers. Additionally, Cambodia's National Center for Parasitology, Entomology and Malaria Control (CNM) implemented an intensification plan in 2018 with a goal of eliminating parasite reservoirs in high-risk populations by deploying technical support services to Cambodia's provinces, strengthening coordination, and ensuring the full implementation of malaria interventions (CFE-DM, 2024).

Dengue is endemic in Cambodia. Dengue is a mosquito-borne, viral infection transmitted by the Aedes mosquito, particularly the Aedes aegypti. Although dengue can be contracted year-round, cases typically increase during the rainy season (May to November) as mosquito breeding sites multiply. Cambodia saw a significant increase in the number of dengue cases in the first nine months of 2023, with 21,568 cases reported, a rise of 184% compared to the same period in 2022, when 7,597 cases were recorded. Additionally, the CNM reported 38 deaths from January to September 2023, up from 14 deaths reported the year prior (CFE-DM, 2024).

According to the Cambodia Country Climate and Development Report (WBG, 2023), emphasized that a monthly temperature of 35°instead of 28°C increases cough incidence by 55% and diarrhea incidence by 83%. Projections find that diarrhea incidence in children could increase by 4% by 2050 due to the temperature rise. All provinces would be affected, from a 3.1% increase in Siem Reap to a 4.4% increase in Mondulkiri. In addition, modeling also projects that these health impacts from climate change could lower the number of hours worked by each person in a year by 1.1% to 1.7% in low and high scenarios, respectively. Stunting and undernutrition are major climate-sensitive concerns in Cambodia, where the average stunting rate is 22%, according to the 2021–2022 dynamic health survey. Climate change also has a direct influence on the spread of vector-borne diseases circulating in Cambodia, including malaria, dengue, and Japanese encephalitis.

8.6.1. Adaptation practices and measures for health sector

The Ministry of Health, and Cambodia's TNC, have emphasized the adaptation measures to climate change in the health sector to reduce morbidity, mortality, injuries, and health vulnerability to climate variability and extreme weather events. The focus of climate change adaptation in the health sector is targeting the three main climate-sensitive health areas, including vector-borne disease, water-borne, and food-borne disease; and health impacts arising from extreme weather as listed in table 6 (MoE, 2022).

Table III. 14: Key relevant climate change adaptation measures and activities for health sector

Adaptation measures	Vector-Borne Disease	Water-Borne/Food Borne Diseases	Extreme Weather Events
Prevention control	• Use of insecticide treated mosquito nets • Use of larvicidal and insecticidal spraying	• Sanitation and hygiene • Supplementary of nutrient and vitamin A • Improve latrines • Safe drinking water • Improving infection control procedures to prevent the spread of illness	• Early warning system instalment and functioning • Sanitation and hygiene • Nutrition and Vitamin A supplement • Safe drinking water
Treatment	• Use of appropriate drug	• Early treatment with oral rehydration fluid • Increase and improve access to health facilities	• Relevant to both vector borne and water borne diseases • and food poisoning
Public education	• Public health awareness on climate change • impacts, disease control, prevention and treatment	• Public health awareness on climate change impacts, sanitation and hygiene, and treatment	• Public health awareness on climate change impacts • Improved community preparedness and sanitation
Capacity	• Improved healthcare facilities, and staffing • Research climate change vulnerability assessment and adaptation (V&A)	• Improved health care facilities, staffing • Research and V&A	• Improved health care facilities, staffing • Emergency response plan and procedures

Knowledge generation	• Epidemiology and entomology research • Climate change vulnerability assessment and adaptation for flood, drought, and climate extreme events • Data management • Surveillance of • Anopheles and Aedes sp. mosquitoes and examining their relationship with climate and weather • Malaria and dengue fever surveillance	• Methodologies, guidelines and models • Surveillance • V&A assessment of flood and drought • Data management • Modelling of Climate variability and health impacts • Data management	• Surveillance • Epidemic preparedness • Data management • Climate projections and early warning • V&A assessment of extreme weather

8.7. Coastal Zone

Cambodia has a coastline of 435 kilometers (km) covering a land area of about 17,237 km^2 plus an exclusive economic zone of about 55,600 km2 and covers the partial territories of Koh Kong, Kampot, Preah Sihanouk, and Kep provinces (GSSD, 2015). The coastal region features several closely interrelated ecosystems: beach, forest and strand vegetation, mangroves (including a Melaleuca-dominated swamp forest), estuarine ecosystems, seagrass, coral reef, and the marine ecosystems of the gently sloping, relatively shallow seabed. Coral reefs have been found in several locations accommodating 34 known species of hard coral and 14 species of soft coral (GSSD, 2015).

The marine and coastal fisheries of Cambodia comprise a great range of vertebrate and invertebrate species including fish, crabs, shrimp, and bivalves. Both freshwater and marine fish are the main source of protein in Cambodia. Fisheries are important contributors to food security and nutrition, accounting for 61% of household animal protein intake (MAFF, 2020).

Climate change is expected to have severe impacts on the coastal areas of Cambodia due to sea level rise, storms and storm surges, and from saltwater intrusion into coastal ecosystems, increased water and air temperatures, altered wind and currents, ocean acidification, and algal bloom or other water quality-related issues. Furthermore, most population of coastal areas are heavily reliant on agriculture, fisheries, and tourism. Ultimately, these effects can cause the loss of multiple ecosystem services provided by coastal areas of environmental, economic, social, and cultural value for many stakeholders and economic sectors (ADB, 2023).

According to the fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), indicated that the mean sea level rise was estimated in the range of 0.44-0.74 m by 2100 globally. The assessment of IPCC AR6 CMIP6 projections for SSP5 8.5 indicate an increase approximately in sea surface temperature 1.7°C by 2040 and 2°C by 2060, and in mean sea level rise of 0.16m by 2040, 0.32 m by 2060, and 0.57 m by 2080, relative to the 2014 baseline. For Cambodia, the analysis of the impact of sea level rise on coastal areas was estimated that a total area of about 25,000 ha will be permanently inundated by a sea level rise of 1 m, and increasing to 38,000 ha at a sea level rise of 2 m. The mean sea level rise of Cambodia was estimated about 1.7 cm/year. Koh Kong province is the most vulnerable to sea level rise (GSSD, 2015). Sea level rise would result in a loss of mangrove forests and marine ecosystems across coastal provinces, salinization of agricultural land and seawater intrusion particularly in Kampot and Kep, and deleterious impacts to critical infrastructure and coastal tourism activities in Preah Sihanouk and Kampot.

Rising sea levels will potentially impact coastal systems in a number of ways, including inundation, flood and storm damage, loss of wetlands, erosion, saltwater intrusion, and rising water tables. Other effects of climate change, such as higher seawater temperatures, changes in precipitation patterns, and changes in storm tracks, frequency and intensity, will also affect coastal systems, both directly and indirectly through their interactions with sea level rise. Rising surface water temperatures, for example, are likely to cause increased coral bleaching and the migration of coastal species toward higher latitudes. Changes in precipitation and storm patterns will alter flood risk and storm damage. Strong winds often occur from November to January and cause problems for farmers by hitting rice yields. In the rainy season, strong winds come from the west or from the sea and can cause storms lasting up to seven days. During strong winds and storms, waves can reach 2-3.5m in height, making sea travel difficult.

Disasters such as extreme events, storms and surges, coastal flooding, and sea level rise pose a threat to the coastline communities of Cambodia. The country is heavily reliant on its fisheries industry for protein production, with the majority sourced from vast freshwater or aquaculture reserves. The national fish and shellfish resources are actively harvested by local communities under small to medium enterprises, which are mostly focused in the coastal and nearshore areas. The climate change will increase the frequency and intensity of extreme events, which may result in damages and losses for marine and coastal fisheries. Climate change will likely result in changes to the physical coastal environment, homes, assets, transport, and tourism, which are impacted to livelihoods and coastal communities.

The wind speed frequency analysis suggested that the western and southern part of Cambodia's coastal zone might be exposed to a higher risk of strong winds in the future. The southern part of the coastal area is where most of the susceptible communities are located. Under current conditions, winds with a speed of more than 40 km per hour will occur only once in 30 years at most, and in the future (2020-2049) they may occur once in 15 years. While the potential damage to infrastructure caused by these winds may be minor, such winds can seriously damage crops, such as maize, if there are no windbreaks. The risk of exposure to high sea waves is also relatively high. At this wind speed, sea waves can reach 6 m in height. Fishermen are advised not to fish under these conditions (GSSD, 2015).

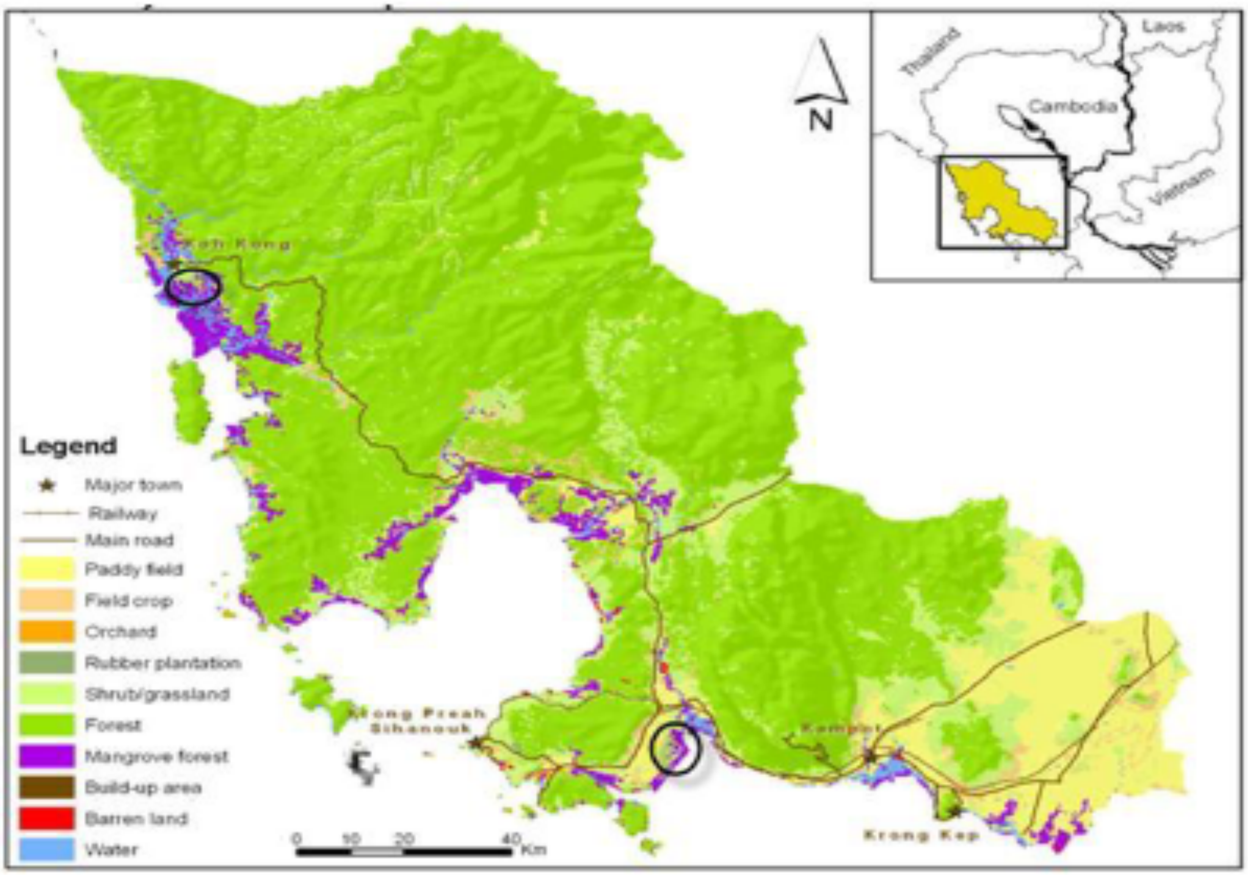


Figure III. 23: Map of the coastal area and its land-use types
Source: (CCCA, 2012)

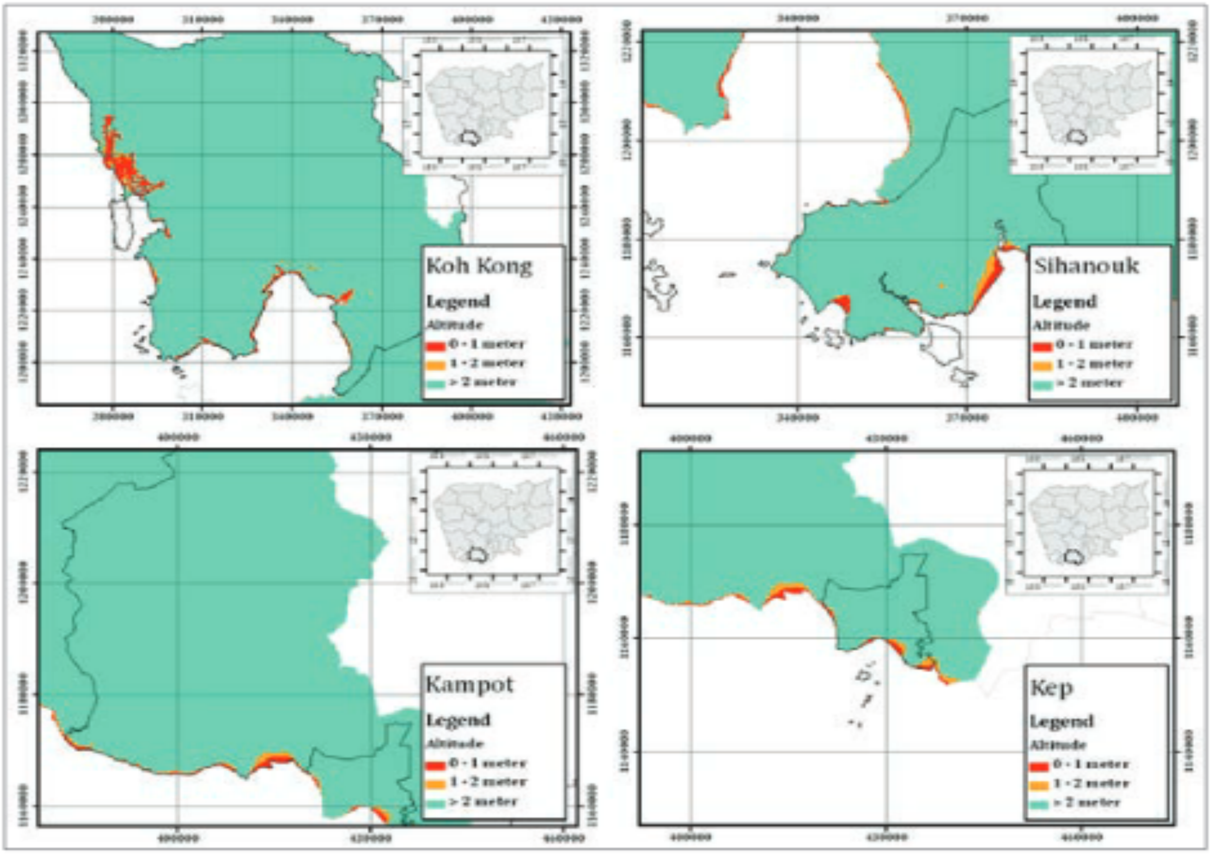
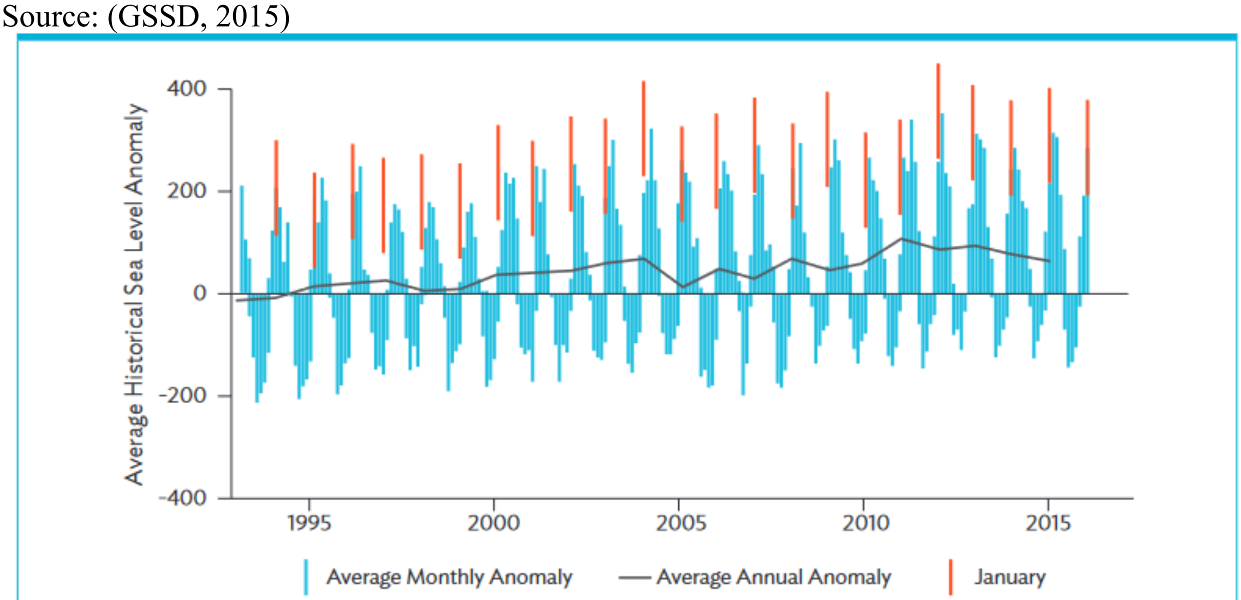


Figure III. 24: Area of coastal zone being inundated due to sea level rise
Source: (GSSD, 2015)



Source: Landell-Mills. 2022. For ADB under transactional technical assistance project: Cambodia Sustainable Coastal and Marine Fisheries Project (53261-001). Figure adapted for this report.

Figure III. 25:Historical Sea Levels for Coastal Cambodia 1993-2015
Source: (GSSD, 2015)

Sea level rise along Cambodia's coast exhibits discernible differences under different scenarios depending on the rate of local land subsidence. Under SSP3-7.0, sea level rise is projected to increase 0.50 meters above the historical baseline near Preah Sihanouk after 2080 (**Figure III.26**). However, this rate of change is slower under SSP2-4.5 and SSP1-2.6, as sea level rise does not reach this threshold until around 2090 under the former scenario and after 2100 for the latter, both with high uncertainty. Compared to SSP3-7.0 which rises 0.69 m (0.36m, 1.07m) by 2100, SSP2-4.5 rises 0.57m (0.25m, 0.94m) while SSP1-2.6 rises 0.45 m (0.13m, 0.80m) over the same timeframe. Much of the uncertainty in local sea level projections comes from potential land subsidence or vertical land motion, with a median of −0.03m attributed to land motion across all scenarios by 2100, but a wide probability range (−0.25m, 0.20m) (WBG, 2024).

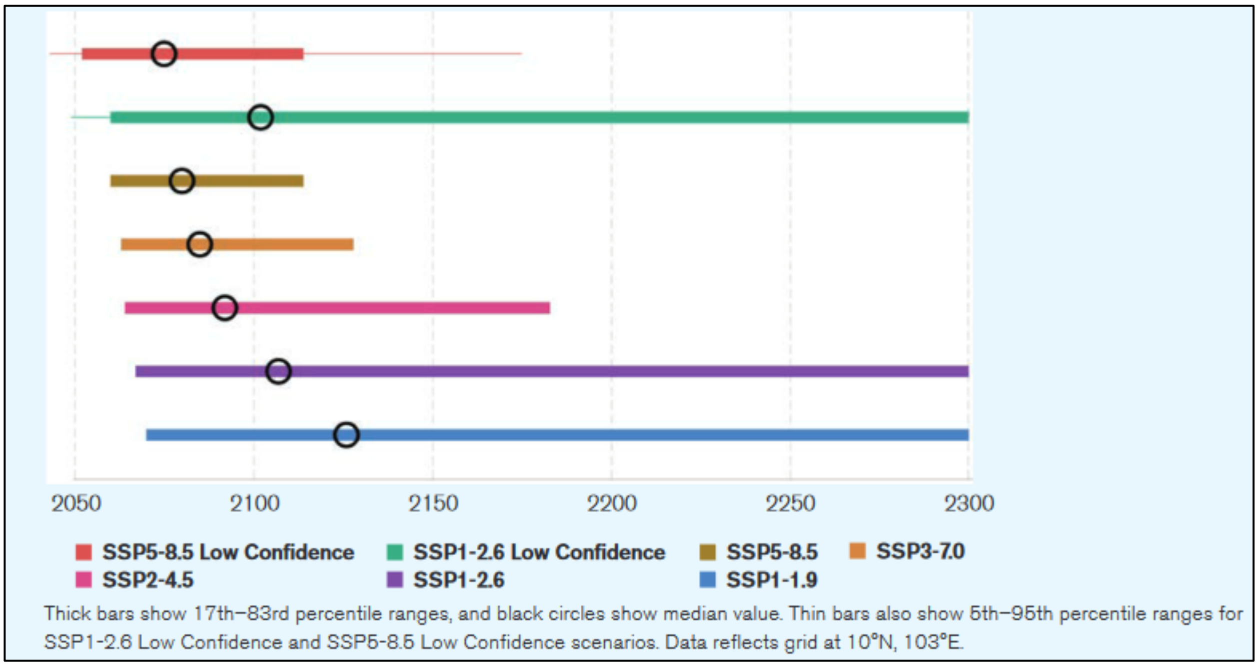


Figure III. 26: Projected Timing of 0 5-Meter Sea Level Rise Along Cambodia's Coast Under Various Scenarios
(Ref Period 1995–2014

8.7.1. Adaptation practices and measures for coastal zone

Long-life infrastructure development requiring high investment should be redesigned taking into consideration climate change (climate proofing). In areas where the likelihood of strong winds and sea level rise is quite high, a new climate-proof building code would need to be introduced. Planting windbreakers in some of the agricultural areas may also be necessary to reduce the negative impact of the strong winds on annual crops. The communities, that are currently facing climate-related problems, and these vulnerabilities need to be incorporated into the design of their development plans. (GSSD, 2015).

