THE KINGDOM OF CAMBODIA
NATION-RELIGION-KING

Cambodia's
Third National Communication

Submitted under the United Nations Framework Convention on Climate Change

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THE KINGDOM OF CAMBODIA
THE NATIONAL COUNCIL FOR SUSTAINABLE DEVELOPMENT
THE MINISTRY OF ENVIRONMENT

THIRD NATIONAL COMMUNICATION

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Acronyms

ADB	Asian Development Bank
AFOLU	Agriculture, Forestry and Other Land Use
APHRODITE	Asian Precipitation – Highly-Resolved Observational Data Integration Towards Evaluation
ARCC	Adaptation and Resilience to Climate Change
ASEAN	Association of South-East Asian Nations
Ave	Average
BaU	Business as Usual
BFC	Better Factories Cambodia
BOT	Build, Operate, Transfer
BRTA	Bilateral Road Transport Agreement
BUR	Biennial Update Report
CBTA	Cross Border Transport Agreement
CC	Climate Change
CCAI	Climate Change and Adaptation Initiative
CCAP	Climate Change Action Plan
CCCA	Cambodia Climate Change Alliance
CCCO	Cambodia Climate Change Office
CCCSP	Cambodia Climate Change Strategic Plan
CCSP-WR	Climate Change Strategic Plan in Water Resources
CCTT	Climate Change Technical Team
CCTWG	Climate Change Technical Working Group
CDC	Council for the Development of Cambodia
CDHS	Cambodia Demographic and Health Survey
CDM	Clean Development Mechanism
CD4CDM	Capacity Development for the Clean Development Mechanism
CFL	Compact Fluorescent Lamps
CH_4	Methane
CIPS	Cambodian Inter-censal Population Survey
CMDGs	Cambodia's Millennium Development Goals
CNMC	Cambodia National Mekong Committee
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COPs	Conference of the Parties
CSOs	Civil Society Organizations
CPA	Component Project Activity
CR	Cambodian Riel

CRU TS4.02	University of East Anglia's Climatic Research Unit Time-Series Version 4.02
CSES	Cambodian Socio-Economic Survey
CSOs	Civil Society Organizations
DCC	Department of Climate Change
DHRW	Department of Hydrology and River Work
DNA	Designated National Authority
DoM	Department of Meteorology
EAC	Electricity Authority of Cambodia
EDC	Electricité Du Cambodge
ERIA	Economic Research Institute for ASEAN and East Asia
ESP	Education Strategic Plan
ESTs	Environmentally Sound Technologies
ESDP	Energy Sector Development Plan
EU	European Union
FA	Forest Administration
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FLEGT	Forest Law Enforcement, Governance and Trade
FOLU	Forestry, and Other Land Use
FWUC	Farmer Water User Committees
GCCAP	Gender and Climate Change Action Plan
GCCSP	Gender and Climate Change Strategic Plan
GDANCP	General Directorate of Administration for Nature Conservation and Protection
GDP	Gross Domestic Product
GEF	Global Environment Facility
GERES	Group for the Environment, Renewable Energy and Solidarity (Groupe Energies Renouvelables, Environment et Solidarités)
Gg	Gigagram
GGGI	Global Green Growth Institute
GHGs	Greenhouse Gases
GMAC	Garment Manufacturers Association in Cambodia
GMS	Great Mekong Sub-Region
GNI	Gross National Income
GMS-CBTA	Greater Mekong Sub-Region-Cross Border Transport Agreement
GPCC	General Population Censuses of Cambodia
GSSD	General Secretariat of the National Council for Sustainable Development
GWh	Giga Watt Hour
GWP	Global Warming Potential
HDI	Human Development Index
HFC	Hydrofluorocarbons

HFO	Heavy Fuel Oil
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome
HRF	Humanitarian Response Forum
ICEM	International Centre for Environmental Management
ICP	International Comparison Programme
ICT	Information and Communication Technology
IDP	Industrial Development Policy
IE	Included Elsewhere
IGES	Institute for Global Environmental Strategies
IIED	International Institute for Environment and Development
ILO	International Labour Organisation
IMR	Infant Mortality Rate
INC	Initial National Communication
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producers
IPPU	Industrial Processes and Product Use
ITC	Institute of Technology of Cambodia
IWRM	Integrated Water Resources Management
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
KAP	Knowledge, Attitudes, and Practices
KC	Key Categories
KHR	Khmer Riel
Lao PDR	Lao People’s Democratic Republic
LDCs	Least Developed Countries
LMB	Lower Mekong River Basin
LoA	Letter of Agreement
LPG	Liquefied Petroleum Gas
LTS	Long-Term Strategy
LULUCF	Land Use, Land Use Change, and Forestry
M&E	Monitoring and Evaluation
MAFF	Ministry of Agriculture, Forestry and Fisheries
MCA	Multiple Criteria Analysis
MCF	Methane Correction Factor
MDG	Millennium Development Goals
MEF	Ministry of Economy and Finance
MIH	Ministry of Industry and Handicraft
MIME	Ministry of Industry, Mines and Energy
MISTI	Ministry of Industry, Science, Technology and Innovation

MLMUPC	Ministry of Land Management, Urban Planning and Construction
MME	Ministry of Mines and Energy
MMR	Maternal Mortality Ratio
MMS	Manure Management System
MoE	Ministry of Environment
MoEYS	Ministry of Education, Youth and Sport
MoH	Ministry of Health
MoINFO	Ministry of Information
MoP	Ministry of Planning
MoT	Ministry of Tourism
MoWAs	Ministry of Women's Affairs
MoWRAM	Ministry of Water Resources and Meteorology
MPTC	Ministry of Post and Telecommunications
MPWT	Ministry of Public Works and Transport
MR	Mortality Rate
MRC	Mekong River Commission
MRD	Ministry of Rural Development
MRV	Measurement, Reporting and Verification
MSME	Micro, Small and Medium Enterprises
MSW	Municipal Solid Waste
MW	Mega Watt
N_2O	Nitrous Oxide
NA	Not Applicable
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NAPA	National Adaptation Programmes of Action
NCCC	National Climate Change Committee
NCDD	National Committee for Sub-National Democratic Development
NCDD-S	National Committee for Sub-National Democratic Development Secretariat
NCDM	National Committee for Disaster Management
NCDs	Non-Communicable Diseases
NCGG	National Council on Green Growth
NCSD	National Council for Sustainable Development
NDC	Nationally Determined Contributions
NE	Not Estimated
NESAP	National Environment Strategy and Action Plan
NEA	National Employment Agency
NF_3	Nitrogen Trifluoride
NFP	National Forest Programme
NGGSP	National Green Growth Strategic Plan

NGOs	Non-Governmental Organisations
NH_3	Ammonia
NIR	National GHG Inventory Report
NIS	National Institute of Statistics
NMVOC	Non-Methane Volatile Organic Compounds
NO	Not Occurring
NOx	Nitrogen Oxide
NPP	Net Primary Production
NPRD	National Program to Rehabilitate and Develop Cambodia
NPRS	National Poverty Reduction Strategy
NPASMP	National Protected Area Strategic Management Plan
NRS	National REDD+ Strategy
NSDP	National Strategic Development Plan
ODS	Ozone Depleting Substances
ODU	Oxidized During Use
PA	Protected Areas
PBN	Performance Based Navigation
PES	Payment for Ecosystem Services
PFCs	Perfluorocarbons
PFE	Permanent Forest Estates
PIP	Public Investment Program
PNCA	Prek Leap National College of Agriculture
PoA	Programme of Activity
PPCR	Pilot Programme on Climate Resilience
PPP	Purchasing Power Parity
PPPs	Public Private Partnerships
PV	Photovoltaic
PUC	Paññāsāstra University of Cambodia
QA	Quality Assurance
QC	Quality Control
RCP4.5	Representative Concentration Pathway 4.5
RCP8.5	Representative Concentration Pathway 8.5
RE	Renewable Energy
REDD+	Reducing Emissions from Deforestation and Forest Degradation “Plus”
RFB	Reference Food Basket
RGC	Royal Government of Cambodia
RS	Rectangular Strategy
RUA	Royal University of Agriculture
RUPP	Royal University of Phnom Penh
REMP	Rural Electrification Master Plan

SCCAPs	Sectoral Climate Change Action Plans
SCCSPs	Sectoral Climate Change Strategic Plans
SEDP	Socio-Economic Development Plan
SF_6	Sulfur Hexafluoride
SIDA	Swedish International Development Cooperation Agency
SLR	Sea Level Rise
SNC	Second National Communication
SO_2	Sulphur Dioxide
SPCR	Strategic Programme for Climate Resilience
SSCA	State Secretariat of Civil Aviation
STC	Save The Children
SY	School Year
TA	Technical Assistance
TAP	Technology Action Plan
TB	Tuberculosis
TEU	Twenty Equivalent Units
Tmax	Maximum Temperature
Tmin	Minimum Temperature
TNA	Technology Need Assessment
TNC	Third National Communication
UN	United Nations
UNCBD	United Nations Convention on Biological Diversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USA	United States of America
USAID	United States Agency for International Development
USD	United States Dollar
V&A	Vulnerability and Adaptation
WB	World Bank
WDCs	Women's Development Centres
WHO	World Health Organization

Foreword

The submission of the Third National Communication (TNC) is in line with Cambodia's policy and strategy and strong commitment to multilateral action on climate change.

As a country that is highly vulnerable to the impacts of climate change, we understand the urgency of ambitious climate action and we want to lead by example, in line with our capacities and responsibilities under the United Nations Framework Convention on Climate Change (UNFCCC).

This Third National Communication presents country's development status, needs, and updated analysis of climate change adaptation and mitigation challenges, an updated inventory as well as an overview of measures taken for climate change actions.

The TNC comes at a crucial time for global climate change action. Recent global trends in greenhouse gas emissions are still below the level of effort required to achieve the objectives of the Paris Agreement on Climate Change. Financial commitments to developing countries are also behind target. At a time when unforeseen economic and geopolitical shocks create competing priorities, it is essential to maintain a strong global commitment to the climate change agenda, which is inseparable from long-term sustainable development.

I hope that this TNC will provide useful data and analysis for the design and implementation of the next generation of climate change adaptation and mitigation measures in Cambodia, in line with our Updated Nationally Determined Contribution (Updated NDC) and Long Term Strategy for Carbon Neutrality (LTS4CN).

I take this opportunity to thank all our partners who have contributed to the development of this document, both at the national and sectoral levels. I would like to thank the United Nations Environment Programme (UNEP) and the Global Environment Facility (GEF) for their support for the development of the TNC.

Say Samal

Chair of the National Council for Sustainable Development
Minister of Environment

EXECUTIVE SUMMARY

This Third National Communication (TNC) has been prepared to meet Cambodia's obligations as a Party to the United Nations Framework Convention on Climate Change (UNFCCC). It is prepared based on the guidelines in Decision 17/CP.8, which contains the following chapters:

Chapter 1 - National Circumstances
Chapter 2 - National Greenhouse Gas Inventory
Chapter 3 - Vulnerability and Adaptation Assessment
Chapter 4 - Measures to Mitigate Climate Change
Chapter 5 - Other Information and Relevant Activities
Chapter 6 - Constraints and Gaps and Support Needs

NATIONAL CIRCUMSTANCES

The Royal Government of Cambodia (RGC) established her constitution in 1993 as a liberal democracy. The country is situated in mainland Southeast Asia, which comprises a total area of 181,035 km^2. The country's topography consists of the central plains surrounded by mountainous highland regions and a coastline to the south. Cambodia's climate is governed by monsoons and characterised by two major wet and dry seasons.

Cambodia's population was 14.68 million in 2013, which shows an increment of 1.28 million from 2008 to 2013. About 80% of Cambodians live in rural areas, while 20% live in urban areas, including the capital. The national population density in 2013 was 82 persons per km^2. Climate change impacts the poverty and health of the population of the country. The poverty of the country differs in urban areas and rural areas, in which the poverty in rural areas is higher than the poverty in urban areas. Cambodia was ranked 129^{th} out of 177 countries based on the Human Development Index (HDI).

Cambodia’s economy relies on four main sectors: agriculture, industry, tourism, and construction. The Agricultural sector is one of the main sectors that supports the rise of the Gross Domestic Product (GDP) of the country. This sector includes rice production, livestock, and rubber. The Forest cover of Cambodia was 73 % of the country's territory in 1960 and declined to 57% in 2010 and 50% in 2014 (BUR, 2020). The National Forest Programme (NFP) aims to establish a policy framework and strategy for sustainable management of the country's forest resources for 2010-2029. The fisheries and aquacultural practices in the country are mainly done through rice-field fisheries and farm aquaculture. The catch yield was 250,000 tons in 2004 with an economic value of US$ 300 million.

The energy sector was developed through the Energy Sector Development Plan (ESDP) (2005-2024) and Rural Electrification Master Plan (REMP). These plans focused on the use of renewable energy sources such as hydropower, biomass, biogas, biofuel, etc. and energy efficiency practices. The entire petroleum consumption is being imported into Cambodia, and offshore oil and gas fields have been drilled to discover potential oil and gas deposits. The industry sector provides a significant contribution to the GDP. The textile, wearing apparel and footwear are fast-growing subsectors. These subsectors represent the largest share of investments in the country, followed by the construction sub-sector, electricity, gas, and water sub-sector, respectively. The main exports of Cambodia are garments, minerals, and agro-based products such as paddy, rice, fish, and rubber.

Cambodia’s road infrastructure was almost completely destroyed after more than 20 years of civil strife and negligence; and it has been restored and built in order to accelerate the economic development and transport demand. There are four main types of transport mode, namely road, rail, maritime, and aviation. The transport network of Cambodia consists of national roads,

provincial roads, and rural roads. Through ports and cargo handling, the water transport sector plays a significant role in Cambodia's economy to international markets. The open sky policy has increased the number of international flights travelling to Cambodia through Phnom Penh International Airport. The government will improve international airports and rehabilitate the local ones located in several tourist destination provinces to support the eco-tourism.

The tourism sector is key contributor to country's economic growth. It creates job opportunities and provides a livelihood to the most Cambodians. By taking advantage of the natural resources of the country to attract tourist, this sector helps in green economic development of the country. This sector accounts for 11.8% of GDP in 2004, and tourist arrival has shown significant improvement over the years. At the same time, Cambodia has lost approximately 25% in revenues from tourism, mainly through the import of foreign goods to boost domestic supplies.

The water resource and irrigation system in Cambodia provides the infrastructure to protect from natural disasters such as floods and droughts. The flood control and seawater- protecting dam projects have been able to reduce the vulnerability by floods and protect cultivated lands by sea water intrusion. People are actively involved in community water supply issues for farming and households through the Farmer Water Users Communities (FWUC). The drinking water supply capacity has also increased significantly over the last decades.

The capacity to strengthen the quality of education in Cambodia is in progress by implementing the "Education for All" strategy, which ensures all children access to all types of ECE services, primary school, and secondary school, and have the opportunity to continue learning at higher level. It also ensures effective leadership and management of education staff at all levels. Basic nine-year education set for most Cambodian children. In addition, the RGC will pay attention to improving the quality of education by providing incentives to teachers, improving curriculum, encouraging outstanding students, training teachers, upgrading teaching methodologies, improving classroom conditions and learning materials, and establishing libraries and laboratories. Cambodia has been promoting gender equality at all sectors and levels through Five-Year Strategic Plan for Strengthening Gender Mainstreaming and Women's Engagement (2009-2013), focusing on gender mainstreaming in policies, strategic plan, and development programs across all sectors.

Solid waste generation in Cambodia has increased over the past decades and has gradually changed from a considerable proportion of biodegradable and organic waste to non-degradable. The solid waste and garbage are disposed to landfills/dumpsites, which are mostly open pits and open burning. The domestic wastewater and urban sewage in Cambodia are collected by sewerage systems. The Ministry of Environment (MoE) does wastewater purification through natural wetland systems and wastewater treatment stations. While 80.2% of urban residents in Cambodia have access to improved sanitation, only 10.7% have access to sewage and wastewater treatment and only 21% of the country is urbanized, that means that a very large part of the population is not covered (ADB, 2017).

Cambodia has made all of her utmost effort to develop the national economy to become one of the most rapid economic growth countries among the developing countries and is envisioned to reach the status of an upper-middle income country by 2030 and a high-income one by 2050. However, the country has experienced the adverse impacts of climate change, which requires to take urgent and appropriate actions. Cambodia is intended to develop her country towards a green, low-carbon, climate resilient, equitable, sustainable, and knowledge-based society.

NATIONAL GREENHOUSE GAS INVENTORY

This report covers the Greenhouse Gas (GHG) emissions estimated for the years 2005 and 2010. Emissions of CO_2, CH_4, N_2O, PFCs, HFC, SF_6, and NF_3 in the sectors of Energy; Industrial Processes and Product Use (IPPU); Agriculture, Forestry, and Other Land Use (AFOLU); and Waste were estimated following 2006 IPCC Guidelines for National GHG Inventories and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. The latest version of the IPCC inventory software (Ver. 2.691) was used to compile the inventories. CO_2 equivalent (CO_2e) emissions were calculated based on the 100-year time-horizon Global Warming Potential (GWP) values from the IPCC's Fourth Assessment Report (AR4).

The total GHG emissions of the inventory years 2005 and 2010, including the FOLU sector, are 39,148.29, and 43,643.99 Gg of CO_2e, respectively. Total emissions (with FOLU) have increased by 2% in 2010 compared to 1994.

The FOLU sector is the highest contributor accounting for 51% and 46% of the total emissions in 2005 and 2010, respectively. The agriculture sector is the second highest contributor accounting for 37% for 2005 and 2010. The IPPU sector has the least contribution to the total emissions due to the lack of carbon-intensive industries in the country.

Prioritized mitigation actions introduced to reduce GHG emissions by 24% in 2050 compared with the BAU scenario. The emissions reductions of 21.6 million tCO_2e/year is expected by 2030, while 44.2 million tCO_2e by 2050. The agriculture sector is expected to provide the major share of 34.4% emissions reductions by 2050.

The country's population has increased by 39% compared to 1994, and the GDP has also increased over the considered period. Per capita emissions (including the FOLU sector) has decreased from 0.4tCO_2e/person in 1994 to 0.3tCO_2e/person in 2010. Similarly, emissions per GDP also have decreased from 1994 to 2010. These declines are resulted from the reduction of the FOLU sector emissions and increment of the GDP of the country.

VULNERABILITY AND ADAPTATION ASSESSMENT

The Vulnerability and Adaptation (V&A) assessment in Cambodia concerned both geographical coverage and sectors that are perceived to be vulnerable to the effects of climate change. The assessment is conducted with good coverage of the national territory. Six sectors are identified as vulnerable to climate change, namely agriculture, water resources, forestry, human health, coastal areas, and gender.

The observed and projected future climate change trends are studied as the initial step of the V&A assessment. The analysis of the observed climate trends of the V&A are based on the CRU-TS4.02 and APHRODITE dataset sources for the two primary climate variables of temperature and precipitation, respectively. The climate change projections are analyzed based on the ensembled climate models with a projection extended up to the year 2100, and the selected scenarios of GHG emissions pathways, including RCP4.5 and RCP8.5.

Observed and Projected Climate Change

Parameter	Observed 1985 – 2017	Projected 2050	Projected 2099
Average Annual Temperature	26.5°C - 27.3°C	Expected increase 1.0°C (both RCPs)	Expected increase 2.5°C (RCP4.5) 4.5°C (RCP8.5)
Average Annual Rainfall Trends	plus/minus 10%	plus/minus 10%	

The agriculture sector: crop production accounted for 13% of the Gross Domestic Product (GDP) of the country in the past years. For crop production, the assessments are focused on the impact of climate change threats such as increased temperature, pest, and diseases outbreak, sea-level rise and saline water intrusion, increased extreme weather events and changes in rainfall patterns. The rice yield is decreased by 10% for every 1°C increase in the minimum temperature during the growing season. To address this issue, a significant number of farmers have been introduced to agriculture practices/technologies to adapt to the effects of climate change. Other similar adaptation interventions have considered for the crop production systems are further listed down under the different main intervention in the chapter, namely main planning for climate change and variability, sustainable water use and management, integrated soil management, sustainable crop management, sustainable farming and livelihood systems, and capacity building and stakeholder organization.

Water resources: the next sector identified under the vulnerability assessment. Cambodia's water resources are dependent upon the Mekong River Basin (MRB), which includes the Tonle Sap basin with 12 tributary sub-basins. Climate change will reduce rainfall during the dry season and more rain during the wet season, with more extreme weather events. Climate change has also altered the habitats of the Tonle Sap basin: increasing the open water by 2–21% and reducing rain-fed habitats by 2–5%, and seasonally flooded habitats by 5–11%. To address water resource issues caused by climate change, several adaptation measures discussed under the chapter are divided as policy-based[1] and vulnerability-based[2] adaptation measures.

The Human health: this sector shows major health issues connected to climate-related threats such as flooding, temperature rise, flash flooding and landslides, heat stress, vector-borne disease, water-borne disease, injury and death. Climate change adaptation measures in the health sector are categorized into prevention, control, treatment, public education, capacity, knowledge gathering, and financing based on climate-sensitive diseases.

Coastal zone: It is projected to be vulnerable to Sea-Level Rise (SLR), seawater intrusion, storm surge, increased temperature, droughts, heavy rainfall, and floods. Mangrove ecosystems and coastal erosion are especially vulnerable to climate change impacts. Suitable adaptation measures for coastal zone are included the construction of protective barriers, awareness programs, and promotion of research relevant to producing resilient species, conservation of mangrove forests, water-saving irrigation systems, and etc.

Gender: women in rural areas are more vulnerable to climate change than men since they depend on local natural resources for their livelihood due to their domestic responsibilities to secure water, food, and energy for cooking and other household activities. When food is scarce due to floods or droughts, women tend to eat less so that their partners and children have a sufficient amount to eat. As such, several adaptation interventions are introduced for the cross-cutting issues of gender

[1] Measures refer to the measures generally dealing with improving the 'enabling environment' or framework conditions for climate change adaptation, and they target the policy, legal and institutional settings as well as the financial and information systems and capacity building

[2] Measures are associated with the technical and infrastructure measures generally dealing with the expected water resources and socio-economic vulnerability

sector. The adaptation measures recommended for the sector are discussed based on few main topics in the chapter, namely invest in building resilience at the local level, invest in building intuitional knowledge, invest in institutional transformation, and enhance institutional governance.

MEASURES TO MITIGATE CLIMATE CHANGE

The proposed GHG emissions measures provide a summary update of the national priorities, strategies, and programs in place to drive the mitigation agenda of the country. In order to provide a better understanding of the best possible combination of mitigation options based on available priorities, strategies, and programs to achieve the NDC mitigation targets to the Paris Agreement, a mitigation assessment through GHG projection modelling has been carried out, covering all five main sectors: energy, IPPU, waste, agriculture, and FOLU. The GHG Inventory data for 2010 is used as the base year.

The assessment was carried out with reference to the business-as-usual (BAU) baseline projections from 2010 through to 2050 that focus on historical development trends in each of the five sectors. The BAU and Mitigation scenarios for Energy, IPPU, Waste, and Agriculture sectors were assessed from Long-Range Energy Alternatives Planning System (LEAP) simulation software, while the FOLU sector is assessed by EX- Ante Carbon – Balance Tool (Ex-ACT). The total of thirty-four (34) mitigation actions are reported, including eleven (11) actions from the energy sector, five (5) actions from the IPPU sector, seven (7) actions from the waste sector, eight (8) actions from the agriculture sector, and three (3) actions from the FOLU sector.

Projected GHG Emissions and Reduction Potentials

Sector	(Million tCO_2e)					
	2030		2040		2050	
	BAU	Mitigation Scenario	BAU	Mitigation Scenario	BAU	Mitigation Scenario
Energy	33.0	2.0	61.4	3.1	114.2	6.4
IPPU	8.2	3.3	9.4	6.3	11.6	8.8
Waste	3.7	1.9	4.2	2.8	4.9	3.8
Agriculture	22.0	4.41	26.2	12.38	30.2	15.2
FOLU	19.9	10.0	19.9	10.0	19.9	10.0

The BAU scenarios for all sectors are 43.4, 58.4, 86.8, 121.1, and 180.8 million tCO_2e in 2010, 2020, 2030, 2040, and 2050, respectively. The energy sector (114.2 million tCO_2e) is the highest contributor to the GHG emissions, followed by the agriculture sector (30.2 million tCO_2e) in 2050. Cambodia would be able to achieve 21.6 and 44.2 million tCO_2e of GHG emissions reductions in 2030 and 2050, respectively. The agriculture sector is expected to provide the major share of 34.4% emissions reductions by 2050.

OTHER INFORMATION AND RELEVANT ACTIVITIES

In Cambodia, most transfer of technologies related to climate change occurs through the implementation of CDM projects and mainstreaming efforts on adaptation. As of 2019, 12 CDM projects were approved. Additionally, Cambodia has signed a partnership with Japan for Joint Crediting Mechanism (JCM). The establishment of the national network and the participation in regional networks have contributed to enhanced cooperation and research in the areas related to climate change. Climate Change related curriculum has been integrated into higher and secondary schools. Higher education centers are keenly engaged in various research projects related to climate change.

The Department of Climate Change (DCC) of the MoE/NCSD, with the support from Cambodia Climate Change Alliance (CCCA) developed a nationwide research study to explore Knowledge, Attitudes, and Practices (KAP1 and 2) in relation to climate change in 2011 and 2015, respectively. A survey on climate change perceptions and awareness found that 85% of respondents believed Cambodia's climate is changing. Some 59% and 91% of respondents had heard of the term "climate change" and associated with the change with human practices.

Cambodia has made efforts to improve the dissemination and sharing of climate change information, including capacity-building activities. Since 2000, many trainings, workshops, public awareness, and other capacity-building activities related to climate change have been conducted.

Systematic observations are instrumental in the successful implementation of the Convention. The Global Climate Observing System (GCOS) was established to coordinate the international undertaking in observing Essential Climate Variables (ECVs) in atmospheric, oceanic, and terrestrial domains. Furthermore, Cambodia has made efforts to continuously monitor the meteorology and hydrology data, land use and forest cover data, and agricultural data with the support of different national and international organizations such as the Department of Meteorology, the MAFF, UNDP, FAO, WFP, CARDI, etc.

Cambodia recognizes the importance of integrating climate risk into national and sectoral policies/strategies, planning and budgetary processes and into the design of individual projects. The Cambodia Climate Change Strategic Plan (CCCSP) 2014-2023, the National Strategic Development Plan (2019-2023). The Rectangular Strategy, Pilot Programme on Climate Resilience (PPCR), and the CCCA are some of the attempts taken by the country for the integration. However, these integration processes are still in the early stage.

CONSTRAINTS, GAPS, AND SUPPORT NEEDS

Cambodia has been facing many constraints and gaps in implementing climate change-related conventions, protocol, and international instruments due to limited financial support, technology transfer, and institutional and human capacity. Furthermore, the lack of systematic coordination among respective agencies was also identified as a barrier to the successful implementation of the Convention and protocol. Substantial gaps are seen in technology transfer, especially in the transport and energy sectors. Limited activity data, national emission factors, and sustainable GHG inventory system were found as the constraints to developing GHG inventory. Additionally, the main constraints in developing the Nationally Appropriate Mitigation Action (NAMA) were a lack of expertise and policies.

Cambodia needs to mobilize around 92% of the funds that they have received from development partners and donor countries in order to complement proposals raised by the line ministries and to translate all those actions into concrete implementation. But the increasing public expenditure spent on climate change impacts has reduced the Cambodia's capacity to adapt and mitigate climate change impacts. Therefore, in order to address climate change-related concerns, Cambodia needs further financial and financial support from the development partners, donor countries, funding institutions, and national budget allocations and capacity building programs to extend research institutes and academia on climate change impact assessments, and mitigation.

1 National Circumstances

1.1 Government Structure

The Kingdom of Cambodia (KoC) is a parliamentary monarchy that established a constitution in 1993 with liberal democracy and a free-market economy as the foundations of the country's political regime. The King is the Head of State and reigns as the symbol of unity and eternity of the nation but does not govern. The KoC is under the motto "Nation-Religion-King," with the objective to build and protect the nation and social achievements, while ensuring the country's independence, integrity, sovereignty, peace, democracy, and progress.

The Constitution stipulates that Cambodia adopts a liberal democracy and pluralism policy and that the Cambodian people are masters of the country. The Constitution also sets out that the power of the Legislative, Executive, and Judicial branches shall be separated. The government has a bicameral legislature consisting of the National Assembly and the Senate. There are three separate branches of Legislative, Executive, and Judiciary. The Parliament, which holds primary legislative power, comprises the National Assembly and the Senate. Members of the National Assembly are directly elected through a proportional representation system. The King appoints the Prime Minister and the Council of Ministers upon submission from the National Assembly. The Constitution establishes the judiciary as an independent branch of government and guarantees its independence from the Legislative and Executive. The process of legislation goes through the National Assembly. After the adoption by the National Assembly, the Senate reviews the law, followed by the Royal Kram of the King to promulgate the Law.

1.2 National Development Planning and Priorities

The National Strategic Development Plan (NSDP) has been developed to implement the RGC's priority policies. The Rectangular Strategy (RS), which has been the hallmark of development since 2004 provides a development framework, which will be implemented over the five-year periods. The RS is a dynamic document that places good governance centre-stage and prioritizes Human Resource Development (HRD), economic diversification, private sector employment, and inclusive and sustainable development.

The Sustainable Development Goals (SDG) were built on the momentum of the earlier Millennium Development Goals (MDGs) in reducing extreme poverty. The development of the SDGs was aligned with local development strategies such as the NSDP that was prioritized and in addition to the 17 global SDGs, Cambodia adopted an additional goal and three targets on unexploded ordnance (UXO).

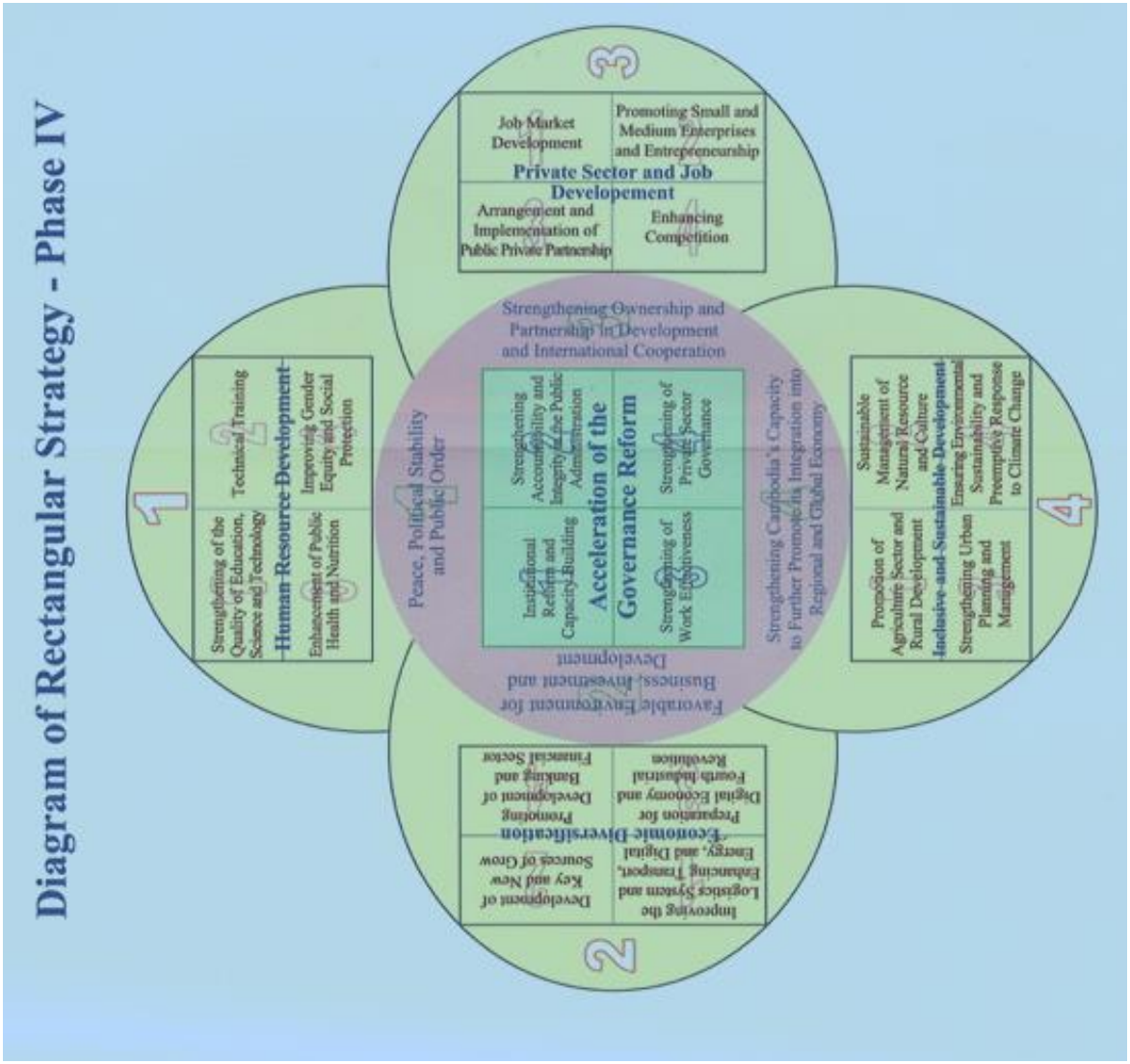


Figure 1.1: Rectangular Strategy-Phase III

Source: NSDP (2014-2018)

1.3 Geographical Location

The KoC is located in mainland Southeast Asia between latitudes 10° and 15° N and longitudes 102° and 108° E. Cambodia covers a total area of 181,035 km^2 extending approximately 580 km from east to west and 450 km from north to south as shown in Figure 1.2. The country's topography broadly consists of the central plains surrounded by mountainous and highland regions, and the coastline to the south. Phnom Penh, the capital city, is located in south-central Cambodia, at the confluence of the Mekong, Tonle Sap, and Bassac Rivers. The Mekong River and its tributaries dominate hydrology. Principal physical features include the Tonle Sap Lake, an outlet of the Mekong during the rainy season, covering up to 10,400 km^2 in the northwest. The Dangrek mountain range in the north and Cardamom Mountains in the southwest forms natural boundaries. Cambodia remains one of the most heavily forested countries in the region. The highest peak is Phnom Aural, sitting 1,813 meters above sea level.

Figure 1.2: Map of Cambodia

1.4 Cambodia's Climate

Cambodia's climate is governed by monsoons and characterized by two major wet and dry seasons: from mid-May to early October, strong prevailing winds from the southwest bring heavy rains and high humidity and from early November to mid-March, winds and humidity are low. The average annual rainfall of 29 years from 1985-2013 ranged from 1,000-1,400 mm in the central lowlands, ranged from 2,000-2,200 mm in uplands to 3,000-4,000 mm in the coastal zone. The annual average temperature is 28^{o}C, with a maximum average of 38^{o}C in April, and a minimum standard of 17^{o}C in January (DoM, 2013 and Heng, 2014). However, over the past decade, some inland provinces have experienced less than 600 mm of rainfall annually. The annual rainfall presents in Figures 1.3, 1.4, and 1.5 below.

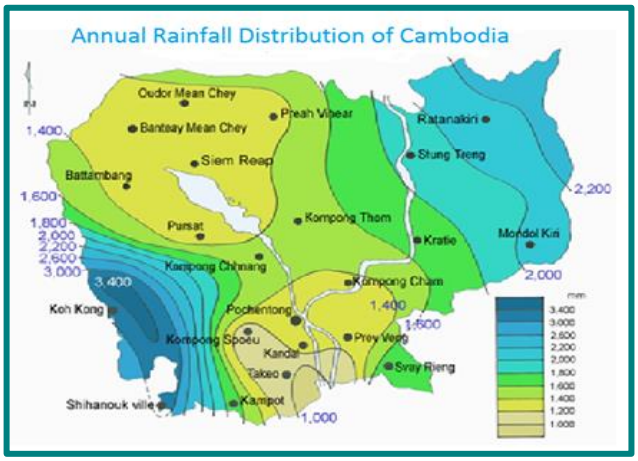


Figure 1.3: Annual Rainfall Distribution of Cambodia

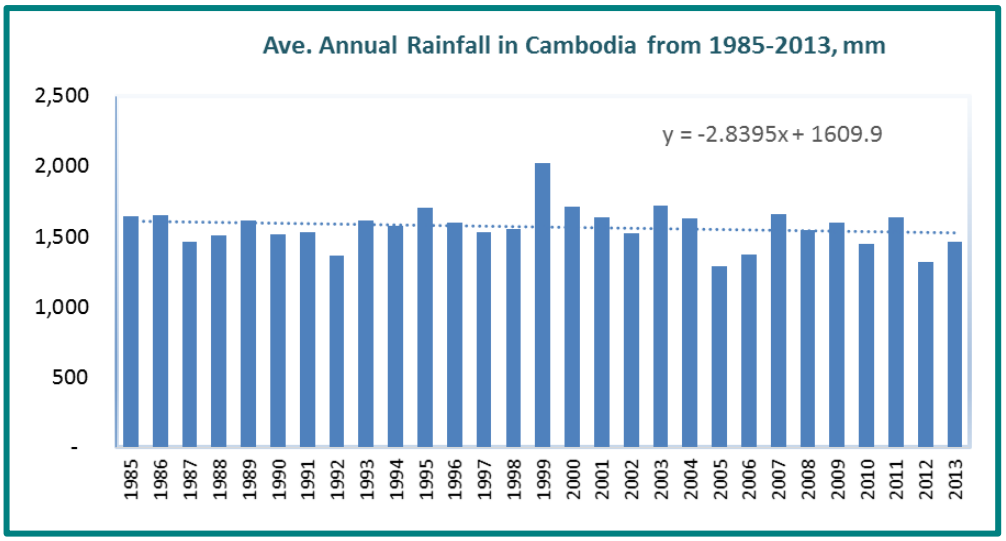


Figure 1.4:Ave. Annual Rainfall in Cambodia (1985-2013)

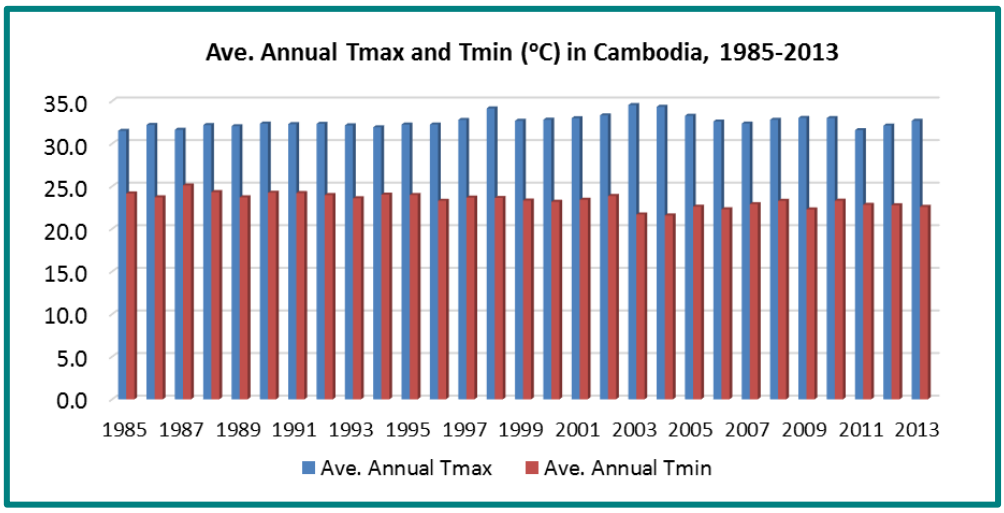


Figure 1.5:Ave.Annual T_{max} and T_{min} in Cambodia (1985-2013)

1.4.1 Weather Stations

There are 200 rainfall stations all over Cambodia operated by the Department of Meteorology of the Ministry of Water Resources and Meteorology (MoWRAM) (MoWRAM, 2009). The rain-gauges are being manned by staff from provincial offices and others by part-time observers. Their status is operating and need network expansion to attain acceptable nationwide coverage density.

1.4.2 Hydrological Stations

Cambodia has a total about 80 manual and 12 automated hydrological stations managed by the Department of Hydrology and River Works (DHRW). Currently, only 50 of the manual stations are operational. There are still 28 ungauged sub-basins in the country including coastal areas. Many of the existing stations need review, especially areas around the Tonle Sap Great Lake, to represent better water resources of each sub-basin. Using the river forecasting model for Cambodia, providing 1-3day water level and flood forecast at 7 stations along Mekong, Bassac, and Tonle Sap River. From the model, Flood Bulletins are issued indicating the forecast water levels, and warnings for floods are shown on sign boards for the public. Values of Warning Levels

and Flooding Levels at different stations are indicated. In addition to the daily weather forecasts, warnings are provided to various hydro-meteorological hazards like thunderstorms, drought, and flash floods (MoWRAM, 2009).

1.4.3 Weather Services

The increasing frequency and intensity of extreme weather events such as floods, drought, windstorms, and thunderstorms have caught the general public's attention on the importance of providing weather services. The weather forecasts and provides warning on weather conditions to relevant stakeholders and the public. This offers short, medium, and long-range weather forecasts and issues Tropical Cyclone Warnings to inform the public of impending hazards. Advance forecasts of El Niño/La Niña, warnings for approaching tropical cyclones and heavy rains enable all sectors and the communities to plan their activities and the people to prepare to reduce or avoid loss and damages from these expected natural hazards.

1.4.4 Floods and Droughts

Cambodia has been protected from the direct impacts of tropical cyclones and typhoons by her surrounding mountains and highlands. The central plains experience seasonal flooding that provides fish and nutrients to soils. However, the frequency of severe floods has increased over the last decade. The 2000 floods were the worst to hit Cambodia in seventy years, while severe floods also marked 1996, 2001 and 2002. While floods affect lowlands areas, the geographical distribution of droughts was widespread. The 1998 drought led to crop failure, while an estimated 2.5 million people were yearly affected in the droughts of 1995, 1996, and 2002 (NCDM, 2002, 2008, and 2011; and MoP, 2005).

In 2009, the natural hazard, which seriously hit to Cambodia was the Typhoon Ketsana. The typhoon had left 43 people dead, widespread damage to houses, rice crops, and infrastructure, which was estimated at US$ 132 million and the amount of US$ 191 million was required for the recovery. Subsequently, 2011 flood-impacted on the people devastatingly, which the country had never faced since 2000. The flood had caused 250 people dead, damages and losses to houses, agricultural and infrastructure sectors with a total amount of US$ 451 million. The raining flood and Mekong flood in 2013 caused 168 people dead and damage to rice transplantation of approximately 62,878 ha (RGC, 2014). In 2013, flood and flash flood were estimated to 377,354 affected households and 168 dead in 20 provinces and cities (Heng, 2014). The Post-Flood Early Recovery Needs Assessment (PFERNA) estimated the total damage and loss caused by the 2013 floods to be US$ 356 million, of which US$ 153 million represented the destruction of physical assets damage in the affected areas, and US$ 203 million was defined as estimated losses in production and economic flows. Damage represented 43% of the total economic impact of the floods, while the remaining 57% was lost (RGC, 2014a). Besides, there were many natural hazards such as lack of water for cultivation in the specific areas, strong wind-storm, lightning, and so on, which annually occurred and caused considerable damages and losses of human life, houses, and destruction of other infrastructure networks. Table1.1 shows Cambodian Natural Disaster from 1991 to 2016.

Table 1:1: Cambodian Natural Disasters (1991-2016)

Year	Disaster Event	No. of Persons Affected	Location
1991	Flood	650,000	Kampong Cham, Prey Veng, Kampot, Kampong Speu, Takeo, and Kandal Provinces
1994	Flood	29,000	Battambang, Takeo, Kampong Cham, Kandal, Kampong Speu Provinces, and Phnom Penh
1995	Famine, Drought	2,500,000	N/A
1996	Famine, Drought	2,500,000	Prey Veng, Kampong Speu, Kampong Chhnang, and Takeo Provinces
1996	Flood	1,300,000	Kratie, Phnom Penh, Rathanak Kiri, Stung Treng, Kampong Cham, Kandal, Prey Veng Provinces
1998	Famine, Crop Failure	900,000	N/A
1999	Flood	527,904	Sihanoukville, Koh Kong, and Kampot Provinces
1999	Flood	106,670	Takeo, Kandal, Kampong Speu, Pursat Provinces, and Phnom Penh
1999	Epidemic, Diarrhoea/ Enteric Diseases	1,254	Ratanak Kiri Province
2000	Flood	3,448,629 and 347 death	Stung Treng, Kratie, Koh Kong, Kampong Cham, Pursat, Kampong Thom, Takeo, and Siem Reap
2001	Flood	1,669,182 and 62 death	Stung Treng, Kratie, and Kampong Cham Provinces
2001	Drought	300,000	N/A
2002	Drought	2,017,340	8 Provinces (43 districts)
2002	Flood	1,439,964 and 29 death	7 Provinces along Mekong River and Tonle Sap Great Lake (41districts)
2004	Flood/Drought	121,012 family (256,444 people)	N/A
2005	Flood, Windstorm, and other Disease	71,517 family (317,689 people), 25 death	5 Provinces along Mekong River Basin
2006	Flood/Drought	71,870 family, 11 death	16 Provinces/towns, 42 districts
2007	Flood	16,108 family	Battambong, Kampong Speu, Svay Rieng, Siem Reap, Kampong Thom, and Kampong Cham Provinces
2008	Drought	N/A	Prey Veng, Kampong Speu, Svay Rieng, Kandal, and Battambang Provinces
2009	Typhoon Ketsana and flash floods	180,000 people were affected, some 49,787 families directly affected by loss of home or livelihood, 43 death, 87 severely injured	Stung Treng, Ratanakiri, Kampong Thom, Kratie, Kampong Cham, Preah Vihear, Siem Reap, Oddar Meanchey, Mondul Kiri, Banteay Meanchey, Battambang, Kampong Chhnang, Preah Sihanouk, and Kampot Provinces
2010	Flash Flood	Thousands of people were affected by the storms and floods; 4 death	Banteay Meanchey, Pursat, Siem Reap, and Preah Vihear Provinces

2011	Flood	354,217 families were affected; 268,631 families were directly affected by the loss of home; 250 death; 23 people severely injured	18 provinces and cities; 122 districts and 687 communes were affected by the flood as detailed provinces: Preah Vihear, Kampong Thom, Battambang, Banteay Meanchey, Siem Reap, Oddar Meanchey, Kampong Cham, Kratie, Stung Treng, Prey Veng, Kandal, Kampong Chhnang, Pursat, Takeo, Phnom Penh, Svay Rieng, Kampot, and Pailin Provinces
2012	Flood/Drought	Floods: 23,691 families were affected; 27 death; 4,395 families evacuated to safety place	Flood: 7 Provinces and 22 districts Drought: 15 Provinces
2013	Flood and Flash Flood	377,354 Affected households; 168 death; 1.8 million individuals living in 20 provinces	20 provinces and city were affected by flood: Preah Vihear, Kampong Thom, Battambang, Banteay Meanchey, Siem Reap, Oddar Meanchey, Kampong Cham, Kratie, Stung Treng, Mondulkiri, Ratanakiri, Prey Veng, Kandal, Kampong Chhnang, Pursat, Takeo, Phnom Penh, Svay Rieng, Koh Kong, and Pailin Provinces
2014	Drought	116,129 ha (5%) of cultivated land was affected About 73% of all districts the impacted of drought	Eighteen were affected by the drought.
2015-2016	Flood and Drought	About 2.5 million people from 625,000 houses were affected, an estimated 950,000 of whom were children, 20,289 ha (0.79%) was damaged	El Niño Event Eighteen Provinces were affected by the drought.

Source: WFP (2005); NCDM (2002, 2008, and 2011); WB (2010); HRF (2013); STC (2016)

1.5 Population

1.5.1 Demography

The country has a population of 15.3 million people in 2019 and is projected to reach 17.3 million by 2023, 18 million by 2028, and around 21 million by 2048 (MoP, 2015; RGC, 2016 and 2019; NIS, 2019). Phnom Penh is the capital and the most populous city in Cambodia, with a population of more than 2 million in 2019, which is projected to reach around 3 million by 2035. The city is densely populated at 3,400 persons per square kilometre (km^2). It has an area of 678.46 km^2, covering 0.37% of the country's total area. The Cambodians were 5.7 million according to the 1962 census, which was the first official census conducted after the country attained independence from the French rule. Due to war and unrest, Cambodia's demographic scenario changed completely after that census. There was no population census organised until 1998, and there were no systematic national surveys until 1993-94. Though, the population changes during the 1970s were examined. The Government of the People's Republic of Kampuchea carried out population counts in 1979 and 1980. There was no further confirmed information about population until 1992.

About 79% of Cambodians live in rural areas (2019). Population size and population growth by the residents of Phnom Penh and other urban regions constitute 21% of the population. The national population density in 2013 is 82 persons/km^2, the plain is 288 persons/km^2, the Tonle Sap is 70 persons/km^2, the coastal is 59 persons/km^2, and the Plateau and Mountain is 25 persons/km^2. The plains region has always accounted for the largest population of 48.9% in 2008 and 49.2% in 2013 of total population. The Tonle Sap region has the second largest population of 32.5% and 32.2% in 2008 and 2013, respectively. The coastal region accounted for 11.4% and 6.9% in 2008 and 2013, respectively. The Plateau and Mountain regions accounted for 11.4% and 11.7% in 2008 and 2013, respectively.

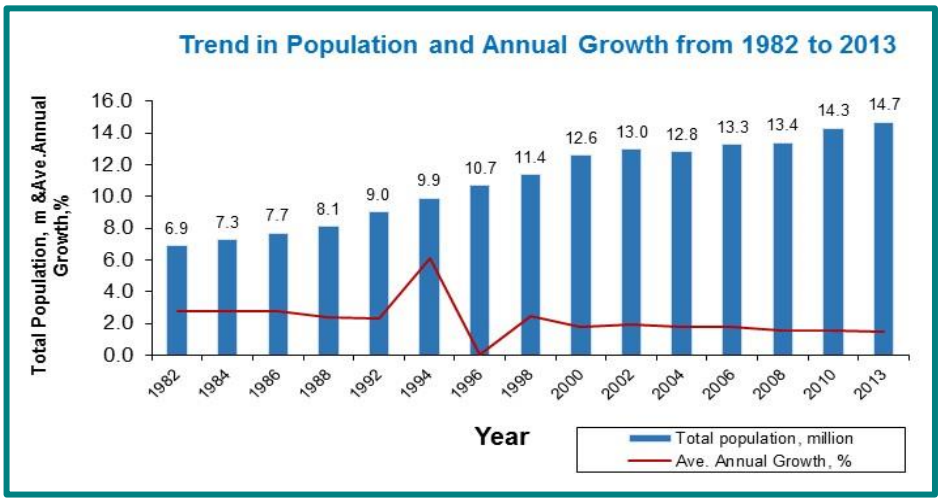


Figure 1.6:Trend in Population and Annual Growth (1982-2013)

1.5.2 Age Group Structure

The population age structure is determined by the same three factors that affect any population's growth rate, namely fertility, mortality, and migration. The age group structure of the percent distribution in different age groups and the graphical presentation from 2004 to 2013 shows in Figure 1.7. The percentage of males and females in the five-year age groups starts with the youngest age group at the bottom and increases with age towards the top of the pyramid. The percentage of males is depicted on the left and females on the right side of the pyramid's center. The shaded area shows the population count of the 2008 Census, while the thickly outlined area shows the population count of 2013.

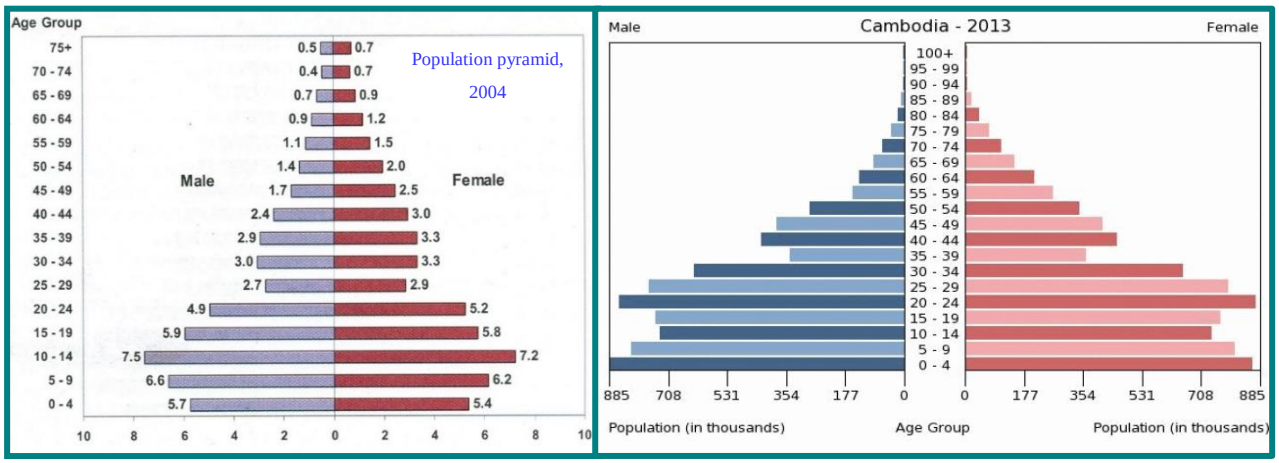


Figure 1.7:Comparison of Population Pyramid (2004-2013)

Source: NIS (2004 and 2013)

1.5.3 Poverty

The poverty rate was 39% in the 1990s decreased to 35% in 2004, while the people below the food poverty line were 20% (RGC, 2014). The occurrence of poverty is lower in the capital city at 5% and other urban areas at 25%, and the highest in rural areas at 39% (RGC, 2002 and World Bank, 2006). In addition, the RGC redefined the poverty line and reduced the poverty headcount estimated at 21.1% in 2010. At the same time, about 12.4% refers to Phnom Penh, 17.0% refers to other urban areas, and 22.7% refers to a rural area and a population below the food poverty line at 13%. The poverty was lower in the capital city of Phnom Penh at 13.3% and other urban areas at 11.5%, and higher in rural areas at 17% (see Figure 1.8 below).

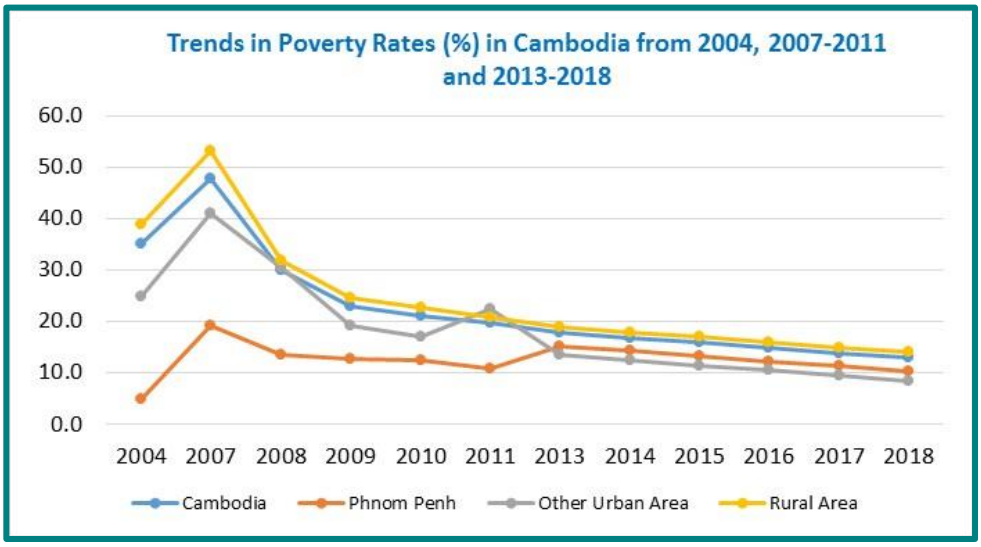


Figure 1.8: Trends in Poverty Rate of Cambodia (2004-2018)

1.5.4 Human Health

The RGC recognizes that healthy people constitute the key basis for human resource development and sustainable socio-economic progress, which emphasises on enhancing the general well-being of all citizens, particularly the poor, women, and children. The Third Health Strategic Plan (HSP3) (2016-2020) outlined the strategic framework for further strengthening operations in the entire health sector (both public and private) to address priorities and to ensure consistent application of strategies across programs. The HSP3 also contained the framework for monitoring and evaluating progress and results of its implementation. The plan also aimed to mobilize adequate financial resources, to inform fiscal allocation, and to guide development assistance in the health sector.