The mangrove forests and their ecosystems are essential for adaptation to climate change in coastal zones, which play two key role functions, habitats for the survival of numerous fish species and

other marine organisms, and act as the frontline against tropical storms, storm surges, reducing coastal erosion and inundation by creating a buffer zone to protect the coastal zone.
The Cambodia's TNC indicated a long list of adaptation options and measures for coastal areas. In the context of sea level rise as well as seawater intrusion, they should:

- Construct saltwater projection dyke saltwater protection dyke
- Build small hills for the animals to seek shelter to solve the problems in case of floods
- Prepare boats for communities and households-
- Inform villagers about the importance of cleaning their houses during and after seawater flooding has occurred.
- Raise awareness and prepare the emergency relief procedures at all the vulnerable villages, and
- Promote research to produce saltwater resilient crop species.

In terms of severe or heavy rainfall, floods, and storm surges, they should:

- Conserve and reforestate of mangrove forests
- Increase weather broadcasting system and improving accessibility to vulnerable groups, for example, through social media
- Encourage local communities to keep up with weather broadcasting news, and
- Plant mangrove forests.

For increased temperature and drought, there are some measures to be prepared such as ensuring water sources for the community by building basins to store drinking water; Preparing medicine for the community concerning both humans and animals; Preparing water sources; Ensuring preparedness in the case of forest fire; Promoting water-saving irrigation systems (e.g. drip irrigation technique); Increasing the capacity of irrigation systems is required, and this includes restoration of existing irrigation canals and building the new ones, especially in the areas of hotspots; Constructing small-scale household-based irrigation schemes like community or household ponds for water harvesting; Promoting resilient agriculture practices like agroforestry, sustainable land management technologies, and other climate-smart agriculture technique.
There are other adaptation options for further implementation including:

- Systematic research into social and cultural aspects of co-management; identification of conflicts and potential resolution opportunities.
- Design and implement demonstration projects through Commune Based Mangrove management.
- Develop a management plan with the involvement of communities, local authorities, and relevant agencies.

- Use of terrestrial management cases of good examples of adaptation for comparison and lessons learned.
- Develop awareness-raising programs for the conservation and sustainable management of natural resources such as mangroves, fisheries and marine resources targeting coastal communities, local authorities, militaries and provincial government officials.
- Explore, in collaboration with mainstream development organisations, the provision of sustainable alternative livelihoods to mangrove dependent communities.
- Develop a compendium of hotspots of coastal biodiversity and undertake advocacy for their protection.
- Policy advocacy through policy briefs, workshops, and seminars; and
- Mainstreaming climate change adaptation measures into commune investment and development plans.

8.8. Gender mainstreaming in climate change

The climate is changing more quickly than anticipated, affecting not only the environment and ecosystems but also people's lives and livelihoods, especially those of women and girls. The natural hazards caused by climate change negatively affect social and economic development and place at risk the resilience of the rural poor through higher frequency and stronger magnitude.

Women are more vulnerable to threats to their livelihoods and heavier responsibilities when it comes to caring for their families because of the effects of climate-related droughts, flooding, and variability. According to the Climate Asia Study by BBC Media Action (2019), 43% of Cambodians said they had to adjust their occupations or way of life to make ends meet when the weather changed, and 60% of the country was unprepared for extreme weather. The men and women significantly took different actions for extreme weather. Most men (82%) knew how to build shelters, swim, or perform first aid in case of extreme weather, while only 42% of women said the same, leaving them more susceptible to dangers like flooding (BBC Media Action, 2019). BBC Media Action (2019) identified men were more likely to report making structural alterations to the home (41% of men, 36% of women), whereas women were more likely to take household actions measures like storing food (53% compared to 44% of men). KAP3 Study by NCSD/MoE (2020), the government stakeholders assumed that women were more vulnerable to the effects of climate change and more likely to experience their effects because they believed that women were physically weaker than men and so less robust. They believed, for instance, that men can withstand hot temperatures better than women, who tend to get sick more easily. At the community level, respondents agreed that women were occasionally more susceptible since they frequently take care of the old and young people. Because of their perceived physical frailty, lack of resources, and difficulty accessing transportation, elderly persons, women with disabilities, women head of households, and children were also viewed as being more exposed to the effects of climate change. Women, girls, men and boys are affected differently, given the socially assigned discriminatory gender roles and responsibilities at the household and community levels (UN Women and CDRI, 2021). In Cambodia, women in rural areas are primarily dependent on local natural resources for their livelihood because of their domestic responsibilities to secure water, food, and energy for cooking and other household activities. In some cases, debt caused by natural disasters has led them to migrate to cities to work in factories or perform domestic work, which carries high risks of sexual exploitation.

Women are the most disadvantaged group, whose reproductive roles mean that they work at home or in places that are prone to natural hazards, especially floods. Since women are responsible for both reproductive and productive work, before a flood, women take care of the household's property and belongings, doing their best to prevent loss and damage. During a flood, women's responsibilities are to stay at home and look after family members while the men go out to look for food and to generate income. Consequently, women tend to become psychologically stressed, worrying that their children will drown, become seriously sick or be bitten by poisonous insects. Food insecurity, looking for fuel and collecting safe water for domestic use, pose more burdens on women than they do on men.

Women and girls living in poverty, indigenous women, women belonging to ethnic, racial, religious and sexual minority groups, as well as women with disabilities are commonly exposed and vulnerable to climate change and disaster-induced risks and are less able to adapt to changes in climatic conditions due to their disadvantaged socio-economic status, the lower positions they are in, limited education, cultural norms, and restricted involvement in decision-making processes. Moreover, women are more vulnerable to climate change due to their persistent poverty and limited educational opportunities, lack of decision-making power, and inadequate access to reproductive and sexual health services linked to pregnancy and childbirth (UN Women and CDRI, 2021).

The influence of gender roles in taking actions in Cambodia, women are typically expected to take care of the home, the children, and the food and clean water supply. This is frequently on top of their work in agriculture or other jobs that bring in money. Wives frequently migrate abroad with their husband in search of employment, adding to this additional load and leaving them as the only breadwinners for extended periods of time. This leaves women especially susceptible during severe weather. According to survey result from KAP3 nationwide conducted by NCSD/MoE (2020), 89% of a woman's responsibility is to take care of her home and family. The likelihood of men and women agreeing with this was the same, although 63% of respondents from rural areas and 55% from urban areas strongly agreed with it.

8.8.1. Adaptation options and measures

According to the Ministry of Woman Affairs, there are many adaption options and measures related to gender and climate change such as below:

- Promote women in decision-making on climate change adaptation and mitigation and natural disaster management at all levels and domains.
- Increase the level of awareness on gender and climate change, including natural disasters, within MoWA and its decentralized offices and stakeholders.
- Increase the level of capacity of the MoWA and its decentralized offices and stakeholders on gender-integrated vulnerability and capacity assessment, planning methods for climate change adaptation and mitigation and natural disaster management.
- Deliver targeted interventions for women with a high level of vulnerability to strengthen their climate change adaptation and mitigation capacities and empowerment (e.g. food security, nutrition, sustainable access to clean water, urban and rural livelihoods, waste management, access to information and support group formation).
- Conduct research and development to increase the availability of data and information on gender and climate change.
- Elicit best practices and lessons on gender and climate change for scaling up, learning and sharing.
- Strengthening institutional capacity and cross-sectoral coordination with a focus on women's roles in climate change adaptation and mitigation.
- Improving capacity, knowledge and awareness of women's role in climate change adaptation and mitigation.
- Reducing vulnerabilities to climate change impacts on disadvantaged women and other groups; and
- Reducing GHG emissions by introducing climate-friendly, low carbon economic activities for women.

8.9. Ecosystems

A significant portion of Cambodia's wealth is found in its many ecosystems, which offer vital services necessary for economic growth, health, and livelihoods. Nonetheless, a variety of non-climate stressors along with the negative consequences of climate change pose a threat to these ecosystems. Since 2000, the growth of industrial agriculture, mining, and other non-climate drivers, like illegal logging, firewood, and charcoal production, have resulted in the loss of about

2 million ha (roughly 23% of Cambodia's forests). Despite this, over 84% of households in Cambodia obtain their firewood needs from nearby forests. Increased temperatures and alterations of precipitation patterns possess the capability to impact and deteriorate the forest's composition, consequently diminishing the total productivity of the forest. In addition to upland deforestation, extreme weather events such as heavy precipitation or stronger tropical storms may cause surface water bodies to become more prone to downslope sedimentation or raise the risk of landslides for communities living below the slope (USAID, 2019a).

Climate stressors, particularly extended droughts, in conjunction with illicit fishing and upstream hydropower development are causing significant harm to the Tonle Sap's essential freshwater environment. During drought years, fish supplies significantly decline, and development puts nutrient loads at risk.

Ecosystems particularly vulnerable to the impacts of climate change due to the following threats:

- Increased temperatures; Loss of key ecosystem services and decreased biodiversity and decreased tourism potential
- Prolonged drought; Deforestation, including increased risk of forest fires
- Increased rainfall; Reduced water quality from soil erosion and sedimentation
- Extreme weather events; Saltwater intrusion of freshwater ecosystems.

8.10. Economic

According to the ILO, disaster is a threat to the economic development of Cambodia in the long term because the growth is narrowly based on a dependence on garment products, tourism, rice, and construction (teerasak, 2016). Since the Mekong River and Tonle Sap basins encircle around 80% of Cambodia, yearly flooding during the wet season alone is projected to cause losses of US$ 100 to 170 million annually(Cambodia PDNA, 2010). In 2011, the World Bank carried out an initial financial risk assessment for Cambodia, which predicted that natural disasters would cause yearly economic losses of US$74.2 million, or 0.7% of GDP(World Bank, 2012). The most common danger in the country is flooding, which causes 55% of all yearly economic losses. The second-biggest risk is drought, which causes 28% of all losses. Quakes and storms account for 3% and 4% of overall losses, respectively (World Bank, 2017).

Every disaster describes the current level of vulnerabilities and offers a projection for the future, as these kinds of incidents are expected to become more severe and frequent. Typhoon Ketsana impacted Cambodia in 2009 after passing through the Philippines, Vietnam, and Lao PDR, three of its neighboring countries. In Cambodia, there were forty-three deaths, 24 provinces were damaged, 1.4% of the population at the time was completely devastated (Cambodia PDNA, 2010). The transport sector is thought to be the most vulnerable regarding physical effects. With a total cost of US$454 million during the three disasters that occurred in 2009, 2013, and 2014, it was the most severely affected (World Bank, 2016).

More severe but less frequent disasters could result in larger economic losses; for instance, damages from a once in a 20-year event could exceed US$405 million, or 3.6% of GDP. A 100-year timeframe could see losses as high as US$825 million, or 7.3% of GDP. Among the countries of the Association of Southeast Asian Nations (ASEAN), this represents the second-highest loss in terms of GDP (World Bank, 2017). In 1991 –2005, people were affected, and total damage was caused by drought about US$138 million, and flood in 1991–2013 about 1,419 US$ million (Guha-Sapir et al., 2016).

GDP caused by climate change (CC) was 0.4% of GDP by 2020, a small but significant impact. By 2030, absolute GDP is projected to be 2.5% lower due to CC. Although this reduction is substantial enough to influence macroeconomic planning, it still means that GDP will be 3.00 times higher than current levels, instead of 3.08 times, which represents only a modest difference. However, the impact of CC steadily increases over time. By 2040, absolute GDP is expected to be 6.0% lower, and by 2050, it will be 9.8% lower of the GDP. The average growth rate for the period from 2016 to 2050 decreases from 6.9% of GDP reduction due to the result of climate change impact. These impacts are more serious and reflect the escalating severity of CC over time, as well as the cumulative effects of reduced investment and slowed growth. The net present value (NPV) of GDP growth paths to 2050 is projected to be 4.4% lower due to CC (**Figure III.27**). This decline highlights the long-term economic challenges posed by climate change, underscoring the need for robust adaptation and mitigation strategies. Integrating climate resilience into economic planning is essential to safeguard future growth and development.

By 2050, reduced labor productivity is projected to account for 57% of all losses and damages (L&D) associated with climate change. Loss of income is expected to constitute 17% of total L&D, while damage to assets will account for 26%, affecting all sectors. The trends indicate that while all types of L&D grow at a similar rate, the relative importance of each type shifts over time. Loss of income is more significant in the early years, primarily impacting the agricultural sector, which experiences slower growth compared to other sectors. As time progresses, reduced labor productivity becomes the predominant source of L&D. This shift is largely due to the long-term effects of climate change on workforce efficiency and health, which become more pronounced over time. The early impact on income highlights the vulnerability of the agricultural sector, emphasizing the need for targeted interventions to support farmers and rural communities. Over time, as reduced labor productivity becomes the main driver of L&D, it underscores the importance of enhancing workforce resilience through health initiatives, education, and training programs.

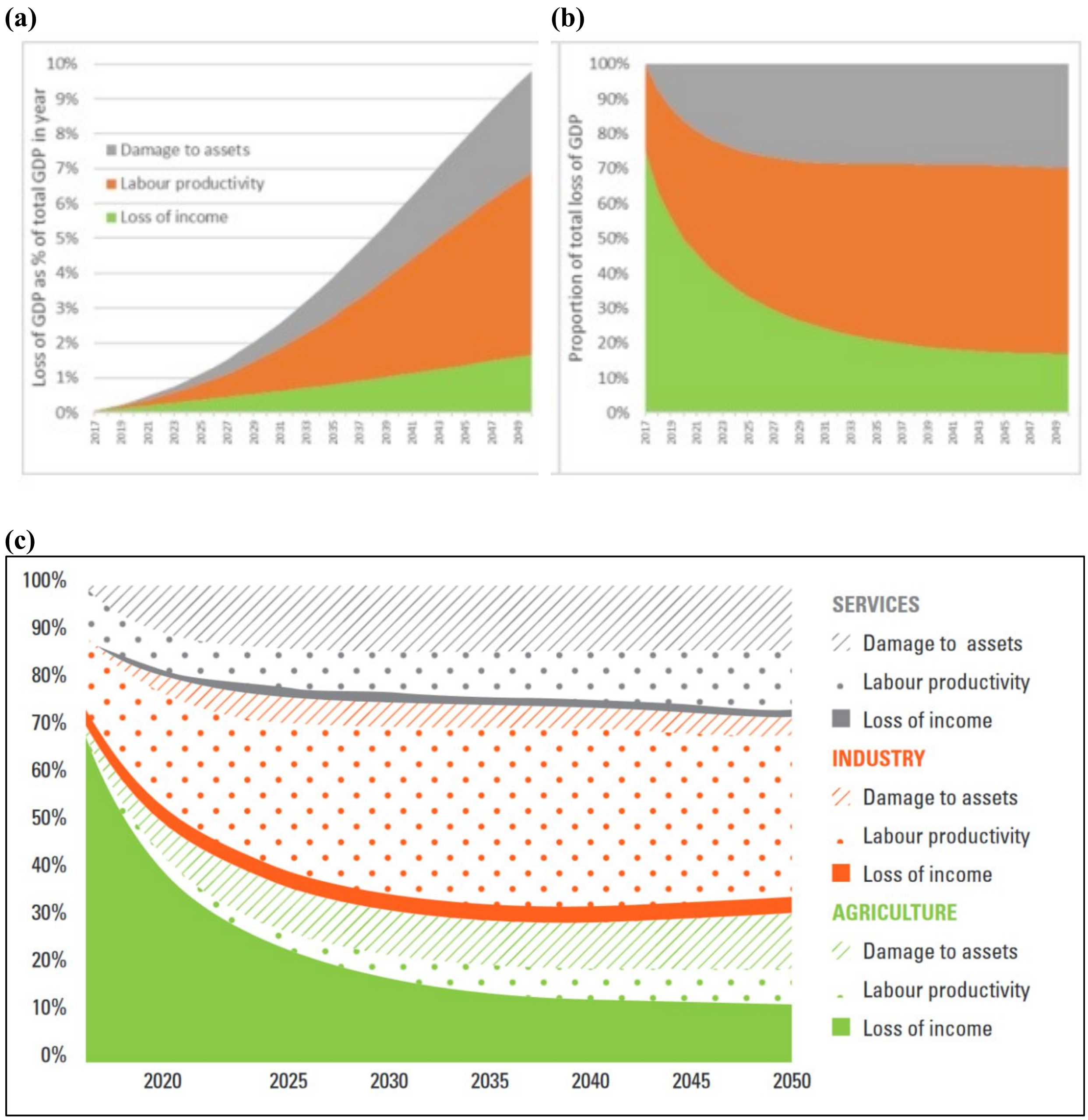


Figure III. 27: Economic impact of climate change a) type of L&D expressed as % of GDP, b) % total L&D and c) share economic impact of CC by main sector and type of L&D

Source: (MEF, 2019)

8.11. Infrastructure

The transport sector plays important roles in Cambodia's national strategic goals of promoting growth, employment, equity, and efficiency, set in the Rectangular Strategy for Growth, Employment, Equity and Efficiency, Phase IV, to enhance transport connectivity and build vibrant logistics systems to enhance the competitiveness and diversification of the economy. The

Industrial Development Policy, 2015–2025 requires the improvement of the transport network, especially along the industrial corridor. The annual national budget for transport infrastructure was US$123.75 million in 2014, US$183.75 million in 2015, US$223.04 million in 2016, US$216.70 million in 2017, and US$158.07 million in 2018.7 The government is preparing an integrated multi-transport and logistics master plan (ADB, 2019).

Road transport is the largest subsector, with an estimated modal share of more than 90% for passenger and freight. By early 2023, the total road length in Cambodia is more than 66,723 kilometers (km), with road density of 0.37km per square kilometer. The distribution of road networks is unbalanced, more in the southern part and less in the northern part areas, due to due to geographic location and population density. Furthermore, these roads are vulnerable to damage by disaster (flood) (RGC, 2023). The number of registered vehicles has been increasing at a double-digit rate each year and was more than 4 million in 2017. The number of registered motorcycles has increased by at least 10% per year since 2005, and they accounted for about 85% of all registrations in 2017 plan (ADB, 2019).

Railway transport is important considering its eco-friendliness and the potential for making greater use of existing railway assets. However, the modal share of railways for passenger and freight is negligible. Cambodia has only 2 lines of railways with a total length of 652 km, which was constructed in a type of single lines of with the road width of one meter. Containers and fuel are transported on the 386 km Northern Line from Phnom Penh to Poipet, on the border with Thailand, and the 264 km Southern Line from Phnom Penh to Sihanoukville Port. The density of railway network is 53,9 km per 10,000 km2 with equal to 0.41 km per 10,000 people (RGC, 2023).

For water transport, Cambodia has seas, rivers, water streams, water canals, and lakes which play very important means for water transportation. The length of inland waterway on river transportation is about 1,750km in the wet season including approximately 30% on the Mekong River, 15% on the Tonle Sap River and Tonle Sap Lake, 5% on the Tonle Bassac River, and 50% on the other waterway. But in the summertime, the navigation way was about 580 km which was changed remarkably. Cambodia has a coastal line in tola of 443km that provides very good conditions for marine navigation and the construction of large deep-sea ports. The country’s two main international ports, Phnom Penh inland and Sihanoukville on the coast are two main international ports (RGC, 2023).

For air transport, currently, Cambodia has 8 airports have been registered, while 3 airports are fully operated including Phnom Penh International Airport, Siem Reap International Airport, and Preah Sihanouk International Airport. These airports are operated and run by the Societe Concessionaire des Aeroport (SCA) company until 2040. In 2017, passengers 4,24 million ware arrived in Phnom Penh International Airport, 4,21 million passengers arrived in Siem Reap International Airport, and 340,000 passengers in Preah Sihanouk International Airport (RGC, 2023).

The transport sector is on the one hand vulnerable to climate change through climate damage to infrastructure, and on the other hand contributes to climate change through greenhouse gas (GHG) emission. According to the previous climate change studies in Cambodia including NAPA, CCCSP, PPCR, SNC etc. the increasing frequency and intensity of storms and floods are the key threats to transport infrastructure (road, bridge, railways, waterways, drainage) in vulnerable areas. There are two key factors that lead to heavy damage of transport infrastructure: 1) increasing flood intensity, 2) technical specifications for the design and construction of roads which are inadequate for climate change adaptation (MPWT, 2014).