Based on the Cambodia Demographic and Health Survey (2014), the infant mortality rate was 28 deaths for every 1,000 live births. This means that 1 in every 36 Cambodian children dies before his/her first birthday. The under-five mortality rate was 35 for every 1,000 live births. Childhood mortality declined substantially over the past decades, infant mortality decreased from 124 deaths per 1,000 live births in 2000 to 35 deaths per 1,000 live births in 2014 (Health Management Information System-HMIS, 2019).

Cambodia has successfully fight against malaria and there was a drop-in cases from a peak of over 100,000 cases or 7.4 per 1000 population in 2006 to over 62,000 cases or 3.9 per 1000 population in 2018. Deaths due to malaria also dropped from around 400 reported deaths in 2006 to zero reported malaria deaths in 2017 (National Centre for Parasitology Entomology and Malaria Control-NCPEMC, 2018). Neonatal mortality rate was 39 and 34 per 1,000 live births in the lowest

and second quintiles, respectively, while it was 16 in the highest quintile. Neonatal mortality was much higher in the rural areas of 35 versus the urban areas of 11.

Malaria and dengue fever are prevalent mosquito-borne diseases. In 2004, more than 95,000 malaria cases were treated with about 400 fatalities. The number of malaria cases treated at public hospitals and health centers was 2.9 per 1,000 populations in 2012. Malaria fatality rate per 100,000 populations decreased from 0.67 in 2011 to 0.32 cases in 2012, thus meeting all the CMDG targets through the National Malaria Elimination Strategic Plan (2011-2025), around 3,700,000 mosquito nets were distributed free of cost to the people. However, the number of dengue cases treated at public health facilities increased from 9,542 in 2008 to 42,382 in 2012. Despite the number of hospitalized patients in 2012 being higher than those in the previous years, the dengue mortality rate nationwide remained low at 0.40 per 100 populations. Tuberculosis Prevalence of Pulmonary Tuberculosis Positive cases decreased 38% or 4.2% annually between the years 2002 and 2011. Tuberculosis death rate was 63 per 100,000 populations in 2011. The tuberculosis cure rate was maintained at over 85% over the last 14 years. Nevertheless, Non-Communicable and Chronic Diseases like Cancer, diabetes, cardio-vascular diseases, eye problems, oral health, and mental illness related to drug use have posed a great burden on the health system because treatment and care of such diseases are expensive and life-long.

The health information system indicated that the Health Equity Fund protected those living below the poverty line. This number was about 2.5 million poor people. The Vouchers for Reproductive Health Services scheme for poor women began in 2011 and was operational in 118 health centers, five referral hospitals, and 4 NGO-run clinics in 9 Operational Districts in 3 provinces. The Health Equity Fund covered 101 to 370 health centres, and from 44 hospitals to 64 hospitals between 2008 and 2012. Community-based Health Insurance is being implemented in 179 Health Centres and 13 Referral Hospitals in 11 provinces, including Phnom Penh, with 166,663 persons (RGC, 2014).

1.5.5 Human Development Index

Comparison of standards of living based on incomes across countries, the incomes component of the Human Development Index (HDI) uses Gross National Income (GNI) per capita converted into Purchasing Power Parity (PPP) terms to eliminate differences in national price levels. The International Comparison Programme (ICP) survey is the world's largest statistical initiative that produces internationally comparable price levels, economic aggregates in real terms and PPP estimates. Cambodia's HDI value for 2016 was 0.576, which put the country in the medium human development category, positioning it at 143 out of 189 countries and territories (UNDP, 2016).

In 2004, Cambodia was ranked 129th out of 177 countries and compared to 2014, which was 143rd out of 190 countries (UNDP, 2006 and 2015), which put the country in the bottom quarter of medium human development. Compared to the other ASEAN Member States, Cambodia's human development lags behind her neighbours. Figure 1.9 describes HDI between 2004 and 2014 for ASEAN members, while the detail one shown in Appendix I.

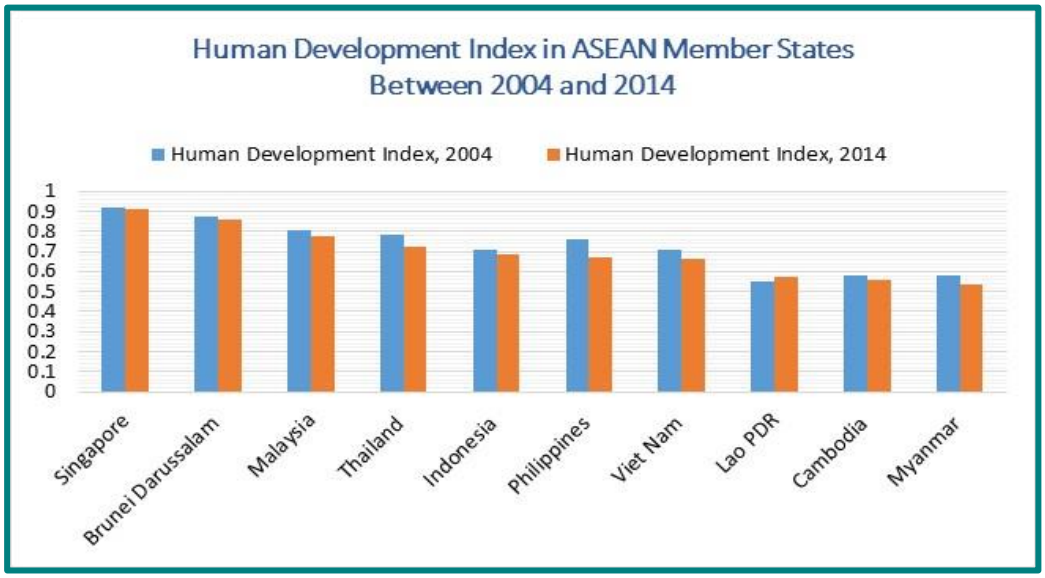


Figure1.9: Human Development Index for ASEAN Member States between 2004 and 2014

1.6 Economy and Finance

1.6.1 Gross Domestic Product

Cambodian economy had to grapple with three different types of problems through the plan period 2009-2013, coming out of the shocks stemming from the global slowdown; maintaining and deepening the growth process; and transforming the economy to move towards higher financial stability. As the country relies mainly on the agriculture sector, the extreme climate events such as flood, drought, and storm has exacerbated the economic development and GDP growth. The annual GDP growth rate from 1994 to 2004 averaged 4.51%, while the economic growth during 2003-2008, averaged around 10% per year, with a record-high annual growth rate of 11.3% in 2005 and the economy grew at an annual rate of 6.7% in 2008, but in 2009 as the world economy faced a downturn, the growth rate in GDP in Cambodia too touched near 0.1%. However, annual GDP grew at an average annual rate of over 8% between 2000 and 2010 and about 7% since 2011. The tourism, garment, construction and real estate, and agriculture sectors accounted for the bulk of growth. Mining is also attracting some investor interest and the government has touted opportunities for mining bauxite, gold, iron and gems. The share of the agriculture sector to Cambodia's GDP decreased from 33.8% in 2010 to 24.7% in 2016, while the industry and service sectors increased from 21.9% and 38.3% in 2010 to 29.5% and 39.9% in 2016, respectively, (WB, 2017).

The challenge for Cambodia's economy is to broaden opportunities for an increasing population, while diversifying from a strong reliance on industry including garment, services and agriculture sectors. The annual GDP and real GDP growth rate from 1994 to 2016 illustrates in Figure 1.10.

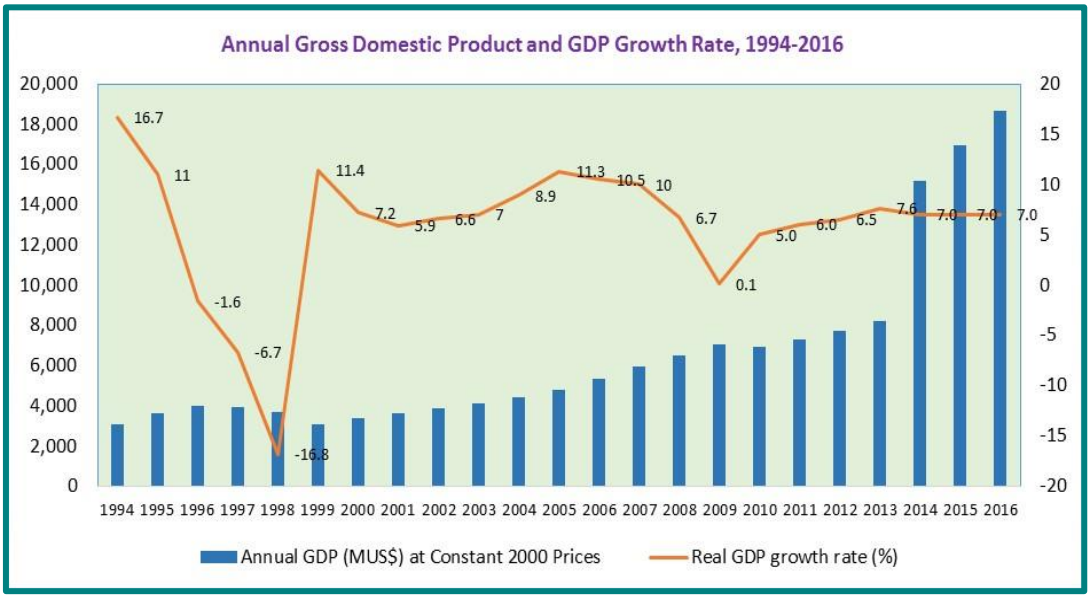


Figure1.10: Annual GDP and Real GDP Growth Rate (1994-2016)

1.6.2 Finance

Since the implementation of the Public Financial Management Reform Programme (PFMRP), the budget revenues increased on average by 26% per annum. The RGC succeeded in mobilizing development cooperation financing from the development partners for her socio-economic development. Likewise, the disbursement reached about US$ 1 billion per annum during the last 5 years. Therefore, development cooperation accounted for 10% of the country's GDP in recent years, potentially contributing to a high economic growth rate.

Cambodia's finance sector is undergoing a transition during 2009-2013, significant progress. Broad money had increased on an average of 21% per annum over 2008-2012 period. The financial market is developing, particularly the security markets, by diversifying institutions and financial instruments. The interbank/money market is likely to grow when the debt security market is established, focusing on the insurance sector on the progress. The country's banking system consists of 21 branches of National Bank of Cambodia, 33 Commercial Banks (23 Domestic Banks and 10 Foreign Banks, and these banks have 171 province and city branches), seven Specialized Banks, and five representative offices (RGC, 2014).

From 2000 to 2004, cumulated FDI in Cambodia amounted to US$ 1.87 billion, predominantly in the investment on physical infrastructure, transport, irrigation, electricity, including NGOs' activities. Total FDI amounted to US$ 229 million in 2004, of which 43% from China, 22% from other ASEAN members, 10% from Hong Kong and 10% from the EU (MoP, 2002), and from 2008 to 2015 accounted for approximately US$ 7.94 billion. The Official External Assistance (OEA) to the Budget (2000-2015) presents in Table 1.2 below.

Table 1:2: Official External Assistance to the Budget (2000-2015) (Million US$)

Items	2000	2001	2002	2003	2004	2008	2009	2010	2011	2012	2013	2014	2015
Official Development Assistance (incl. NGOs)	**286.8**	**362.2**	**429.9**	**416.9**	**375**	**957.3**	**960.8**	**1,044.60**	**707**	**459.6**	**1,566.40**	**1,242.20**	**1,000.80**
Technical Assistance	N/A	N/A	N/A	N/A	N/A	222.4	241.3	221.2	118.1	78	263.7	251.1	214.7
Capital Assistance	N/A	N/A	N/A	N/A	N/A	594.3	584.5	693.6	516.5	328.5	1238.3	897	696.8
Other than TA	N/A	N/A	N/A	N/A	N/A	140.6	135	129.8	72.4	53.1	64.4	94.1	89.3

Source: NIS (2005); RGC (2010 and 2014)

1.7 Agriculture

1.7.1 Rice Production

Cambodia's agriculture plays a vital role in supporting economic growth, ensuring equity and food security, and developing the rural economy. This is predominantly rainfed, based on household subsistence, and characterized by low input and moderate or low fertility land, thus making it dependent on weather conditions and changing climate.

As for 2013, areas under all crops reached more than 3 million ha (RGC, 2014). Rice provides about 70% of nutritional needs and was planted on 2.5 million ha or 90% of the total crop area (MAFF, 2005). Some 80% of rice production stems from local varieties cultivated during the rainy season. High-yielding varieties are mainly planted during the dry season, and account for the remaining 20% of rice production. Since 2006-2008, the overall agricultural production had increased remarkably provided that concerned institutions had been striving to change farmers' behaviour in crop farming practices, crop preservation and harvesting, and increase irrigation capacity and favourable weather conditions. The share of the agriculture sector was 5.5% in 2006, 5.0% in 2007, and 5.7% in 2008. In 2008, the total cultivated land area was 2.61 million ha, producing about 7.15 million metric tons of paddy, resulting in an average yield of 2.74 tons per ha and a surplus of 2.02 million metric tons of milled rice (RGC, 2010).

During 2009-2012, the average paddy yield increased from 2.84 tons per ha to 3.12 tons and total production increased from 7.59 million tons to 9.29 million tons. Cambodia had a surplus of paddy from 3.5 million tons in 2009 to 4.7 million tons in 2012 *(about 2.24-3.03million tons of milled rice).* The increases in paddy production, rice export, and rice surplus clearly showed that Cambodia had significantly achieved her "Policy on the Promotion of Paddy Production and Rice Export" in rice production. The details area, rice production and yield growth from 2008 to 2016 are present in Table 1.3 below.

Other horticulture and industrial crops cultivated areas of maize, cassava, mung bean and soybean increased from 774,660 ha in 2010 to 2,034,000 ha in 2016. The cultivated area under horticulture and industry crops in 2012 was 1,000,880 ha compared with 930,777 ha in 2011. Production increased from 9.93 million tons in 2011 to 10.85 million tons in 2012. The cultivated area under permanent crops was 193,751 ha in 2012, 17.5% higher than 2011. The Area, Rice Production and Growth from 2008 to 2016 shown in Table 1.3 below.

Table 1:3: Area, Rice Production and Growth (2008-2016)

Description	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016
Land under Crops	000 ha	596	645	774	930	1,000	1,000	1,714	1,874	2,034
Cultivated Area	Million ha	2.61	2.72	2.79	2.97	3.01	3.08	3.10	3.15	3.20
Harvested Area	Million ha	2.60	2.67	2.78	2.77	2.98	3.06	3.10	3.15	3.20
Yield	Tonne per ha	2.74	2.84	2.97	3.17	3.12	3.00	3.15	3.18	3.21
Total Production	Million tonne	7.12	7.59	8.25	8.78	9.29	9.19	9.76	10.01	10.28

Source: MAFF (2009 and 2013); RGC (2010 and 2014)

1.7.2 Livestock

Cambodia's animal husbandry has been traditionally practiced at the household. Cattle and buffaloes provide most of the agricultural draught, manure for fertilising crops and constitute essential household assets (MoE, 2004,b and 2005). 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. In 2013, around 75% (1.6 million) of all household agricultural holdings raised livestock and/or poultry during the census enumeration. The most common large livestock raised of farm households were cattle and buffalo, though cattle were six times more numerous than buffalo, and cows were 10% more numerous than bulls. With an estimated 3.2 million cattle throughout the country, there was an average of three animals per household raising cattle. Almost 70% of households that raised poultry reported between 25 and 499 chickens, ducks etc., respectively, (NIS and MAFF, 2015).

From 2004-2008, livestock production had moderately increased and the number of cattle raised increased by 2.5% on an annual average. The number of pigs raised has declined from 2.42 million heads in 2004 to 2.21 million heads in 2008 due to an increase in in-flows of pigs and other pig-related products from neighbouring countries (RGC, 2010). However, the number of pigs and poultry notably increased from 2.12 and 23.33 million heads to 2.46 and 27.32 million heads, respectively, between 2009 and 2012. The number of cattle raised had declined from 3.58 million heads to 3.38 million heads and the number of buffalo also declined. The overall number of domestic animals probably increased by 3% per year, this growth is due to increased demand for animal products, mainly meat. The livestock and poultry's share of Cambodia GDP in 2012 accounted for 3.9% at current prices (RGC, 2014). The number of households engaged in raising livestock and poultry in Cambodia from 2009 and 2014 is estimated at 1,814,000 (56% of all households). In 2014 the three most common types of livestock and poultry the households raised were chicken, which accounted for about 64%, ducks, at 23% and cattle, at 7%. In addition, the Cattle, Buffalo, Swine, Poultry accounted for 2.47 million heads, 0.45 million heads, 1.37 million heads, and 29.23 million heads, respectively, (NIS, 2015).

1.7.3 Rubber

Rubber development is based on the Strategy for Natural Rubber Development in Cambodia (2011-2020). In 2012, total areas under rubber plantations were 280,355 ha. In this regard, 54,209 ha or 19.34% of total areas under rubber plantations were under existing agro-industrial rubber plantations, 118,448 ha or 42.25% under economic land concession companies, and 107,696 ha or 38.41% under smallholding rubber plantations. Some 55,361 ha plantations are already being tapped, producing about 65,000 tons for exports. In 2013, total areas under rubber plantations is 307,854 ha implying that the RGC has reached its target (300,000 ha by 2020) (MAFF, 2013 and RGC, 2014). The rubber plantation by year was presented in Table 1.4 below.

Table 1:4: Estimated Rubber Areas (2008-2016)

Type of Rubber Plantation	Unit	Year of Planting								
		2008	2009	2010	2011	2012	2013	2014	2015	2016
Agro-industry (Ex-Estate plantation)	Ha	N/A	N/A	N/A	N/A	54,360	1,000	1,000	1,000	1,000
Agro-industry (ELCs)	Ha	N/A	N/A	N/A	N/A	18,449	20,000	20,000	20,000	15,000
Smallholdings	Ha	N/A	N/A	N/A	N/A	107,696	5,000	7,000	7,000	6,000
Total	**Ha**	**111,400**	**128,400**	**143,400**	**158,400**	**280,505**	**26,000**	**28,000**	**28,000**	**22,000**

Source: MAFF (2009 and 2013); RGC (2010 and 2014)

1.8 Forestry

Cambodia is one of the richest biodiversity hotspots within the region. Biodiversity and ecosystems whose natural processes are deeply inter-connected provide numerous essential resources and services for the livelihoods and well-being of the people, wildlife, national economy, environment, and climate hazards mitigation.

Cambodia's forests which used to cover around 73 % of the country's territory in 1960 declined to 61% of the total land area in 2002. The loss of forest cover is consistent with land use and land cover change patterns associated with demographic growth and economic development in most countries. In addition, in 2016, it decreased to an area of 8.742.401 ha, equivalent to 48.14 % of the country's total land area, (includes rubber plantation, palm oil plantation and other perennial crops) (MoE, 2018). Forests play significant roles in traditional rural livelihoods, providing construction wood, fuel-wood, food, medicine, and ensuring ecosystem functions such as watershed, storm and coastline protection. As a complement to farming and fishing, forest foraging constitutes a safety net for rural people. Forests' contribution to the GDP reached at a maximum of 5.4% of GDP in 1998, but declined to 1.9% in 2006 (MEF, 2006). From 2009-2013 indicated that the forest contributed to the GDP *was* still decreasing from 0.81% to 0.66% and similarly during the period from 2014-2016 account*ed* for from 0.76% to 0.67% (MEF, 2009 and MEF, 2013).

Cambodia's forests cover classified into eight groups: evergreen, semi-evergreen, deciduous, other forests, wood and shrubland, evergreen, wood and shrubland dry, bamboo, and non-forests (MAFF, 2004) and was presented in Table 1.5 below.

Table 1:5: Forest Cover Classification

Forest Type	Geographic Distribution (Low, Medium and High) = Level of Disturbance
Evergreen forest	Evergreen forests are usually multi-storied forests where trees maintain their leaves during the whole year. They comprise the lowland tropical rain forests, hill evergreen forests, dry evergreen forests, and streams and rivers (gallery forests).
Semi-evergreen forest	Semi-evergreen forests contain variable percentages of evergreen and deciduous trees, the rate of evergreen trees varying from 30% to 70%. Semi-evergreen forests continue to appear evergreen throughout the year, even when the percentage of deciduous trees is high.
Deciduous forest	Deciduous forests comprise dry mixed deciduous forests and dry Dipterocarp forests. Deciduous forests drop their leaves more or less entirely during the dry season. The human impact such as fire is usually much higher than other forest types. Dry Dipterocarp forests naturally have an open character. Undisturbed deciduous forests may have a crown cover of only 40%, soil and grass may significantly impact reflections from these forests. As a result, it is challenging to separate deciduous forests from shrub land during the dry season.
Other forests	This land cover type includes regrowth, stunted forests, mangrove forests, inundated forests, and forest plantations. The regrowth of secondary forests is representative of a continuous, usually dense layer of smaller trees. Stunted forests grow very slowly because of poor site conditions on hydromorphic soils and rock outcrops. Heavily disturbed forest like mosaics of forest, regrowth, and cropping, corresponding to shifting agriculture in which the percentage of forest is more than 40%, and areas of old regrowth and young secondary forest in the process of regenerating after clear-cutting, are also included in this category.
Wood and shrubland evergreen	Wood and scrubland are a mixture of shrubs, grass and trees, the trees cover, however remains below 20%. This class can be found mainly on shallow soils, on the top of mountains under climax conditions or due to non-sustainable land use. Theoretically, there is a chance of becoming forest again. The signature remains light red during the whole year. Young regrowth after shifting cultivation is also included in this class when the shifting cultivation mosaic becomes invisible. There is usually a dense layer of shrub and grass with some trees.
Wood and shrubland dry	This class's 'Dry' variant can be found in dry plateaus and on dry and sun exposed slopes. The signature is light grey during the dry season and light brownish-grey to violet during the wet season, the texture is medium to rough.
Bamboo	Large areas of dense bamboo are usually discernible due to their pink and orange color and their typical texture. A sparse or small bamboo coverage will not be detectable and will remain in one of the other classes.
Non-forests	This category merges agricultural areas, urban areas, water bodies, grassland and barren land.

Source: FA (2008)

Number of protected areas has increased from 23 up to 72 areas (including three biodiversity corridor), representing 41 % of the country's area consisting of National Parks, Wildlife Sanctuaries, Protected Landscapes, Multiple-Use Areas, Ramsar Sites, and Biodiversity Corridors. The protected area system helps protect the natural resources, ecological system, and biodiversity, such as forests, mountains, freshwater/marine fishery, beaches, and freshwater that provide numerous benefits for the environment, human well-beings, and livelihoods. The government created community-protected regions up to 115 as of 2012 to stabilize in the coming years and the community-protected regions are on the rise. The Environmental Sustainability-Forestry Development Indicators was presented in Table 1.6 below and the Protected Areas Management was shown in Table 1.7 below.

Table 1:6: Environmental Sustainability-Forestry Development

	Unit	2008	2009	2010	2011	2012	2013	2015 (est.)
Surface of 23 Protected Areas	Ha	3,100,199	3,100,199	3,111,041	3,111,041	3,111,041	3,111,041	3,111,041
Community Protected Areas	Numbers	82	84	98	102	115	120	140

Source: MoE (2005 and 2014); MoP (2014)

Table 1:7: Protected Areas Management

Type of PA	Description
National Park	A natural area in land and/or water territories, which is established to: a. Protect the area's role or roles in the ecosystem to benefit people of all generations. b. Limit the use that may harm or destroy biological resources, natural resources, cultural resources, and functions/roles of the area concerning the objectives of the established site. c. Serve as bases for recreation, visits, education, research, and belief, provided that these activities do not cause threats to the natural environment and local culture.
Wildlife Sanctuary	An area in and/or water territories requires active interventions for management purposes to ensure the maintenance of habitats and to meet necessary conditions for any species of animals or plants.
Protected Landscape	An area in and/or water territories, in which human interactions with nature create uniqueness in natural beauty or ecology or culture and are generally abundant in biological resources. Maintaining the traditional interaction is vital to age and life for defence, maintaining, and developing the area.
Multiple Use Site	An area in land and water territories is rich in natural resources that are intact and require management activities to ensure long-term protection and maintenance of biological resources and ecosystem. In the meantime, it provides genuine products and services for users to meet the community's needs.
Ramsar Site	A wetland that is considered as an area of ecological or biological importance of international nature.
Tonle Sap Biosphere Reserve	A Biosphere Reserve is an area representing an ecosystem that is essential, not severely damaged, and surrounded by sustainable development zones, allowing for limited human activities.
Natural Heritage Site	An area in land and/or water territories has natural or semi-natural uniqueness. It has outstanding or extraordinary value because that area is rare, of a quality that represents the ecosystem, or of beauty or cultural importance.
Marine Park	A coastal area that is affected by marine tides mixed with water from mountain forests, including islands, covered by forests, plants, wildlife, and fish of all kinds, with historical and cultural value. This area is recognized by law to be managed.

Source: MoE (2014)

To overcome the challenges, Cambodia has developed a series of policies, strategies and action plans to conserve, protect and ensure sustainable use of biological resources for socio-economic development, including the Royal Decree on the Protection of Natural Areas (1993), Law on Environmental Protection and Natural Resource Management (1996), Law on Forestry (2002), Law on Natural Protected Areas (2008), Law on Fisheries (2006), Sub-Decree on Environmental Impact Assessment Process, Cambodia National Biodiversity Strategy and Action Plan (2016), National Protected Areas Strategic Management Plan (2017-2031), and Sub-Decree on the Establishment of Biodiversity Conservation Corridor of Natural Protected Areas (2017), and other legal instruments. In 2017, the RGC announced a new sub-decree that protects almost 1.5 million hectares as "Biodiversity Conservation Corridors". The new corridors connect existing PAs, allowing species migration. The aim of this sub-decree is to ensure the stability and security of ecosystem, wildlife, and plant species, especially the endangered and rare species. The sub-decree also aims at increasing the role of ecosystem in the PAs for the benefit of social development. More importantly, it encouraged the engagement from local communities and relevant stakeholders to manage and utilize the environmental and natural resources within the PAs sustainably.

The National Protected Area Strategic Management Plan (NPASMP) (2017- 2031)

The NPASMP is the first comprehensive strategy document for protected areas in Cambodia. It represents an important milestone in moving towards a climate-resilient future for our country. It reflects Cambodia political will and commitment to safeguarding a network of protected areas that contributes to the country's economy and sustainable development, including poverty reduction, through the conservation and sustainable use of its biological, genetic resources, natural and cultural resources, and other ecosystem services. The concept of ABS is new in Cambodia. There is a need to inform and build expertise in the country. More specifically, community participation in the development and implementation of any ABS legislation is essential. Many government institutions have been assigned to work closely with indigenous people and local communities because these communities play an important role in decision-making for the conservation and management of natural resources.

National REDD+ Strategy (2017-2026)

The Cambodia National REDD+ Strategy (NRS) takes note of the Cancun Agreement, the Warsaw Framework for REDD+, the Paris Agreement and RGC policies. Cambodia has developed and submitted her FRL to the UNFCCC; developed her national forest monitoring system; and undertaken significant analytical and awareness work on establishing a safeguards information system that will include a grievance mechanism. The institutional framework for REDD+ enables Cambodia to report her GHG emissions from the land use, land use change, and forestry (LULUCF) sector and provide a technical annex to the BUR as part of the process to request results based payments.

Action and Investment Plan for the Implementation of the National REDD+ Strategy

Following National REDD+ strategy, the REDD+ Action & Investment Plan (AIP) sets up the programmatic framework of investments needed to achieve the REDD+ Strategic Objectives (SOs) identified in the NRS. It presents the institutional arrangements, actions and financial needs to implement REDD+ in Cambodia. The purposes of the AIP are to channel finance towards REDD+ objectives and guide investments for effective implementation of various REDD+ strategies (Policies and Measures - PaMs) across the country, in a way that ensures social inclusion and gender equality.

1.9 Fisheries

Fish is an essential source of protein in rural people's diet, and constitutes an income-generating activity to supplement rice cultivation and fish continues to be a vital source of food, nutrition and income of millions of Cambodians. The average annual fish consumption is 67 kg per year per person and fish provides Cambodian people with about 80% of animal protein, as well as more than 4.5 million people having been directly involved in the fishery sector. Total fish production grew to over 471,000 tons in 2008, the principal increases coming from rice field capture and steady growth in aquaculture (RGC, 2010).

In terms of catch yield, Cambodia's ranks fourth in the world (140 to 190kg/ha), with an estimated 250,000 tons in 2004 and an economic value of US$ 300 million (MoE, 2005). Cambodia's inland fisheries are directly affected by seasonal patterns of floods and droughts, and thus vulnerable to changing climate conditions. Aquaculture has been implemented through pursuing diverse approaches, including enhancing rice-field fisheries and establishing Community Fish Refuge Ponds which can help increase farm aquatic production by up to 15% per annum. Total production of bred fish and freshwater prawn was up to 74,000 tons, an increase of approximately 3%;

fingerling production was 140 million heads, an increase of roughly 8%; crocodile production was 250,000 heads, an increase of 25% due to its skin has high economic value. There are 516 communities for the management and sustainable use of natural resources. The RGC has implemented fisheries reforms to promote small-scale fishing. In 2012, the annual inland and marine catch quantities were 509,000 tons and 99,000 tons, respectively. In addition, the production of aquaculture products was 74,000 tons in 2012, an increase of 3% over 2011. Developing aquaculture development is an important additional policy of the Government in order to help ensure food security. The Fish Catch and Aquaculture Production from 2008 to 2016 shows in Table 1.8 below.

Table 1:8: Fish Catch and Aquaculture Production (2008-2016)

Description	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fishing Lots	Sq. Km	415	415	415	415	415	415	N/A	N/A	N/A
Release to community fishing	%	56.4	56.4	56.4	56.4	56.4	56.4	N/A	N/A	N/A
Aquaculture (15% increased)	000 Tonne	N/A	50	60	72	74	80	97.8	112.5	129.4
Fish Catch from all sources	000 Tonne	471	515	617	668	726	788	752	790	829

Source: MAFF (2009 and 2013); RGC (2010 and 2014)

1.10 Energy

1.10.1 Energy Resources

Significant progress has been made in increasing the available supply of electricity and expanding the electricity network. The development of the energy sector through an Energy Sector Development Plan (ESDP) (2005-2024) and Rural Electrification Master Plan (REMP) focusing on the use of renewable energy are being implemented. Cambodia has imported her entire consumption of petroleum products, steadily increasing from US$ 549 million in 1998 to US$ 691 in 2004. Cambodia's renewable energy sources are abundant but remain largely untapped (NIS, 2005). A 115KV-transmission line, from Thai border to supply electricity to Banteay Mean Chey, Siem Reap, and Battambang Provinces, was completed and was already fully operational. A 230KV-transmission line (110 km), from Cambodia-Vietnam to Phnom Penh, and Takeo Sub-station have been fully operational in early second quarter of 2009. A 115KV circuit of 23 km has been added to Phnom Penh and a sub-station was installed in the western part of Phnom Penh in 2009 (RGC, 2010).

The Energy sector development was to expand the electricity supply coverage further, lower the tariff, and strengthen institutional mechanisms and management capacity by constructing and operating several hydropower plants such as (i) Kamchay Hydropower Plant with a total of 193.2 MW; Third Kirirom Hydropower Plant with capacity of 18 MW; Atai Hydropower Plant with capacity of 120 MW; Stung Russeychrum Krom Hydropower Plant with a capacity of 103 MW and a total capacity of 338 MW; and Coal-fired Power Plant in Preah Sihanouk with a capacity of 100 MW (RGC, 2014). Although significant progress has been made, the energy sector also faces challenges of electricity production from hydropower plants, which provides sufficient supply only in rainy season, while in dry season, power production is only 25%. Thus, there is a need to step up the implementation of the electrification strategy to realize the goal “by 2020, all villages in Cambodia will have access to electricity supplied by the national grid and other sources”.

Biomass accounts for more than 80% of total national energy consumption, including forests products, agricultural crops and residues, and municipal waste and sewerage. It is required to foster the development of all types of renewable energy such as biomass, biogas, bio-fuel, etc., and to enhance energy efficiency through the use of energy-saving stoves to reduce the use of fuel,

firewood, charcoal, etc. It is expected that offshore oil and gas fields are a common asset of all Cambodians. Thus, oil and gas production can drastically transform Cambodia's economy, society, and GHG emissions characteristics (World Bank, 2007).

The total final energy consumption in Cambodia grew by an annual average of 6.9% during 2010-2015. The final energy consumption in 2015 was 3.4 million tons of oil equivalent, comprising 50.5% petroleum products, 36.0% biomass, 13.1% electricity, and 0.4% coal. The transport sector was responsible for nearly half (46%) of the final energy consumption. In 2015, renewable energy accounted for 65% of the total energy consumption and among them, 46% came from traditional biomass such as wood, charcoal, and dung; 15% from modern biomass such as biogas produced from human and animal waste; and 3% from hydropower (ADB, 2018).

1.10.2 Energy Production and Consumption

In 2015, the RGC has a substantial increase in consumers availing electricity supply. As reported by the licensees, the number of consumers by the end of 2015 is 1,859,205, almost 30 % higher than in 2014. Diesel and Heavy Fuel Oil (HFO) are the only fuels used to generate electricity in Cambodia. Biomass use is limited to micro-generation installations and captive systems. Independent Power Producers (IPP) accounted for 64% of total electricity produced in 2004, the remainder was provided by Electricité Du Cambodge (EDC), the State electric utility, and the Ministry of Industry, Mines and Energy (MIME). The electricity generation in 2015 increased by 46.79%, compared to 2014 (EAC, 2016). The quantity of energy sent-out by the IPPs, and Consolidated licensees classified by generation type is shown in Table 1.9.

Table 1:9: 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: EAC (2016) and MME (2016)

In 2013, Cambodia's energy sources can almost cover all consumption demands as an annual electricity consumption increased from 139kWh/person in 2008 to 268kWh/person, growing around 14% per year (MoP, 2014 and MME, 2016). The number of all types of electrical networks putting in operation from 2008 to 2013 has remarkably increased, making 51% of all villages in the entire country in 2013 accessible to electricity supply. The main challenges are to continue the increase in electricity production to meet the growing demands and the expansion of the coverage of the distribution network to all remaining villages, and prepare a more reasonable electricity tariff for consumers. The Annual Electricity Consumption and Transmission Line Network from 2008 to 2016 shows in Table 1.10.

Table 1:10: 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: RGC (2010 and 2014)

1.10.3Main Source of Fuel for Cooking

Fuelwood (firewood and/or charcoal) is the traditional primary sources of the household for cooking in Cambodia. In 2004, about 91% of households use fuelwood for cooking. While charcoal and Liquid Petroleum Gas (LPG) are more accessible in urban areas refers to 23% and 20% of households, respectively, they are marginally used nationwide as cooking fuel account for 5% and 2%, respectively, (Table 1.11). These statistics have remained broadly unchanged since the 1998 General Population Census (CIPS, 2004). Some 84% of households depended on firewood for cooking in 2005, which came down to 79.5% in 2010 and 62% in 2013. In 2015, 83.5% of Cambodian households relied on firewood as an energy source mainly for cooking and they consumed more than 80% (2018) of their energy sources for cooking (ADB, 2019).

Short-term strategy for reducing the proportion of families using firewood is to encourage the use of an effective stove, which can save the charcoal about 20%, compared with normal stove and reasonable price. In response to this strategy, about 2.5 million effective stoves were distributed for selling in the markets since 2003 until 2013 with the use of practical charcoal ovens has helped to prevent and reduce the forest logging for firewood or charcoal production.

Table 1:11: Main Sources of Cooking by Households

Total Rural/Urban	Unit (%)	Firewood	Charcoal	Kerosene	Liquefied Petroleum Gas (LPG)	Other	Year
Total Cambodia	**100**	**90**	**5.3**	**1.8**	**1.7**	**1.2**	**1999**
Total	100	86.1	7.8	0.6	4.4	1.1	
Urban	100	55	23	0.7	19.8	1.6	2004
Rural	100	91.3	5.2	0.6	1.9	1	
Total	100	74.8	8.1	0	15.8	1.3	
Urban	100	43.2	20.8	-	33.7	2.3	2014
Rural	100	88.9	6.3	0	3.9	0.9	

Source: NIS (2004 and 2015)

In 2004, only 14% of households had access to city power, while kerosene lighting and battery lighting was used by 70% and 17% of households, respectively. Some 91% of households use fuelwood for cooking. While charcoal and Liquid Petroleum Gas (LPG) are more accessible in urban areas of 23% and 20% of households respectively, they are marginally used nationwide as cooking fuel of 5% and 2% respectively. These statistics have remained broadly unchanged since the 1998 General Population Census (NIS, 2004). As for 2014 the primary lighting sources used by households in Cambodia are the publicly-provided electricity/city power and battery, which constitute 58% and 31%, respectively. For households using batteries, this source is probably also used to power the TV stand and lighting. Some households also used the kerosene lamp as the energy source for lighting in Cambodia, at 7%. Looking at the differences in each domain, almost all homes in Phnom Penh had used publicly provided electricity as lighting sources. The share is lower for households in other urban and other rural areas, at 92% and 47%, respectively. In other rural areas, the battery and kerosene lamp was still commonly used by households for lighting. Table 1.12 presents Main Sources of Lighting by Households.

Table 1:12: Main Sources of Lighting by Households

Total Rural/Urban	Unit (%)	City Power	Generator	Kerosene	Battery	Other	Year
Total Cambodia	**100**	**12.5**	**1**	**79.9**	**3.5**	**1.5**	**1999**
Total	100	14	1.3	64.5	16.2	2.2	2004
Urban	100	51.4	1.6	34.2	8.9	1.1	
Rural	100	7.9	1.3	69.5	17.4	2.3	
Total	100	58.2	0.8	7.4	30.5	3.1	2014
Urban	100	91.7	0.3	2.3	4.4	1.3	
Rural	100	47.3	1	9.1	38.8	96.2	

Source: NIS (2004 and 2015)

1.11 Industry

The industry sector, the fastest growing industry since its emergence a decade ago, concentrates on export-oriented garment manufacturing. The industry increased from 12.7% of GDP in 1993 to 28.9% in 2004 with an average annual growth rate of more than 15%. Textile, wearing apparel and footwear was the fastest-growing subsector with an average annual increase of 41% over the period, totalling 89% of good exports in 2004. It was observed that the industry employs only 8% of the labour force, far below the agriculture sector with 75% (NIS, 2007).

In 2011, the number of industrial enterprises, large and small, exceeded 500,000, and they provided more than 1.6 million jobs, including more than 500,000 in the textiles, garments, and footwear industries. More than 100,000 legal overseas workers sent more than US$ 200 million per annum in the form of remittances. The RGC established the National Employment Agency (NEA) to provide employment services to job seekers and the Employment Forum to exchange information related to job markets. It helped increase the monthly minimum wage in textile, garment, and footwear industries from US$ 50 to US$ 80, while encouraging employers to provide other additional monthly benefits of about US$ 20 to workers (RGC, 2014). Cambodia's gross value by industry in 2010 accounted for US$ 4,492.4 as indicated by the manufacturing of 41%; textile, wearing, and footwear of 30%; and construction of 17% as presented in Figure 1.11 below.

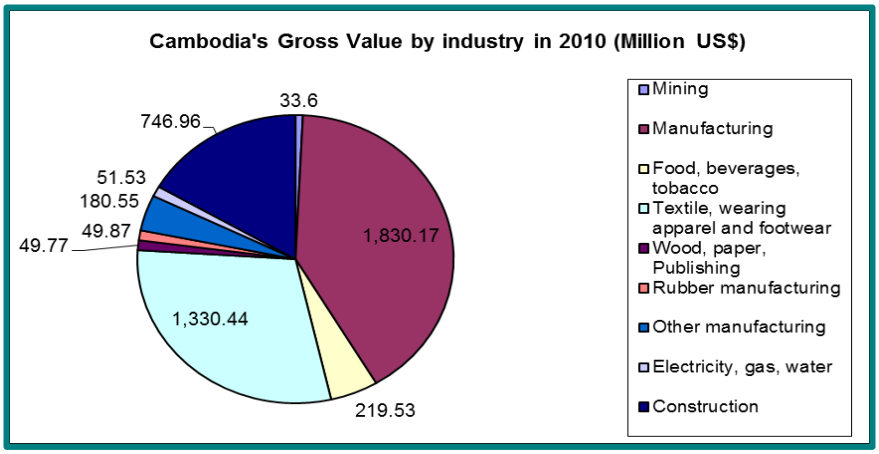


Figure 1.11: Cambodia's Gross Value by Industry in 2010

From 2009 to 2016 the industrial sector, including mining, manufacturing, electricity, gas & water, as well as construction required an investment of US$ 1,011.7 million in 2009 and US$ 2,517.3 million in 2016. Within this group, the manufacturing sector (that includes the textile, apparel and footwear sub-sector) will be required the largest share of the investment of US$ 431.80 million in 2009 and US$ 1,150.37 million in 2016, followed by the construction sub-sector, that required the

investment of US$ 383.10 million in 2009 and US$ 840.85 million in 2016, and the electricity, gas and water sub-sector that required an investment of US$ 142.71 million in 2009 and US$ 391.56 million in 2016 (RGC, 2014). Therefore, in 2008, the economic significance of manufacturing and garment industry output accounted for US$ 3,727.07 million and US$ 3,011.71 million, respectively. Figure 1.12 shows economic significance of manufacturing and garment industry outputs in Cambodia.

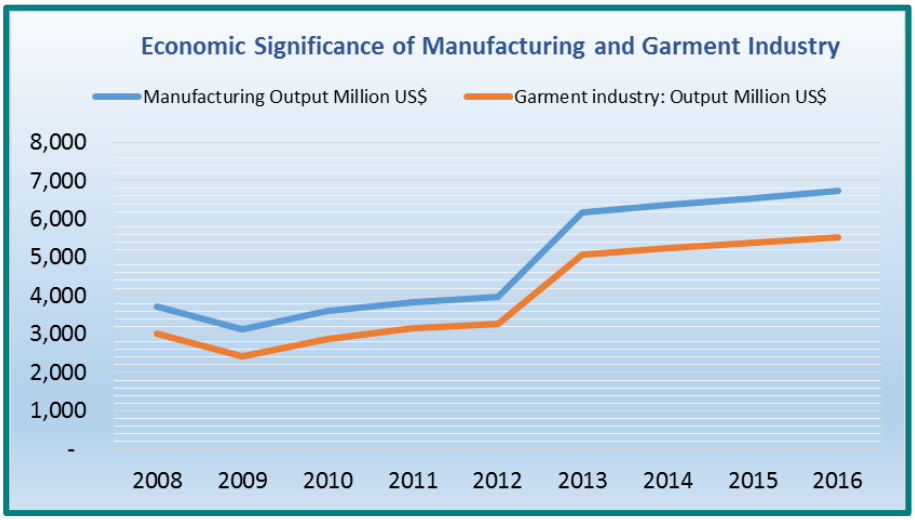


Figure1.12: Economic Significance of Manufacturing and Garment Industry Outputs
Source: RGC (2014)

The preferential access to the EU and US markets, the absence of restrictive quotas, and the lower production costs contributed to the emergence of the Cambodian export-oriented garment manufacturing in the mid-1990s. In addition, Cambodia has managed to take advantage of a corporate social responsibility niche, whereby factories are independently monitored by the International Labour Organisation (ILO)'s *Better Factories Cambodia (BFC)* programme. The project grew out of a trade agreement between the USA and Cambodia, whereby Cambodia was promised access to US markets in exchange for improved working conditions in the garment sector (ILO, 2016). Cambodia has access to EU markets without quotas or duties as the Least Developed Country (LDC). The USA and the EU represented 64 and 29%, respectively, of Cambodia's total garment exports in 2005. The USA and Cambodia Bilateral Textile Agreement, initially covering 2000 and 2001 and later extended until 2004, provided an incentive to increase the quota for Cambodian garment export to the USA linked to ongoing improvements in labour conditions in garment factories.

Cambodia’s Export values and market share of the footwear sector continued to record rapid growth in 2015, with exports increasing by 21.8% to US$ 538 million, while exports of garments rose by 6.5% to US$ 5.7 billion (ILO, 2016). The total exports of the garment and footwear sector reached US$ 6.3 billion in 2015, representing 7.6% growth over 2014. The EU continued to represent the largest market for Cambodia’s garment and footwear exports. During 2015, 46% of Cambodia’s garment and footwear exports went to the EU, while 30% were shipped to the US market. The remaining 24% were destined for other markets, mainly Canada and Japan. An increasing share of Cambodia’s exports from the sector had gone to the EU in recent years, with the US share falling. Cambodia’s garment industry exported from 1995 to 2015 shows in Figure 1.13 and Factories of the Garment Textile and Footwear, and Economic significance of Cambodia’s garments export indicated in Appendix I.

Figure1.13: Cambodia's Garments Export (1995-2015 and 2017)
Source: ILO (2016) and WB (2016)

1.12 Trade and Balance of Payments

1.12.1 Exports and Imports

Cambodia's main exports are garments, minerals, and agro-based products (paddy, rice, fish, and rubber). These suffered a setback in 2009 due to slack (low) demand in the international markets. In 2013, expected exports stood at US$ 6.9 billion compared to US$ 3 billion in 2009 (RGC, 2014). At the same time, expected imports amounted to US$ 9 billion in 2013 compared to US$ 4.5 billion in 2009. Intermediate product imports constituted a large component of the increase in imports. The trade deficit was (minus) 15.3% of the GDP in 2008, which gradually reduced to (minus) 13.6% in 2013. After accounting for capital transfers, the current account deficit looks better, but is still negative. It is evident that the export volumes from agriculture, mining, manufacturing and services combined with other contributions to the current account balance, are not large enough to meet the import bill.

The country's FDI prospect index, after maintaining a growth momentum of 7.6% between 2014 and 2015, is expected to trend down marginally to 7.1% in 2016 and 6.9% in 2017 (MEF, 2016). China accounts for about one-third of FDI inflows to Cambodia. There is a growing concern that China's economic adjustment may make China's investors to pull back from foreign investment. Cambodia's exports have slowly but steadily diversified in recent years of garment products to other products and from the US market to other markets. The share of garments in the country's exports had been shrinking from 86% in 2011 to nearly 74% in 2015, and mid-2016 account for 73%, while the share of other products (electronic components, bikes, etc.) had been rising from only 7.4% in 2011 to 21.1% in 2015, and increasing about 23.2% in the mid-2016. Table 1.13 presents growth and share of value commodity exports from 2011to mid-2016.

Table 1:13: Growth and Share of Value Commodity Exports (2011-mid 2016)

Commodity for Export Growth	Unit	2011	2012	2013	2014	2015	Mid 2016
Garment	%	32.1	7.3	17.8	10.7	14.5	10.8
Rubber	%	121.8	-16.8	6.5	-11.6	6.7	-30.5
Rice	%	206.7	27.6	92.9	-5.3	26.9	-8.9
Others	%	29.3	92.0	64.9	50.4	11.9	16.9
Commodity for Export Share	Unit	2011	2012	2013	2014	2015	Mid 2016
Garment	%	86.4	82.0	77.1	73.5	73.7	73.0
Rubber	%	4.0	3.0	2.5	1.9	1.8	1.2

Rice	%	2.2	2.4	3.8	3.1	3.4	3.0
Others	%	7.4	12.6	16.6	21.5	21.1	23.2
Total		**100**	**100**	**100**	**100**	**100**	**100**

Source: MEF (2016)

Cambodia's imports experienced significant variations across the major import value categories. Cumulative import bill grew by about 13.4% in 2015, lower than the 18.1% in 2014 as shown in Table 1.14 (MEF, 2016). While import value of construction materials, food and beverages and miscellaneous categories grew at a slower pace in 2015, imports of textiles and fabrics, petroleum products and vehicle grew faster, reflecting the strong performance of the garment industry and robust consumer spending.

Table 1:14: Annual Percentage Change of Value of Imports

Commodity for Import Change	Unit	2011	2012	2013	2014	2015	Mid 2016
Consumption Goods	%	-4.6	21.8	10.7	32.3	25.6	16.5
Steel, Cement and construction equipment	%	-7.5	35.4	15.3	36.1	22.9	13.6
Garment products and Fabric	%	37.2	16.5	21.9	19.8	7.6	6.9
Vehicles	%	20.9	36.1	2.1	24.5	33.2	21.7
Petroleum products	%	103.7	12.6	5.7	5.9	10.7	15.5
Others	%	6.5	11.8	24.5	24.4	6.1	2.4

Source: MEF (2016)

1.12.2 Balance of Payments

Cambodia's trade and current account deficits as a share of the GDP were likely to improve this year and the next due to the import compression. Exports as a ratio of the GDP were likely to stabilize at 46.2%, while imports are seen to decline from about 66% in 2015 to 64% in 2016, and projected about 63% in 2017. With stable official development assistance, the compression in the trade deficit is also accompanied by an improvement in the current account deficit. The latter is likely to decline from 9.6% of the GDP in 2015 to 9.1% in 2016, and projected about 8.5% in 2017 (MEF, 2016). Figure 1.14 shows Cambodia's balance of payment for the share of the GDP from 2011 to 2017.

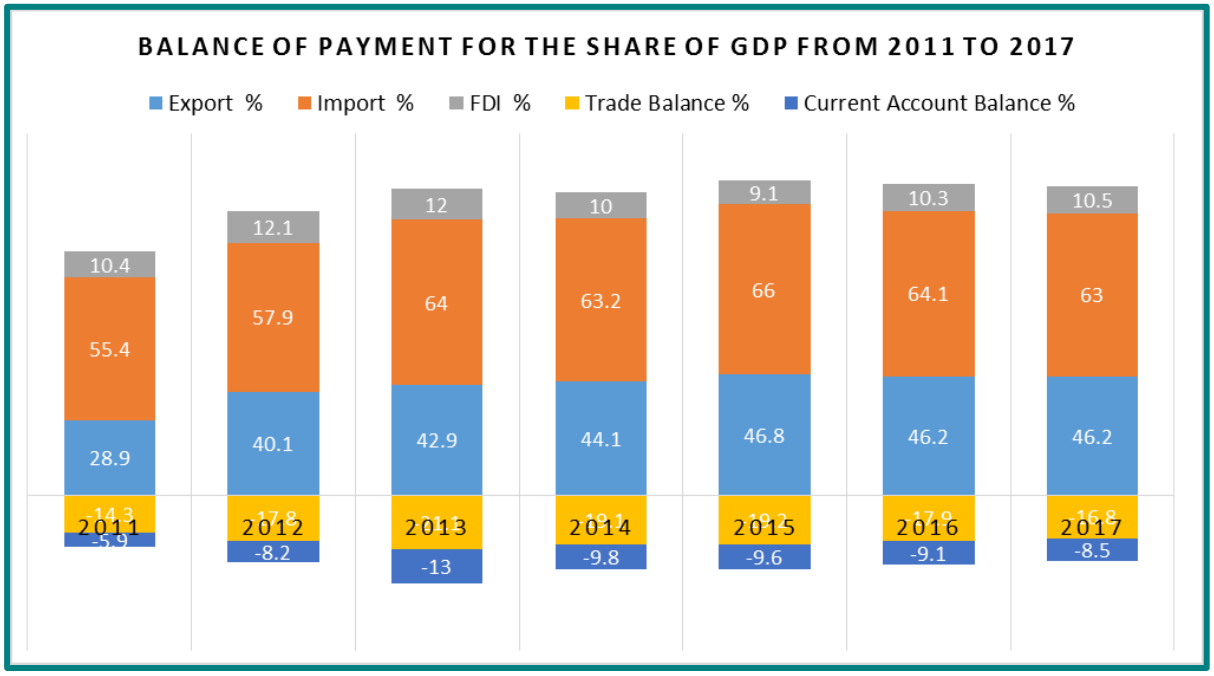


Figure1.14: Cambodia's Balance of Payment for the Share of the GDP (2011-2017)

1.13 Transport

1.13.1Land Transport

Cambodia's road network consists of 38,870 km of national roads (11%), provincial roads (9%), and rural roads (80%). About 1,699 km of two-lane national roads were covered with asphalt and 319 km covered by red gravel (NIS, 2007 and MoP, 2005). The rehabilitation and construction of single-digit National Roads Network is now nearing completion. The main National Roads (asphalted) now connect Phnom Penh with almost all provincial capitals, and link to major cross-border check points with the neighbouring countries (RGC, 2010). At the end of 2008, the total roads network was 39,618 km of roads that including: 2,119 km of single-digit National Roads. 3,086 km of double-digit National Roads; 6,413 km of Provincial Roads, of which 113 km were now asphalted. During the period of implementation of the NSDP 2006-2010 (2006-2008), the total length of national and provincial roads that were rehabilitated and asphalted was 2,342 km. In addition, by 2009, the paved roads had the total length of 2,661km equivalent to 51% of single-digit and increased 3,500 km in 2012 and double-digit National Roads with the distance of 5,205 km (Table 1.15). At the end of 2012, the national and provincial roads, under control of the MPWT and the Ministry of Rural Development (MRD) measured a total roads network of 47,263 km.

The number of registered motor vehicles (cars, minibuses, pick-ups, buses, trucks, motorcycles) increased by 79% between 1994 and 2004, which corresponded to an annual growth rate of almost 7%. Motorcycles represented 70% of vehicles, followed by cars (26%), and trucks (3%) (NIS, 2007). Registered 1,361,575 vehicles (1,197,296 units were motorcycles and 164,279 units were cars and trucks, which is a sharp increase compared to the preceding 5 years). Vehicles registered between 1990 and 2012 were 2,175,418 units. Some 426 sub-standard trucks were adjusted to comply with the laid down technical standards. The road death toll from 2009-2013 increased by 44.53% compared with 6,421 of the earlier 5 years (RGC, 2014).

Table 1:15: The Transport Sector in Cambodia (2008-2016)

Description	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016
Primary & Secondary roads	Km	11,494	119,494	11,618	11,618	11,618	12,263	12,263	12,263	12,263
Paved	Km	2,342	2,661	2,781	2,800	3,500	500	600	500	500
Railways	Km	650	650	650	650	650	266	386	257	319
International Ports	Number	2	2	2	2	2	2	2	2	2
International Airports	Number	2	2	3	3	3	3	3	3	4
Domestic Airports	Number	9	9	8	8	8	8	8	8	8

Source: RGC (2010 and 2014)

Transport of passengers and goods on the railways is quite limited as Cambodia's railway network was built between 1929 and 1942 (385 km Northern Line), and in the 1960s (266 km Southern Line). The network is in a dilapidated state and not usable along large sections. Both freight and passenger transports by rail have decreased over the past decade, with the rehabilitation of the national road network. Railway plans are now being prepared to rehabilitate and expand this mode of transport and to integrate it into the regional railway network. A 30 years concession agreement between the Royal Railways of Cambodia and a private company (Toll Royal Cambodia) was signed on 2009 and railways network will be rehabilitated: (i) the missing link from Sisophon-Poipet 48km (to connect to Thai railways); (ii) the line between Phnom Penh and Sihanouk Ville Port of 264 km; and (iii) the line from Phnom Penh to Sisophon of 338 Km. The new building of the Railway Department began construction in December 2012. The Traffic Volume on Rail Transport from1999 to 2006 shows in Table 1.16 below.

Table 1:16: Traffic Volume on Rail Transport (1999-2006)

Traffic Volume	Unit	1999	2000	2001	2003	2004	2005	2006
Goods	000’ tons	268	340	410	433	298	269	316
	ton-km	77,386	91,956	105,025	100,486	77,702	20,002	92,500
Passenger	000’persons	429	335	223	94	82	48	11
	000’person-km	50,209	45,419	32,415	13,450	10,378	5,173	5,173
Equipment	tons	415	3,283	1,806	713	523	350	73
	000’tons-km	573	461.4	281	109	83	66	17

Sources: CNMC (2003) and MPWT (2007)

1.13.2 Water Transport

For both marine and river transports play significant roles in linking Cambodia's economy to international markets. Sihanoukville, the country's only deep sea port, had seen its quantities of cargoes, containers and vessels steadily increased since 1996. Some 3.9 million tons of cargo was handled through the port by 2010, up from 1.6 million tons in 1999. The Open Sea Strategy at the Sihanouk Ville Port, a 400-meters expansion of container terminal with 135 9-meters-deep vessels/month completed. This terminal has a maximum container storage capacity of 7,900 TEUs (Twenty Equivalent Units) at a time or 340,000 TEUs/year; an average lifting capacity of 25 Containers per hour per derrick. In 2008, the total quantity of cargo in transit was 2,057,967 tons, and 258,000 TEUs of containers; compared to a cargo of 1,818,877 Tons and 253,271 TEUs of containers in 2007 (RGC, 2010). NSDP Update (2009-2013) indicated that the cargo quantities: 12,141,414 tons, which is an increase by 49.57% compared to 8,117,654 tons in the previous 5 years. Container throughputs: 1,189,108 TEUs, which is an increase by 3.77% compared to 1,145,868 TEUs in the previous 5 years (RGC, 2014).