In the transportation sector, urban public transportation will become more widespread and electric vehicle penetration will grow in the passenger vehicle fleet. Investments in rail development will start after 2030. Emissions will be also reduced by more moderate use of electric vehicles, increased fuel efficiency for internal combustion engine vehicles, and higher penetration of compressed natural gas (CNG) for interregional buses and for trucks. Under the LTS4CN scenario, 70% of motorcycles and 40% of cars and urban buses are expected to be electric vehicles by 2050.

8.11.1. Adaptations and measures

The summary of key adaptation measures and actions for the transport sector based on the review on the climate change documents of the Royal Government of Cambodia has been summitted to the UNFCCC, including NDC, LTS4CN, and TNC indicated in the **Table 13**.

Table III. 15: Summary of key adaptation measures and actions for the transport sector from NDC, LTS4CN and TNC

NDC	LTST4CN	TNC
Adaptation measures in Transport sector		
Develop national road construction and maintenance design standards for national and provincial roads, considering climate change impacts, including developing an M&E framework for climate proofing and low-carbon technology road	Increased use of public transportation	Increase of public transport
Repair and rehabilitate existing road infrastructure and ensure effective operation and maintenance systems, considering climate change impact	Moderate penetration of electric vehicles	Promote electrical vehicles
Rural road rehabilitation and improvement for climate change resilience	Rail for freight and passengers	Shift long distance freight movement from trucks to train

The climate change action plan for transport sector 2014-2018 of the Ministry of Public Work and Transportation (MPWT 2014) had set up some strategies and action to address climate change adaptation and mitigation including to promote climate resilience in transport infrastructure and to promote low-carbon consumption for Green House Gas reduction in transport sector.The strategy priority for adaptation to promote climate resilience in transport infrastructure by considering the impact of climate change including (1) develop national road construction and maintenance design standards for national and provincial roads, (2) repair and rehabilitate existing road infrastructure and ensure effective operation and maintenance system, (3) capacity building and institutional strengthening for addressing to climate change.

In the CCCSP 2014-2023 launched strategies responding to climate change for adaptation and mitigation co-benefit in energy sector including:

- Build and rehabilitate climate-resilient rural road infrastructures and connect production areas to the market
- Promote capital-intensive urban transport infrastructure planning and development
- Enhance the quality of rural infrastructure (roads, irrigation, wells and culverts) to be resilient to flood and drought
- Promote low-carbon, climate-resilient city development planning and develop city-level coordination mechanisms (e.g. capital and provincial effective mass transport, modernization of wastewater treatment facility and landfill)
- Shift long-distance freight movement from truck to train., Enhance traffic management
- Promote capital-intensive urban transport infrastructure development and planning.

For the transport sector, some adaptation options and measures are co-benefit with the mitigation sector which should be considered and considered for implementation related to promoting and improving the development and application of public transport (road, rail, and water) for passengers and freights, E-vehicle, bicycles, climate resilient roads construction, rehabilitation and management as well as enhance traffic management in urban areas.

F. Monitoring and Evaluation of Adaptation Actions and Processes

(paras. 112–114 of the MPGs)

As climate effects increasingly challenge development progress, there is a need for national-level frameworks that monitor and evaluate both adaptation and development. These would allow developing countries to provide evidence for the effective planning and implementation of future investments at a national scale, allowing them to prioritize investments most effectively and bargain harder for climate finance. But the M&E of adaptation responses is often limited to the project level; portfolio M&E and national-level M&E frameworks remain limited. There has been little investment in national-level M&E frameworks to measure aggregated country level impacts. However, the M&E of adaptation solutions is frequently limited to the project level; M&E

frameworks at the national and portfolio levels are still few. To quantify the total effects at the national level, little money has been invested in M&E frameworks at the national level.

9. Monitoring and Evaluation Approaches and System

The M&E system on climate change response plays an integral role to monitor, assess and generate lessons learned and evidence for designing future climate actions matching the ever-increasing challenges posed by climate change on development progress in Cambodia. The Cambodian Climate Change M&E Framework tracks both national institutional readiness indicators (measuring national institutions capacities to manage climate risks) and the impact indicators covering adaptation and mitigation. These indicators have been updated regularly. Data on the evolution of these indicators can be found on the data portal. Cambodia's Climate Change Strategic Plan (CCCSP 2014-2023) released in 2013, indicated as one of its key elements, the establishment of a national M&E framework for climate change response. This led to the development of the Cambodian Climate Change M&E Framework mentioned above.

Cambodia's national M&E system has been developed for monitoring the implementation of the NSDP to develop a reliable and consistent framework for monitoring and evaluating development interventions at national, sectoral and subnational levels. The NCSD and its Secretariat's Department of Climate Change (DCC) have coordinated the development of the M&E framework since 2013. The government has developed an M&E policy framework for the NSDP's 2014–2018 cycle which will help implementers assess the country's performance at multiple levels: programme, project, sector, national, subnational and entire economy (**Figure III 28**) (RGC, 2014).

M&E framework (CCMEF) under the CCCSP 2014-2023, the aim of the national framework for monitoring and evaluation of climate change is to:

- Measure to what extent adaptation efforts have been effective in keeping development on track in a changing climate.
- Monitor climate change mitigation actions and low-carbon development policies.
- Generate evidence and lessons as a basis for future policy development.
- Facilitate the coherent integration of M&E of climate change in national development planning and key sectors.
- Provide the information required to fulfil the reporting obligations towards the UNFCCC and development partners.

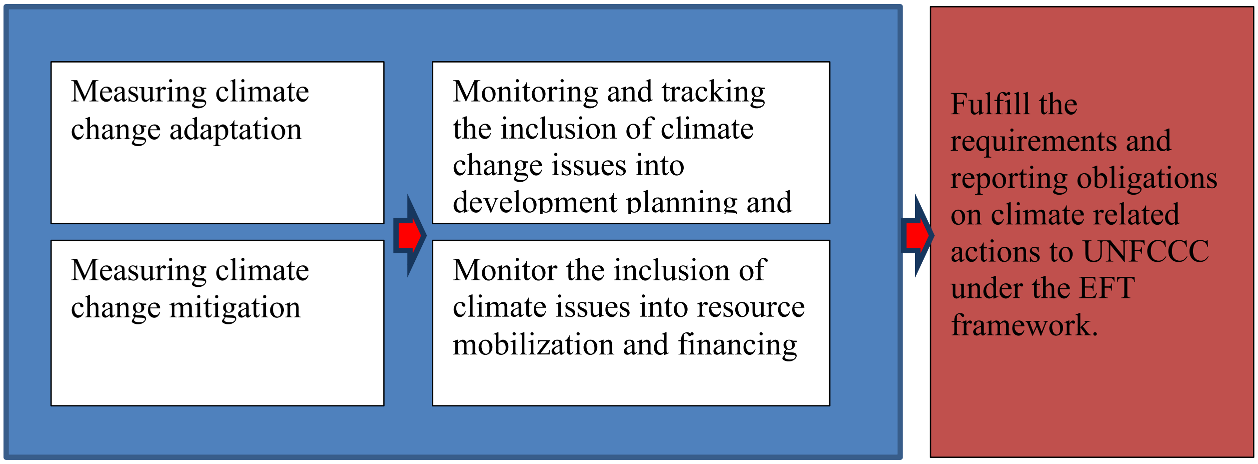


Figure III. 28: Climate Change Monitoring workflow

The impacts of climate change are complex and multi-dimensional and addressing them requires coordinated M&E action across multiple sectors and scales. Recognizing this, a hierarchical M&E framework was developed through the TAMD approach to coordinate and collate national and sectoral level Climate Risk Management (CRM) activity information. **Figure III.29** lays out the multiple layers of the design over the M&E framework to track adaptation progress across various level.

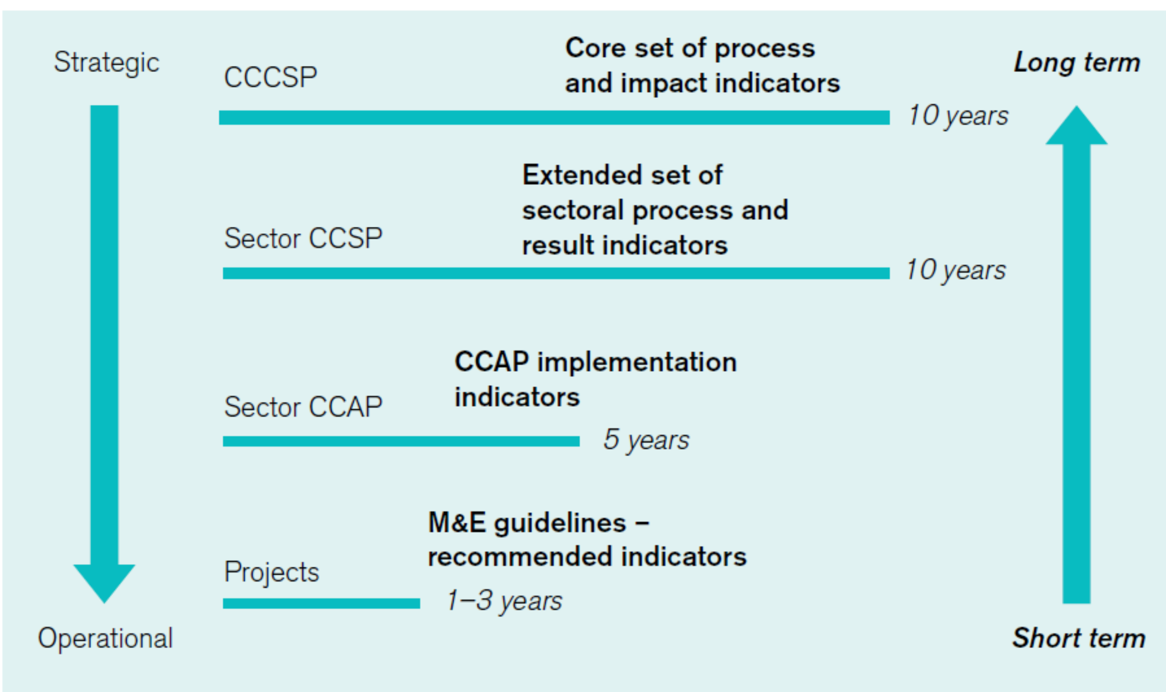


Figure III. 29: Multiple layer indicator framework (TAMD)
Source: (Rai et al., 2015)

10. Evaluation and Indicators

Together with multiple stakeholders and in close collaboration with the International Institute for Environment and Development (IIED) they were testing indicators and building baselines. The framework was presented to stakeholders and the public in April 2016. The M&E framework of Cambodia is indicator-based. It adopts a twin-track approach measuring, on the one hand, how well the national institutions are in managing climate risks through institutional readiness indicators and, on the other hand, how successful climate interventions are in reducing vulnerability or lowering carbon emissions through impact indicators. The baseline results reflect the position of Cambodia in 2014. Cambodia is using IIED's Tracking Adaptation and Measuring Development (TAMD) approach to facilitate its national M&E framework. The TAMD approach assesses the effectiveness of responses to climate change by integrating the extent and quality of risk management of countries or organizations (Track 1) with the effectiveness of adaptation measures in lowering climate vulnerability and promoting development (Track 2) (**Figure III.30**). This twin-track strategy can be used to evaluate how development interventions can increase communities' ability to adapt to climate change, as well as whether adaptation to climate change results in effective development.

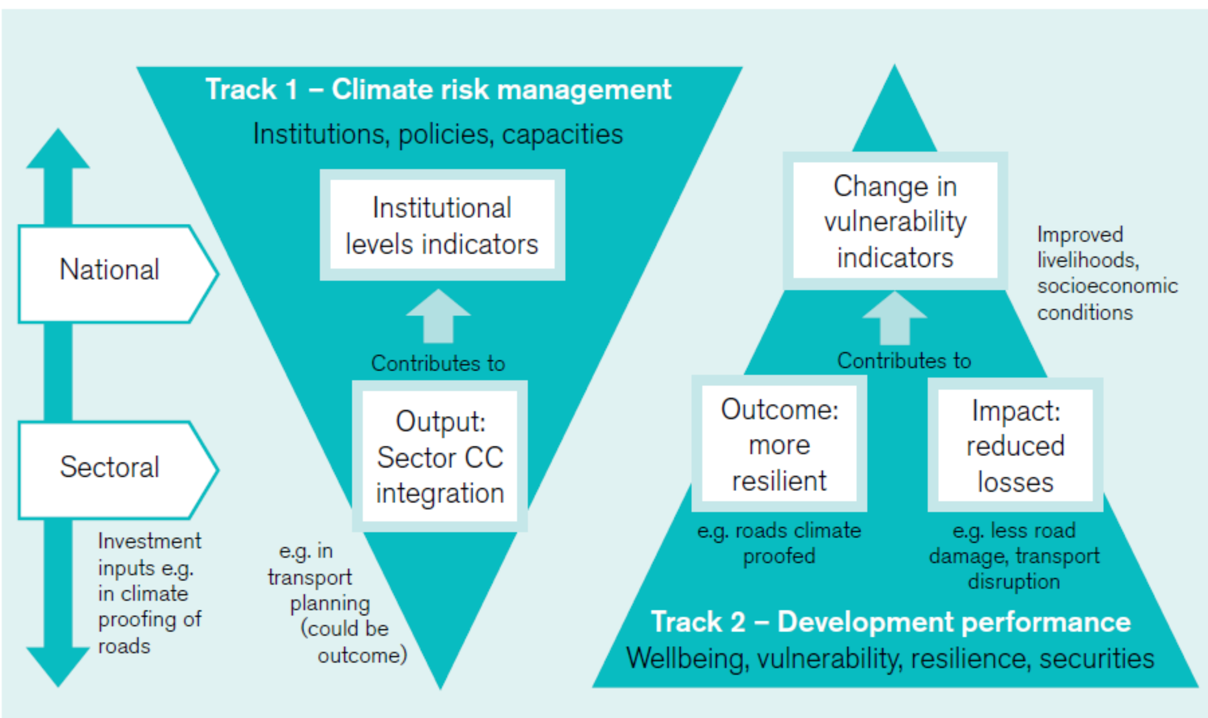


Figure III. 30: Overview of TAMD framework
Source: (Rai et al., 2015)

At the national level, NCSD/DCC (MoE) oversees annually producing and analyzing the core set of indicators of the national framework. The M&E framework has been designed to include an indicators framework with baselines and targets for tracking the CCCSP and related action plans.

From the outset the indicators framework planned to include two categories measuring institutional response for climate change management and development performance in a changing climate:

- **Upstream indicators**, tracking effectiveness of climate risk management: This will include indicators related to the institutional framework, mainstreaming of climate change in policies and planning processes, climate financing, capacities of institutions, equity and transparency, and engagement of stakeholders and the private sector.
- **Downstream indicators**, tracking changes in the development situation, emissions and climate vulnerability of communities and ecosystems: The indicators will include national development statistics, indicators aggregated from sectors and individual adaptation and mitigation projects. To understand whether adaptation is taking place, actions will be required to be assessed alongside climate trends, incidence and magnitude of climate extremes.

The CCCSP/ CCMEF subsequently adopted the Tracking Adaptation and Measure Development approach (TAMD), which is designed around a similar twin-track approach.

- Track 1 (upstream) measures how well countries or institutions can manage the climate risks (policies, institutional capacity etc.)
- Track 2 (downstream) measures climate change adaptation efforts, as well as how well climate change interventions boost community resilience or improve their adaptive capacity to climate variability.

The institutional readiness indicators (Track 1) are measured through scorecards. The scorecards are applied by the key climate change sensitive sectors/ ministries of the Climate Change Technical Working Group (CCTWG). CCTWG analyses scorecard results and discusses ways forward. DCC The commune database is the main channel for accessing data from the local level and is being used for the impact indicators related to adaptation (Track 2).

The framework also uses scorecards to assess five institutional readiness indicators at regular intervals to understand how Cambodia is increasing its institutional capacity to respond effectively to climate change. The aims of the national M&E framework for measuring climate change responses are to measure the extent to which adaptation and mitigation efforts have been effective in keeping development on track in a changing climate; generate evidence and lessons as a basis for future policy development; and facilitate the coherent integration of M&E of climate change in national development planning and key sectors. The proposed indicator framework includes:

1. A core indicator set at national level, with five institutional readiness indicators related to policies, institutions and capacities, 3 impact indicators related to reduction in vulnerabilities, damage and loss and GHG emissions, and
2. Two to three indicators from each sector.

The 5 indicators related to institutional readiness and 2 impact indicators related to vulnerabilities and impact were measured in 2014 (**Table III. 16**). The baseline for the indicator on GHG emissions (by sector and per capita) will be measured in 2017 and the baseline measurement for sectoral level indicators is ongoing.

Table III. 16: Core indicator set in the National M&E Framework for climate change

Institutional readiness indicators	Impact indicators
Indicator 1: Status of climate policy and Strategies: Status of development of national policies, strategies and action plans for climate change response	Percentage of communes vulnerable to climate change
Indicator 2: Status of climate integration into development planning: Status of inclusion of climate change in long, medium (NSDP) and short term (PIP) national and sub- national planning.	Families affected due to floods, storms and droughts
Indicator 3: Status of coordination: Status and functionality of a national coordination mechanism for climate change response and implementation of the CCCSP.	GHG emissions (by sector and per capita)
Indicator 4: Status of climate information: status of production, access and use of climate change information.	+ 2 or 3 indicators per sector
Indicator 5: Status of climate integration into financing: Status, availability and effectiveness of a Financial Framework for Climate Change response.	

The CCCSP suggests two indicator categories to measure institutional response for managing climate change and development performance in a changing climate. The TAMD approach was used by the Department of Climate Change and IIED to understand how Cambodian institutions are managing climate risks and how well investment in climate change have contributed to reducing vulnerability and losses to families from climate hazards. The institutional readiness indicators are measured through scorecards. The scorecards are applied by the key climate change sensitive sectors/ministries which are part of the Climate Change Technical Working Group (CCTWG). CCTWG analyses scorecard results and discusses ways forward. In addition, the NCSD/DCC is also supporting the sectors in the development of their respective climate change M&E frameworks.

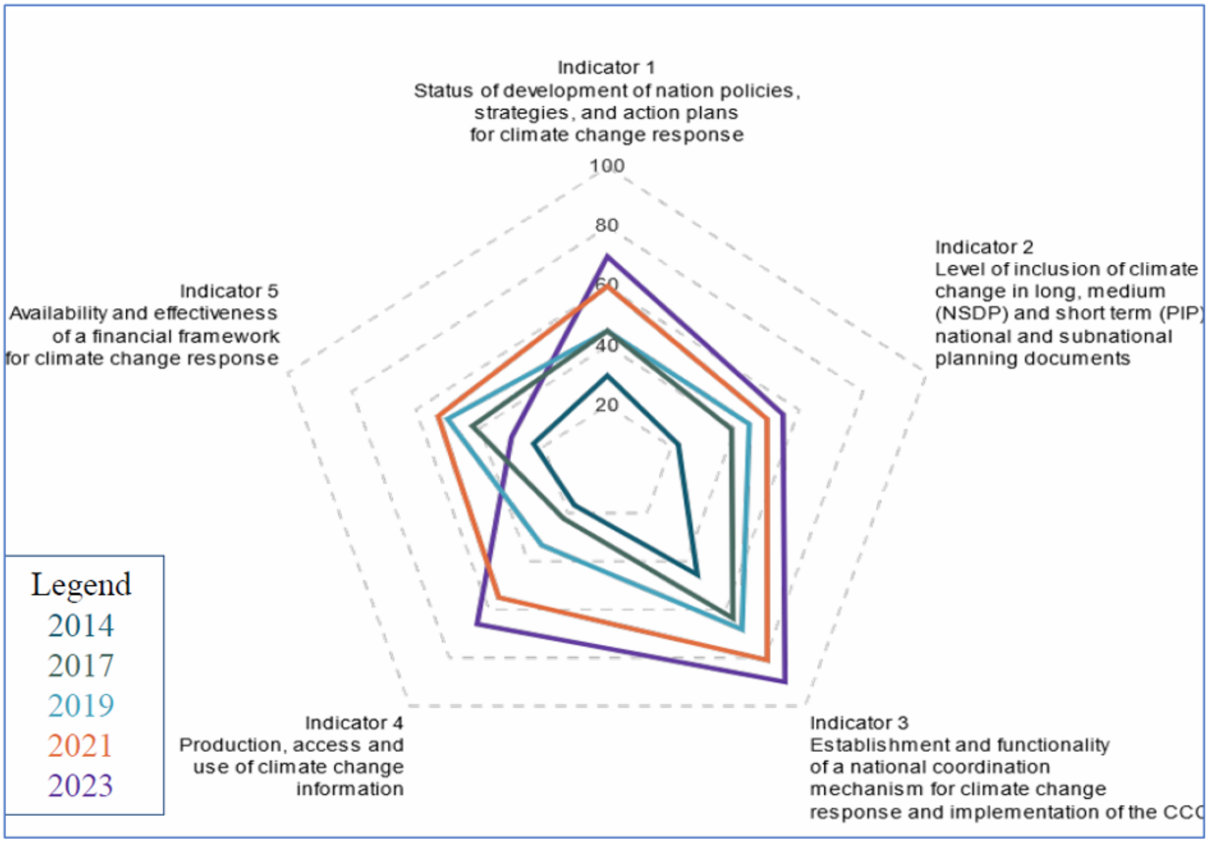
10.1. National-level indicators

On national level, NCSD/DCC oversees annually producing and analyzing the core set of indicators of the national framework. The commune database is the main channel for accessing data from the local level and is being used for the impact indicators related to adaptation. The

NCSD/DCC has been leading the efforts to strengthen the country's capacity for M&E of the climate change response and has played a critical role in the development of the present framework and establishment of its M&E information system. NCSD/DCC has coordinated the development of the M&E framework together with multiple stakeholders and in close collaboration with IIED. GIZ has been supporting the development of sectoral M&E frameworks for the Ministry of Agriculture, Forest and Fisheries as well as for the Ministry of Health and the Ministry of Public Works and Transport. While the NCSD is taking the lead in the implementation of the framework, ongoing support is being provided by the Cambodia Climate Change Alliance and other donors.