The Bassac, Mekong, and Tonle Sap Rivers, the port of Phnom Penh occupies a central position in river transport. The throughput of the port peaked in 1997 at 658,000 tons (75% of which was imported fuel). A total of 1,543 vessels called at Phnom Penh Port in 2008, compared to 1,398 vessels in 2007. Total quantity of cargo in transit through the port in 2008 was 1,240,339 tons, increasing 12% compared to 1,106,701 tons in 2007. The number of containers transiting the port in 2008 was 47,507 TEUs, with a very small increase compared to 47,504 TEUs in 2007. Number of passenger vessels in 2008 was 1,878, showing a decrease of 3% comparing from 1,931 in 2007. In 2016, Cambodia’s deep water Port located in Bay of Kampong Som on the Gulf of Thailand operated and governed by the Sihanoukville Autonomous Port (PAS) had 12 berths equipped with cargo handling facilities and managed 35 % of Cambodia's total trade volume (UNOCD, 2016).

1.13.3 Air Transport

Cambodia's open sky policy has resulted in a substantial increase in air travel in the last decades. The progress of air transport services has significantly contributed to the development of the tourism sector and the growth of economy. The country has two international airports: one in Phnom Penh and one in Siem Reap, gateway to the temples of Angkor, the country's primary tourist destination.

Phnom Penh International Airport: Airport transport has been remarkably progressing, which can be noticed by the increase in the international airlines operating their regular flights to Cambodia (18 airlines). Airport infrastructure: total size of boarding lounge for the international terminal is 16,000 sqm (on-going expansion by 850 sqm). The terminal can handle 2 million passengers (2,077,282 both international and domestic passengers in 2012). While the domestic

terminal is 3,670 sqm. Air traffic control has also been steadily improved and strengthened. Air Navigation System has been implemented since July 2013 (RGC, 2014).

Siem Reap International Airport: Airport transport of 17 airlines have been operating regular flights. The boarding lounge for both terminals (international and domestic) are 13,700 sqm (with possible extensions), which is capable of handling 1.5 million passengers (2,223,029 passengers). Air Navigation System: PBN Flight Procedure has been designed and was implemented in 2014. Visitor arrivals and departures by international to Cambodia increased from 1,442,188 in 2004 to 4,311,549 in 2013, and by domestic increased from 191,584 in 2004 to 296,413 in 2013 (NIS, 2005 and SSCA, 2014). The number of Flight, Passenger and Cargo in 2004 and 2013-2016 shows in Table 1.17.

Table 1:17: Members of Flight, Passenger and Cargo in 2004 and 2013-2016

Type	Indicator	Unit	2004	2013	2014	2015	2016
International	Flight	Number	2,132	44,260	8,686	53,555	8,910
Domestic	Flight	Number	5,869	9,400	0,340	1,374	12,512
International	Passengers	Pax	1,442,188	4,311,549	4,742,704	5,216,974	5,738,671
Domestic	Passengers	Pax	191,584	296,413	326,054	358,659	394,525
International	Cargo	Ton	17,790	31,977	35,175	38,693	42,562
Domestic	Cargo	Ton	12	516	568	625	687

Source: NIS (2005); SSCA (2014); RGC (2014); UNOCD (2016)

1.13.4 GMS Cross Border Transport Agreement

The Greater Mekong Sub-Region-Cross Border Transport Agreement (GMS-CBTA), including its 20 Annexes and Protocols, is now affected. The RGC has ratified and adopted 3 Protocols and 17 Annexes. To implement this agreement, the RGC entered into bi-lateral MOUs on Initial Implementation of GMS-CBTA with Thailand and Viet Nam. Bilateral Road Transport Agreement (BRTA) Cambodia-Lao PDR.

1.14 Tourism

Tourism in Cambodia is a ‘cultural and natural tourism that has actively contributed to the development, protection and conservation of cultural and historical heritage and natural resources and the sustainable utilisation of these potentials. To a lesser extent, nature-based tourism is the main attraction for international visitors. The leading tourist destination consists of the temples of Angkor, a World Heritage site, built between the 9th and 15th centuries, covering an area of 400 km^2.

Tourism is one of the priority sectors of the RGC, which has been contributing to the economic and social development, job opportunity creation and income generation, improving living conditions and poverty reduction of Cambodian people, in particular to reducing climate change and promotion of green economic development.

Visitors arrived by air travelled from other ASEAN countries (10%), other Asian countries (20%), Europe (12%), and the Americas (9%). The tourism sector experienced a growth rate of over 20% per year between 2003 and 2007, and 5.5% in 2008 (RGC, 2010). The number of tourist arrivals declined in 2009 but increased to 3.58 million, of which 2.71 million from Asia in 2012. In this regard, Vietnam was ranked the first followed by Korea, China, Japan, and Lao PDR. Tourists from both Europe and America showed an increase of 12-13% during period 2011-2012. Tourism data indicated that number of international visitor arrivals sharply increased by 43.0% in last 5 years, namely 2.01 million in 2007 to 2.44 million in 2011 (CDC, 2013). As the number of tourists

increased, the hotel occupancy also was improved from 54.8% in 2007 to 66.2% in 2011. Visitors arrived in Cambodia increased from 3.01 million to 5.65 million in 2016. However, the local visitors are the large number to be taken into account against foreign visitors, the local visitors were from 6.73 million in 2008 to 9.30 million in 2016, respectively, as shown in Figure 1.15 below. Tourism is the fastest-growing sub-sector in services and accounted for 11.8% of GDP in 2004. International visitors arrivals in Cambodia have grown from about 118,000 in 1993 to more than a million people in 2004, at an average growth rate of 24%. Tourism expenditures have similarly increased from an estimated US$ 100 million in 1995 to US$ 578 million in 2004 (MoT, 2007). Consequently, the amount that tourism sector generated has also increased from US$ 1,403 million in 2007 to US$ 1,766 million in 2011 and still growing, accounting for US$ 3,359 million in 2016 from tourism directly and helped earn more than US$ 3 billion through indirect impact. At the same time, however, it is believed that Cambodia approximately lost 25% in revenues from tourism, primarily through the import of foreign goods to boost domestic supplies including vegetables, fruits, fish, furniture, and labours. It is noted that in 2012, tourism sector created around 320,000 to 500,000 direct jobs in 2016 and several thousand indirect jobs. Figure 1.15 illustrates Cambodia's tourism of foreign and domestic visitors (2008-2016), while Table 1.18 expresses tourism in Cambodia.

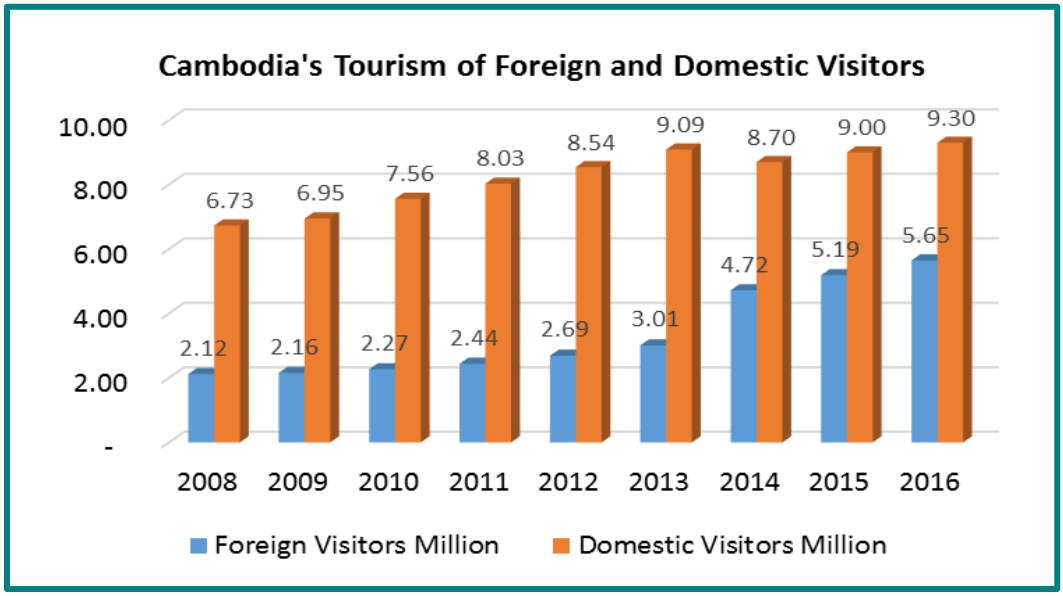


Figure 1.15: Cambodia's Tourism of Foreign and Domestic Visitors (2008-2016)
Source: RGC (2010 and 2014)

Table 1:18: Tourism in Cambodia

Foreign Visitor	Million	2.12	2.16	2.27	2.44	2.69	3.01	4.72	5.19	5.65
Domestic Visitors	Million	6.73	6.95	7.56	8.03	8.54	9.09	8.7	9	9.3
Accommodations (Hotels & Guest Houses)	1000, Room	32.85	37.19	40.91	44.18	47.27	50.11	50.32	53.85	57.62
Employment in Tourism Sector	1000	300	305	315	317	320	330	425	455	500
Incomes from Tourism	Million US$	1,595	1,617	1,682	1,766	1,872	2,022	2,802	3,054	3,359

Source: RGC (2010 and 2014)

1.15 Water Resource

1.15.1 Water Resource and Irrigation System Management

The rehabilitation and construction of irrigation infrastructure have been conducted to expand the irrigation system's capacity and to protect against natural disasters and climate hazards (floods and drought) that are becoming more unpredictable climate change (MoWRAM, 2003 and 2010). By

the end of 2008, the capacity of the irrigation systems increased to provide water for 827,373 ha of the agricultural land. This represented 31.6% of the total cultivated land, accounting for 2,615,741 ha, and could provide water for rice crops totalling 582,085 ha of land in the rainy season, and 245,288 ha of land in dry season. The increasing occurrence and severity of floods exacerbated by climate change resulted in high costs for the maintenance and upgrading of roads and irrigation infrastructure, typically in urban areas where more assets and populations are concentrated (Heng, C. T., 2015; CCAI, 2016, and RGC, 2014).

The installation of 12 pumping stations and repairing one pumping station could rescue paddy rice of 305,225 ha for drought, 137,122 ha in dry season and 168,103 ha for the rainy season (RGC, 2010; MoWRAM, 2010). There are 350 Farmer Water Users Communities (FWUC), involving 305,550 famer households. The RGC has rehabilitated existing irrigation systems, constructed new ones, and taken other measures to maximize the full potential of irrigation systems (RGC, 2014). The RGC has also established water-user communities with increased participation from farmers in order to implement priority policies through the MoWRAM, focusing on the 5 strategies of water resources management and development of irrigation systems; flood and drought management; enactment of laws and regulations related to water; water resources and meteorological information management; and administration and human resource development.

The RGC will continue to fully cooperate with other Mekong Member Countries under the MRC Framework to ensure the Sustainable of the Mekong River Basin and has committed to full self-financing by 2030 for which each Government is fully responsible. Cambodia National Mekong Committee (CNMC) is an inter-ministerial committee responsible to ensure effective coordination among 17-member line ministries in implementing all related programs and activities at regional and national levels under the framework of the Mekong River Commission (MRC). The MRC Strategic Plan, Integrated Water Resources Management (IWRM) Principles, and MRC IWRM-based Basin Development Strategy have been developed and updated for implementation. The CNMC with full cooperation and coordination of its members of key line agencies have been actively implementing the MRC IWRM-based Basin Development Strategy and related programmes such as Basin Development Plan; Fisheries; Irrigated Agriculture; Sustainable Hydropower; Flood Management; Drought Management; Climate Change adaptation; Mekong IWRM; Information and Knowledge Management; and Integrated Capacity Building, to serve national and regional interests.

1.15.2 Water Supply for Drinking

Around 51% of the population living in all urban centers has access to safe drinking. The Water Supply Authorities (WSA) of these urban centers increased their supply capacity based on people's actual needs. Drinking water supply capacity has increased significantly over the last decades. In 2009, around 90% of Phnom Penh's population had access to safe drinking water. 17,590 poor households, many female-headed households, received support through a policy of subsidised charges for water use based on their income (RGC, 2010 and 2014). From 2008 to 2012, the coverage rate of piped water supply in urban areas increased from 52% in 2008 to 68.5% in 2012, except Phnom Penh, which had a coverage rate of 85% in 2012. Over the same period, the number of urban households having access to safe water supply increased from 269,755 to 400,181. In 2020, 21% of the population cannot get safe drinking water in under a 30-minute roundtrip. In total, 3.4 million people are still in need of basic access to safe water in Cambodia. Further expansion of the coverage of clean water supply to the rural and urban areas is conducted through the rigorous implementation of the National Strategy for Rural Water Supply and Sanitation (NSRWSS) (2011-2025).

1.16 Education

The high priority of the RGC to strengthen the quality of education has been remaining. It is recognised as a necessary and critical element for human development and poverty reduction. The RGC has made significant progress in implementing the "Education for All" strategy by ensuring equity of access to and the basic nine years education for most Cambodian children. To effectively tackle the enormous challenges in the education sector, and to encourage in building partnerships to carryout joint planning and programming for the education sector. The first Education Strategic Plan (ESP) (2001-2005) developed to further strengthen the quality of education and to increase the recurrent expenditure allocations for the education sector in the National Budget allocated resources, which have risen from 183.2 billion CR (US$ 44.68 million) in 2000 to 742.5 billion CR (US$ 181.09 million) in 2009 (RGC, 2010).

The ESP (2009-2013) was update to ensure the harmonisation of the education sector plan with the mandate of the Legislature and focused on achieving the goals and policies of the RGC for the education sector. In addition, the RGC paid attention to improve the quality of education by providing incentives to teachers; improving curriculum; encouraging outstanding students; training teachers and upgrading teaching methodologies; improving class room conditions and learning materials; and, establishing libraries and laboratories. In order to ensure equitable opportunity, establish dormitories for students, especially female students; build schools for all levels, particularly in rural and remote areas; and increase scholarships for poor students.

Additionally, the ESP (2014-2018) further redesigned to demonstrate a logical relationship between the strategic framework, programs, activities and both human and financial resources. The ministry continued to give a high priority to equitable access for high quality basic education services and it focused on the expansion of Early Childhood Education (ECE), expanding access to quality secondary and post-secondary education and Non-Formal Education, and Technical and Vocational Education. Also, a specific measure was taken to assure the education for marginalized children and youth.

1.16.1 Number of Schools

The MoEYS dynamically increased the number of primary, lower secondary, and upper secondary schools from 8,628 in School Year 2005/06 to 9,834 in the School Year 2008/09. The increases from 2005/06 to 2008/09 are pre-schools from 1,429 to 1,798; primary schools from 6,277 to 6,565; lower secondary schools from 911 to 1,451; and secondary schools from 252 to 349 (MoEYS, 2009). In order to reduce gaps in accessibility to education services for children from indigent households in remote areas, more primary schools were built. In 2015 the number of schools reached 7,073 primary schools; however, 40.9% of primary schools and 53.7% of secondary schools do not have water even there are little differences between the urban and rural schools (MoEYS, 2017).

1.16.2 Number of Teaching Staff

With to the increase of schools, the MoEYS increased the number of teaching staff from 78,606 in 2005/06 to 81,350 in 2008/09 mainly at the secondary level. The number of staff teaching as pre-school teachers increased from 2,708 to 3,092; primary school teachers decreased from 50,378 to 45,511; lower secondary school teachers increased from 18,579 to 23,576; and upper secondary school teachers increased from 6,941 to 9,171. The percentage of female teachers at primary level reached 44.8% of the total in 2008/09. The MoEYS recruited 5,000 new teachers annually in the recent years. In 2015, there were a total of 88,818 teaching staff, of whom 51% were primary

school teachers, 31% were lower secondary school teachers, 13% upper secondary school teachers, and 5% kindergarten teachers (UNESCO, 2015).

1.16.3Number of Students

Total enrolment in primary and secondary public schools decreased from 3,427,394 in 2005/06 to 3,251,000 in 2008/09. This is mainly because of the decrease in primary schools from 2,558,467 to 2,262,834 due to the decrease of school age populations. Lower secondary schools increased from 588,333 to 605,707. The increase in upper secondary school enrolment was from 204,925 to 292,423. However, as a result of efforts, the enrolment rates at the primary, lower secondary and upper secondary levels have improved significantly. At the primary level the net enrolment rate increased from 91.3% in 2005/06 to 94.4% in 2008/09, at the lower secondary school level from 31.3% to 34.0%, and at the upper secondary school level from 11.3% to 16.4%.

During 2009 to 2013, the net enrolment rate of primary education (Grades 1-6) increased from 94.4% in School Year (SY) 2008-2009, 97% in 2012-2013, with a completion rate of 87.3%. During this plan period the number of primary schools increased by 345 to 6,910. The gross enrolment rate at the lower secondary education (Grades 7-9) was 53.6% in 2012-2013 and completion rate 42.1%. During this plan period, the number of secondary schools increased by 92 to 1,214; of these 84.2% have toilets and 51.6% have clean water. The gross enrolment rate at upper secondary school in 2012-2013 was 27.4%, and the completion rate 27.8%. During this plan period, the number of upper secondary schools increased by 84 to 433. The literacy rate among youth aged 15-24 years rose to 91.5% in 2011, an increase of four percentage points compared to 2008. In addition, 2014-2016, the number of primary schools increased from 6,915 to 7,073 with the enrolment 97.3% to 98.6% respectively. Table 1.19 presents the education in Cambodia from 2008 to 2016.

Table 1:19: Education in Cambodia

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: RGC (2010 and 2014); MoEYS (2010 and 2014)

1.16.4Literacy Rates

Literacy rates among populations in the age-group 15-24 years, suggest there have been substantial improvement since 2008/09. However, in the later years (2009 to 2016), progress appears irregular a point-to-point comparison between 2008/09 and 2009/10, and a comparison between 2010, 2011, 2011, 2012, 2013, 2014, 2015, and 2016 would the best results. Nevertheless, the rate of increase in literacy is about 0.5% to 1.5%. Figure 1.16 illustrates literacy rates among population between 15 and 24 years below.

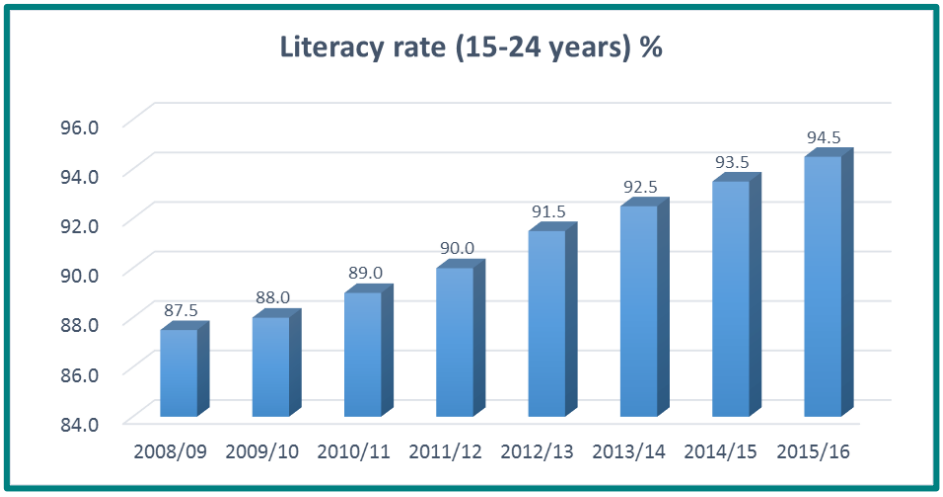


Figure1.16: Literacy Rates among Population between Age 15 and 24 Years

1.17 Gender

1.17.1 Gender in Economic Employment

Gender was mainstreamed in the NSDPs (2009-2013) and (2014-2018) that have been strongly focusing on promoting gender equality at all sectors and levels. The number of monitoring indicators on M&E are now gender-sensitive. The RGC has made regular efforts to provide economic opportunities for women to generate incomes for their families. Participatory female workers in the workforce in the capacity of wage/ salary-workers is a positive signal towards gender equality. Based on CSESs of 2009, 2010, and 2011, suggest that this ratio have stood between 42-45%, lower than the 50% mark in those years. In the agricultural and industrial sectors, the targets have been achieved or exceeded, though in the service sector, this proportion remains low (RGC, 2010).

1.17.2 Legal Protection for Women

Domestic violence cases decreased from 41,474 in 2006 to 35,408 in 2009 (MoWA, 2010 and MoP, 2014). In accordance with Article 14 of the Law on Prevention of Domestic Violence and Protection of Victims, local authorities issued 13,053 Administrative Decisions in 2009 and 11,136 in 2010. While, Article 20 stated that courts shall issue protection orders to victims on request. It was reported that in 2014, over 30% of Cambodian women had experienced physical, sexual, emotional or economic intimate partner violence experience in her lifetime (UNICEF, UNFPA, and UN Women, 2020).

1.17.3 Women in Decision-Making

The RGC is advocating with political parties to increase female representation in the parliament as proportion of female members in the Senate remained stable, standing at 14.75% between 1999 and 2012. The number of women in the National Assembly has continuously increased over the past four legislatures. In 1993, female lawmakers constituted only 5% of the total. This rose to 19% in 2003 and 20.3% in 2013. The proportion of female members in the Senate remained stable at 14.75% between 1999 and 2012 with the target of 30% in each case is yet to be achieved.

As in early 2013, there was 1 female deputy prime minister, 3 female ministers, 38 female secretaries of state and 48 female under-secretaries of state or holders of equivalent ranks. The Government looks forward to increased participation of women in positions of decision-making

in the new government in 2013 and beyond (MoP, 2014). The RGC issued a guideline to all ministries and institutions in 2007, advising them to increase the proportion of women in the new recruits from 20% to 50%. The numbers of female civil servants increased from 32% in 2007 to 35% in 2012. In addition, the RGC issued a Royal Decree on Revision of Retirement Age of Female Civil Servants by increasing women's retirement age to 60 years, and on voluntarily basis. As of 2013, the proportion of female deputy governors of capital/provinces was 21%. There was 2 female governor of cities, districts/khans and 186 deputy governors of cities, districts/khans (29%). The proportion of female members of communes/sangkats also increased from 15% in 2007 to 18% in 2012 (MoP, 2014).

1.18 Waste

1.18.1 Environmental Quality Management

The MoE has undertaken measures to strengthen waste management at source and at final dumpsites to control environmental pollution. The MoE has also encouraged urban waste recycling and has tried to coordinate large-scale investments in waste management. Additionally, the ministry strengthened the sewage management systems at the sub-national levels, by setting up wastewater treatment plants in the provinces of Battambang, Preah Sihanouk, Siem Reap, the coastal provinces, and provinces surrounding the Tonle Sap Lake. The MoE has improved its surveillance on major pollution sources, e.g. factories and large enterprises, by encouraging installation of liquid waste treatment plants at source, air purification devices before emission, and noise reduction equipment.

The environmental management approaches to monitor air pollution and disturbance by noise and vibration; to look into possibilities of monitoring air pollution in the capital and provinces; to monitor hazardous wastes management; and to strengthen the quality, capacity of laboratories and provincial environment officials, and to promote public awareness on environmental pollution and public health.

1.18.2 Solid Waste

Cambodia has limited resources and capacity for waste management as the composition of solid waste, in particular in urban centres, has gradually changed from a large proportion of biodegradable and organic waste to non-degradable. The annual amount of municipal solid waste (MSW) as a large quantity of generated solid waste in the municipality of Phnom Penh increased significantly for the last few decades, from 0.136 million tons in 1995 to 0.361 million tons in 2008, and reached it was estimated to reach 0.635 million tons in 2015 (JICA, 2005). There are about 60 dumpsites and an engineered landfill across the country. The amount of waste generation at the national level was estimated by the MoE at approximately 318kg/cap/year or 4.96 million tons per year in total in 2012 (MoE, 2013). In 2013, landfills of Cambodia was 76 landfills/dumpsites as mostly open pits and open burning of Phnom Penh, Siem Reap, Sihanoukville, Kampong Cham, Battambang, and Kampot. The quantity of solid waste generating was estimated of 2,672,019 ton/year with collection rate of whole country 37%, however, accounted for 500 ton per day for Phnom Penh (Sam, 2016). Figure 1.17 shows Municipal solid waste disposal at landfills from 2004 to 2016.

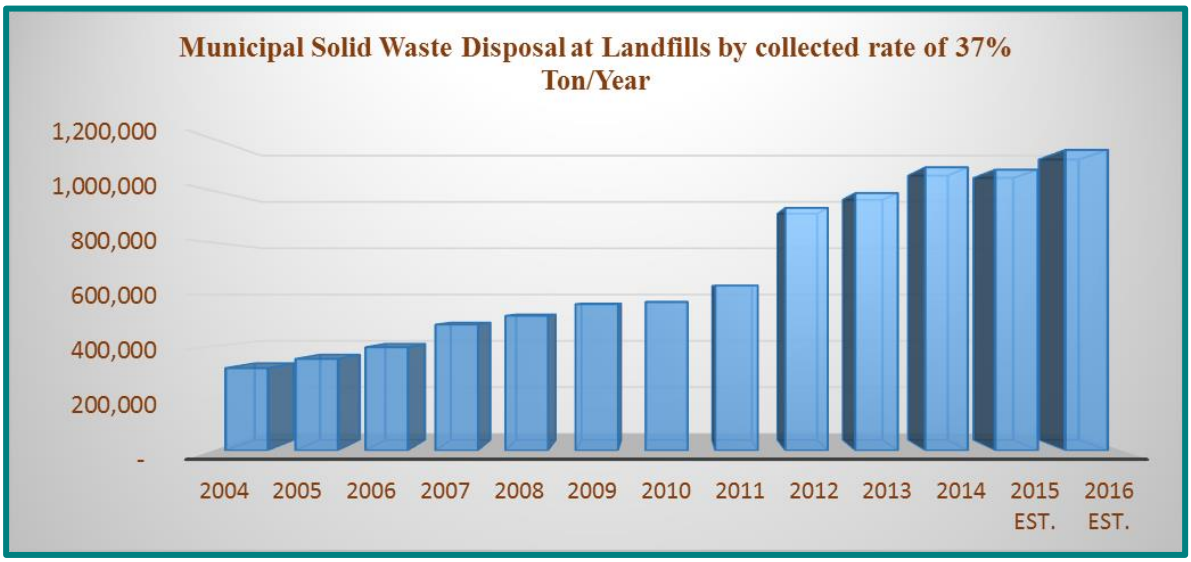


Figure1.17: Municipal Solid Waste Disposal at Landfills (2004-2016)

1.18.3 Wastewater

Sewage system plays a common role to collect together domestic wastewater, rainwater including treated industrial effluents prior to run-off to wetlands and/or receiving sources. Domestic wastewater and urban sewage are commonly collected by sewerage system and run off to drainage and retention pond/lake or wetland afterward for self-purification through natural treatment process, and finally runs off to the main watercourse. Wastewater treatment process is to stabilize pond system of anaerobic pond, facultative pond, and maturation pond, it is designed for Biochemical Oxygen Demand (BOD) removal rate of 95%, Coliform removal rate of 99%, and Temperature of 24˚C (Chrin, 2013). The MoE (2004) estimated that 20% of the total daily vegetable consumption of Phnom Penh comes from Boeung Cheung Ek Lake and two smaller wetlands within the city by wetlands into which over 1 million m^3 of the city's household wastewater is discharged daily. There is limited wastewater treatment in Cambodia. Wastewater is usually left to oxidize in large holding ponds or lakes, or directly flushed into waterways. About 9% of Cambodian households are connected to sewage, while 78% do not have access to any form of toilet facilities (CIPS, 2004). The lake receives about 80% of the waste/sewage water from the city along with the untreated effluent of 3,000 small and large scale industrial enterprises. Despite existing regulations mandating treatment prior to discharge, industrial wastewater is similarly released into public water bodies (MoE, 2005).The lake is an effective, low cost means of biological treatment of the city's waste water through its aquatic vegetable production, capturing and reutilizing valuable nutrients which otherwise would have been lost from the discharged urban wastewater.

As for water pollution control, the MoE has monitored the quality of public water in rivers, streams, lakes, and public sewers, look into possibilities to expand the monitoring of public water quality, and monitor pollution caused by wastewater from factories and enterprises (RGC, 2010).

1.19 Institutional Arrangements

1.19.1 Climate Change Institutional Framework

In 2006, the RGC established the National Climate Change Committee (NCCC), a cross-sectoral and multi-disciplinary body to prepare, coordinate and monitor the implementation of policies, strategies, legal instruments, plans, and programmes related to climate change. The Climate Change Technical Team (CCTT) was established as an inter-ministerial body to provide technical

support to the NCCC in fulfilling its mandate. The Department of Climate Change (DCC) serves as the Secretariat for the NCCC and coordinates the activities of the CCTT (RGC, 2013).

In 2015, the NCCC was reformed and its function were taken over by the National Council for Sustainable Development (NCSD). The Council comprises high-level representatives (Secretaries and Under-Secretaries of State) of concerned government ministries and agencies, with the Prime Minister as its Honorary Chair and the Minister of Environment as its Chair. Council membership has increased compared to the NCCC, covering many ministries and agencies, including provincial governors. The CCTT was modified as the Climate Change Technical Working Group (CCTWG) with mandate and priority programme to support the NCSD for strengthening Cambodia's capacity to respond to climate change. The CCTWG's members are the representatives from line ministries who act as technical focal points to facilitate the review, formulation, and implementation of policies, strategies, action plans, and programs to enhance climate change response. Figure 1.18 depicts the institutional framework of the NCSD.

The NCSD has made efforts to improve the coordination of climate change activities in Cambodia and to promote a stronger, comprehensive and effective climate change response, including the preparation of the Cambodian Climate Change Strategic Plan (CCCSP) 2014-2023, the Sectoral Climate Change Action Plans, and the Climate Change Financing Framework.

The mandate of the DCC is to undertake technical activities for implementing the UNFCCC, liaison with other agencies and enhancing cooperation to promote the implementation of climate change policies, advising the government in the field of climate change, as well as other tasks such as public awareness, data management, and promoting research and capacity building. Figure 1.19 describes institutional framework for the DCC.

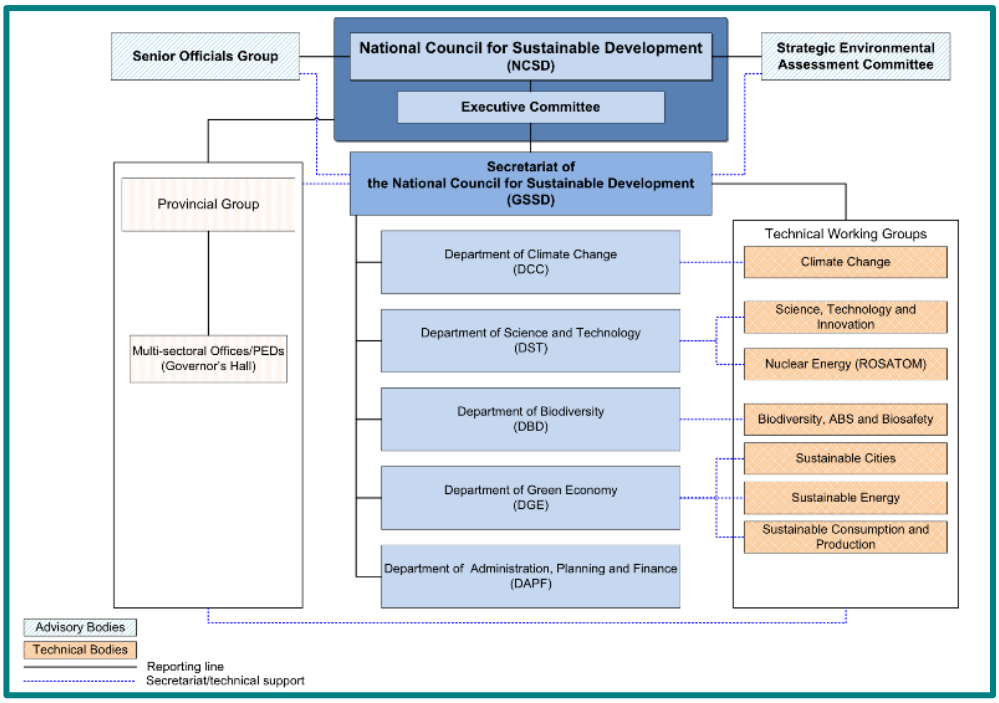


Figure1.18: Institutional Framework of the National Council for Sustainable Development

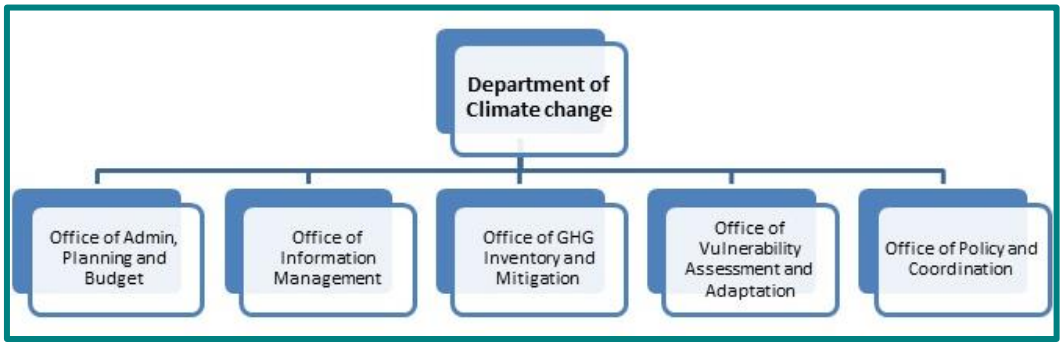


Figure1.19: Institutional Framework for the Department of Climate Change

1.19.2 Obligations under UNFCCC, Kyoto Protocol, and Paris Agreement

Cambodia has obligations as a signatory party of the UN Climate Change Convention, Protocol, and Agreement. Under Articles 4 and 12 of the UNFCCC, Cambodia shall report her emissions by sources and removals by sinks of GHG inventory, national mitigation and adaptation measures, and any other relevant achievement towards the objective of the Convention. Under the Kyoto Protocol, Cambodia shall set up institutional arrangements for the national approval of Clean Development Mechanism (CDM) activities. The NCSD were explicitly established with the primary roles and responsibilities of assisting the RGC in dealing with national climate change issues and in assisting Cambodia in fulfilling its international obligations. The formulation of national communications under the UNFCCC falls under the purview of the NCSD. It provides the basis for institutional continuity at both the policy-making and technical levels, across a comprehensive range of government stakeholders. In addition, the DCC acts as the Secretariat of Cambodia's Designated National Authority (DNA) for the CDM and National Designed Authority (NDA) for the Green Climate Fund (GCF). The Initial Nationally Determined Contribution

Box 1.2: The NCSD has the General Secretariat of the NCSD as its secretariat, which bases in the MoE. The NCSD has roles and responsibilities as followings:

- Formulating, directing, and evaluating policies, strategic plans, action plans, legal instruments, programmes and projects related to sustainable development;
- Promoting the mainstreaming of sustainable development into relevant policies, legal instruments, strategic plans, action plans, programs and projects in collaboration with relevant line ministries and agencies;
- Mobilizing resources for the implementation of policies, legal instruments, strategic plans, action plans, programmes and projects related to sustainable development;
- Establishing and fostering partnerships with development partners, private sector, academia, and other relevant stakeholders aimed at supporting sustainable development;
- Encouraging and promoting research study, education, training, exchange of technologies and dissemination relevant to sustainable development;
- Proposing national positions and strategies for participating in international agreements, meetings and negotiations relevant to sustainable development;
- Reviewing and giving approval on national communications under the multilateral environmental agreements to which Cambodia is a party;
- Managing government information and communications relevant to sustainable development;
- Leading, managing and facilitating the works related to green economy, climate change, biodiversity conservation and biosafety; and
- Implementing any other duties assigned to it by the RGC.

(INDC) was submitted in 2015, indicating the possible emission reductions of around 27%, excluding AFOLU sector by 2030 from the BaU level.

Cambodia signed the Paris Agreement on Climate Change on 22th April 2016 at the UN Headquarters in New York and ratified on 6th February 2017 (come into force on 8th March 2017). The country is expected, among other benefits of Greater financial support, technology transfer, and capacity building to respond to climate change and disasters; participation in a new carbon pricing mechanism; and reduction of the country's adaptation costs in the long-term. Cambodia submitted her first BUR and updated NDC in 2020 and Long-Term Strategy for Carbon Neutrality (LTS4CN) to the UNFCCC in 2021.

1.19.3 Constraints and Policy Implications

Limited technical, human, and financial resources bring major constraints to the preparation of national communications and other relevant reports on a continuous basis. While the NCSD is permanent institutions, its mandates extend beyond national communications, and include the facilitation, coordination, and implementation of mitigation and adaptation measures. In line with national development priorities, government funding is likely to continue focusing on adaptation to climate change, poverty reduction, and other measures with immediate social impacts. Thus, full cost funding of national communications will remain necessary in the foreseeable future to assist Cambodia in fulfilling her reporting obligations.

1.20 Cambodia at a Glance

Table 1:20: Cambodia General Information on National Circumstances

Criteria	Unit	2000	2005	2010	2015
Area	Km^2	181,035	181,035	181,035	181,035
Population	Million	12.6	13.8	14.3	15.4
Urban Population	%	16	15	19.5 (2008)	21.6
Rural Population	%	84	85	80.5 (2008)	78.4
Annual Average Growth Rate	%	1.8	2.06	1.54	1.46
National Average Population Density	$Person/km^2$	70	75	83	87
Population Below Poverty Line	%	-	34.7 (2004)	13	<5
Life Expectancy	Years	M: 54; F: 58	M: 61; F: 65	M: 61.4; F: 67.7	M: 67.5; F: 71.4
Literacy Rate	%	68.9 (CSES 1999)	73.6 (2004)	89	94.5
Share of GDP by Economic Activity:					
GDP per Capita	US$	288	468	792	1,237
Share of Agriculture in GDP	%	35.9	30.9 (2004)	27.8	25.1
Share of Industry in GDP	%	21.8	28.9 (2004)	34.5	33.2
Share of Services in GDP	%	37.1	34.4 (2004)	37.7	41.7
Agriculture Activity:					
Cultivated Area for Short Term Food Crop	000 ha	2,413.70	2,468.2 (2004)	774	1,874
Cultivated Area for Wet Season Rice	000 ha	2,060.60	1,816	2,291	2,538
Cultivated Area for Dry Season Rice	000 ha	262.3	293	384	487
National Average Paddy Rice Yield	Tonne/ha	1.9	2.35	2.97	3.18
Wet Season Paddy Rice Yield	Tonne/ha	1.81	1.17	2.23	2.44
Dry Season Paddy Rice Yield	Tonne/ha	3	3.54	3.72	3.93
Livestock:					
Non-Dairy Cattle "Cow"	000 heads	2,992.70	3,039.9 (2004)	3,768 (2009)	2,478 (2014)
- Buffalo	000 heads	693.7	710.1 (2004)	711 (2009)	452 (2014)
- Swine	000 heads	1,838.30	2,428.6 (2004)	1,860 (2009)	1,376 (2014)
- Poultry	000 heads	15,249.80	12,990.6 (2004)	32,497 (2009)	29,231 (2014)
Forest Coverage of Total Land Area	%	58	59.09	57.07	59.19 (2013)

2 National Greenhouse Gas Inventory

2.1 Inventory Reporting

Cambodia's GHG inventory was compiled and submitted in agreement with Article 4.1(a) of the Convention in accord with Article 12: national inventories of anthropogenic emissions by sources and removal by sinks of all GHG not controlled by the Montreal Protocol. This inventory report presented Cambodia's national GHG emissions by sources and GHG removal by sinks for 2005 and 2010. The Energy, IPPU, AFOLU, and Waste sectors emissions are reported. The GHG emissions estimated in this report include direct emissions (CO_2, CH_4, and N_2O). Due to limited data, other gases (NOx, CO, NMVOCs, and SO_2) are not reported.

The inventory has been developed following 2006 IPCC Methodology Guidelines. The Global Warming Potentials (GWPs) used are those of the Fourth Assessment Report (AR4) of the IPCC, based on the effects of GHGs over a 100-year time horizon. These GWPs were selected for two reasons: first, these were the ones used for the Cambodia NDC; and second, to allow for comparison with the GHG inventories of developing countries.

Due to a lack of information on their occurrence, the emissions of Perfluorocarbons (PFC), Sulphur Hexafluoride (SF_6) and Nitrogen Trifluoride (NF_3) have not been estimated. Gases considered ozone precursors: carbon monoxide (CO), Oxides of Nitrogen (NOx), Non-Methane Volatile Organic Compounds (NMVOCs), and Sulphur Dioxide (SO_2), have been estimated when the required data was available. For estimating the emissions of precursors, the Guidelines of EMEP/EEA 2016 have been used, as proposed by the IPCC.

2.2 Inventory Process

The MoE is the focal point to the UNFCCC. In the fifth mandate of the RGC, the MoE was officially reformed to strengthen natural resource management and to ensure environmental quality management in the context of sustainable development. The DCC was responsible for coordinating, managing, and leading the preparation the TNC.

National and international consultants were recruited to assist in the preparation of report based their respective expertise. Relevant line ministries and stakeholders were identified to facilitate and coordinate during the preparation process.

2.3 Methodology of Calculation of GHG Emissions and Removals

This inventory report was prepared to the extent of the country's capabilities, using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and Good Practices Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). Inventory was compiled using the IPCC inventory software (Ver. 2.691). Due to the unavailability of country-specific emission factors, Tier 1 approach, which is based on default emission factors were used to assess emissions attributed to all the sectors. Emissions are expressed in CO_2e using GWP published in the IPCC's AR4. Activity data were collected from national institutions and international publications and other relevant, accessible, and reliable sources.

2.4 Trends in Emissions

The results of assessment show that Cambodia's GHG emissions in 2005 and 2010 were 39,148.29 and 43,643.98 $GgCO_2e$ (with the FOLU sector). This indicates a drastic emissions reductions in 2005 compared to previous years. However, a trend of increment can again observe in the 2005-2010 period.

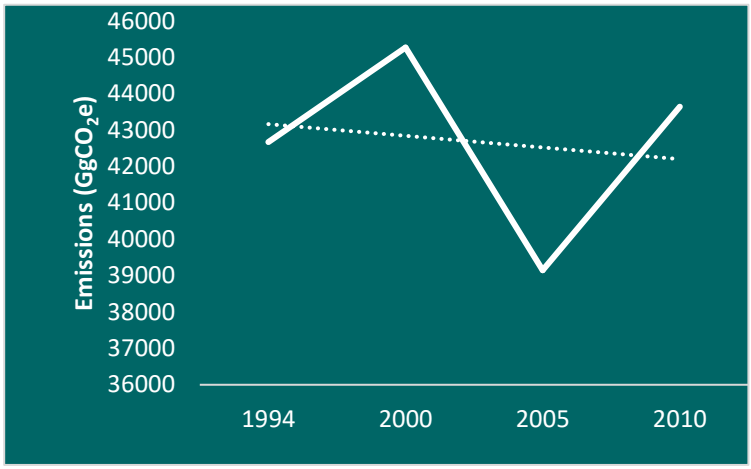


Figure 2.1: National inventory trend (1994-2010) for aggregated GHG emissions (including FOLU)

The major contributor to the GHG emissions during the entire period was the FOLU sector, which is driven by the change in carbon stocks due to deforestation and other changes in land use. However, FOLU emissions indicate a drastic reduction in 2005 and 2010 compared to previous years. This was caused by the change of Tier in emissions estimation from Tier 2 to Tier 1 in the later years due to the limitations of the IPCC inventory software.

The second-largest contributor to the GHG emissions of the country was the agriculture sector, which is an indication of Cambodia's agriculture-driven economy. The main driver for incrementing GHG emissions in the agriculture sector is the development of rice cultivations. As indicated in Table 2.1, Cambodia's emissions without the FOLU sector have been recorded as 19,195.13 and 23,693.39 $GgCO_2e$ in 2005 and 2010, respectively. This indicates 23% and 51 % increments in 2005 and 2010, respectively, compared to 1994. The Comparison of re-calculated values in the First BUR of Cambodia with the INC and SNC Values shown in Appendix II.

Table 2:1: Trend of National Greenhouse Gas Emissions ($GgCO_2e$)

Categories	1994	2000	2005	2010
Energy	2,690.95	3,102.73	3,166.09	4,999.48
IPPU	3.81	6.04	13.06	503.12
Waste	1,756.18	2,111.61	1,648.17	1,863.97
Agriculture (3A+3C)	11,202.58	13,032.31	14,367.81	16,326.82
Forest and Other Land Use (FOLU) (3B +3D)	27,018.62[1]	27,018.62	19,953.16	19,950.59
Total (without FOLU)	**15,653.52**	**18,252.69**	**19,195.13**	**23,693.39**
Total (with FOLU)	**42,672.14**	**45,271.31**	**39,148.29**	**43,643.98**

[1] This only includes emissions attributed to 3B

As per the results given in Table 2.1, emissions attributed by Energy, IPPU, and Agriculture sectors have increased over the years, while the waste sector emissions declined in 2005 compared to previous years before rising again in 2010. The decline of the waste sector emissions in 2005

resulted from the reduction of emissions attributed to the Open Burning (4.C.2) category. The decline of the said category's emissions over the years resulted from the reduction of the percentage of the population who practice open burning as a waste disposal method. However, the rise of the emissions in 2010 was due to the increment of emissions attributed to other categories. The FOLU sector emissions indicate a declining trend over the years. The Energy sector emissions have increased over the years with respect to the increment of fuel usage in the country. The resumption of the cement production in Cambodia has caused the drastic increment of the IPPU sector emissions in 2010.

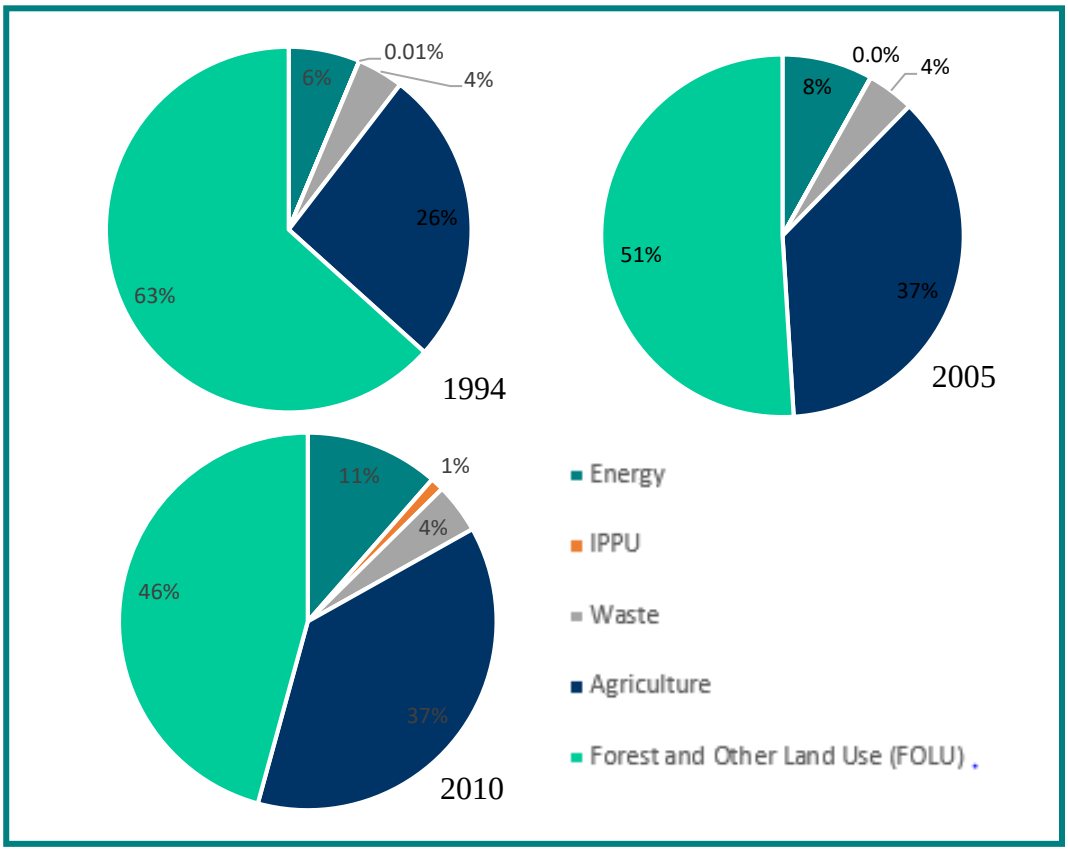


Figure 2.2: Contribution of each category to the total GHG emissions

In terms of the contribution of each GHG to total national emissions, CO_2 is the main contributor, driven by the FOLU sector to total national emissions, followed by CH_4, N_2O, and HFC. Table 2.2 indicates the contribution of each gas to the total emissions over the years.

Table 2:2: GHG Emissions by Gas with the FOLU Sector (Gg)

GHG	1994	2000	2005	2010
CO_2	29754	30102	22864.28	25164.90
CH_4	435.61	516.92	551.51	609.53
N_2O	6.8	7.54	8.35	10.48
HFC	NO	NO	6.65	118.07

NO -Not Occurring

The percentage contribution of each gas to the total emission is presented in Table 2.3. As per the given results contribution of the CO_2 to the total emissions has decreased over time, while CH_4 and N_2O contribution have increased. This is mainly due to the reduction of the FOLU sector emissions over the years.

Table 2:3: Contribution of Each Gas to National Total GHG Emissions with the FOLU (%)

GHG	1994	2000	2005	2010
CO_2	70	66	58	58
CH_4	26	29	35	35
N_2O	5	5	6	7
HFC	0	0	0	0

Figure 2.3 indicates the National Inventory trends for aggregated GHG emissions excluding FOLU. Agriculture and the Energy sector are the major contributors to the total GHG emissions in the absence of the FOLU sector.

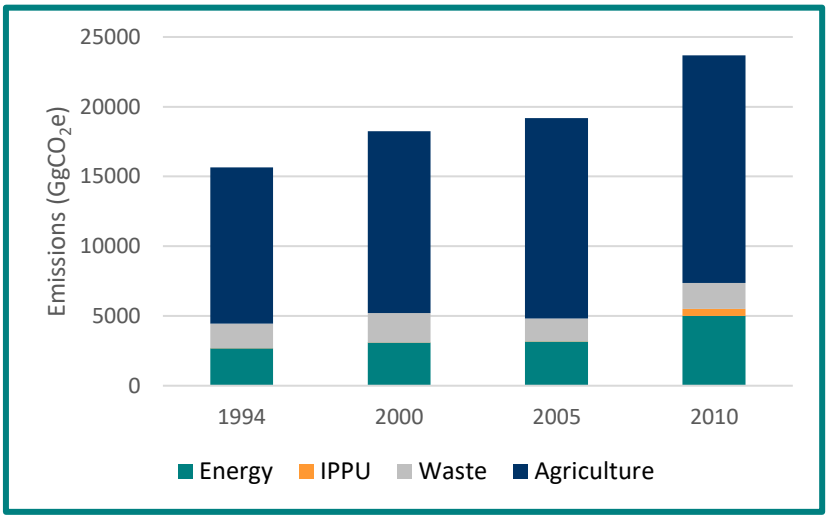


Figure 2.3: GHG emissions by categories excluding the FOLU sector

As the agriculture sector is the major contributor in the absence of the FOLU sector, the main GHG contributor to the total emission is CH_4, followed by CO_2, N_2O, and HFC.

Table 2:4: GHG Emissions by Gas without the FOLU Sector

GHG	1994	2000	2005	2010
CO_2	2735.3	3083.8	2911.12	5214.31
CH_4	435.61	516.92	551.51	609.53
N_2O	6.8	7.54	8.35	10.48
HFC	NO	NO	6.65	118.07

The percentage contribution of each gas to the total emissions (without the FOLU sector) is presented in Table 2.5. As indicated in this Table, CO_2 contribution has increased over the years, while the contribution of the CH_4 has reduced. The contribution of the N_2O remained the same.

Table 2:5: Contribution of Each Gas to National Total Emissions without the FOLU Sector (%)

GHG	1994	2000	2005	2010
CO_2	17	17	15	22
CH_4	70	71	72	64
N_2O	13	12	13	13
HFC	0	0	0	0

The GDP of Cambodia had increased substantially within the considered period, similarly the population had also increased (39%) by 2010 compared to 1994. However, Cambodia's emissions

per capita and GDP have generally declined over the last sixteen years. These declines have mainly resulted from the reduction of emissions estimation in the FOLU sector. Figures 2.4 and 2.5 illustrates the trend of per capita emissions and per GDP emissions over the years.

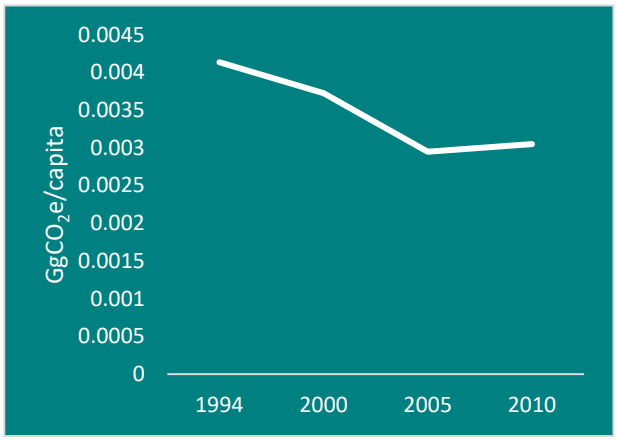


Figure 2.5: Trend of per capita emissions

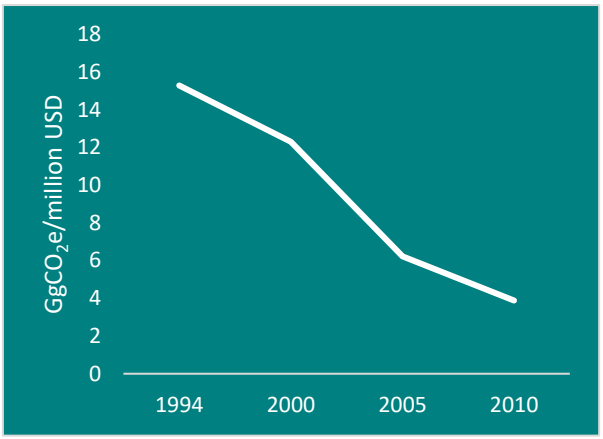


Figure 2.4: Trend of per GDP emissions

2.5 Key Category Analysis

A key source category significantly influences a country's total inventory of direct GHGs in terms of the absolute level of emissions, the trend in emissions, or both. Cambodia has identified key categories for the inventory using Approach 1 for both level and trend assessments as recommended in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and Good Practice Guidance (IPCC, 2006) and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). This chapter summarizes the key category analysis for the inventory years 2005 and 2010.

KEY CATEGORY ANALYSIS FOR THE INVENTORY YEAR 2005

When the FOLU sector is included in the assessment, it has identified that Land Converted to Other Lands, Forest Land Remaining Forest Land, and Rice Cultivation are the most significant of the key categories. (i.e., contributing more than 10% of the level or trend) in 2005. When the FOLU sector was excluded from the assessment, Rice cultivation, Enteric Fermentation, Road Transport, Incineration, and Open Burning of Waste and Solid Waste Disposal have identified as the most significant of the key categories. Table 2.6 below summarizes key categories identified by level assessment and trend assessment for the inventory year 2005.