Compared to the baseline in 2014, the scorecard results show that Cambodia has strongly invested in better coordination mechanisms to respond to climate change. This includes a dedicated climate change department in the General Secretariat of the National Council for Sustainable Development (NCSD). Additionally, there have been efforts to integrate climate considerations into national and sectoral policies, demonstrating a high level of political commitment to climate action.

However, the production of, access to, and use of climate information systems remain weak. With data scattered across various ministries and agencies, it is difficult to access reliable climate-related information. The lack of a centralized climate data repository hampers the ability to make informed decisions. When information does exist, the capacities to meaningfully assimilate and use the data are inadequate. Training and technical support are insufficient, leading to underutilization of available data. This clearly shows Cambodia's climate change readiness in some matters more than others. While the country has made significant strides in establishing institutional frameworks and demonstrating political will, there is a pressing need to enhance technical and operational capacities. Improving data management, fostering inter-agency collaboration, and building the skills necessary to analyze and apply climate data are crucial steps forward. One of the challenging issues, the country has observed of decreased the availability and effectiveness of the financial framework for climate response (**Figure III.31**).



Institutional Readiness Indicators - 2023

Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5
70%	55%	90%	66%	30%

Figure III. 31: Tracking progress of institutional Readiness Indicator in 2023

Source: (MoE, 2023)

10.1.1. Sectoral level indicators

After establishing the baseline for Tracks 1 and 2 indicators at the national level, IIED, with support from GIZ, piloted TAMD in the MPWT, one of fourteen of Cambodia's sectoral ministries that have developed their own Climate Change Action Plan (CCAP) so far. IIED supports MPWT to monitor and evaluate its CCAP using same principles and approach as applied when measuring national performance.

The CCAP indicator framework comprises four main categories:

- CCAP delivery and mainstreaming
- Institutional readiness to climate change
- Results or outputs indicators

- Impact indicators.

TAMD approach was used to develop baselines for MPWTs institutional readiness for climate change and the percentage of roads and bridges affected by floods (impact indicators).

10.1.2. Effectiveness and Sustainability of Adaptation Actions

In the long run, the government would need capacities and resources to invest in M&E so it can track progress against national objectives and ensure development is kept on track despite the stresses of climate change. The national framework will be implemented in three stages, according to the CCCSP: short-term (2014), medium-term (2018), and long-term (2024). IIED worked with the Cambodian government to establish baselines against its core indicators for the first term. Between 2018 and 2024, the Department of Climate Change (DCC) of the General Secretariat of the National Council for Sustainable Development (GSSD) will assess progress made in relation to these standards. The DCC's Policy and Coordination Office will also coordinate M&E reporting from various line ministries.

- **Short to medium term**
  - *Operationalize the Monitoring, evaluation and learning unit:* The DCC's Policy and Coordination Office is responsible for implementing the M&E framework, which includes collecting data against the core indicators, conducting in-depth studies in some cases and coordinating M&E reporting with line ministries.
  - *Capacitate DPs within sectoral ministries:* Although DCC will play a role in coordinating with line ministries, M&E at sector level is expected to be the responsibility each line ministry's DoP. To ensure effective reporting of progress from line ministries, it will be important that the DCC's Policy and Coordination Office acquaints individual DoPs with data collection procedures and templates for analysis and reporting.
  - *Validating national and sectoral baseline results on the ground:* The current baseline for vulnerability and impact indicators is calculated from data available in Cambodia's commune database. Using a national database is a practical approach for measuring impacts at national level.
- **Medium term**
  - *Replicating the M&E approach across all fourteen-line ministries:* The framework should be mainstreamed in the remaining line ministries in the medium term. This will require establishing sectoral Track 1 and 2 indicators and developing baselines and procedures for data collection.
  - Mainstreaming M&E for climate change within subnational and local planning. It is recommended that the approach is piloted at the local level.
  - *Refining the commune database:* The vulnerability and impact indicators could be augmented by including new vulnerability-focused questions in the commune

database, based on participatory vulnerability assessments in selected communes.The approach to identifying indicators of vulnerability has been to undertake statistical analyses of the correlations between the available development or wellbeing indicators (e.g. poverty, infrastructure, health, etc.) and metrics of climate-related loss and damage, with the latter lagging by a year in relation to the former. Development indicators exhibiting strong and statistically significant correlations with loss and damage indicators are identified as potential useful proxies for vulnerability (i.e. vulnerability indicators).

❖ **Long term**

- *Regular monitoring of core indicators:* This can be supported by long-term evaluations.
- *Analysing M&E results at national and sectoral levels* and using this information for better planning and targeting of climate-resilient interventions. For example, commune and village-level information on vulnerability levels and impacts can be used to target support towards specific communes, districts, and villages.
- *Updating M&E indicators or vulnerability indices if needed:* The framework can be revised based on lessons that emerge during the piloting phase.

G. Information Related to Averting, Minimizing and Addressing Loss and Damage Associated with Climate Change Impacts

(para. 115 of the MPGs)

Averting, minimizing, and addressing the adverse effects of climate change in the Kingdom of Cambodia are becoming increasingly urgent. The rain today falls differently from how it used to; the onset of the rainy season is less predictable, and storms that used to bring renewal now damage homes and inundate villages. Dried ground, receding forests, sea intrusion, and increasing salinity are reducing lives based on agriculture and natural resources in the country. Rising natural poles and intensifying summers are transforming Cambodia's landscape and making the country tougher and crueler. Negative impacts of climate change affect more ecosystems and the livelihoods of Cambodian people who live from the environment. Over the past two decades, some of the climate related phenomena in Cambodia reportedly affecting agriculture, water resources, and human health include: increasingly frequent and severe heavy rains, flooding, and erosion; more rapid and significant changes in land use and land cover; the concentration and severity of heat and drought events; and changing trends in rainfall patterns and intensities.

10.2. Understanding loss and damaged

Adaptation focuses on reducing vulnerability and increasing resilience to climate change impacts. Mitigation focuses on reducing the amount of climate change by decreasing the greenhouse gases in the atmosphere. In contrast, loss and damage focus on those impacts that are largely unavoidable, even with adaptation and mitigation. Put another way, loss and damage operate at the margins of both adaptation and mitigation. The inadequate distinction of these concepts often leads to misconceptions and imprecise discussions about how to avert, minimize, or address loss and damage. Effective interventions to avert, minimize, or address loss and damage must be tailored to the unique characteristics of the climate change impacts and the context in which they occur. While there are similarities that cross-cutting all climate change impacts, effective solutions must also be tailored to individual geophysical, ecological, socio-economic, and cultural characteristics, as well as the ability to strengthen and restore underlying systems to increase their sustainability and recognize and be tailored to the existing set of underlying vulnerabilities and resilience by promoting the support, repairing, and establishment of local, national, and global mechanisms, institutions, and governance systems which emphasis is not on short-term losses and damages, but rather on long-term losses and damages.

10.3. International Partnerships and Collaborations

RGC acknowledges that international partnerships play a crucial role in averting, minimizing, and addressing loss-and-damage risks associated with climate change impacts. The RGC has conducted various research projects and initiated several activities with international organizations, development partners, non-governmental organizations, and various countries to mitigate, manage, and address climate change in forestry, land, agriculture, fisheries, water, and handicraft production. Nonetheless, the RGC still views international partnerships as a key factor, and cooperation with other countries would enhance capacity and increase the effectiveness of addressing these issues. Thus, various financing and investment projects and initiatives have strengthened partnerships with donor grant assistance and projects facilitated by international cooperation in several sectors. Owing to the support of these partners, Cambodia has achieved significant results in natural resource management and environmental protection, including addressing floods. To provide financial support in dealing with climate change, the Agriculture Office of Japan intends to financially support the project. The project is implemented by the Agriculture Office of Japan and the Royal Government of Cambodia in Siem Reap Prefecture. The project started in 2021 and will be completed with the handover of resources after 2024. It is expected that the Japanese Government's grant as official development assistance will contribute to a more resilient Cambodian society against climate change, which is a concern for both Cambodia and the international community.

There is no clear policy or legal framework that discusses issues associated with loss and damage, including addressing maladaptation in Cambodia’s future. This is a gap, a barrier to avoiding, minimizing, and addressing loss and damage related to climate change issues that require a collaborative effort between different layers of both international and national authorities.

10.4. Information of loss and damage over the last two decades

Cambodia has faced various types of disaster events including droughts, floods, storms, lightning, pest outbreak and landslide have been documented associated to lose and damage in this last two decades which is 97% were directly affected by disaster events between 1996 and 2023.

The data has been recorded as 5.9 thousand of people were reported dead, injured and missing, 117 thousands of houses were damaged and destroyed, 3.1 million ha of agricultural land were damaged, 26 thousands of livestock were lost, while 8.3 million kilometers of roads were affected (**Table III. 17**). Expenditures have been allocated for the rehabilitation and reconstruction of physical infrastructure and public services, amounting to millions of dollars in annual national budgets.

Table III. 17: The effect of disaster events between 1996-2023

Events	Deaths	Injured	Missing	Houses Destroyed	Houses Damaged	Relocated	Evacuated	Losses $USD	Education Centers	Hospitals	Damages in Crops (ha)	Lost cattle	Damages in roads Mts
Drought	0	0	0	0	0	0	0	0	11	0	1033462	1154	1110
Epidemic	37	0	0	0	0	0	0	0	0	0	0	0	0
Fire	243	372		5530	1511	0	69	180000	1	0	275	9	0
Flood	1243	1115	2	2401	31810	17186	769158	0	947	1839	2059768	24683	8256737
Lightning	1182	664	1	39	185	0	337	0	1	1	502	453	0
Pest Outbreak	0	0	0	0	0	0	0	0	0	0	15915	0	0
River Bank Co	3	2	0	203	531	694	46	0	0	0	0	0	1870
Storm	243	822	2	15492	59064	0	3111	0	75	39	5458	74	210

Source: (NCDM, 2023)

H. Cooperation, Good Practices, Experience and Lessons Learned

(para. 116 of the MPGs)

Since the early 2000s, Cambodia has been at the forefront of climate change adaptation action, and the country has undertaken significant efforts in shaping an institutional setup to best address climate change, coordinating by the Climate Change Department of MoE. In 2006, the National Climate Change Committee, comprised of 19 ministries and government agencies, was created with the mandate to prepare coordinate and monitor the implementation of policies, strategies, regulations, plans and programmes in addressing the issues of climate change. In 2015, the NCSD and its General Secretariat were established and given authority to made efforts to improve the coordination of climate change activities in Cambodia and to promote a stronger, comprehensive and effective climate change response as well as formulation climate policy, strategy, action plan and guidance in particular to the establish strong policy and legal framework to help Cambodians shift to more sustainable, resource-efficient, climate resilient, low carbon modes of development.

An increasing number of actors, including government and communities, CSO, private sector, academia and development partners, with the support of the DCC, are getting involved and acting on the ground related to climate change adaptation. From large programs e.g. Strategic Program for Climate Resilience, SPCR (ADB), CCCA (EU, SIDA, UNDP), Reducing the Strengthening

Rural Livelihoods, SRL (UNDP) to individual or community interventions, Cambodia is preparing itself for a climate resilient sustainable future.
At the sub-national level, with the help of DCC and in coordination with the National Committee for Sub-National Democratic Development (NCDD), local governments are increasingly using commune vulnerability assessments to identify climate adaptation measures that can increase community's resilience to the effects of climate change, targeting them for funding through their Commune Investment Programs (CIP).

Adaptation remains the priority for Cambodia, mitigation is increasingly becoming a key part of the country's response to climate change as growing evidence shows that many mitigation investments can generate co-benefits in terms of climate change adaptation, development, employment, energy security and public health. With funding from the Climate Investments Funds-Pilot Program for Climate Resilience (PPCR), the Royal Government of Cambodia, with support from the Asian Development Bank and the World Bank, prepared the Strategic Program for Climate Resilience (SPCR), comprising seven investment projects in key sectors including agriculture, water resources, transport and urban development and technical assistance (TA) on mainstreaming climate resilience into development planning. The PPCR enhances resilience in key sectors, strengthens technical and institutional capacities, and builds adaptation knowledge for scaled up actions. The SPCR supports inter-ministerial collaboration, effective engagement of stakeholders, and collaboration within government agencies and with civil society organizations, other development partners and the private sector, with the objective to mainstream climate resilience into national and sub-national development policies, plans and projects supported by scaled up financing of adaptation activities in the key development sectors. The underlying success of the SPCR lies in transforming national and sub-national development at policy and operational levels to be more risk-responsive, climate-resilient and gender-sensitive.

The CCCA is a joint initiative of the Royal Government of Cambodia and development partners to address climate change in Cambodia. It provides a unified engagement point to pool resources for the mainstreaming of climate change into national and sub-national policies and programmes. The CCCA has been active since 2010, and the current third phase of the programme (2019-2024) builds on the main achievements of the previous phases:

- The development of the Cambodia Climate Change Strategic Plan 2014-2023 (CCCSP) and corresponding fourteen associated action plans (CCAPs) developed by key ministries.
- The operation of the grant facility (42 Government and NGO projects supported in key aspects of climate change); and
- The increasing of visibility and understanding of climate change, both within Government and the society.

The CCCA programme engages a wide range of stakeholders and promotes innovative partnerships between government, civil society, academia and the private sector. It also works constantly on improving information and knowledge available on climate change and ensures that the existing data is reliable and updated.

Under support from CCCA, 15 government's ministries have developed their own Climate Change Action Plans, which proposed of 171 climate actions projects related to adaptation measures about 93% and mitigation about 7%. The MoE, MAFF and MoWRAM have, together, proposed 62 adaptation and mitigation projects, but only 12 of these (or 19%) were in operation by 2016. These ministries face similar challenges in implementing their climate change projects: Financial constraints; limited human capacity; a lack of reliable and comprehensive data sets and research; and a lack of technology transfer and awareness. An overview of barriers and opportunities is shown in the **Table III. 18** below, with elaborations provided in the following sections (NCDDS, 2019).

Table III. 18: Barriers and opportunities for sub-national implement climate change adaptation

Category	Barriers	Opportunities
Policy and institutional aspects	Scope for improved interagency coordination of CCA initiatives Inadequate land use planning and management	Strong political support for the D&D process Scope for improved, site-specific disaster preparedness and contingency planning Scope for improved CCA in urban areas
Information and knowledge base	High time-and-space variability of rainfall and stream flow Sea level and land subsidence are not systematically monitored	-Detailed. high-resolution satellite data readily available New hydro-meteorological data portals in an advanced state of implementation -Manuals, guidelines and reference documents are readily available
Capacity and skills	-A remaining need exists for sub-national consolidation of CCA and DRR mainstreaming -EIA and climate screening modalities exist but are not consolidated	-Recent comprehensive training programs have been conducted for subnational practitioners -A clear scope for improved extension services, based on sharing of existing (but fragmented) expertise
Financial/economic constraints	Current commune- and district-level budgets can cover urgent infrastructural maintenance only – there is no room for pro-active development	-Substantially increased budget allocations have been announced -Various targeted CCA financing options are available -Scope for cost recovery Scope for private sector collaboration
Technology	Tools and modalities for identification, scoping and	Several related development initiatives are in progress

	design optimization exist but are not well consolidated	
Social aspects	Good public awareness of climate-related pressures and concerns, but limited awareness of adaptation options	-Scope for expanded community-based cultivation, forestry and irrigation scheme operation, including knowledge sharing and dissemination of 'success stories' -Scope for expanded access to microcredit and crop insurance -Scope for strengthened interaction with the academic community and the NGOs/ CSOs

Chapter 4:

Information on financial, technology development and transfer and capacity- building support provided and mobilized under Articles 9–11 of the Paris Agreement

Under Paris Agreement

A. National circumstances and institutional arrangements

(paras. 119–120 of the MPGs)

1. Institutional arrangements for financial support

Cambodia is making significant efforts on different elements of climate finance, mainly the streamlining of climate change into national and ministerial budgets, as well as the MRV of climate finance. The lead entities of the MRV of support in Cambodia are the Ministry of Economy and Finance (MEF) and the Cambodian Development Cooperation Board (CDCB) of the Council for the Development of Cambodia (CDC). The MEF is the competent authority for budgetary issues and public finance management in Cambodia. Since 2017, the MEF included guidance on climate change in annual budget circulars. Prior to this, key ministries have also started to integrate climate change in the way they prioritize activities for the national budget. Using the ex-post expenditure data provided by line ministries, and also using the data from the ODA database, the MEF performed in years 2018, 2019, 2020, 2021, 2022 and 2023 three annuals Climate Expenditure Review (CPER) of the country for the fiscal years 2017, 2018, 2019, 2020,2021 and 2022 respectively, where the expenditure carried out in the country in projects related directly or indirectly to climate change was measured and reported.

The NCSD and the Cambodian Climate Change Alliance (CCCA) provided technical support and verified the data on climate finance measured and monitored by the MEF. The ODA database is maintained by the CRDB. While the ODA Database is Government owned and managed, the responsibility for entering data lies with development partners. Regarding climate change expenditure, the NCSD and the CCCA provide guidance to the MEF on how to identify climate change- related expenditure in the budget of the country. The NCSD, the CDC, CCCA and the MEF agreed on the definition of climate change relevance weights to public expenditure, depending on the objectives and scope of the different expenditure items. Using these climate change relevance weights, the expenditure of the country is split in three categories. The calculations are made by the MEF with the collaboration of the National Institute of Statistics. The measurements are validated by the CRBD and the NCSD. Regarding the ODA data, the measurement and data entry in the ODA database is made by the different multilateral and bilateral agencies with activity in Cambodia. A Manual has been developed by the CRDB for enabling users to understand how to fill-in the data and using the database. Both the expenditure and the ODA data are used for producing reports to inform the international community and donors as well as national stakeholders. The expenditure data is used mainly for policy making purposes, but also for providing information to donors and the public about the efforts made in Cambodia to address climate change. The ODA database data is used for producing tailored reports for donors, development partners, and others. In the ODA database, the information is also publicly available. Visitors can make searches by sector, donor, province, type of assistance, implementing agency, among other variables. One of the sectors is named “cross-sectoral programmes”, within which climate change is found as one of the main items.

The information is reported in the corresponding chapters on support received in the National Communication and Biennial Update Report of the country. Both climate change expenditure and ODA measurements are validated by the CRBD and the NCSD. The content of the BUR and NC is validated in multi-stakeholder processes, involving validation workshops and online consultations. The extend of information provided on support needed and received and its transparency is also verified under the process.

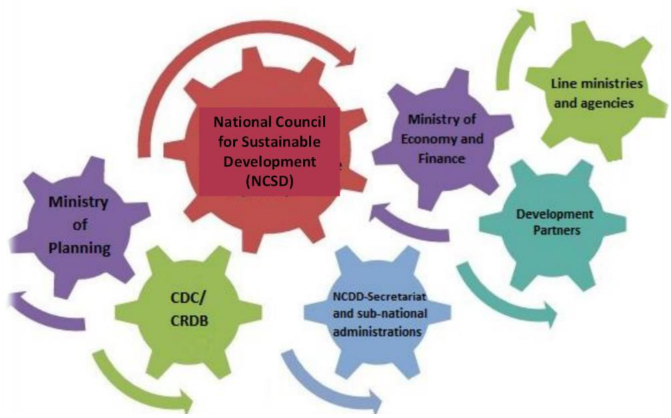


Figure IV. 1: Key Entities of MRV for Support Received

B. Description of Underlying Assumptions, Definitions, and Methodologies used to provide information on support needed and received

(paras. 121–122 of the MPGs)

2. Methodologies, underlying assumptions and definitions

Methodology and assumptions applied for developing the BTR chapter on support needed and received, and elaborating the Common Tabular Formats (CTF), are presented in following section. It provides an overview of the methodology, scope, data sources, main assumptions, typology and weighting and definitions according to the MPGs. Moreover, it explains the key data that was included in the analysis as well as it discusses certain gaps and limitation in the data which underline the final methodology used in the BTR. For the tracking of support received in the BTR, both national and international financial sources are considered. Moreover, support needed is quantified at the sectoral level, as Cambodia’s Climate Public Expenditure Review (CPER) is annually consolidating and analyzing financial support received at the sectoral level. Finally, it’s noted that Cambodia provides the CTF Tables III.6, III.7, III.8, III.9, III.10, III.11, III.12, III.13 in annexes as produced by the ETF Reporting Tool on this document.

3. Overview of methodology used for analyzing support received in Cambodia

Climate finance available to Cambodia mostly comes from international and increasingly national sources. A large part of this funding come through the modification of mainstream spending on development and services. This will require changes in practices, to ensure that the modifications that are made are appropriate and that enough resource are allocated to the climate response. It will also be useful to consider the optimum level of CC funding because this will encourage improved practices and commitment to address current climate conditions and impacts required to reflect the national CC funding need.

There is an uncertainty about the level of international funding dedicated to CC will be met the Paris Agreement goal. This creates some challenges for government, especially as much of this funding will need to be provided as 'top-up' funding to match on-going expenditure by government or by development partners. Therefore, the government is making plans to manage the uncertainty in these resources, based on the prioritization and costing of climate actions in the Sectoral Climate Change Action Plans (CCAPs), submitted by 15-line ministries and agencies[86]. The Cambodia Climate Financing Framework (CCFF) is developed to assesses public climate finance resources available to Cambodia, including from international and national sources as follow:

1. *Dedicated/global climate funds:* climate finance available from global institutions and mechanisms such as CIF, SPCR, GEF, LDCF, AF, FCPF, UN-REDD and GCF, that are dedicated to addressing CC through adaptation and/or mitigation.
2. *Dedicated/in-country funds* are the portion of climate funds that are dedicated for addressing climate issues and that is directly financed by the Cambodian government through its annual budget means and by bilateral and multilateral donors active in Cambodia. This type of funds also includes projects that are managed by donors' regional offices.
3. *Integrated/in-country funds* refer to the type of resources financed by the government and donors in Cambodia that is not primarily meant for climate issues but involves some degree of relevance (low and mid) to CC either explicitly or implicitly. In this type of finance, the climate aspect is integrated or embedded in the mainstream development projects.

Regarding climate actions, the CCFF covers adaptation, mitigation and cross-cutting areas, including:

1. Policies that do not require to be changed in design, but which deliver benefits

[86] MLMUPC, MoT and MoInfo were added to the CCFF exercise, and MIME was split in two: MIH and MME. MPTC were included although its CCAP is pending approval.

that are affected by CC and so may justify more (or less) funding.

2. Policies that need to be modified to take account of CC (e.g. Climate proofing irrigation etc.)
3. Policies that are primarily devoted to CC. These are often associated with technical work (such as studies, strategies and information) and may be linked to investments or to planning capacity, including support for local resilience. They may also include retrofitting climate proofing features to infrastructure and relocating settlements and economic activities away from floods and vulnerable natural resources.

4. Scope, data sources and underlying assumptions

4.1. Scope

It is based on the available information and data on Cambodia's Climate Public Expenditure Review (CPER) published by the Ministry of Economy and Finance (MEF) from 2020 to 2023, which (i) Includes public expenditure **for fiscal year 2020, 2021, 2022 and 2023**, and (ii) Analyses the public expenditure data for the 15 ministries and agencies with an approved Climate Change Action Plan, and for the Ministry of Posts and Telecommunications (MPTC).

4.2. Data sources

The CPER report undertakes the methodology validated since 2015 by (i) identifying expenditures which deliver some degree of climate change benefits, and (ii) weighting these expenditures based on the share of their benefits contributing to the climate change response. The tools used for identifying and weighting expenditures are based on the "Methodological Guidebook: Climate Public Expenditure and Institutional Review (CPEIR)" developed by the UNDP regional programme on the Governance of Climate Finance. The sources of the data and their underlying assumptions are presented below:

1) **Recurrent Spending of central government**: Since the 2019 CPER report, CPER analysis uses the actual recurrent expenditure from FMIS. The recurrent spending data was provided by the FMIS Secretariat of MEF. Data obtained for programme budget ministries was broken down to group of activities which are detailed enough to conduct the climate change tagging and assessment. Detailed data on the functional classification of the programme budget ministries' expenditures is **available for 15 CCAP ministries.**
2) **Domestic financed Investment**: The source for "Domestic financed investment" remains actual figures, but since the 2019 report figures from the FMIS have been used. In this regard, more and more comprehensive data can be obtained, especially on the counterpart funding.
3) **MEF and CDC loan and grant**: **External finance** (CDC and MEF loan and grant): data on development partner disbursements was provided by the CDC/CRDB (ODA database)

the General Department of International Cooperation and Debt Management. CDC/CRDB data includes all development partners' loans and grants with data templates designed by CDC/CRDB. MEF data includes actual disbursements from development partners' loans and grants under MEF management. When data on loan and grant projects came from two sources (CDC/CRDB and MEF), data from MEF is used.

4) In the case of loan and grant programmes involving several implementing ministries/agencies, disaggregated information on the share of disbursements channeled to each implementing agency is not always available. In these cases, estimated percentages have been applied for each implementing agency based on the project/program documents and past experiences. It is assumed that the percentage share is constant for each year over the multi-year life of the project/program.
5) Continued analysis on estimated climate change current expenditure of **Sub-National Administration expenditure** from the aggregate level of the actual spending data during the period 2018-2022.
6) Gender qualitative analysis based on CDC/CRDB database.
7) Exchange rate used for its calculation is approximately at 4,000 KHR/US$.
8) Analysis of the ODA database relied on the climate change sector and thematic markers (with some limitations as development partners tagging of these markers is improving but not yet systematic), and on additional information available in the database on project objectives and outputs; and
9) The CPER assignment was coordinated by the General Department of International Cooperation and Debt Management of the MEF, with support from the FMIS, the General Department of Budget of the MEF to provide and process data as well as provide inputs for the report. The Information Management Department of CDC/CRDB provided the loan and grant data of the ODA database. MEF technical officials have processed the loan and grant data, including tagging for climate change relevance and allocation of disbursements to relevant ministries and agencies.

4.3. Typology and Weights

The Table IV.1 showed the typology of climate change categories and its weights, based on the cost benefit concepts, and the UNDP's 2015 methodological guidebook on the Climate Public and Institutional Review[87]. The CC weighted item is found by the multiplying the weight to its spending level.

87 https://www.undp.org/asia-pacific/publications/methodological-guidebook-climate-public-expenditure-and-institutional-review-cpeir

Table IV. 1: Climate Change public expenditure typology and weights

Climate Change Categories	Abbreviation	Weights	Descriptions
Renewable energy	RE	20%	Renewable projects, including hydropower, solar, bioenergy…
Forestry Management	FM		
• **Forestry Management general**	FM	10%	General forest management
• **Forestry Management, CC direct**	FMC	100%	Direct impact to forest under REDD+, carbon credit, GCF
Disaster reduction	DRM	50%	Arrangement or investment made for disaster reduction
Infrastructure (pure CC proofing)	ICP	50%	Expenditure with objective to avoid flood, or infrastructure highly resilient to cc, like bridge or road designed for water flow
Disaster response	DRR	100%	Infrastructure maintenance or improvement (mainly) or food assistance after disaster events
Water against drought/flood	WCC	50%	Dam or Dike preventing flood or water reservoir, or investment to keep water resources, secondary objective to cc
Health (climate sensitive diseases)	HCC	10%	Health related to vector born disease, malaria…
Planning for climate change	PCC	100%	Planning or projects for cc, CCCA, GCF…
Irrigation	IRR	25%	Irrigation system
Water general	WG	33%	water resource management
Biodiversity and conservation	BC	50%	biodiversity and conservation
Eco-tourism	ECT	5%	Eco-tourism expenditure
Livelihoods target	LVT		
• **Livelihoods (CC Proof)**	LVTC	100%	livelihoods with climate change sensitive or resilience: ADB climate resilience on rice, and IFAD ASPIRES
• **Livelihoods (of CC Venerable)**	LVT	50%	livelihoods with vulnerable groups or small group holders, or geographically vulnerable
Livelihoods (general)	LVG	5%	General livelihood
Emissions (secondary objective)	EG	10%	Expenditure items support reducing the emission, ICT support, traffic management, railroad, …
Energy General	ENG	2%	On-grid electricity, transmission lines
Road improvement (incl. CC proofing)	ROC	15%	road improvement or rehabilitation, mainly increase height, or lay with tarmac
Road (no indication of CC proofing)	ROG	5%	Road construction in general, mostly dirt road, road in the rural areas
Infrastructure (secondary benefits)	IG	5%	Mixed infrastructure road and other, improve transportation and less emission
Water quality (general)	WQG	5%	Clean water supply and sanitation water
Planning (general)	PG	2%	Planning general that indirectly support cc
Health (General)	HG	2%	Health general that indirectly support cc
Governance (General)	GG	2%	Governance support to cc ecosystem

Source: CPER, 2023.

5. Key Definitions

Key glossary and definitions, which are commonly used in CCFF and CPER methodologies are explained below:

- Adaptation. ‘Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities’

(IPCC).

- Business as Usual. A scenario in which there are no changes to current government policies. Typically used to refer to a scenario in which no new mitigation actions are undertaken.
- CC Relevance Weights. The extent to which a government or other activity is associated with CC. Usually measured in terms of the extent to the declared motives for the activity express a primary or secondary concern with adaptation of mitigation, although measured in the CCFF as the proportion of benefits that arise because of CC. In theory, used as the basis for determining eligibility for the level of CC top-up, compared to total funding.
- Dedicated CC Activities. Activities that generate few or no benefits if there is no CC. These include 'soft' activities (e.g. to strengthen CC planning). In practice, any activities for which at least 50% of benefits are derived because of CC are included, to simplify planning.
- Integrated CC Activities. Activities for which the benefits arising because of CC account for up to 50% of the total benefits.
- Mitigation. Actions that aim to reduce the level of climate change, typically by reducing greenhouse gas emissions or by promoting GHG sequestration.
- Modalities. The methods for managing climate finance, including the institutions involved and the instruments and measures used by those institutions, along with any associated legislation or regulations required.
- Non-CC Activities. Activities where the benefits are unaffected by whether CC takes place or not.
- Proofing. Changing the design of an activity so that the potential damage arising from CC is reduced or eliminated.
- Resilience. The ability to withstand the potential damage that may be caused by climate change. The opposite of vulnerability.
- Soft Activities. Activities that do not directly provide benefits to the general population, including capacity building, planning, public awareness, studies (except feasibility studies that are an integral part of delivering infrastructure or services).
- Top-Up. Funding provided to activities that generate benefits regardless of climate change, to encourage the activities to be redesigned to pursue mitigation and/or adaptation benefits, in addition to the other benefits.
- Vulnerability. The likelihood that a household or ecosystem will be harmed by climate change. Typically expressed as a combination of a) exposure to risk; b) sensitivity to that exposure; and c) capability to cope with the exposure and sensitivity. The opposite of resilience.

6. Common Tabular Formats (CTF)

CTF tables report financial, technology transfer, and capacity-building support provided and needed are mainly quantified at the sectoral and/or project level and therefore the CTF tables III 1-5, III.6, III.8, III.10 and III.12 as per the MPGs are reported. The table 2 shows an overview of all the CTF relevant for support with a reference page in the MPGs and clarify whether the CTF is reported or not with an additional explanation.

Table IV. 2: Overview of the reported CTF tables.

Common Tabular Format	Reference Provision in the MPGs	BTR Report	Explanation
Table III. 1-5 on Support provided	Paragraphs 123, 124, 125, 127, 129	No	It's not mandatory as Cambodia is a developing country.
Table III.6 Information on financial support needed by developing country Parties under Article 9 of the Paris Agreement	Paragraph 133	Yes	Information on financial support needed is quantified at the sectoral level by project based on Cambodia's Updated NDC and therefore is reported.
Table III.7 Information on financial support received by developing country Parties under Article 9 of the Paris Agreement	Paragraph 134	Yes	Financial support received at the project level for projects across the three types of support: Mitigation, Adaptation and Cross-cutting, is reported.
Table III.8 Information on technology development and transfer support needed by developing country Parties under Article 10 of the Paris Agreement	Paragraph 136	Yes	Information on technology development and transfer support needed at the project level is available in Cambodia and therefore not reported. The notation key [NR] is applied.
Table III.9 Information on technology development and transfer support received by developing country Parties	Paragraph 138	No	Technology development and transfer support received at the project level for projects across the three types of support: Mitigation, Adaptation and Cross-cutting, is not reported.
Table III.10 Information on capacity-building support needed by developing country Parties under Article 11 of the Paris Agreement	Paragraph 140	No	Information on capacity-building support needed at the project level is not available in Guyana and therefore not reported. The notation key [NR] is applied.
Table III.11 Information on capacity-building support received by developing	Paragraph 142	No	Capacity-building support received at the project level for projects across the three

country Parties under Article 11 of the Paris Agreement			types of support: Mitigation, Adaptation and Cross-cutting, is not reported
Table III.12 Information on support needed by developing country Parties for the implementation of Article13oftheParis Agreement and transparency-related activities, including for transparency-related capacity-building	Paragraph 144	No	Information on for the implementation of Article 13 of the Paris Agreement and transparency-related activities, including for transparency- related capacity-building at the project level is not available and therefore not reported. The notation key [NR] is applied.
Table III.13 Information on support received by developing country Parties for the implementation of Article13oftheParis Agreement and transparency-related activities, including for transparency-related capacity-building	Paragraph 144	Yes	Support received at the project level for transparency-related activities, including for transparency-related capacity- building at the project level, is reported.

C. Information on financial support provided and mobilized under Article 9 of the Paris Agreement

Article 9 of the Paris Agreement (paras. 123–125 of the MPGs)

7. Financial Support Received

Domestic sources increase significantly to 48% of total weighted climate change spending, up from 37% in 2022, offsetting the 11.5% decrease in the external funding, which still accounts for 52% of the total. The share of climate change expenditure in GDP is 2.1% in 2023, about the same as in 2022. In absolute terms, public expenditure with climate change benefits has slightly increased by 8% from KHR 2,561 billion in 2022 to KHR 2,769 billion (about USD 692.3 million), reflecting the continued strong spending on resilient infrastructure such as roads, irrigation systems and dams, energy, and climate-resilient agriculture projects.

Table IV. 3: Proportion of climate change expenditure to total public expenditure and GDP

	2020	2021	2022	2023
CC public expenditure (weighted) vs. total public expenditure	7.3%	7.4%	6.8%	7.1%
CC public expenditure (weighted) vs. GDP	2.2%	2.3%	2.1%	2.1%

Source: CPER, 2023

The amounts allocated from domestic resources (national budget) for climate change expenditure reached KHR 1,341 billion in 2023, an increase of KHR 394 billion or 41.6% compared to 2022. In 2023, the domestically financed climate change expenditure accounts for 48.4% of the total climate change expenditure, up from 37% in the previous year, while externally financed climate change expenditure accounts for 51.6%, down by 11.5% compared to 2022.

Since June 2020, the RGC's social protection package has provided cash transfers to the poor and vulnerable households, by using the Ministry of Planning's ID Poor, contributing indirectly to climate change resilience and increased adaptation capacity for their livelihoods during Covid-19. In the implementation of the "Cash Transfer for the Poor and Vulnerable Households" initiative, cash assistance from the national budget disbursement in 2023 amounted to about KHR 1,872.4 billion (or US$ 468 million), which was estimated to contribute to the livelihood adaptation response in climate expenditure. The majority of funded climate change expenditure, including external sources, continues to flow through the national treasury and the MEF financial systems, representing 89% of the total in 2023.

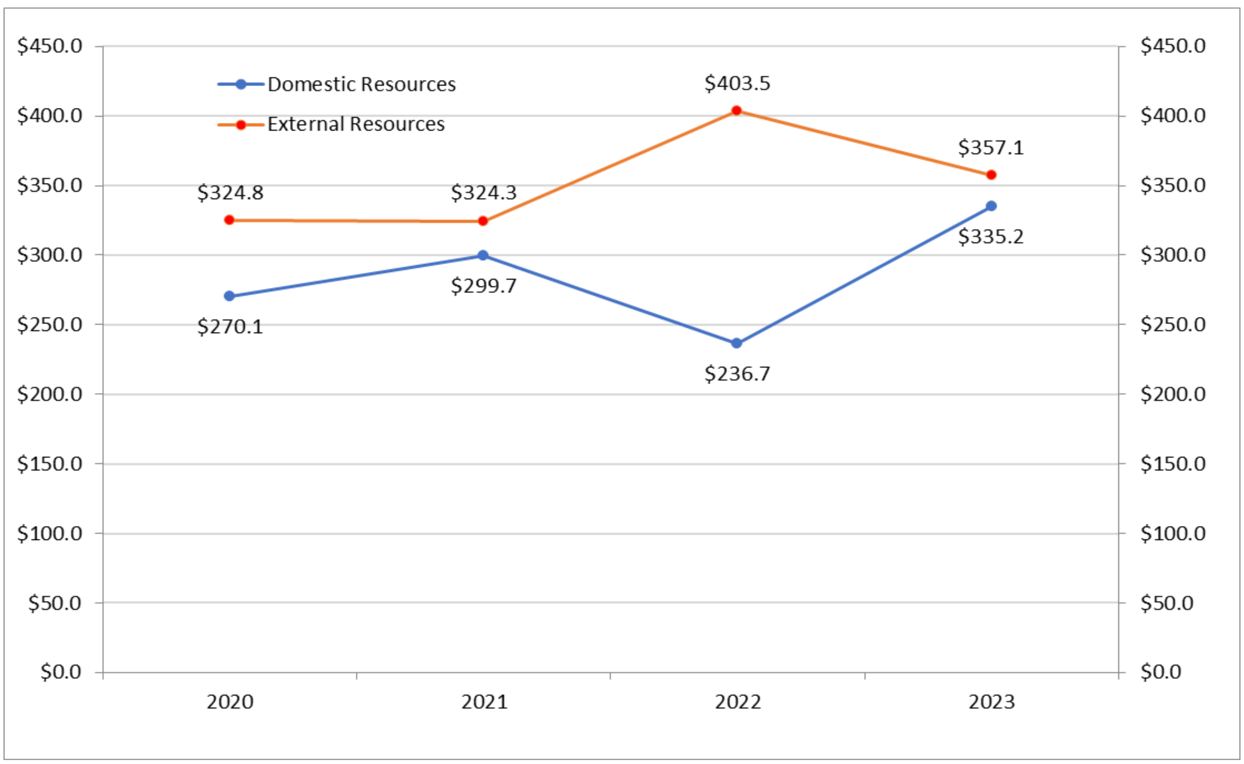


Figure IV. 2: Source of Public Climate Finance (In millions of US$)
Source: CPER, 2020, 2021, 2022 and 2023

To look at the loan disbursement flow, the data from the MEF's General Department of International Cooperation and Debt Management is a useful resource. The total concessional loan disbursements amounted to KHR 6,103 billion (or about USD 1.53 billion), or an 13.4% increase in 2023. In terms of the CC spending, the CC concessional loans rose to KHR 1,080 billion in 2023, modestly increasing by 4% compared to 2022. At the same time, the CDC's total ODA dropped by 11%, reaching to US$ 1,890 million in 2023 from US$ 2,125 million in 2022, as their grant and loan component drops by 11% and 12% respectively. In the overall ODA trend, despite there was a decline in 2023, the climate finance has performed relatively well, offset by the domestically financed infrastructure investment.

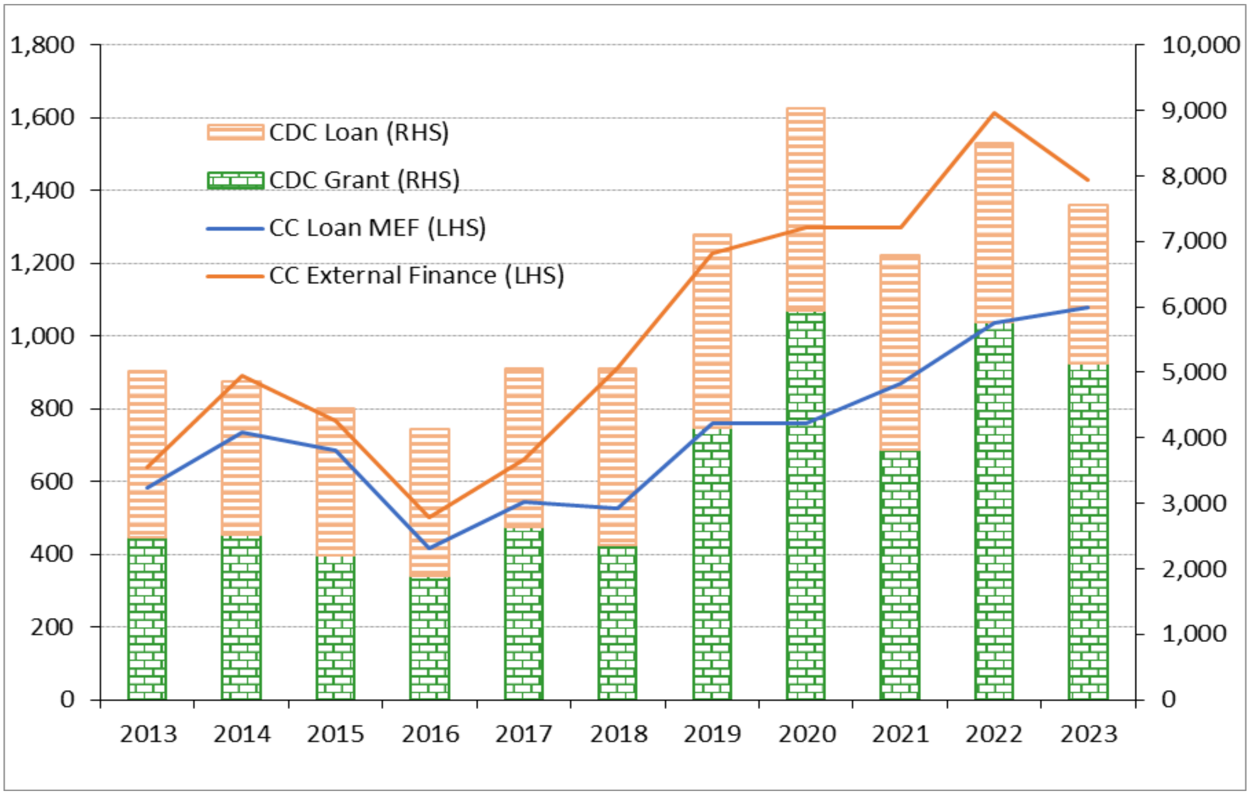


Figure IV. 3: Sources of CC external finance (In millions of US$)
Source: CPER, 2023

In terms of CC external resources, Table 5 below shows that the top five development partners for climate change expenditure in 2023 are China (22%), ADB (18%), IFAD (10%), World Bank (9%) and Japan (8%).