Table 2:6: Summary of Key Category Analysis for the Inventory Year 2005

IPCC Category Code	IPCC Category	GHG	With FOLU		Without FOLU	
			LA 2005	Trend 2005	LA 2005	Trend 2005
1.A.1	Energy Industries - Liquid Fuels	CO_2		√		√
1.A.1	Energy Industries - Biomass	CH_4		√		√
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2		√	√	√
1.A.3.b	Road Transportation	CO_2	√	√	√	√
1.A.4	Other Sectors - Liquid Fuels	CO_2		√	√	√
1.A.4	Other Sectors - Biomass	CH_4			√	
3.A.1	Enteric Fermentation	CH_4	√	√	√	√
3.A.2	Manure Management	N_2O	√	√	√	√
3.A.2	Manure Management	CH_4	√	√	√	
3.B.1.a	Forest Land Remaining Forest Land	CO_2	√			
3.B.6.b	Land Converted to Other Land	CO_2	√			
3.C.1	Emissions from Biomass Burning	CH_4				√
3.C.1	Emissions from Biomass Burning	N_2O				√
3.C.3	Urea application	CO_2				√
3.C.4	Direct N_2O Emissions from Managed Soils	N_2O	√	√	√	
3.C.5	Indirect N_2O Emissions from Managed Soils	N_2O		√	√	√
3.C.7	Rice Cultivation	CH_4	√	√	√	√
3B[1]	Land	CO_2		√		
4. A	Solid Waste Disposal	CH_4	√	√	√	√
4. C	Incineration and Open Burning of Waste	CH_4			√	
4. C	Incineration and Open Burning of Waste	CO_2		√		√
4.D	Wastewater Treatment and Discharge	CH_4			√	
4.D	Wastewater Treatment and Discharge	N_2O		√		

KEY CATEGORY ANALYSIS FOR THE INVENTORY YEAR 2010

When the FOLU sector is included in the assessment, it has identified that Land Converted to Other Lands, Forest Land Remaining Forest Land, and Rice Cultivation are the most significant of the key categories. (i.e., contributing more than 10% of the level or trend) in 2010. When the FOLU sector was excluded from the assessment, Rice Cultivation, Enteric Fermentation, Road Transport, and Solid Waste Disposal have identified as the most significant of the key categories. Table 2.7 below summarizes key categories identified by level assessment and trend assessment for the inventory year 2010.

Table 2:7: Summary of Key Category Analysis for the Inventory Year 2010

IPCC Category code	IPCC Category	GHG	With FOLU		Without FOLU	
			LA 2010	Trend 2010	LA 2010	Trend 2010
1.A.1	Energy Industries - Liquid Fuels	CO_2	√	√	√	√
1.A.1	Energy Industries - Biomass	CH_4		√		√
1.A.1	Energy Industries - Solid Fuels	CO_2				√
1.A.2	Manufacturing Industries and Construction - Liquid Fuels	CO_2	√	√	√	√
1.A.3.b	Road Transportation	CO_2	√	√	√	
1.A.4	Other Sectors - Liquid Fuels	CO_2		√	√	√
1.A.4	Other Sectors - Biomass	CH_4			√	√
2.A.1	Cement Production	CO_2		√	√	√
2.F.1	Refrigeration and Air Conditioning	HFCs, PFCs				√
3.A.1	Enteric Fermentation	CH_4	√	√	√	√
3.A.2	Manure Management	N_2O	√		√	√
3.A.2	Manure Management	CH_4	√		√	√
3.B.1.a	Forest Land Remaining Forest Land	CO_2	√			
3.B.6.b	Land Converted to Other Land	CO_2	√			
3.C.1	Emissions from Biomass Burning	CH_4				√
3.C.1	Emissions from Biomass Burning	N_2O				√
3.C.3	Urea Application	CO_2		√		√
3.C.4	Direct N_2O emissions from Managed Soils	N_2O	√	√	√	√
3.C.5	Indirect N_2O Emissions from Managed Soils	N_2O		√	√	
3.C.7	Rice Cultivation	CH_4	√	√	√	√
3B	Land	CO_2		√		
4. A	Solid Waste Disposal	CH_4	√	√	√	√
4. C	Incineration and Open Burning of Waste	CH_4		√		
4. C	Incineration and Open Burning of Waste	CO_2				√
4.D	Wastewater Treatment and Discharge	CH_4			√	√

2.6 Uncertainty Analysis

Uncertainty estimates are an essential element of a complete emissions inventory. The purpose of estimating the uncertainty attached to emissions estimates is principally to provide information on where inventory resources should be allocated to maximize future improvements to inventory quality. Assessing uncertainty is a challenging exercise, especially in the absence of quantitative data. Cambodia has conducted the uncertainty analysis according to Approach 1 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories and Good Practice Guidance (IPCC, 2006) and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000).

The upper range of the default uncertainty values provided in 2006 IPCC guidelines and expert judgment were used to decide the uncertainty associated with the activity data and emission factors. Uncertainty of the annual estimations was calculated based on combined uncertainty. Uncertainty in trend was calculated based on sensitivity A and sensitivity B, considering 1994 as the base year. Equations provided in Table 3.2 of Chapter 3 in Volume 1 of 2006 IPCC Guidelines were used for the analysis. As indicated in Table 2.8, the uncertainty of the inventory has decreased over the years.

Table 2:8: Uncertainty of the 2005 and 2010 Inventories

Year	Uncertainty of Total Inventory (%)	Trend Uncertainty (%)
2005	47.08	38.57
2010	44.17	33.91

2.7 Time Series Consistency

Revised 1996 IPCC Guidelines for National GHG Inventories were used to develop Cambodia's First and Second National Communications, including inventory years for 1994 and 2000, respectively. First Biennial Update Report (fBUR) used the 2006 IPCC Guidelines for National GHG Inventories and recalculations were done for the 1994 and 2000 inventory years. Re-calculated values in the fBUR were used in this inventory for trend developments. Please see Annex I for value comparison.

2.8 Quality Assurance and Quality Control

As defined in the IPCC Guidelines, Quality Control (QC) and Quality Assurance (QA) procedures were implemented during the preparation of this inventory. The sector experts were charged with ensuring that adequate QC procedures were performed for the inventory, its supporting documents, calculation spreadsheets, and the IPCC GHG inventory software usage. The project's team leader was responsible for ensuring transparency, completeness, consistency, comparability, and accuracy of the GHG inventory. An international consultant performed the QA procedure. The GHG inventory archive process consisted of three levels: activity data, analysis, and GHG inventory reports for each sector. Inventory calculations were archived through the IPCC software. The USEPA templates were used for documentation. Figure 2.6 illustrates the QA/QC process followed to develop the inventory.

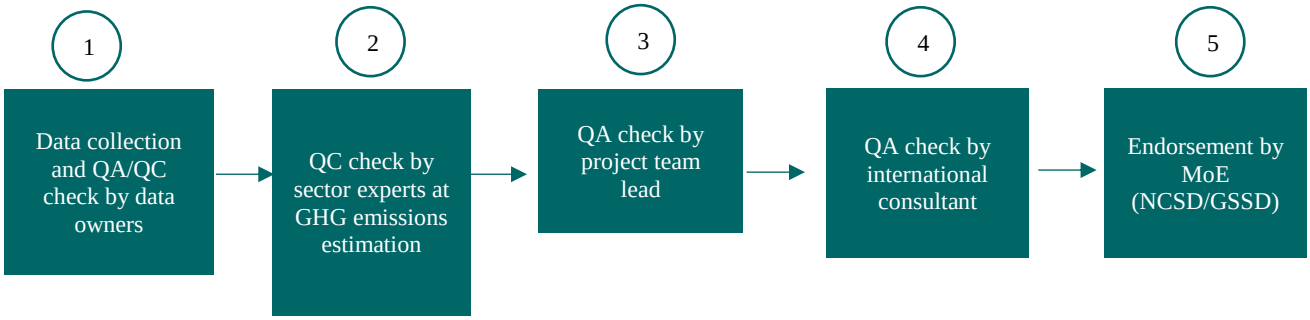


Figure 2.6: QA/QC process of inventory development

2.9 Completeness Assessment

Within each source category, the completeness assessment of the inventory was conducted following the IPCC guidelines. Results of the assessment are presented in Tables 2.9 and 2.10 for 2005 and 2010 inventories, respectively. The following notation keys are used in the assessment.

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

Table 2:9: Short Summary for Inventory Year 2005

Categories	Emissions (Gg)			Emissions CO_2e(Gg)				Emissions (Gg)				
	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF6	Other halogenated gases with CO_2 equivalent conversion factors	Other halogenated gases without CO_2 equivalent conversion factors	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	22864.28	551.51	8.35	6.64	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NE	NE	NE	NE
1 - Energy	2760.04	11.91	0.37	NA	NA	NA	NA	NA	NE	NE	NE	NE
1.A - Fuel Combustion Activities	2760.04	11.91	0.37	NA	NA	NA	NA	NA	NE	NE	NE	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	6.41	NE	NE	6.65	NE	NE	NE	NE	NE	NE	NE	NE
2.A - Mineral Industry	NE	NE	NE	NA	NA	NA	NA	NA	NE	NE	NE	NE
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.D - Non-Energy Products from Fuels and Solvent Use	6.41	NE	NE	NA	NA	NA	NA	NA	NE	NE	NE	NE
2.E - Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE	NA	NA	6.65	NE	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA
2.H - Other	NE	NE	NO,NA	NE	NO,NA	NO,NA	NE	NE	NE	NE	NE	NE
3 - Agriculture, Forestry, and Other Land Use	20036.98	484.14	7.317	NA	NA	NA	NA	NA	NE,NA	NE,NA	NE,NA	NE,NA
3.A - Livestock	NA	213.93	2.505	NA	NA	NA	NA	NA	NE	NA	NE	NA
3.B - Land	19970.11	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate Sources and Non-CO_2 Emissions Sources on Land	83.82	270.21	4.812	NA	NA	NA	NA	NA	NE, NA	NE, NA	NE, NA	NE, NA
3.D - Other	-16.94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4 - Waste	60.86	55.47	0.67	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.A - Solid Waste Disposal	NA	32.38	NE	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.B - Biological Treatment of Solid Waste	NA	0.27	0.016	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.C - Incineration and Open Burning of Waste	60.86	8.77	0.16	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.D - Wastewater Treatment and Discharge	NA	14.05	0.5	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.E - Other (please specify)	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5 - Other	NA	NA	NE	NA	NA	NA	NA	NA	NE	NE	NE	NE
5.A - Indirect N_2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3	NA	NA	NE	NA	NA	NA	NA	NA	NE	NE	NE	NE
5.B - Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Memo Items (5)												
International Bunkers	60.9	0	0	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.A.3.a.i - International Aviation (International Bunkers)	60.9	0	0	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.A.3.d.i - International Water-Borne Navigation (International Bunkers)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.A.5.c - Multilateral Operations	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table 2:10: Short Summary for Inventory Year 2010

Categories	Emissions (Gg)			Emissions CO_2 Equivalents (Gg)				Emissions (Gg)				
	Net CO_2 (1)(2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
Total National Emissions and Removals	25184.42	609.53	10.48	118.1	NA, NE, NO	NA, NE, NO	NA, NE, NO	NA, NE, NO	NE	NE	NE	NE
1 - Energy	4622.74	10.66	0.37	NA	NA	NA	NA	NA	NE	NE	NE	NE
1.A - Fuel Combustion Activities	4622.74	10.66	0.37	NA	NA	NA	NA	NA	NE	NE	NE	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	NA	NA	NA	NA
2 - Industrial Processes and Product Use	385.06	NE	NE	118.1	NE	NE	NE	NE	NE	NE	NE	NE
2.A - Mineral Industry	376.46	NE	NE	NA	NA	NA	NA	NA	NE	NE	NE	NE
2.B - Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.C - Metal Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.D - Non-Energy Products from Fuels and Solvent Use	8.6	NE	NE	NA	NA	NA	NA	NA	NE	NE	NE	NE
2.E - Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE	NA	NA	118.1	NE	NA	NA	NA	NA	NA	NA	NA
2.G - Other Product Manufacture and Use	NE	NE	NE	NE	NE	NE	NE	NE	NA	NA	NA	NA
2.H - Other	NE	NE	NO,NA	NE	NO,NA	NO,NA	NE	NE	NE	NE	NE	NE

3 - Agriculture, Forestry, and Other Land Use	20096.68	535.27	9.39	NA	NA	NA	NA	NA	NE,NA	NE,NA	NE,NA	NE,NA
3.A - Livestock	NA	224.45	2.63	NA	NA	NA	NA	NA	NE	NA	NE	NA
3.B - Land	19970.11	NE	NE	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.C - Aggregate Sources and non-CO_2 Emissions Sources on Land	146.09	310.82	6.77	NA	NA	NA	NA	NA	NE, NA	NE, NA	NE, NA	NE, NA
3.D - Other	-19.52	NA	NA	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
4 - Waste	60.43	63.6	0.72	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.A - Solid Waste Disposal	NA	40.15	NE	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.B - Biological Treatment of Solid Waste	NA	0.32	0.02	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.C - Incineration and Open Burning of Waste	60.43	8.71	0.16	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.D - Wastewater Treatment and Discharge	NA	14.43	0.54	NA	NA	NA	NA	NA	NE	NE	NE	NA
4.E - Other (please specify)	NO	NO	NO	NA	NA	NA	NA	NA	NO	NO	NO	NA
5 - Other	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.A - Indirect N_2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH_3			0	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.B - Other (please specify)	0	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items (5)												
International Bunkers	122.74	0	0	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.A.3.a.i - International Aviation (International Bunkers) (1)	122.74	0	0	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.A.3.d.i - International Water-Borne Navigation (International bunkers) (1)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.A.5.c - Multilateral Operations (1)(2)	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

2.10 Greenhouse Gas Emissions by Sectors

2.10.1 Energy sector

The total emissions of the energy sector only include CO_2, CH_4, and N_2O emissions from fuel combustion activities. This sector has emissions from Energy industries (1.A.1), Manufacturing industries and Construction (1.A.2), Transport (1.A.3), and other sectors (1.A.4).

METHODOLOGY

The methodologies used in the Energy sector was based on the 2006 IPCC guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). Analysis was conducted using IPCC Inventory software (Ver. 2.691). Tier 1 approach was used to assess all the subcategories due to the unavailability of country-specific emission factors.

ACTIVITY DATA AND EMISSION FACTORS

For the inventory year 2010, activity data were collected from the Ministry of Mines and Energy (MME) and Energy balance of -2010, Economic Research Institute for ASEAN and East Asia report -2010 (hereinafter referred to as ERIA report, 2010). Activity data were not available for the 2005 inventory year. Therefore, activity data were generated by extrapolating activity data of 2010 and National consultant data. Table 2.11 shows the activity data and emission factors used to estimate CO_2, CH_4, and N_2O emissions attributed Energy sector.

Table 2:11: Activity Data and Emission Factors of the Energy Sector (2005 and 2010)

Sub-category	Fuel type	Activity data (TJ)		Emission factor		
		2005	2010	CO_2	CH_4	N_2O
1.A.1 - Energy Industries	Sub-bituminous Coal	-	727.37	96,100	1	1.5
	Residual Fuel Oil	1,482.87	9,784.33	77,400	3	0.6
	Diesel	615.57	347.73	74,100	3	0.6
	Biomass (wood/wood waste)	181.62	293.08	112,000	30	4
1.A.2 - Manufacturing Industries and Construction	Sub-bituminous Coal	-	211.53	96,100	10	1.5
	Residual Fuel Oil	718.68	5,191.63	77,400	3	0.6
	Gas/Diesel	2,221.76	2,763.23	74,100	3	0.6
	Biomass (wood/wood waste)	33,999.13	27,507.28	112,000	30	4
1.A.3 - Transport	Jet Kerosene for 1.A.3.a.i International Aviation	851.66	1,716.59	71,500	0.5	2
	Jet Kerosene for 1.A.3.a.ii Domestic Aviation	62.32	125.6	71,500	0.5	2
	Motor Gasoline	11,488.99	16,412.26	69,300	33	3.2
	Gas/Diesel	18,279.06	22,734.32	74,100	3.9	3.9
	LPG	105.09	125.6	63,100	62	0.2
1.A.4.a Commercial/Institutional	Kerosene	398.91	586.15	71,900	10	0.6
	Residual Fuel Oil	57.96	418.68	77,400	10	0.6
	LPG	1,120.95	1,339.78	63,100	5	0.1
1.A.4.b Residential	Kerosene	256.44	376.81	71,900	10	0.6
	LPG	245.21	293.08	63,100	5	0.1
	Firewood	25,232.85	23,265.27	112,000	300	4
	Charcoal	14,048.81	10,552.68	112,000	200	1
	Biogas	-	101.99	54,600	5	0.1
1.A.4.c Agriculture/Forestry /Fishing/Fish Farms	Gas/Diesel	1,077.22	1,339.78	74,100	10	0.6

Table 2.12 shows the sources of activity data for 2010. Default emission factors provided in the IPCC Inventory software (Ver. 2.691) were used for emissions estimation.

Table 2:12: Sources of the Energy Sector Activity Data for 2010

Category	Type of fuel used	Source of data
1.A.1.a.i - Electricity Generation	**Sub-bituminous Coal**	**ERIA report, 2010**
	Residual Fuel Oil	MME
		ERIA report, 2010
	Diesel	MME
		ERIA report, 2010
	Biomass (wood/wood waste)	MME
1.A.2 - Manufacturing Industries and Construction	Sub-bituminous Coal	ERIA report, 2010
	Residual Fuel Oil	
	Gas/Diesel	
	Biomass (wood/wood waste)	MME
1.A.3.a.i - International Aviation	Jet Kerosene	ERIA report, 2010
1.A.3.a.ii - Domestic Aviation	Jet Kerosene	MME
		ERIA report, 2010
1.A.3.b - Road Transportation	Motor Gasoline	ERIA report, 2010
	Gas/Diesel	
	LPG	
1.A.4.a - Commercial/Institutional	Kerosene	
	Residual Fuel Oil	
	LPG	
1.A.4.b - Residential	Kerosene	
	LPG	
	Firewood	
	Charcoal	Extrapolated based on 2012 data in ERIA report, 2012
	Biogas	ERIA report, 2010
1.A.4.c.i - Stationary	Gas/Diesel	

GREENHOUSE GAS EMISSIONS

GHG emissions of the energy sector for 2005 by the gas type are presented in Table 2.13. The sector has contributed 8% of the total national emissions. As shown in the Table, CO_2 is the highest contributor (87%) to the Energy sector, followed by CH_4 and N_2O emissions accordingly.

Table 2:13: The Energy Sector Emissions in CO_2e for 2005

Categories	CO_2e Emissions (Gg)			
	CO_2	CH_4	N_2O	Total
1 - Energy	2,760.04	297.6	108.5	3,166.09
1.A - Fuel Combustion Activities	2,760.04	297.6	108.5	3,166.09
1.A.1 - Energy Industries	160.39	0.3	0.6	161.28
1.A.1.a - Main Activity Electricity and Heat Production	160.39	0.3	0.6	161.28
1.A.1.a.i - Electricity Generation	160.39	0.3	0.6	161.28
1.A.2 - Manufacturing Industries and Construction	220.26	25.72	41.06	287.04
1.A.3 - Transport	2,161.76	11.43	32.25	2,205.42
1.A.3.a - Civil Aviation	4.46	0.01	0.04	4.5
1.A.3.a.ii - Domestic Aviation	4.46	0.01	0.04	4.5
1.A.3.b - Road Transport	2,157.30	11.43	32.21	2,200.93
1.A.4 - Other Sectors	217.64	260.1	34.63	512.37
1.A.4.a - Commercial/Institutional	103.9	0.26	0.12	104.27
1.A.4.b - Residential	33.92	259.6	34.32	327.82
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	79.83	0.27	0.2	80.29
1.A.4.c.i - Stationary	79.83	0.27	0.2	80.29

Table 2.14 shows the GHG emissions by gas type for 2010. The sector has contributed 11% of the total national emissions. This indicates emissions increment of the sector over the years. As shown in the Table, the highest contribution to the total emissions in the energy sector is from CO_2 (92%), followed by CH_4 and N_2O gases. The majority of emissions from this sector are from the transport sector, which accounts for 2,205.42 Gg of CO_2e in 2005, which is 70% of the total emissions in the energy sector. The second highest contribution was from other sectors accounted for 16% of the total emissions. In 2010, the transport sector accounted for 2,897 Gg of CO_2e emissions, which is 58% of the total emissions in the energy sector. Energy industries were the second-highest contributors.

Table 2:14: The Energy Sector Emissions in CO_2e for 2010

GHG Source and Sink Categories	CO_2e emissions (Gg)			
	CO_2	CH_4	N_2O	Total
1 - Energy	4,622.74	266.4	110.4	4,999.48
1.A - Fuel Combustion Activities	4,622.74	266.4	110.4	4,999.48
1.A.1 - Energy Industries	852.98	1	2.49	856.46
1.A.1.a - Main Activity Electricity and Heat Production	852.98	1	2.49	856.46
1.A.1.a.i - Electricity Generation	852.98	1	2.49	856.46
1.A.2 - Manufacturing Industries and Construction	626.92	21.28	34.31	682.51
1.A.3 - Transport	2,838.89	15.96	42.16	2,897.00
1.A.3.a - Civil Aviation	8.99	0.01	0.08	9.06
1.A.3.a.ii - Domestic Aviation	8.99	0.01	0.08	9.06
1.A.3.b - Road Transport	2,829.91	15.95	42.09	2,887.94
1.A.4 - Other Sectors	303.96	228.2	31.42	563.52
1.A.4.a - Commercial/Institutional	159.1	0.42	0.22	159.73
1.A.4.b - Residential	45.59	227.4	30.96	303.94
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	99.28	0.34	0.24	99.86
1.A.4.c.i - Stationary	99.28	0.34	0.24	99.86

Figure 2.7 shows the details of the GHG emissions from the energy sector by the sub-categories.

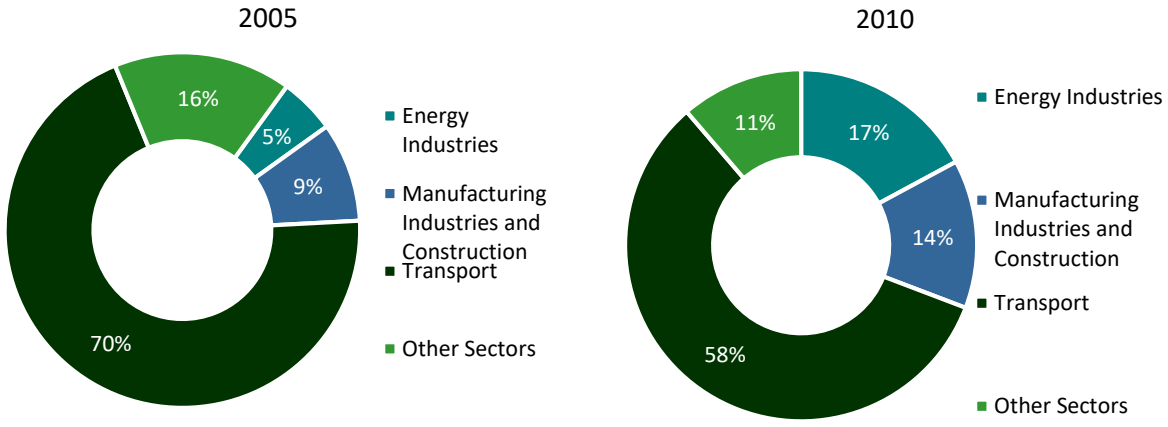


Figure 2.7: Contribution of sub-categories in energy sector for the total emissions in 2005 and 2010

Table 2:15: Comparison between the Reference Approach and Sectoral Approach for 2005

Fuel Types	Reference Approach				Sectoral Approach		Difference	
	Apparent Consumption (TJ)	Excluded Consumption (TJ)	Apparent Consumption (excluding non-energy use and feedstocks) (TJ)	CO_2 Emissions (Gg)	Energy Consumption (TJ)	CO_2 Emissions (Gg)	Energy Consumption (%)	CO_2 Emissions (%)
Liquid Fuels: 22 items	27,071.01	0.00	27,071.01	1,962.44	38,131.02	2,760.03	-29.01	-28.9
Solid Fuels: 11 items	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gaseous Fuels: 1 item	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Fossil Fuels: 3 items	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Peat: 1 item	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	27,071.01	0	27,071.01	1,962.44	38,131.02	2,760.03	-29.01	-28.9

REFERENCE APPROACH

The reference approach for the 2005 inventory year was conducted based due to the absence of Energy balance from the MME for the year 2005. Energy balance from the MME was used for the reference approach of the 2010 inventory year. The comparison between the two approaches for the years 2005 and 2010 are shown in Table 2.15 and Table 2.16, respectively.

The significant differences between the emissions estimated from the reference approach and the sectoral approach in 2005 is due to the absence of direct data from the sources for the year 2005. Most of the activity data used in the sectoral approach for the year 2005 are extrapolated from 2010 data. For 2010, most of the activity data are directly available from official sources. Therefore, the differences between the results from the sectoral approach and the reference approach are less.

Table 2:16: Comparison between the Reference Approach and Sectoral Approach for 2010

Fuel Types	Apparent Consumption (TJ)	Excluded Consumption (TJ)	Apparent Consumption (excluding non-energy use and feedstocks) (TJ)	CO_2 Emissions (Gg)	Energy Consumption (TJ)	CO_2 Emissions (Gg)	Energy Consumption (%)	CO_2 Emissions (%)
Liquid Fuels: 22 items	59,745.64	0.00	59,745.64	4,348.36	61,839.04	4,532.51	-3.39	-4.06
Solid Fuels: 11 items	544.28	0.00	544.28	52.29	938.89	90.23	-42.03	-42.05
Gaseous Fuels: 1 item	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other Fossil Fuels: 3 items	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Peat: 1 item	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**60,289.92**	**0**	**60,289.92**	**4,400.64**	**62,777.93**	**4,622.74**	**-3.96**	**-4.8**

2.10.2 Industrial Processes and Product Use

The total emission of the Industrial Processes and Product Use (IPPU) sector only include CO_2 and HFC emissions from industrial activities. The sector consists of emissions from Cement Production (2.A.1), Lubricant Use (2.D.1) and Refrigeration, and Air Conditioning (2.F.1).

METHODOLOGY

The methodologies used in the IPPU sector were based on the IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). Analysis was conducted using IPCC Inventory software (Ver. 2.691). Tier 1 approach was used to assess all the subcategories due to the unavailability of country-specific emission factors.

ACTIVITY DATA AND EMISSION FACTORS

Primary activity data providers for both 2005 and 2010 inventories were cement manufacturing plants, the ERIA and the National Ozone Unit of the MoE. Table 2.17 shows the type of activity data used for 2005 and 2010, along with the sources.

Table 2:17: Activity Data of the IPPU Sector for 2005 and 2010

Category	Type of Activity Data Used	Activity Data for 2005	Activity Data for 2010	Source of Data
2.A.1-Cement Production	Portland type 1 (Tonne)		735,413	Data provided by Cement Manufacturer
	% Of Clinker in Portland cement		92.62	
	Plastering cement (Tonne)		78691	
	% Of Clinker in Plastering cement		54.42	
2.D.1-Lubricant Use	Industry (TJ)	93.66	125.6	Cambodia Energy Statistics - ERIA
	Transport sector (TJ)	343.44	460.55	
2.F.1.a - Refrigeration and Stationary Air Conditioning	HFC -125(Tonne)		1	The National Ozone Unit (Ministry of Environment)
	HFC-134a(Tonne)	1	4	
	HFC-143a(Tonne)		1	
2.F.1.b - Mobile Air Conditioning	HFC-32(Tonne)	0.49	3	The National Ozone Unit (Ministry of Environment)
	HFC-125(Tonne)	0	3	
	HFC-134a(Tonne)	27	186	

Default emission factors provided in the IPCC Inventory software (Ver. 2.691) were used for emissions estimation. Table 2.18 demonstrates the emission factors used in the calculation for Cement Industry and Lubricant usage.

Table 2:18: Emission Factors for the IPPU Sector

Category	Description/Unit	Emission Factor
2.A.1-Cement Production	Tonnes CO_2/tonne clinker	0.52
2.D.1-Lubricant Use	Carbon Content of Lubricant (Tonne-C/TJ)	20

The GWP published in the IPCC's AR4 were used for the F-gases as presented in Table 2.19.

Table 2:19: GWP Potential of F-Gases

Gas	GWP
HFC -32	675
HFC-125	3500
HFC143a	4470
HFC134a	1430

GREENHOUSE GAS EMISSIONS

Total emissions from the sector for the year 2005 were 13.06 Gg CO_2e, which is less than 1% of the country's total emissions. Table 2.20 shows the summary of GHG emissions for the year 2005 from the IPPU sector by the gas. As presented in the Table, HFCs are the highest contributor accounting for 51% of the total emissions of the IPPU sector.

Table 2:20: The IPPU Sector Emissions in CO_2e for 2005

Categories	Emissions in $GgCO_2e$				
	CO_2	CH_4	N_2O	HFCs	Total
2 - Industrial Processes and Product Use	6.41	NE	NE	6.65	13.06
2.D - Non-Energy Products from Fuels and Solvent Use	6.41	NE	NE	NA	6.41
2.D.1 – Lubricant Use	6.41	NE	NE	NA	6.41
2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE	NA	NA	6.65	6.65
Refrigeration and Stationary Air Conditioning (2.F.1.a)	NE	NA	NA	0.55	0.55
Mobile Air Conditioning (2.F.1.b)	NE	NA	NA	6.10	6.10

NA- Not Applicable, NE-Not Estimated

Total emissions from the sector for 2010 were 503.12 Gg CO_2e, which is 1% of the country's total emissions. As indicated in Table 2.21, CO_2 is the highest contributor of the sector, accounting for 77% of the total emissions. This is mainly due to the emissions attributed to the cement industry.