Table IV. 4: Top 25 of Climate change (weighted) expenditure per development partner (in Millions of US$)

No.	Development Partners	2020	2021	2022	2023	Total
1	China	$59.2	$49.5	$39.8	$71.0	$219.5
2	ADB	$42.2	$44.7	$45.3	$60.1	$192.2
3	IFAD	$14.0	$16.9	$27.3	$33.3	$91.5
4	World Bank	$12.4	$19.5	$47.0	$30.8	$109.6
5	Japan	$74.6	$35.9	$61.5	$26.1	$198.0
6	France	$5.0	$8.2	$43.2	$21.4	$77.7
7	Republic of Korea	$9.4	$26.7	$27.0	$18.8	$81.8
8	EU/EC	$9.8	$16.0	$14.5	$18.4	$58.7

9	Australia	$8.5	$10.1	$9.0	$14.1	$41.6
10	USA	$15.1	$16.9	$14.5	$10.7	$57.2
11	New Zealand	$2.8	$2.7	$2.3	$4.3	$12.1
12	Germany	$3.0	$11.1	$5.2	$3.6	$22.8
13	WFP	$0.7	$5.7	$2.3	$3.0	$11.6
14	Switzerland	$1.0	$1.0	$2.4	$2.9	$7.3
15	FAO	$2.3	$1.4	$1.4	$2.3	$7.4
16	UNDP	$3.4	$1.5	$2.0	$1.9	$8.8
17	Sweden	$5.4	$0.9	$0.5	$1.0	$7.8
18	Czech Republic	$0.2	$0.4	$0.8	$0.5	$1.8
19	Canada	$0.0	$0.3	$0.9	$0.5	$1.8
20	Global Fund	$1.3	$1.3	$0.4	$0.4	$3.3
21	UNIDO	$2.9	$0.5	$0.6	$0.3	$4.3
22	UK	$0.3	$0.7	$0.6	$0.3	$1.9
23	UNICEF	$0.3	$0.3	$0.3	$0.3	$1.1
24	Ireland	$0.0	$0.2	$0.1	$0.3	$0.5
25	WHO	$0.2	$0.2	$0.2	$0.3	$0.9
Total		$274	$272	$349	$326	$1,221

Source: CPER, 2023

Mitigation expenditure accounts for 3% of the CPER 2023, while adaptation accounts for 97%. This is broadly in line with the government's policy priorities, where adaptation is the main priority, while mitigation is a smaller but growing component of the climate change response. It is worth noting that mitigation is significantly funded by the private sector, especially through investments in renewable energy.

8. Sectoral allocation of climate change-related expenditure

In 2023, the infrastructure ministries (MPWT, MoWRAM and MRD) shared 49.4% of the climate change expenditure, slightly decreased from 50.2% in the previous year, reflecting a significative increase in flood and drought infrastructure expenditure and continued strong but declining spending on roads and rural roads. In this context, the MoWRAM had the largest share with 24% of climate change expenditure in 2023, which increased by 15% from 2022, mainly due to a continued increase in large expenditures in river dams and water reservoirs for flood and drought prevention, and irrigation rehabilitation. In the same year, the MPWT accounts for the second largest share at 19% of Cambodia’s climate change expenditure, increased by 4%, with high spending in national road construction and rehabilitation. The investments in climate-related rural infrastructure (small-scale irrigation, rural water and sanitation, and rural roads) under the MRD are at 6.4% in 2023, declined by 11%, after its rebound in 2022, due to lower spending on rural roads.

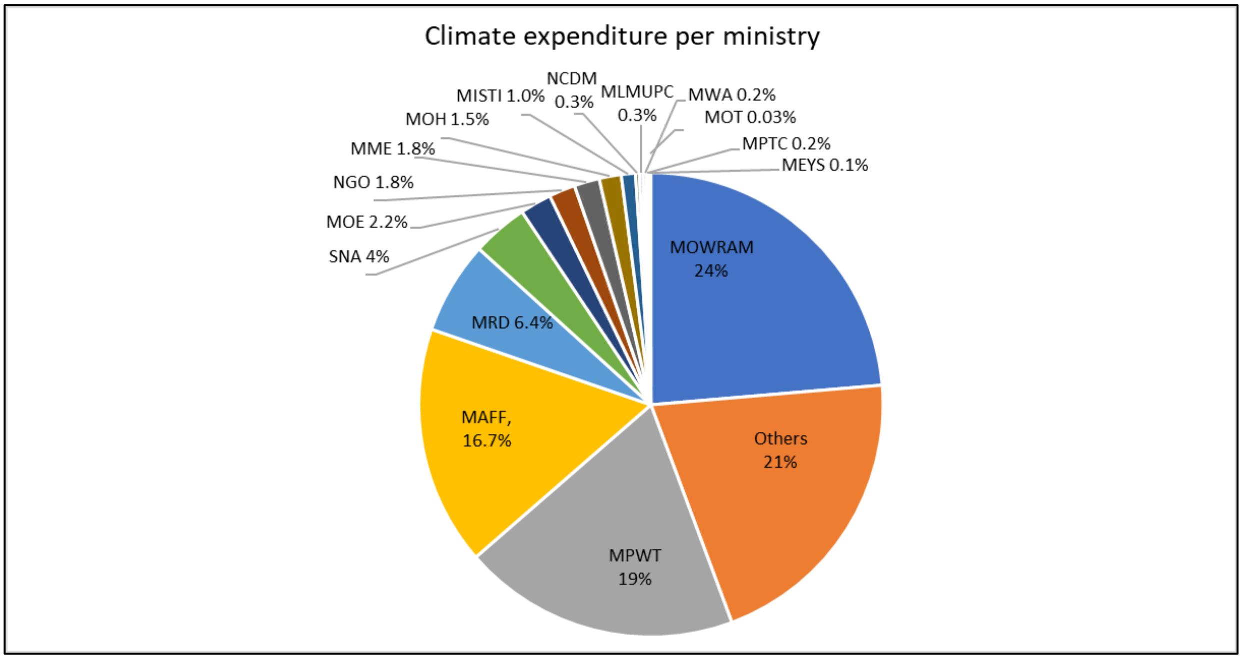


Figure IV. 4: Allocation of climate expenditure per ministry in 2023
Source: CPER, 2023

MAFF accounted for 16.7% due to large investments in CC resilient agriculture, mainly from external financing, followed by MRD which shared 6.4%, SNA (3.9%), MoE (2.2%), NGOs (1.8%), MME (1.8%) and MoH (1.5%), while other ministries/institutions shared less than 1% of the total climate spending.

The MAFF's climate-related spending on agriculture, forestry and fisheries sectors increased by a significant 43% in 2023, similar to the 46% increase between 2021 and 2022. External finance remains the main source of finance in the agriculture sector, representing about 73% in 2023, reflecting development partners' high support for climate action in agriculture, especially in resilient crop, small-holder farmers, and resilient rice commercialization.

The climate change expenditures in the social sectors (education, health and gender) accounts for a much smaller share of the total climate expenditure, 1.9%, further decreased by 16% from 2022 to 2023. The education sector under the MoEYS (0.1% of the total) and gender sector under the MoWA (0.2%) increase by 1% and 94% respectively in 2023, where these activities and people's

physical movement revived after Covid-19 periods. The MoH's CC expenditure shared only 1.5% and continued to drop by 23% in the year 2023, after the Covid-19 period.
In 2023, the MoE remained at the same level of 2022, with the 2.2% of the total climate spending.

The MoE's sources of funding are 80% from external sources, including projects on sustainable landscape, wetland conservation, biodiversity and conservation, and natural resource management. Climate change spending in the energy and mining sectors under the MME represents 1.8% in 2023, a 69% increase, due to continued strong financing from external sources for energy and transmission lines. In this sector, much larger investments are made by the private sector. The water supply and sanitation sector[88] in urban/semi urban contexts under the MISTI accounted for about 1% of the total climate spending in 2023, an 27% increase from 2022, mainly due to higher investment projects in clean water supply and sanitation. The SNA represents about 3.9% of the total climate change spending, increasing by about 0.2% from 2022.

It should be noted that the CPER only reviews in detail the expenditures of the ministries that have adopted climate change action plans. Since the 2020 climate expenditure review, in the specific context of the COVID-19 pandemic, there has been a very significant increase in social protection expenditure via cash transfer, with a focus on poor and vulnerable citizens. This expenditure is reported under the Ministry of Social Affairs, Veterans and Youth Rehabilitation, which is included in the CPER under the category "others".

Table IV. 5: Climate change expenditure by ministry (total development partner and national) in millions of US$

Climate Change Expenditure	2020	2021	2022	2023	Total
MLMUPC	5.8	5.2	1.2	1.8	13.9
MOT	0.7	1.0	0.8	0.3	2.7
MISTI	4.7	10.6	5.4	6.8	27.4
MOINFO	0.0	0.0	0.0	0.0	0.0
MPTC	1.4	1.7	2.2	1.2	6.4
MAFF	66.9	55.4	80.8	115.4	318.4
MME	13.9	6.8	7.2	12.2	40.1
MOWRAM	122.1	131.7	142.6	163.7	560.0
MPWT	155.3	145.6	128.5	133.5	562.9
MRD	40.5	34.4	50.0	44.7	169.5
MOH	9.1	32.8	13.8	10.6	66.2
MoEYS	0.4	1.7	0.7	0.7	3.4
MoWA	0.7	0.9	0.9	1.7	4.1
NCDM	0.9	5.7	1.9	1.9	10.3
MOE	26.7	32.2	14.0	15.2	88.1
SNA	19.7	19.8	23.8	27.0	90.3
NGO	13.4	16.7	14.8	12.7	57.5

88 Water supply and sanitation systems for communities in the rural areas are under the MRD. Water supply is mainly invested and operated by the state-owned enterprises and the private sector.

Total CC, CCFF ministries	**482**	**502**	**489**	**549**	**2,021**
Others	**113**	**122**	**152**	**143**	**530**
Total CC, all ministries	**595**	**624**	**640**	**692**	**2,551**

Source: CPER, 2020, 2021, 2022 and 2023

D. Information on support for technology development and transfer provided under Article 10 of the Paris Agreement

(paras. 126–127 of the MPGs)

Cambodia sees the transfer of mitigation and adaptation technologies to developing countries, particularly least-developed countries, as imperative to combating climate change and supporting sustainable development. Such initiatives offer possible win-win solutions for the global climate, as developing countries can avoid traditional routes to economic growth by increasing energy efficiency and reducing environmental pollution and GHG emissions, while sustaining socio-economic development. In Cambodia, most transfer of technologies related to climate change occurs through the implementation of CDM projects. These CDM projects are associated with renewable energy, industrial waste heat, agricultural and livestock wastes to generate electricity and heat, and hydropower. Most proponents of CDM projects are private companies. The Table 4.17 lists the CDM projects in Cambodia registered as of September 2021. For each project, identified with its formal title, the specific Methodologies used, total estimated emissions reductions in metric tons of CO_2 equivalent per annum (Red) and date of registration with the UNFCCC. Methodology identification is as follows: AM – Large Scale; ACM – Consolidated Methodologies; AMS – Small Scale. Each project title is hyperlinked to the respective project profile page on the UNFCCC website.

Table IV. 6: CDM Projects in Cambodia

Project/ PoA Tittle	Methodology	Type of Project	Registered Date	Reduction (tCO_2e per annum)
Angkor Bio Cogen Rice Husk Power Project	AMS-I.A. ver. 7 AMS-III.E. ver. 7 AMS-I.D. ver. 18	Biomass	10-Aug-06	51,620
TTY Cambodia Biogas Project	AM0022 ver. 4	Biogas	3-Sep-08	50,036
Methane fired power generation plant in Samrong Thom Animal Husbandry, Cambodia	AMS-III.D. ver. 13 AMS-I.A. ver. 12	Biogas	3-Dec-08	5,593
Kampot Cement Waste Heat Power Generation Project (KCC-WHG)	AMS-III.Q. ver. 2	Waste heat	17-Apr-09	17,107
W2E Siang Phong Biogas Project Cambodia	AMS-III.H. ver. 14 AMS-I.F.	Biogas	7-Apr-11	26,592

	AMS-I.C. ver. 17			
Biogas Project at MH Bio-Ethanol Distillery, Cambodia	AMS-III.H. ver. 16 AMS-I.C. ver. 18	Biogas	16-Feb-12	58,146
Lower Stung Russei Chrum Hydro-Electric Project	ACM0002 ver. 12	Hydro	21-Aug-12	701,199
Stung Tatay Hydroelectric Project	ACM0002 ver. 12	Hydro	14-Dec-12	563,074
Cambodia Stung Atay Hydropower Project	ACM0002 ver. 12	Hydro	19-Dec-12	266,472
Kamchay Hydroelectric BOT Project	ACM0002 ver. 13	Hydro	8-Oct-13	281,348
Waste to energy using biomass Gasification in Southeast Asia LDCs programme of activities- PoA	AMS-I.A. AMS-I.B. AMS-I.D.	Biomass	14-Mar-16	549

E. Information on capacity-building support provided under Article 11 of the Paris Agreement

(Paras. 128–129 of the MPGs)

As pointed out in the earlier sections, Cambodia has received technical support for the preparation of the INC, SNC, and TNC, the NAPA, the CCCSP (2014-2023), Sectoral Climate Change Action Plan (SCCAP), BUR, INDC, Updated NDC, and LTS4CN, etc. Many human resources development programmes and institutional capacity arrangement and enhancement have been awarded. Cambodia has upgraded from climate change project-based support to a permanent institution- the Cambodia Climate Change Office (CCCO) was created on 23rd June 2003 and the DCC in October 2009- a strong indication of the Government's commitment to strengthening climate change institutions.

The Government established the NCCC in 2006 to be responsible, *inter alia,* for (1) coordinating the implementation of climate change activities in Cambodia; (2) developing climate change policies, strategies, legal instruments, plans and programs; and (3) integrating climate change concerns into relevant policies, strategies and legal instruments. The NCCC was integrated into the NCSD in 2015 with a similar function, especially to coordinate the implementation of climate change activities. The CCTWG was created to support the NCSD. It acts as technical focal points in the respective government institutions to facilitate the review, formulation, and implementation of policies, strategies, action plans, and programmes to enhance climate change response. Cambodia has also received some supporting projects on capacity building. The detailed information on financial aid is shown in **Table IV. 7**.

Table IV. 7: List of Capacity Building Support Projects Received

No	Project Name	Financing ($)	Donors	Project Period
1	Cambodia Climate Change Alliance Phase 1	10,848,784	UNDP, EU, Sida, Danida	2010-2014
2	Cambodia Climate Change Alliance Phase 2	12,397,600	UNDP, EU, Sida	2014-2019
3	Southeast Asia Knowledge Network of Climate Change Offices	100,000	UNEP	2013-2014
4	Preparation of the Intended Nationally Determined Contribution (INDC) in 2015 under the UNFCCC	136,000	UNEP	2015-2017
5	Cambodia's Initial Biennial Update Report	352,000	UNEP	2015-2019
6	Reducing the Vulnerability of Cambodian Rural Livelihoods through Enhanced Sub-national Climate Change Planning and Execution of Priority Actions	4,567,500	UNDP/GEF	2016-2019
7	Enabling Activities for the Preparation of Third National Communications under the UNFCCC	480,000	UNEP	2016-2019
8	Cambodia Climate Change Alliance Phase 3	11,868,895	UNDP, EU, Sweden	2019-2024
9	Readiness and Preparatory Support Proposal for Green Climate Fund	272,338	GCF	In pipeline
10	Cambodia's Initial Biennial Transparency Report	504,000	UNEP/GEF	2022-2025
11	Capacity building and accreditation support of Direct Access Entity to private banks for on-lending and/or blending fiduciary functions	553,230	GGGI/GCF	2023-2025
Total		42,080,347		

9. Information Related to gender and climate change

9.1. Overview of Gender Mainstreaming in Climate Change Programming

This section assesses to what extent gender has been integrated into climate change programming, based on quantitative data from externally funded projects and other qualitative assessments on a case study of a project on CSO-Public partnership to favor safe water access in rural areas in 2023.While the data on climate change finance and gender linkages are relatively scarce, this section looks at the available evidence from the CDC's ODA database. Gender in key climate change projects[89] are presented in following table.

Table IV. 8: Climate Change finance and gender linkages in CDC's ODA database

CDC's CC and Gender spending	2020	2021	2022	2023
Number of Gender tagged projects	4,860	2,859	4,060	4,977
CC & Gender related spending (in Billions of KHR)	2,623	2,027	3,201	4,068
Weighted CC & Gender spending (in Billions of KHR)	458	505	690	938
Weighted CC & Gender spending (In Millions of USD)	116	126	173	235

Source: CPER, 2023

In 2023, the weighted CC and gender spending of the overall external programmes to the total CC expenditure is at 5.5% (or KHR 938 billion). The 66%, or KHR 4,977 billion, of total CDC's ODA budget is tagged as gender relevant, with an increase from the 48% (KHR 4,060) in 2022. On the other hand, only 24% (KHR 4,068 billion) of the total climate change relevant programmes were also tagged as having a specific gender focus, with an increase from 20% in 2022. The increase in the share of gender programmes in total climate change expenditure is primarily in the areas of disaster management, rural infrastructure, rural electrification, fisheries, social protection reform, and water resources management, reflecting the fact that climate change and gender-tagged programmes had a positive trend in 2023.

Climate Change is one of the key focus areas for the Neary Rattanak VI Strategic Plan (2024-2028). Of the gender-tagged programmes in CDC's ODA database, 82% are also climate change relevant, rising from 79% in 2022. The increase of this percentage is due to the higher level of total gender related programmes in 2023, in which the absolute number of expenditures on gender and climate change relevant had increased by 23%. This indicates that while climate change remains a significant issue from a gender perspective, more efforts need to be made to systematically integrate gender concerns into climate change programmes. Based on the NDC/LTS4CN tracking results of 2023, women engagement through the actions implemented was between 62% of the actions under implementation reported the gender related progress made. It should be noted that Cambodia's updated Nationally Determined Contribution (NDC) includes climate change commitments up to 2030 and a strong focus on gender. Cambodia is committed to submitting the next NDC by 2025 and to making it more ambitious and inclusive, keeping a strong focus on the gender and climate change nexus.

[89] Gender data in the chart is based on the ODA database tag (self-reporting by development partners) and climate change data is based on expert team analysis of the ODA database. Both gender and climate exchange data are unweighted (i.e. expenditure is relevant to CC and gender but not 100% allocated to these objectives).

10. A case of study mainstreaming gender in a project on CSO-Public partnership to favor safe water access in rural areas

10.1. Background

The Department of Rural Water Supply (DRWS) of the Ministry of Rural Development in partnership with Teuk Saat 1001 has implemented the project "CSO-Public partnership to favor safe water access in rural areas", funded by the Cambodia Climate Change Alliance (CCCA 3). The 28 months project (from 1st June 2021 until 30th September 2023) targeted and observed changes in 2 communes: Trapeang Thum Commune, in Siem Reap province and Tuek Chour Commune, in Banteay Meanchey province. The overall objective was to mutualize innovative solutions and methodologies to achieve access to safe water in drought affected rural communes by establishing new water kiosks and organizing workshops to strengthen the sector at national and local level. The main benefit of the project is to enable and maintain access to safe drinking water in rural areas impacted by water scarcity. Since the launch of the 2 water kiosks in May 2022, the operation had been maintained despite weather impact (heavy rains or hot season drying raw water sources), proving the sustainability of the facilities despite the climate change effects.

10.2. Project Contribution

The project is focused on access and consumption of safe drinking water, with the baseline and end line analysis, and the monthly performance of the water kiosks show the steady consumption of safe drinking water in the 2 communes. The 2 kiosks are managed by 2 committed women independent entrepreneurs, who actively join workshops and meetings organized under the project aiming to strengthen and to always maintain the water kiosk operation, even during water scarcity events. It is worth mentioning that the 2 entrepreneurs are part of the top performers of Teuk Saat 1001 network, since they sell on average 100 bottles per day in their respective communes. Before the installation of the water kiosks, more than 50% of the people in the areas used raw water for drinking purpose. Based on the final survey, most of the population has switched from unsafe to safe water. Furthermore, 75% of households reported experiencing of being impacted by drought or water scarcity, hence lacking drinking water, before the project started. In the end line of the project, none of the surveyed households were reported facing lack of drinking water. Thus, the newly installed water kiosks contributed to provide safe drinking water to the communities in both rainy and dry seasons. To attenuate the climate change impact and especially water scarcity periods, water providers in communes need to implement easy and efficient procedures to ensure their drinking water production will not be disrupted. Thus, the mitigation guideline proposed in outcome 2 was designed for this purpose. The objective was to list down solutions to identify alternative water sources, when the primary source is dry. To ensure the implementation and the understanding of the guideline, workshops and trainings have been conducted at provincial and training level. The water entrepreneurs participated to the trainings and are aware of the steps to be taken in case of future challenges.

10.3. Project Results

The holistic model implemented through the water kiosks has a positive impact on the environment, since users are refrained to boil raw water after consuming safe water produced from the water kiosks. In addition, Teuk Saat 1001 assess that each kiosk established under this project contribute to avoiding 100t of CO_2 emission a year, according to the technical note of the project, using a model that is certified by the Gold standard, allowing Teuk Saat 1001 to emit carbon credit. 15 years after the 1st MoU signature[90], the collaboration between the DRWS and Teuk Saat 1001 passed to a new level. Indeed, to implement this project both organizations had collaborated closely to conduct the capacity building and systems strengthening activities, benefitting at the end the water sector in rural areas. Each year, Teuk Saat 1001 is audited to determine the quantities of CO_2 reduced thanks to the water kiosks activities, involving CCCA teams in the process could be a good case study topic. The project contributed to develop soft and hard skills at entrepreneur and public servant level. Before becoming entrepreneurs, the 2 women managing the kiosk were seamstress and contract teacher; thanks to CCCA grant, they were trained to manage the kiosks not only acquiring technical skills in the water production field but also trained in marketing, finance, entrepreneurship and team management transversal know- how which contribute to elevate their educational level. This will give them better professional opportunities if they decide to stop being a water entrepreneur. The project has implemented 10 workshops at national and provincial levels resulting in (i) the development of a mitigation guideline to help rural water providers to cope with water scarcity issue and (ii) a draft of a technical module to be used by any stakeholders for the construction of bottled water production facilities. The five most important achievements are:

[1]. 2 sustainable community safe drinking water kiosks powered by solar energy were established to supply safe drinking water to communities in 2 communes affected by drought
[2]. One water scarcity mitigation guideline was developed and disseminated.
[3]. One training module on community safe drinking water kiosk model was developed.
[4]. The DRWS staff gained better understanding of community safe drinking water kiosk model through capacity building activities; and
[5]. Improved behavior changes and health impact, comparing the Baseline and End line survey findings.

11. Lessons learned

The project generates five lessons learned below.

[1]. Partnership between public institution and CSO accelerate rural communities' accession to safe drinking water.

90 Between Ministry or Rural Development and Teuk Saat 1001, 1st MoU signed in 2009.

[2]. Support and good collaboration from local authorities is key factor to the success of the project implementation.
[3]. Sustainability approach, thanks to the entrepreneurship model combined with the continuous follow-up, enable access to community safe drinking water service on a long run.
[4]. Securing secondary water source is important to ensure drinking water production and supply; and
[5]. Close monitoring is a requisite for each project site.

Chapter 5:

Information on financial, technology development and transfer and capacity- building support needed and received under Articles 9–11 of the Paris Agreement

Under Paris Agreement

A. National circumstances, institutional arrangements and country-driven strategies

(para. 131 of the MPGs)

1. National Circumstances

This section has reported under Articles 9–11 of the Paris Agreement (paras. 119–120 of the MPGs) in Chapter 5.

B. Underlying assumptions, definitions and methodologies

(para. 131 of the MPGs)

This section has reported in Article 10 in Section B (para 121-122 of MPGs)

C. Information on financial support needed by developing country Parties under Article 9 of the Paris Agreement

(para. 132-133 pf the MPG)

2. Finance needed

Despite ongoing efforts, financial needs remain high, and most actions require financial support. Future resource mobilisation will look towards a reasonable mix of national and international funds, in addition to market mechanisms, where appropriate, and in line with progress on Article 6 of the Paris Agreement. The NDC Roadmap indicated that Cambodia will also require the development of a climate investment plan to aggregate finance needs, gaps, sources, options, and the creation of a project pipeline.

2.1. Mitigation

The finance needs per sector as submitted by each ministry in their mitigation shows that the total funding required for mitigation actions is over **US $5.8 billion.** The FOLU, waste, and energy sector mitigation actions require the most funds. These are mostly conditional upon international support.

Table V. 1: Summary of mitigation finance need

Sector	Estimated finance necessary (million US $)
Agriculture	**49.4**
Energy	**672.1**
Forestry	**3,466.4**
Industry	**78.7**
Waste	**1490.3**
Transport	**10.6**
General[91]	**3.1**
TOTAL	**5,770.6**

Source: Ministries' submissions and BUR (2020)

2.2. Adaptation

Based on the finance needs per sector submitted by relevant line ministries in their adaptation, the total funding required for adaptation actions is just over **US $ 2 billion.** Infrastructure, water, and agriculture require the highest funding, representing almost 85% of total adaption finance needed.

Table V. 2: Summary of adaptation finance need

Sector	Estimated finance need (US $)
Agriculture	306,268,600
Coastal zones	72,000,000
Enabling actions	21,050,000
Energy	322,000
Human health	467,685
Industry	Not reported
Infrastructure	957,990,000
Livelihoods, poverty and biodiversity	211,125,000
Tourism	2,500,000 (as minimum)
Water resources	468,798,900
TOTAL	**2,040,522,185**

Source: Ministries' submissions and BUR (2020)

Most of the financing mechanism is conditional upon international support. In fact, almost half of the actions specifically included an indication of conditionality, whilst only five specified that implementation may be possible, at least partially, through existing budget allocations (see detailed table in Appendix 2). In any case, more analysis will need to be carried out as part of the NDC tracking process to ensure transparency.

[91] It included in the other categories (Energy, Waste, IPPU, Agriculture, FOLU), such as: 1) Promoting One Tourist, One Trees campaign; 2) Installing air quality monitoring equipment in all provinces across and establishing an air quality data monitoring center with mobile application for public information and access.

3. Barriers and capacity needed

The NDC review identified the need for capacity building for the NDC implementation, especially for the NCSD/DCC, CCTWG, sectoral and sub-national TWGs. In addition, each ministry submitted its own capacity building requirements. The table below summarises the barriers and capacity need for the NDC implementation as submitted by each ministry and identified in the NDC review, the tackling of which will require strong international support

Table V. 3: Barriers and capacity needs

Ministry	Barriers	Capacity needs
MISTI	• Technical capacity • Finance • Regulatory framework • Inter-ministerial cooperation • Participation from private sector (factory owners and workers) • Labour skill • Data from factories • Equipment	• Financial support • Human resource training • Support from top management
MLMUPC	• Finance (budget for activity implementation) • Climate change information toolkit and capacity • Data systems to monitor and evaluate the impacts of climate change interventions	• Capacity on climate change (otherwise MLMUPC has full technical capacity) • Support to strengthen the CCTWG of MLMUPC Capacity support for technical staff of the four General Department within MLMUPC as well as horizontal (line agencies) and vertical actors (sub-national government) in carrying out the activities.
MME	• Lack of regulatory framework • Limited capacity for data collection and monitoring • Lack of data management system	• Human and institutional capacity building • Financial support • Capacity on mainstreaming climate change into energy infrastructure planning and development

	• Lack of integrated decision support system	• Integrated decision support system for integration of climate data (from various ministries) to support resilient energy infrastructure
MOE	• Climate model expertise • Concept note and proposal development • Data management and reporting	• As coordinator for the NDC implementation, the MOE would be expected to build its own capacity and the one of the line ministries in several areas, including: • Coordination and integration • Capacity building and knowledge management • Stakeholder engagement • Mitigation and adaptation including: • Environmental, social, economic impact assessment • ESS and gender implementation • Sectoral knowledge and best practices • GHG measurement and accounting • Vulnerability assessment • Policy development and appraisal • MRV/Transparency including: • GHG measurement and accounting • Negotiations skills • Public financial management • Database development
MOEYS	• Finance • Concept note development • Technical capacity	• Concept and case studies on climate change, DRR, climate emergency, response planning • Data collection and monitoring systems • Integration of climate change into school curriculum and teacher training curriculum, • M&E framework and systems for Education Management Information System (EMIS) and climate change.
MOH	• Finance for climate change infrastructure and innovation • Human resources	• Technical and financial support from external sources both for policy development, infrastructure and

	• Gender involvement • Technical support	behaviour change communication and awareness raising
MOINF	• Finance • Technical • Human resources on climate change and environment	• Cooperation from stakeholders and expert ministries is crucial
MOP	• Finance • Capacity • Technical Assistance	• MoP has the capacity to guide sectoral ministries to implement their activities • Capacity building is necessary for all staff (by sector) on climate change • MoP and NCSD need capacity to assist in mainstreaming climate change in development plan. • Being the key ministry to coordinate finance to the sectors, MoP might also require support in the following areas: •Financial and technology needs assessments •Financial modelling and cost benefit analysis •Business case and project concept note writing •Financial and investment terminology •Understanding of the constraints and requirements of investors •Accreditation and access to climate finance •Environmental, Social Safeguards (ESS) and gender
MOT	• Finance • Technical • Human resources on climate change and environment	• Cooperation from stakeholders and expert ministries is crucial
MOWRAM	• Finance • Capacity of staff	• Technical support and cooperation from the private sector are required

	• Needs assessment - particularly on technology • Data/information centres	
MPWT	• Finance • Human resource (capacity building) • Research and development	• Capacity on climate change to be built for implementation and access to finance
MRD	• Finance • Human resources	• Outsourcing some services to firms on project design and quality assurance • For the implementation of the Government budget, MRD have enough capacity to deliver
NCDD	• Capacity of implementers and NCDD • Finance • Policy (at the national level)	• Existing capacity is not yet sufficient for implementation. Climate change is still new • Human Resources are dedicated mostly for decentralisation and de-concentration, as reflected in the upcoming NCDD Strategy for 2021-2030
NCDM	• Resource person • Finance from development partners (governmental budget is limited) • Policy/standards (for example private engagement in DRM)	• NCDM would be able to deliver with technical and finance support
MOWA	• Capacity building to better understand the concept of gender and gender analysis, • M&E • Finance	• Resource person needs • Technical support • Gender safeguards mitigation measures implementation

	• Coordination (institutional arrangements)	
MAFF	• Human resources • Finance • AFOLU GHG data • Technology	• Capacity building on Enhance Transparency Framework (ETF) and Management Information System(s) (MIS) • Technical support to establish and operate a tracking system for the NDC, CSDG and other relevant climate change strategies • Technical support for improving activity data and emission factor

Source: Ministries' submissions and NDC Roadmap (2019)

D. Information on financial support received by developing country Parties under Article 9 of the Paris Agreement (para. 134 of the MPGs)

(paras. 134 of the MPGs)

As pointed out in the earlier sections, Cambodia has received much support for the preparation of the INC, SNC, and TNC, the NAPA, the CCCSP (2014-2023), Sectoral Climate Change Action Plan (SCCAP), BUR, INDC, Updated NDC, and LTS4CN, etc.Many human resources development programmes and institutional capacity arrangement and enhancement have been awarded. Cambodia has upgraded from climate change project-based support to a permanent institution-- the Cambodia Climate Change Office (CCCO) was created on 23rd June 2003 and the DCC in October 2009- a strong indication of the Government's commitment to strengthening climate change institutions.

The Government established the NCCC in 2006 to be responsible, *inter alia,* for (1) coordinating the implementation of climate change activities in Cambodia; (2) developing climate change policies, strategies, legal instruments, plans and programs; and (3) integrating climate change concerns into relevant policies, strategies and legal instruments. The NCCC was integrated into the NCSD in 2015 with a similar function, especially to coordinate the implementation of climate change activities. The CCTWG was created to support the NCSD. It acts as technical focal points in the respective government institutions to facilitate the review, formulation, and implementation of policies, strategies, action plans, and programmes to enhance climate change response.

Cambodia has also received some financial support to address climate change impacts, disaster risks, GHG mitigation, etc. The detailed information on financial aid is shown in **Table V.1**.

Table V. 4: List of Project and Financial Supports Received

No	Project Name	Financing ($)	Donors	Project Period
1	Cambodia Climate Change Alliance Phase 1	10,848,784	UNDP, EU, Sida, Danida	2010-2014
2	Cambodia Climate Change Alliance Phase 2	12,397,600	UNDP, EU, Sida	2014-2019
3	Southeast Asia Knowledge Network of Climate Change Offices	100,000	UNEP	2013-2014
4	Vulnerability Assessment and Adaptation Program to Climate Change within the Coastal Zone of Cambodia Considering Ecosystem and Livelihood Improvement	1,635,000	UNEP/GEF	2011-2016
5	Strategic Program for Climate Resilience	86,000,000	Climate Investment Funds	2013-2019
6	Cambodia Climate Change Alliance Phase 2	12,397,600	UNDP, EU, Sida	2014-2019
7	Preparation of the Intended Nationally Determined Contribution (INDC) in 2015 under the UNFCCC	136,000	UNEP	2015-2017
8	Cambodia's Initial Biennial Update Report	352,000	UNEP	2015-2019
9	Reducing the Vulnerability of Cambodian Rural Livelihoods through Enhanced Sub-national Climate Change Planning and Execution of Priority Actions	4,567,500	UNDP/GEF	2016-2019
10	Enabling Activities for the Preparation of Third National Communications under the UNFCCC	480,000	UNEP	2016-2019
11	Enhancing Climate Resilience of Rural Communities Living in Protected Areas of Cambodia	4,900,000	Adaptation fund	2013-2018
12	Building Climate Resilience of Urban Systems through Eco-system Based Adaptation (EBA) in Asia-Pacific Region	1,000,000	UNEP/GEF	In pipeline
13	Readiness and Preparatory Support Proposal for Green Climate Fund	272,338	GCF	In pipeline
14	Strengthening Climate Information and Early Warning Systems in Cambodia to Support Climate Resilient Development and Adaptation to Climate Change	4,900,000	LDC-F	NA
	Strengthening the Adaptive Capacity and Resilience of Rural Communities Using			

15	Micro Watershed Approached to Climate Change and Variability to Attain Sustainable Food Security	5,200,000	LDC-F	NA
16	Building Adaptive Capacity through the Scaling up of Renewable Energy Technologies in Rural Cambodia	4,600,000	SCC-F	NA
Total		**137,489,222**		

E. Information on technology development and transfer support needed by developing country Parties under Article 10 of the Paris Agreement

(paras. 135–136 of the MPGs)

4. Mitigation

Limited information has been provided on technology availability in mitigation sectors. In waste, required technology is available in the country and region (e.g. Thailand, Vietnam, and Malaysia). In the energy sector, technologies such as Solar Home Systems (SHS), direct and alternating current (AC/DC) micro grids, and solar battery charging stations are available in the country. In the agricultural sector for example, compost technology is currently available. Key technologies in the transport sector include digital systems for GHG emission MRV; spatial planning tools for network management, including traffic management and newer technologies for electric mobility.

The findings from national GHG inventories under the national communications to the UNFCCC indicate that the energy sector; the agriculture sector; and the LULUCF are the main sources and sinks of GHG emissions. The RGC also recognized these sectors as priority development sectors in the national development plans and policies. If implemented, the mitigation options provide real and tangible social and economic benefits for local communities. As a non-Annex 1 country, Cambodia is not required to reduce GHG emissions. Yet, efforts made by Cambodia in the reduction of GHG emissions would contribute to the global efforts to fight the adverse impacts of climate change. Cambodia needs to promote and mobilize resources to implement the proposed mitigation actions in the INDC (RGC, 2015).

Table V. 5: Priority Actions by Sectors for GHG Mitigation

Sector	Priority Actions	GHG Reduction ($MtCO_2e$) in 2030
Energy Industries	[1]. National grid connected renewable energy generation (solar energy, hydropower, biomass and biogas) and connected decentralized renewable generation to the grid. Off-grid electricity such as solar	**1,800 (16%)**

	home systems, hydro (pico, mini); and Promoting energy efficiency by end-users	
Manufacturing Industries	[2]. Promoting use of renewable energy and adopting energy efficiency for garment factories, rice mills, and brick kilns.	**727 (7%)**
Transport	[1]. Promoting mass public transport; and [2]. Improving operation and maintenance of vehicles through motor vehicle inspection and eco-driving, and the increased use of hybrid cars, electric vehicles, and bicycles	**390 (3%)**
Others	[1]. Promoting energy efficiency for buildings and more efficient cookstoves; and	**155 (1%)**
	[2]. Reducing emissions from waste using bio-digesters and water filters	

Source: GSSD (2015)

The followings are detailed descriptions of GHG mitigation actions by sectors needed to be addressed:

4.1. Energy Sector

- Emissions from the energy sector has increased steadily, accounting for the largest share in the sector's emissions of 44% in 1996 and 40% in 2000. According to technology prioritization for the energy efficiency sector, CFLs and energy-efficient appliances--the best opportunity to reduce energy consumption in the residential sector are most favorably scored, which are needed to implement further. To improve the mitigation responses in the energy sector, the following needs shall be addressed:
- Promote the use of energy-efficient lighting (CFLs) and energy-efficient appliances by lowering tax levied on CFLs and energy-efficient appliances as well as introducing/modifying the existing regulations to encourage public use and raise public awareness.
- Mainstream energy-efficient lighting into sub-national and national development plans.
- Energy efficiency labeling.
- Promote research and development in low-cost, energy-efficient household appliances.
- Establish facilities to test PV systems or components or produce components/PV panels for solar systems produce components/PV panels for solar systems.
- Assist developing hydropower technology.
- Promote appropriate biomass gasification, rice milling, and wind technology.
- Energy and emission data collection should be improved to estimate the total demand and to understand process efficiency to define the optimal mitigation options.
- Renewable energy investments should be increased and facilitated; and
- Develop government strategies to support a low carbon economy.

4.2. Transport sector

In 2000, the transport sector was the largest net contributor to national GHG emissions, accounting for 38% (GSSD, 2015). Three main strategic responses: avoid or reduce travel, shift to more environmentally clean modes of travel, and improve energy efficiency and transport technology have still been preferred to reducing GHG emissions from the transport sector. Phnom Penh's city bus system was re-launched (whose bus fleet is provided by Korea, China, and Japan) initially with three running routes in 2015, and subsequently extended to 13 in 2018. Among other reasons, Cambodians' preference to private mode of commute, shortage of physical road facilities, and limited urban planning also hinder the widespread adoption of the public transit system (RGC, 2013). Additionally, GHG emissions increase in the transport sector, essentially road transport, as traffic congestion has reached critical levels. Cambodia does not have vehicle emission standards, which would have banned high-polluted vehicles from the street. Unsafe vehicles could be seen on Cambodian roads, while the road traffic law is loosely enforced, contributing to the growing number of traffic accidents and air pollution. To make it worse, government officials have limited capacity in relation to vehicle inspection and vehicle emissions assessment, coupled with limited technical capacity, facilities, and equipment. To improve the mitigation responses in the transport sector, the following needs shall be addressed:

- Investment in energy-efficient urban transport infrastructure.
- Public transport planning and travel demand management.
- Development and enforcement of vehicle emission standards; and
- Enhancing vehicle emissions control and inspection & maintenance in large cities.

4.3. Agriculture Sector

While livestock populations have remained relatively constant, the expansion of rice cultivation has resulted in higher emissions of methane in 2000 (GSSD, 2015). Rice cultivation accounting for 68% of agricultural emissions, followed by enteric fermentation from domestic livestock accounting for 16%. To improve the mitigation measures in the agriculture sector, the following needs shall be addressed:

- Water management
    - Intermittent drainage in the rainy season; and
    - Inadequate irrigation system, and machinery.
- Fertilizer management
    - Farmers' limited knowledge about sulphated fertilizer.
    - High cost of sulphated fertilizer.
    - Limited scientific research about the optimal sulphated fertilizer use based on soil types, rice varieties, and environmental characteristics.
    - High costs of biogas plants.

- The time-consuming process of making compost; and
- Transport of slurry to rice fields.

4.4. Land Use, Land-Use Change, and Forestry (FOLU)

Between 1994 and 2000, removals from the LULUCF only increased by 7% (GSSD, 2015). The existing forest sinks cannot absorb the increasing emissions due to the pace of current and forecasted economic growth. To improve the mitigation responses in the LULUCF sector, the following needs shall be further addressed:

- Forest protection through REDD+
  - The effectiveness of forest management and protection largely depends on addressing the drivers of deforestation; and
  - High transaction costs.
- Sink enhancement and management: afforestation and reforestation
  - Low development benefits; and
  - Land use competition with other land uses.

- Agro-forestry
  - Not well integrated in the Cambodia context; and
  - Inadequate household capacity (time, money, and interest).

Cambodia's INDC estimated that the LULUCF sector expects to contribute to the emissions reductions of 4.7tCO_2eq./ha/year by increasing the forest cover to 60% of the total national land area by 2030 maintaining it after 2030 (GSSD, 2015). The country needs to mobilize resources and encourage the implementation of the following measures:

1) Reclassification of forest areas to avoid deforestation with below details:
   - Protected areas: 2.8 million hectares.
   - Protected forest: 3 million hectares.
   - Community forest: 2 million hectares.
   - Forest concessions reclassified to protected and production forest: 0.3 million hectares; and
   - Production forest: 2.5 million hectares.
2) Implementation of the Forest Law Enforcement, Governance and Trade (FLEGT) programme aims to improve forest governance and promote international trade in verified legal timber

5. Adaptation

The agricultural sector indicated detailed technology needs for climate smart practices in all its proposed actions, ranging from stress tolerant varieties to systems of rice intensification to integrated pest management and integrated soil and nutrient management. There are a number of innovative information platforms and databases in use for disaster risk management, including CAMDI (to monitor the impact of disasters, and the DesInventar package), real-time technology-based weather forecasting methods and technology transferred from the French and Finnish meteorological societies, in addition to manuals and toolkits such as the Community Based Disaster Risk Management Field Practitioners Handbook and the KoBo toolbox for community assessment. The energy sector continues to adapt renewable energy and energy efficiency technologies to the Cambodian context. The health sector makes use of several systems, such as the National Dengue Surveillance System, or the CAMEWARN, a case-based surveillance system which covers seven epidemic prone diseases and syndromes. The infrastructure sector makes use of several guidelines for climate proofing investment developed by the Asian Development Bank (ADB) and the World Bank. Technologies in use in the land use planning sector include land survey high technology, aerial photography for mapping, soil tests for spatial planning, downscaled climate projections and network-level vulnerability assessments. In the water resources sector, groundwater analysis, vulnerability and risk assessments, in addition to groundwater monitoring systems are in use.

Cambodia has undertaken initiatives to mainstream adaptation into national and sub-national development plan and strategy, and in specific sectors such as in the agriculture, forestry and human health sectors, as well as coastal zone management (RGC, 2015). Cambodia developed the NAPA (2006), in which coping mechanisms to hazards and climate change impacts were identified, as well as key adaptation needs. It may, in turn, inform future climate change strategies, financing frameworks, and national development planning and budgeting. The National Adaptation Plan Financing Framework and Implementation Plan (GSSD, 2017), an essential guiding tool for mobilizing resources, will expedite the implementation of the NAP process. Cambodia's INDC also identified a number of priority actions for adaptation measures (RGC, 2015). The government needs to mobilize further resources and promote the implementation of the proposed priority actions as listed in the table below:

Table V. 6: Priority Actions for Adaptation

Priority Actions
Promoting and improving the adaptive capacity of communities, especially through community-based adaptation actions, and restoring the natural ecology system to respond to climate change
Implementing management measures for protected areas to adapt to climate change
Strengthening early warning systems and climate information dissemination
Developing and rehabilitating the flood protection dike for agricultural and urban development

Increasing the use of mobile pumping stations and permanent stations in responding to mini-droughts, and promoting groundwater research in response to drought and climate risk
Developing climate-proof tertiary-community irrigation to enhance the yields from agricultural production of paddy fields
Promoting climate resilient agriculture in coastal areas through building sea dikes and scaling-up of climate-smart farming systems
Developing crop varieties suitable to Agro-Ecological Zones (AEZ) and resilient to climate change (include coastal zone)
Promoting aquaculture production systems and practices that are adaptive to climate change
Repairing and rehabilitating existing road infrastructure and ensuring effective operation and maintenance, considering climate change impacts
Up scaling the Malaria Control Program towards pre-elimination status of malaria
Up-scaling of national programmes to address the risk of acute respiratory infection, diarrhea disease and cholera in disaster-prone areas, including conducting surveillance and research on water-borne and food-borne diseases associated with climate change
Strengthening technical and institutional capacity to conduct climate change impact assessments, climate change projections, and mainstreaming of climate change into sector and sub-sector development plans

Source: RGC (2015)

6. Enabling technologies

The enabling sectors use a range of known technologies including radio, TV and social media for information and awareness to sharing lessons learned from other countries, or the National M&E Manual to monitor progress on indicators.

F. Information on technology development and transfer support received by developing country Parties under Article 10 of the Paris Agreement

(paras. 137–138 of the MPGs)
This section has reported under Article 10 under section D (paras. 126–127 of the MPGs)

G. Information on capacity-building support needed by developing country Parties under Article 11 of the Paris Agreement

(para. 139-140 of the MPGs)
Not available information

H. Information on capacity-building support received by developing country Parties under Article 11 of the Paris Agreement

(paras. 141–142 of the MPGs)
This section has reported under Article 10 under section E (para. 128-129 of the MPGs)

I. Information on support needed and received by developing country Parties for the implementation of Article 13 of the Paris Agreement and transparency related activities, including for transparency-related capacity-building

(paras. 143–145 of the MPGs)

7. Operationalized of Monitoring Reporting and Verification (MRV)

The RGC's approach to developing and operationalising its domestic measurement, reporting and verification (MRV) systems focuses on integration into the existing climate change M&E framework structure of the CCCSP rather than setting up new layers of institutional structures.

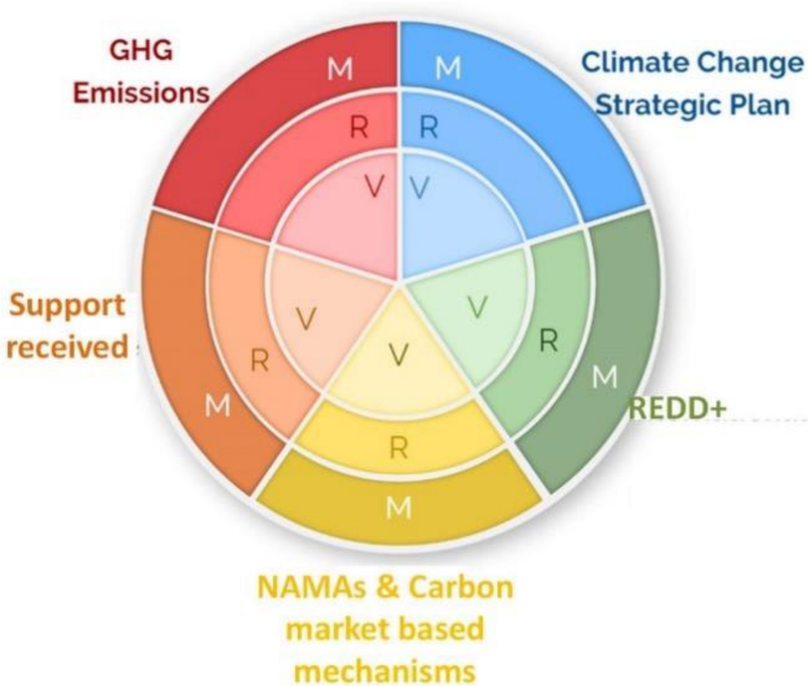


Figure V. 1: MRV systems in Cambodia
Source: NCSD (2020)

Cambodia has made significant efforts in establishing robust information systems for MRV. The country has five well-established MRV systems (GHG emissions, CCCSP, which includes adaptation and mitigation, REDD+, Project level MRVs for two planned Nationally Appropriate Mitigation Actions (NAMAs), 12 Clean Development Mechanism (CDMs), 6 Joint Crediting Mechanism (JCMs), and 6 Verified Emissions Reductions (VERs) and Support received.

8. MRV for NDC Tracking

Cambodia puts great emphasis on the development of an integrated and detailed MRV system, which is also aimed at achieving the implementation of the NDC. It will be comprised of the following components (mitigation, adaptation, GHG inventory, support received, and support needed).

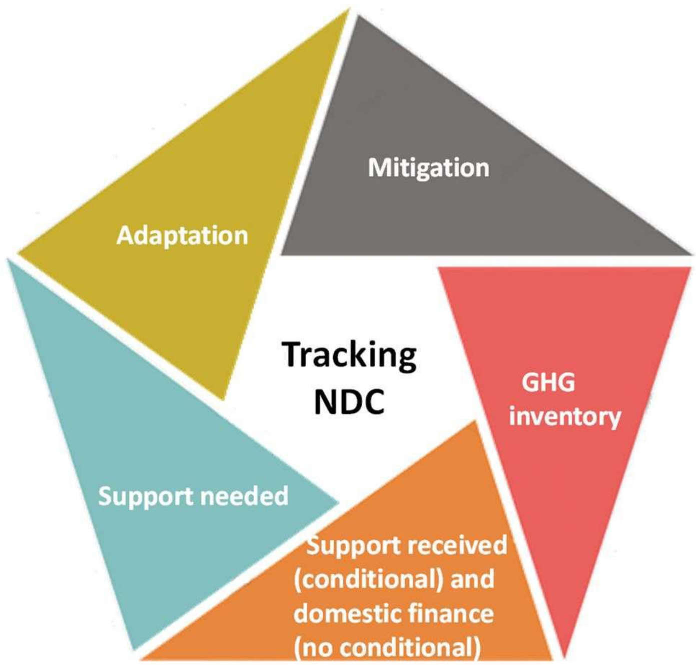


Figure V. 2: Components of MRV for NDC tracking
Source: NCSD (2020)

The system will detail how monitoring will happen, and how data will be managed, aggregated and translated into reports, with particular attention paid to gender and vulnerable groups. A simple, accessible and understandable **NDC tracking online system** will be developed and the tool will be made accessible online. It is expected that, to the extent possible, the system will harmonise and track all data needs for the relevant international agencies and domestic stakeholders. It will serve as a data repository for in-country stakeholders, including to provide knowledge management for the private sector and to track their contributions to the SDGs, and international ones, particularly the UNFCCC and any other relevant international reporting agency. Verification from third parties, including academic institutions, will be considered.

The system will also consider the ISAF (accountability framework) supported by the NCDD (financed by the WB). This ensures proper accessibility of information at the community level (Information for Citizens I4C) and accountability at the commune levels to follow-up on the proposed measures.

9. Constraints and Gaps, and Support Needs

International communities agreed to hold the increase in the global average temperature to well below 2 °C and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change (CC) (UNFCCC, 2015). Cambodia's contribution to GHG emissions is regionally and globally insignificant with per capita GHG emissions of about 0.23tCO_2 e/year in 2000 and is expected to increase to 1.3tCO_2e/year in 2050 (GSSD, 2015); however, Cambodia was severely affected by the adverse impacts of climate change, for instance, damage from floods of USD157 million, USD30 million, and USD12 million in 2000, 2001, and 2002, respectively, (GSSD, 2015). The 2013 flood estimated the total cost of USD 356 million—about 202 million was for loss and 153 million is for damage (RGC, 2014). Mean temperatures are expected to increase between 0.013ºC to 0.036ºC per year by 2099 (GSSD, 2015). Climate change impact is expected to reduce average GDP growth to 6.6% and absolute GDP by 0.4%, 2.5%, and 9.8% in 2020, 2030, and 2050, respectively, (MEF and NCSD, 2018).

The RGC has participated with the international communities through the development and active implementation of several climate change-related policies and strategies, such as CCCSP 2014-2023 with a vision to develop Cambodia towards a green, low-carbon, climate-resilient, equitable, sustainable, and knowledge-based society (RGC, 2013) and INDC with an expectation of reducing a maximum of 3,100MtCO_2e (27%) of GHG emissions by 2030 compared to the BAU (RGC, 2015). However, Cambodia has been facing many constraints and gaps for the implementation of climate change related conventions (e.g. United Nations Convention on Biological Diversity-UNCBD and United Nations Convention to Combat Desertification-UNCCD) and international instruments in response to climate change impacts because of limited financial support, technology transfer, and institutional and human capacity.

Cambodia has received significant and continuous support technically and financially. The country has prepared and submitted national communications (i.e. first and second national communications, while the third one is under preparation); the NAPA (2006); Technology Needs Assessment and Technology Action Plans for Climate Change Mitigation (2013), BUR, INDC, Updated NDC, LTS4CN, etc. These documents were developed with technical support from the international experts and urged for financial supports from the development partners, funding institutions, and donor nations. A lot of policies and strategies (e.g. CCCSP: 2014-2023) to address climate change impacts have been developed and implemented; however, they remain limited because of insufficient financial and technical support. For instance, after the approval of the NAMA on Energy Efficiency in the Garment Industry, the proposed actions have not been implemented. Additionally, only 14 out of the proposed 171 projects under the National Adaptation Plan (NAP) Financing Framework and Implementation Plan received full financial support, while 16 were partially supported (GSSD, 2017). The country has limited human resources to prepare national GHG inventory and climate change vulnerability assessment as well as limited data and information to improve the estimation. More elaboration of constraints and gaps to respond to climate change impacts are discussed as follows:

9.1. Human resources and capacity needed

Cambodia has been engaged with human resource development since 2000 through trainings, workshops, public awareness and other capacity building activities related to climate change (GSSD, 2015). Many officers have been assigned to participate in many climates change related short-term trainings both in the country and abroad. Long term scholarships for climate change-related majors have also been awarded ranging from master's to Doctor of Philosophy. However, Cambodia remains limited experts and researchers in GHG inventory and mitigation, climate vulnerability assessment and adaptation measures, climate change and energy, climate agronomists, climate economists, etc. Furthermore, it has been observed that systematic coordination among related agencies remains limited to address climate change.

The government has gradually shifted from the support from international technical assistance to more nationally owned responsibilities. The officials from Cambodia have participated and dialogue at the international climate forums, discussion, and negotiations (e.g. Conference of the Parties). The ratification of the Paris Climate Agreement, Cambodia is expected to receive greater financial support, technology transfer, and capacity building to deal with climate change impacts and disasters. Although many capacity-building programmes are provided the country still seeks more technical and human resources support to increase and enhance her capacity to respond to climate change. The programmes should be extended to research institutes and academia on specific topics such as climate change impact assessments, economic impact of climate change, assessment of co-benefit of GHG mitigation, climate change public expenditure, GHG inventory and mitigation, and REDD+, etc.

9.2. Financial Gaps to implement the adaptation and mitigation measure

Cambodia has received both grant and loan from development partners, funding institutions, and donor countries to address climate change impacts. However, Cambodia still faces financial constraints to ensure effective implementation of the proposed adaptation and mitigation options. Climate change financing remains a key barrier in Cambodia although a lot of key milestones have been achieved including the formulation of relevant national and sectoral policies and action plans. Cambodia needs to mobilize further financial support both from the development partners, funding institutions, and donor countries as well as her own national budget to address climate change concerns. Furthermore, more financial support should be mobilized and secured for the longer term as climate change impacts are likely to reduce GDP growth by 0.4%, 2.5%, 6.0%, and 9.8% in 2020, 2030, 2040, and 2050, respectively, (MEF and NCSD, 2018). The government must put further effort into increasing GDP incomes or mobilize additional support from international communities to ensure stable GDP growth of 7% through to 2050 to achieve development targets-- the high middle-income country by 2030 and a high-income level by 2050.

Between 2009 and 2014, the public expenditure on climate change had increased from USD 91.7 million (or 0.9% of the GDP) to USD 211.7 million (or 1.4 % of the GDP) (GSSD, 2017); however, it represented only 3.1% of the total public expenditure in 2016, falling from 3.8% in 2015 proportion of climate change expenditure to the total public expenditure and the GDP. Development partners remain the biggest source of funds for climate change responses (62%), and the reduction in external climate change financing is affecting Cambodia's capacity to adapt to and to mitigate climate change impacts. Cambodia's climate change financing framework was functioned since 2014, aiming to guide future financing for both adaptation and mitigation of climate change. It promotes a common approach to defining climate financing demand and assessing the level of resources available and the prospects for future financing (GSSD, 2017). The National Adaptation Plan (NAP) Financing Framework and Implementation Plan, an essential guiding tool for mobilizing resources, was also developed in 2017 to expedite the implementation of the NAP process. 15 sectoral climate change action plans were identified covering 171 actions, which requires a total budget of around USD865.5 million; only 7% out of the proposed budget was supported (GSSD, 2017). The Table below shows financing gap analysis to implement Climate Change Adaption Plans (CCAPs) proposed by 15 sectoral line ministries/institutions.

Table V. 7: Financial gap of the key line ministries under the proposed CCAP

No	Ministry	# Of CCAP Projects	# Of Priority Actions	Funded Projects	Partially Funded	Non-Funded	CCAP Cost ($ Million)	Financing Gap ($ Million)	Gap%
1	MAFF	29	17	0	1	28	187.6	187.1	**100%**
2	MIH	17	0	0	1	16	11	10.75	**98%**
3	MLMUPC	8	2	0	1	7	9.1	8.8	**97%**
4	MME	9	0	0	1	8	5	4.8	**96%**
5	MoE	17	2	8	4	5	27.7	6.9	**>25%**
6	MoEYS	7	2	0	1	6	10.6	10.2	**97%**
7	MoH	11	1	0	1	10	46.8	46.4	**99%**
8	MoINFO	5	0	0	1	4	4.3	4.2	**97%**
9	MoT	8	1	0	1	7	3.4	3.2	**96%**
10	MoWAs	6	0	1	1	4	3.6	3.3	**93%**
11	MoWRAM	16	8	0	1	15	272.5	272.1	**100%**
12	MPTC	6	0	0	0	6	4.6	4.6	**100%**
13	MPWT	11	1	1	0	10	211	210	**100%**
14	MRD	10	5	4	1	5	56.7	17.9	**32%**
15	NCDM	11	1	0	1	10	11.8	11.7	**99%**
Total		**171**	**40**	**14**	**16**	**141**	**865.5**	**802.6**	**92.70%**

Source: GSSD (2017)

9.3. Technology Transfer and needs

Cambodia recognizes the necessity of technology development, transfer, and diffusion in promoting resilience to climate change as well as reducing GHG emissions. Some mitigation technologies have been transferred to Cambodia through various mechanisms (including the Clean Development Mechanisms under the Kyoto Protocol and JCM), yet substantial gaps remain. As the initial step to fill the gaps, Technology Needs Assessment (TNA) for climate change mitigation technologies was conducted, while the associated Technology Action Plans (TAP) were prepared in 2013 (RGC, 2013a). The analysis covered two prioritized sectors - the transport sector and the energy sector. 14 technologies in the transport sector and 12 in energy efficiency were proposed, but only two for each sector were selected namely, energy efficient urban mass transport and vehicle emission standards for the transport sector, while energy efficient lighting (Compact Fluorescent Lamps-CFL) and energy efficient household appliances for the energy sector. Although the TAP was developed since 2013, the determined priority sectors remain validated and are implemented by the MPWT, the MME, and the Ministry of Industry and Handicraft (MIH). Several barriers are identified for the diffusion of CFLs and household energy efficient appliances- - higher product price, absence of regulations to mandate or encourage public use, and limited public awareness. Although these technologies are generally available in Cambodia, they have had limited success with end consumers who cannot yet discern their economic, social, and environmental benefits. At the same time, the transfer and diffusion of technologies in the transport sector face significant barriers in terms of capital and investment requirements. All technologies are produced outside Cambodia, while their prices are high for most Cambodians. Renewable energy has a lot of potentials, but still faces a shortage of facilities and appropriate regulations, slowing down the uptake. The promotion of solar energy is challenging because the facilities to test photovoltaic (PV) systems or solar panels are currently unavailable. Biomass gasification is an appropriate technology for the rural area, but hand-on-training is needed to increase capacity in operation and maintenance. The country has not developed national policy or strategy on technology needed to address climate change besides the Technology Action Plan. The country needs, at least, to promote and mobilize resources to implement proposed seven project ideas raised in the TAP (see Table 6.3). Moreover, more technology needs by sectors to address climate change impacts and mitigation measures are required.

Table V. 8: Seven Project Ideas of the TAP

No.	Project Ideas	Budget Required ($)	Project Duration (Year)
1	Promoting energy efficiency lighting through demonstration and outreach	600,000	**3**
2	Mainstreaming energy efficient lighting into sub-national and national development plans	600,000	**2**
3	Energy efficiency labeling in Cambodia	600,000	**2**

4	Promoting research and development in low-cost, energy- efficient household appliances	1 million	**3**
5	Promoting urban public transport in Phnom Penh	30 million	**5**
6	Public transport planning and travel demand management	1 million	**3**
7	**Enhancing vehicle emissions control and inspection and maintenance in large cities**	**3 million**	3

Source: RGC (2013a)

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A solar-powered irrigation system installed by Solar Green Energy Cambodia (SOGE) in the rice fields in Cambodia's Pursat province will help hundreds of farmers utilize renewable energy in rice farming.

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