Table 2:21: The IPPU Sector Emissions in CO_2e for 2010

Categories	Emissions in $GgCO_2e$				
	CO_2	CH_4	N_2O	HFCs	Total
2 - Industrial Processes and Product Use	385.06	NE	NE	118.07	503.12
2.A - Mineral Industry	376.46	NE	NE	NA	385.06
2.A.1- Cement Industry	376.46	NE	NE	NA	385.06
2.D - Non-Energy Products from Fuels and Solvent Use	8.59	NE	NE	NA	8.59
2.D.1 – Lubricant Use	8.59	NE	NE	NA	8.59

2.F - Product Uses as Substitutes for Ozone Depleting Substances	NE	NA	NA	118.07	118.07
Refrigeration and Stationary Air Conditioning (2.F.1.a)	NE	NA	NA	6.55	6.57
Mobile Air Conditioning (2.F.1.b)	NE	NA	NA	111.5	111.5

NA- Not Applicable, NE-Not Estimated

The contribution of the sub-categories to the total emissions of the sector is illustrated in Figure 2.8. As illustrated in this figure, Product Uses as Substitutes for Ozone Depleting Substances was the main contributor to the sector in 2005, accounting for 51% of the total emission. The second highest contributor (49%) was Non-Energy Products from Fuels and Solvent Use. In 2010, the mineral industry was the main contributor to the sector, accounting for 75% of the total emissions. The second highest contributor (23%) was from Product Uses as Substitutes for Ozone Depleting Substances (ODS).

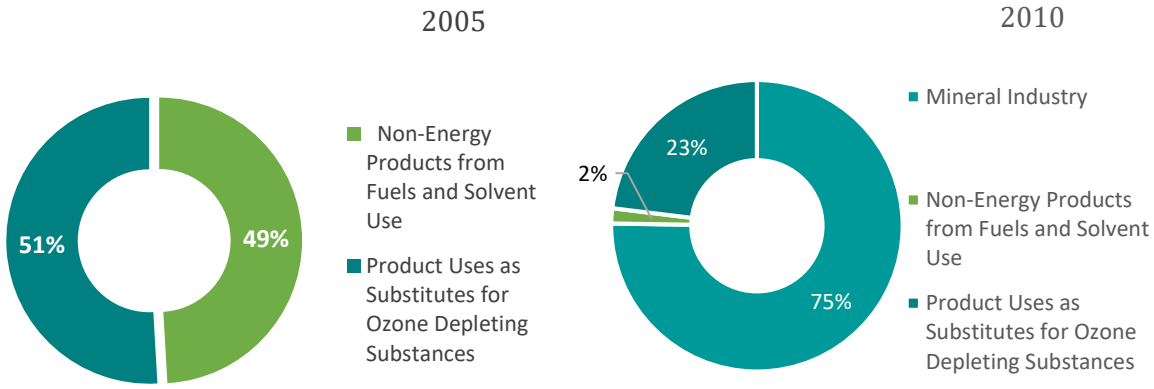


Figure 2.8: Contribution of sub-categories in the IPPU sector for the total emissions in 2005 and 2010

2.10.3 Agriculture, Forestry and Other Land Use Sector

Cambodia has considered Livestock (3A), Aggregate sources and non-CO_2 emission sources on Land (3C) under the agriculture sector while Land (3B) and Other (3D) emission categories were considered under Forestry and Other Land Use (FOLU). Emissions attributed to ten sub-categories including Enteric Fermentation (3.A.1), Manure Management (3.A.2) under Livestock (3A), Forest Land (3.B.1) and Other Land (3.B.6) under Land (3B), Urea Application (3.C.3), Direct N_2O Emissions from Managed Soils (3.C.4), Indirect N_2O Emissions from Managed Soils (3.C.5), Indirect N_2O Emissions from Manure Management (3.C.6) and Rice Cultivation (3.C.7) under Aggregate sources and non-CO_2 emissions sources on Land (3C) and Harvested Wood Products (3.D.1) under Other (3D) were considered under the main four categories. The key GHGs considered under the sector are CO_2, N_2O, and CH_4.

METHODOLOGY

The methodologies used in this inventory were based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2006). The methodology for AFOLU sector calculation followed the IPCC Tier1 approach. Default emission factors for developing countries and the Asian region were selected. Analysis was conducted using IPCC inventory software (Ver 2.691).

ACTIVITY DATA AND EMISSION FACTORS

Most of the activity data were collected from the MoE, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Ministry of Economy and Finance (MEF). Table 2.22 summaries the activity data sources of the AFOLU sector.

Table 2:22: Sources of the AFOLU Sector Activity Data for 2005 and 2010

GHG Source and Sink Categories	Activity Data	Data Sources
3.A.1 - Enteric Fermentation 3.A.2 - Manure Management	- Livestock Population (Head)	Ministry of Agriculture, Forestry and Fisheries
3.B.1 - Forest Land 3.B.6 – Other Land	- Land Use Classification in hectares	Ministry of Environment Ministry of Agriculture, Forestry and Fisheries
3.C.3 - Urea Application	- Fertilizer Consumptions (Urea) in tons	Ministry of Economy and Finance
3.C.7 - Rice Cultivation	- Rice Field in hectares (dry) - Rice Field in hectares (wet)	Ministry of Agriculture, Forestry and Fisheries

Data used for the Manure management (3.A.2) are the same data used to calculate Indirect N_2O Emissions from manure management (3.C.6). Data derived from 3.C.3 and 3.C.7 were used to calculate the 3.C.4 and 3.C.5 subcategories. The relevant livestock populations for Cambodia are other non-dairy cattle, buffaloes, sheep, goat, horse, swine, birds (poultry), and elephants. To this date, Cambodia does not have any population of dairy cattle. Livestock (3A) category and Indirect N_2O Emissions from Manure Management (3.C.6) sub-category have been calculated based on livestock population in 2005 and 2010. Activity data and emission factors used for enteric fermentation and manure management are shown in Table 2.23.

Table 2:23: Emission Factors and Activity Data for Livestock Sub-Category

Livestock Type	Activity Data		Emission Factor	
	Annual Average Population (head)		Enteric Fermentation (kg CH_4/head/ year)	Manure Management (kg CH_4/head /year)
	2005	2010		
Cattle (non-dairy)	3,193,146	3,484,481	47	0.34
Buffaloes	676,646	702,074	55	0.32
Swine	2,688,612	2,057,431	1	0.5
Birds (poultry)	15,085,547	20,559,361	-	0.82
Horses	7,682	12,468	18	0.46
Sheep	689	613	5	1.17
Goats	23,987	10,547	5	1.37
Elephants	98	81	-	0.46

Land emissions in Cambodia is coming directly from land use changes. Net emission value has an emission component from land conversions to non-forest lands and carbon offset component from forest lands. The Stock-Difference Method is used to estimate the net emission from lands including offsets from 3. B.1. Forest lands, and emissions from 3.B.6. Other lands. The Forest

Reference Level uses LANDSAT images to classify Cambodia's land area into 22 categories, including 9 classes of natural forests, 2 classes of forest plantations. The activity data is prepared to the comparison of different cartographies for 2006 and 2010. These 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. The correspondence with the IPCC land use classification is provided in Table 2.24.

Table 2:24: Biomass Content of Forestlands for 2005 and 2010

Land Use/cover			Above-Ground Biomass (t)	Below Ground Biomass (t)
Category		Sub-Category		
Forest	**Natural Forest (Nf)**	Evergreen (E)	163	31
		Semi-Evergreen (Se)	243	44
		Deciduous (D)	85	18
		Pine Forest (P)	100	20
		Bamboo (B)	0	0
		Mangrove (M)	150	29
		Rear Mangrove (Mr)	165	32
		Flooded Forest (Ff)	70	15
		Forest Regrowth (fr)	75	16
	Forest Plantation	Pine Plantation (Pp)	100	20
		Other Plantation (Tp)	100	20

The activity data is the set of land use matrixes (Table 2.25) prepared to compare different cartographies for 2006 and 2010. These matrixes mostly focus on forest areas because they were elaborated in the framework of the REDD+ program to define the forest reference level.

Table 2:25: Forest Area Change Matrix between 2006 and 2010

Forest Type		Year 2010											
		E	Se	P	D	B	M	Mr	Ff	Fr	Tp	Pp	NF
Year 2006	E	3,560,063.50				20.2				4,610.30	1,055.90		144,521.10
	Se	171.6	1,384,195.90		12.6					3,285.30	42.1		65,733.40
	P			8,156.60									0
	D				4,477,380.90	9.7		8.4		1,114.60	2,275.60		132,627.80
	B					128,795.80				11.4			1,029.80
	M	143.5	55.2				31,031.20	40.2					789.5
	Mr		77.7				90.8	26,482.70		43.2			824.5
	Ff								471,842.10	592.2			124,920.90
	Fr	174.9	5.9		83.2			10.9	20.4	190,385.90	277.4		25,164.50
	Tp		16.7		26.1				7.5	161.5	8,013.90		35,321.30
	Pp												0
	NF	13,371.60	6,765.90	0	20,894.00	2,104.80	320.7	828.5	52,135.30	49,137.10	5,549.20	10.9	7,177,829.20
Total		3,573,925.10	1,391,117.30	8,156.60	4,498,396.80	130,930.50	31,442.70	27,370.70	524,005.30	249,341.50	17,214.10	10.9	7,708,762.00
		19.70%	7.70%	0.00%	24.80%	0.70%	0.20%	0.20%	2.90%	1.40%	0.10%	0.00%	42.40%

Urea application, harvested area, cultivation types, and duration for rice cultivation are the main activity data considered when calculating the Aggregate sources and non-CO_2 emissions sources on Land (3C).

Table 2:26: Activity Data and Emission Factor for Urea Application

Year	Activity Data	Emission Factor
	Urea application (kg)	CO_2 (tC/t of urea)
2005	114,297,080	0.2
2010	199,212,754	

Activity data for direct and indirect N_2O emissions from managed soils are the same activity data for urea application (Table 2.26) since the only synthetic fertilizer addition to the soils considered in the calculation is Urea application. Urea has 46% Nitrogen content which leads to direct and indirect N_2O emissions. Table 2.27 shows the emissions factors used for direct and indirect N_2O emissions calculation for managed soils.

Table 2:27: Emission Factors for Indirect and Direct N_2O from Managed Soils

Direct N_2O Emissions from Anthropogenic N input types to estimate annual direct N_2O-N emissions produced from Managed Soils	Emission Factor for N_2O emissions from N inputs (Kg N_2O-N /kg N inputs)
Inorganic Fertilizers	0.01
N in animal manure, compost, sewage sludge, other	0.01
Crop Residues	0.01
Mineralization in Mineral Soils	0.01
Anthropogenic N input types to estimate annual direct N_2O-N emissions produced from flooded rice	Emission Factor for N_2O emissions from N inputs (Kg N_2O-N /kg N inputs)
Inorganic Fertilizers	0.003
N in animal manure, compost, sewage sludge, other	0.003
Crop Residues	0.003
Indirect N_2O emissions from managed soils	
Frac Leach (kg N/kg of N additions)	0.3
$Frac_{GASM}$ (kg N volatilized/kg of N applied or deposited) for organic fertilizer	0.2
$Frac_{GASF}$ (kg N volatilized/kg of N applied) for synthetic fertilizer	0.1
EF for N_2O emissions from atmospheric deposition (kg N_2O-N/kg NH_3-N+NO_x-N volatilized)	0.01
EF for N_2O emissions from N Leaching and runoff (kg N_2O-N/kg N leaching/runoff)	0.0075

Indirect N_2O emissions occur from livestock manure N that volatilizes as NH_3 and NOx and N leached from manure management systems. It is based on livestock categories, the number of heads, and manure management systems. Activity data on the number of livestock were reported under 3.A- Livestock category. Emission factors used for calculating the indirect N_2O emissions from manure management are listed in Table 2.28.

Table 2:28: Emission Factors for Indirect N_2O Emissions from Manure Management

	Emission Factor
Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces	0.01 kg N-N_2O/kg (N-NH_3 + N-NOx)
Indirect N_2O emissions due to leaching and runoff from manure management	0.0075 kg N-N_2O/kg (N leaching)

Table 2:29: Activity Data and Emission Factors for Rice Cultivation

Cultivation Type	Activity Data		Emission Factors and other Parameters			
	Annual Harvested Area (ha)	Cultivation Period (day)	Baseline Emission Factor (kg CH_4/ ha)	Scaling Factor for Water Regimes during the Cultivation Period	Scaling Factor for Water Regimes before the Cultivation Period	Conversion Factors for Organic Amendments
2005						
Irrigated Rice Cultivation	241,446	150	1.3	1	1.29	1
Rainfed Rice Cultivation	2,173,010	150	1.3	0.28	1.29	1
2010						
Irrigated Rice Cultivation	277,732	150	1.3	1	1.29	1
Rainfed Rice Cultivation	2,499,591	150	1.3	0.28	1.29	1

Emissions from harvested wood products which was released from solid waste disposal sites have been taken into account in Cambodian GHG inventory for 2005 and 2010.

GREENHOUSE GAS EMISSIONS

Total GHG emissions from the AFOLU sector contributed 34,337.9 Gg of CO_2e, representing 88% of Cambodian national GHG emissions in 2005. Emissions from Land was the main source of AFOLU emissions, contributing 58% for 2005 of the sector's emissions. The second highest contributor (20%) was rice cultivation for the inventory year 2005. Table 2.30 shows the AFOLU sector emissions in CO_2e for 2005.

Table 2:30: The AFOLU Sector Emissions in CO_2e for 2005

Categories	GHG Emissions and Removals			
	CO_2	CH_4	N_2O	Total
3 - Agriculture, Forestry, and Other Land Use	**20,036.98**	**12,103.58**	**2,180.41**	**34,320.97**
3.A - Livestock	NA	5,348.36	746.54	6,094.90
3.A.1 - Enteric Fermentation	NA	4,756.09	NA	4,756.09
3.A.2 - Manure Management[1]	NA	592.27	746.54	1,338.81
3.B - Land	19,970.11	NA	NA	19,970.11
3.B.1 - Forest Land	-8,129.67	NA	NA	-8,129.67
3.B.6 - Other Land	28,099.78	NA	NA	28,099.78
3.C - Aggregate Sources and non-CO_2 Emissions Sources on Land	83.82	6,755.22	1,433.87	8,272.91
3.C.3 - Urea Application	83.82	NA	NA	83.82
3.C.4 - Direct N_2O Emissions from Managed Soils	N/A	NA	875.62	875.62
3.C.5 - Indirect N_2O Emissions from Managed Soils	N/A	NA	387.46	387.46
3.C.6 - Indirect N_2O Emissions from Manure Management	N/A	NA	170.79	170.79
3.C.7 - Rice Cultivation	N/A	6,755.22	N/A	6,755.22
3. D- Other	-16.94	N/A	N/A	-16.94
3.D.1- Harvested Wood Products	-16.94	N/A	N/A	-16.94

NA- Not Applicable

Total emissions of the AFOLU sector were 36,277.4 $GgCO_2e$ in the year 2010. The AFOLU sector emission contribution to the net national GHG emissions is 83%. Emissions from Land (3.B) was the main contributor accounting for 55% of the sector's emissions. The second highest contributor was rice cultivation (21.4%). The summary of the GHG emissions from sources and removals from sinks is given in Table 2.31 for the AFOLU sector in 2010.

Table 2:31: The AFOLU Sector Emissions in CO_2e for 2010

Categories	GHG Emissions ($GgCO_2e$)			
	CO_2	CH_4	N_2O	Total
3 - Agriculture, Forestry, and Other Land Use	20,096.68	13,381.80	2,798.93	36,277.41
3.A - Livestock	NA	5,611.35	782.53	6,393.88
3.A.1 - Enteric Fermentation	NA	5,118.06	NA	5,118.06
3.A.2 - Manure Management[5]	NA	493.29	782.53	1,275.82
3.B - Land	19,970.11	NA	NA	19,970.11
3.B.1 - Forest land	-8,129.67	NA	NA	-8,129.67
3.B.6 - Other Land	28,099.78	NA	NA	28,099.78
3.C - Aggregate Sources and Non-CO_2 Emissions Sources on Land	146.09	7,770.46	2,016.39	9,932.94
3.C.3 - Urea Application	146.09	NA	NA	146.09
3.C.4 - Direct N_2O Emissions from Managed Soils	NA	NA	1,368.19	1,368.19
3.C.5 - Indirect N_2O Emissions from Managed Soils	NA	NA	466.54	466.54
3.C.6 - Indirect N_2O Emissions from Manure Management	NA	NA	181.66	181.66
3.C.7 - Rice Cultivation	NA	7,770.46	NA	7,770.46
3. D- Other	-19.52	NA	NA	-19.52
3.D.1- Harvested Wood Products	-19.52	NA	NA	-19.52

NA- Not Applicable

When considering the AFOLU sector emissions only, 66% emissions are coming from other Land (3.B.6) sub-category following up rice cultivation (16%) and enteric fermentation (11%) in the year 2005. The same order is received for 2010 by illustrating 63% from other Land, 18% from rice cultivation and 12 % from enteric fermentation, as shown in Figure 2.9. Other land category consists of CO_2 emissions, while rice cultivation and enteric fermentation are consisted CH_4 emissions.

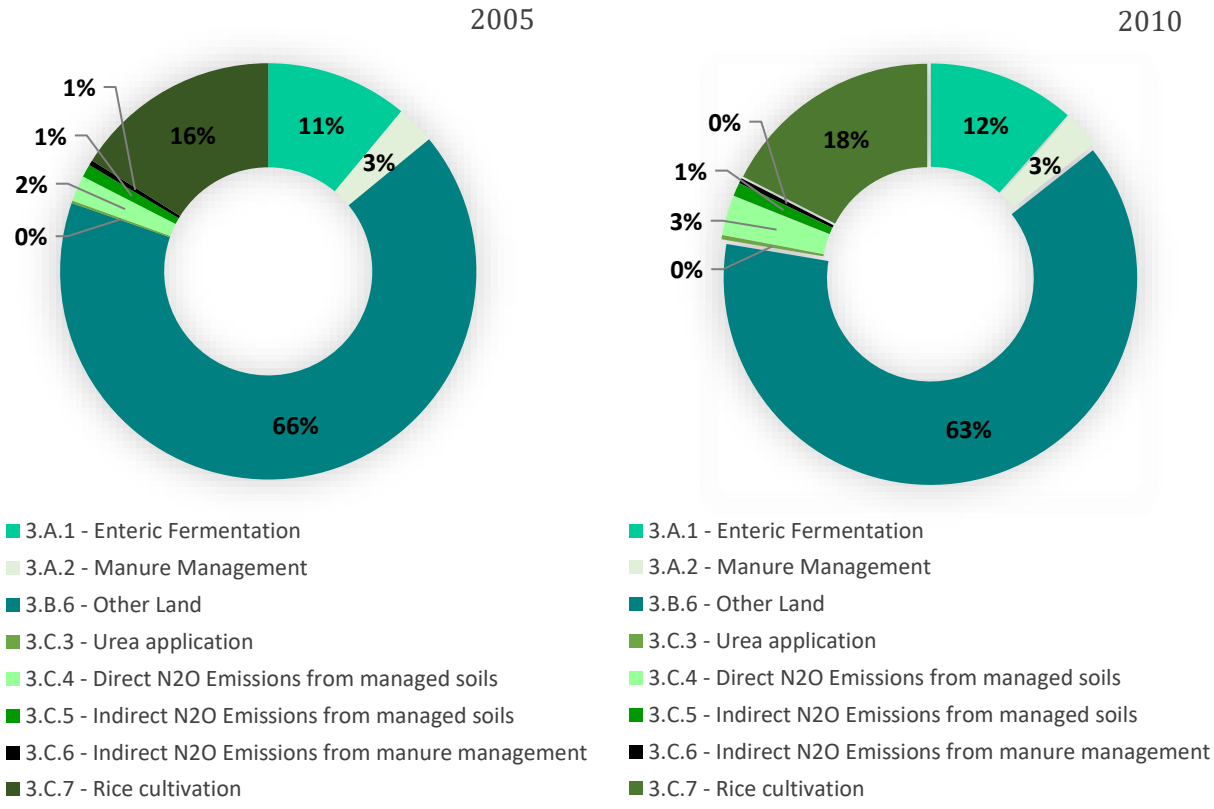


Figure 2.9: Contribution of sub-categories in the AFOLU sector for the total emissions in (2005 and 2010)

More than 99% of CO_2 removal of the AFOLU sector is mainly from forest land. Harvested wood products only contributed to 0.3% of total removal in both 2005 and 2010.

2.10.4 Waste sector

The waste sector comprises five main categories, including Solid waste disposal (4A), Biological treatment of solid waste (4B), Incineration and open burning of waste (4C), Wastewater treatment and discharge (4D) and Other (4E). Cambodia has assessed emissions attributed to all these categories except for category 4E. The key GHGs considered under the sector are CO_2, CH_4, and N_2O.

METHODOLOGY

Methodologies followed for the waste sector analysis are based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006) and Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (IPCC, 2000). The methodologies for waste sector calculation followed the IPCC Tier1 approach with default emission factors. The IPCC inventory software (Ver 2.691) was used for the calculation.

ACTIVITY DATA AND EMISSION FACTORS

The population data, which have been collected from the National Committee for Sub-National Democratic Development (NCDD) complemented with the world bank database were used for the estimation of several activity data during the assessment, such as the total amount of Municipal Solid Waste (MSW) open burned (for 4. C - Incineration and Open Burning of Waste) and amount of organically degradable materials in domestic wastewater (for 4.D - Wastewater Treatment and Discharge). The summary of activity data used to assess waste sector emissions are listed below in Table 2.32.

Table 2:32: Summary of Main Data Sources for the Waste Sector

Categories	Activity Data	2005	2010	Data Sources
4.A - Solid Waste Disposal	Population data (capita)	13,872,000	14,248,812	NCDD complemented with the World Bank database
	GDP ($ millions)	6,293	11,634	MoP complemented with the World Bank database and National Institute of Statistics
	Waste per capita (kg/cap/yr)	270	270	2006 IPCC default
	Average weight composition			- Asia Pacific Workshop on Global Partnership on Waste Management, Mapping needs and activities on waste management, Country report by the Government of Cambodia, Siem Reap
	Food (%)	54.86	54.86	- KOICA project study, 2010 (MoE, 2017)- Only Phnom Penh
	Garden (%)	0	0	- Seng B., 2013, landfill waste at Sihanouk Ville
	Paper (%)	10.47	10.47	- The Asia Foundation, 2015 - Only Phnom Penh
	Wood (%)	2.43	2.43	
	Textile (%)	2.43	2.43	
	Nappies (%)	0	0	
	Waste Generation Rate (Gg/$m GDP /yr)	0.0076	0.0076	MoE
4.B - Biological Treatment of Solid Waste	Conversion Rate (m^3/kg)	NA	0.04	Assessment of the Cambodian National Biodigester Programme
	Amount of Biogas Produced and Consumed from (tonnes)	NA	2,024	Energy Balance
	Total Annual amount Treated by Anaerobic Digestion (Gg)	NA	42.16	Estimated based on the assessment of the Cambodian National Biodigester Programme
	Total MSW Generated (Gg)	3, 745	3,847	2006 IPCC defaults*population
	% of Waste Composted (%)	1.83	1.84	Estimate based on Yut S. and Seng B., 2018. KAP on waste management
	Total Waste amount Composted Annually (Gg)	68.43	70.8	Estimate based on total MSW generation and % of waste composted
4.C - Incineration and Open Burning of Waste	Population Data (capita)	13,872,000	14,248,812	NCDD complemented with the world bank database
	Waste Per Capita (kg/cap/day)	0.74	0.74	2006 IPCC default
	Fraction of Population Burning Waste (Fraction)	0.6	0.58	Yut S. and Seng B., 2018. KAP on waste management (data of 2012)
4.D - Wastewater Treatment and Discharge	Population Data (capita)	13,872,000	14,248,812	NCDD complemented with the world bank database
	Degradable Organic Component (BOD) - (kg BOD/ cap/ yr)	14.6	14.6	2006 IPCC default
	Correction Factor for Additional Industrial BOD Discharged into Sewers	1.25	1.25	2006 IPCC default
	Fraction of Population Income Group	Rural – 0.81%		CDB data, NCDD
		Urban low income –		
	Per Capita Protein Consumption (kg/ person/yr)	20.81	22.05	Per capita protein consumption (kg/person/yr)

The solid waste disposal emissions are dependent on the default parameters given under the IPCC software version 2.691 for the "Asia-south -east" region and "Tropical wet" climate zone.

Emission factors used for the emissions calculation of remaining waste sector categories are presented in Table 2.33.

Table 2:33: Summary of Default Emission Factors for the Waste Sector (2005 and 2010)

Categories	Emission Factors	Value
4.B - Biological Treatment of Solid Waste	CH_4 emission factor for anaerobic digestion of solid waste (gCH_4/kg of waste treated)	0.8
	CH_4 emission factor for composting	4
	(gCH_4/ kg of waste treated)	
	N_2O emission factor for composting	0.24
	(g N_2O/ kg of waste treated)	
4.C - Incineration and Open Burning of Waste	Oxidation factor (fraction)	0.58
	Methane emission factor	6,500
	($kgCH_4$/Gg Wet Waste)	
	Nitrous oxide emission factor	150
	(kgN_2O/Gg Dry Waste)	
4.D - Wastewater Treatment and Discharge	Untreated- sea, river, lake- Emission factor (EF) (kg CH_4/kg BOD)	0.06
	Treated- septic system - Emission factor (EF) (kg CH_4/kg BOD)	0.3
	Treated- latrine - Emission factor (EF) (kg CH_4/kg BOD)	0.06
	Emission factors (kgN_2O-N/kg N)	0.005

GREENHOUSE GAS EMISSIONS

Table 2.34 indicates the contribution of each gas to the total emissions of the Waste sector. As given in the Table, the total estimated emissions for the waste sector in 2005 was 1,648.16 $GgCO_2e$, which accounts for 4% of the total emissions in the country. The CH_4 emission is the key gas in the year. All the emission categories under the waste sector contribute to the CH_4 emissions, and solid waste disposal is the primary category to emit CH_4, contributing 58% of the total CH_4 emissions in the year.

Table 2:34: The Waste Sector Emissions in CO_2e for 2005

Categories	Emissions in $GgCO_2e$			
	CO_2	CH_4	N_2O	Total
4 - Waste	60.86	1,386.68	200.62	1,648.16
4.A - Solid Waste Disposal	NA	809.50	NA	809.50
4.B - Biological Treatment of Solid Waste	NA	6.84	4.89	11.73
4.C - Incineration and Open Burning of Waste	60.86	219.19	47.03	327.08
4.C.2 - Open Burning of Waste	60.86	219.19	47.03	327.08
4.D - Wastewater Treatment and Discharge	NA	351.15	148.70	499.85
4.D.1 - Domestic Wastewater Treatment and Discharge	NA	351.15	148.70	499.85

NA- Not Applicable

Table 2.35 summarizes the waste sector emissions for the year 2010. As given in the Table, the total estimated emissions for the waste sector in 2010 was 1,863.97 $GgCO_2e$, which is accounts for 4% of the total emissions in the country. The CH_4 emission is the key gas in the year. Similar to the year 2005, all the emission categories contributed to the CH_4 emissions, and solid waste disposal is the major category to emit CH_4, accounting for 63% of the overall CH_4 emissions.

Table 2:35: The Waste Sector Emissions in CO_2e for 2010

Categories	Emissions in $GgCO_2e$			
	CO_2	CH_4	N_2O	Total
4 - Waste	60.43	1,589.94	213.60	1,863.97
4.A - Solid Waste Disposal	NA	1,003.69	NA	1,003.69
4.B - Biological Treatment of Solid Waste	NA	7.92	5.06	12.98
4.C - Incineration and Open Burning of Waste	60.43	217.64	46.7	324.77
4.C.2 - Open Burning of Waste	60.43	217.64	46.7	324.77
4.D - Wastewater Treatment and Discharge	NA	360.69	161.84	522.53
4.D.1 - Domestic Wastewater Treatment and Discharge	NA	360.69	161.84	522.53

NA- Not applicable

Figure 2.10 shows the GHG emissions in the year 2005 and 2010 from the waste sector by category. The majority of emissions in the sector are from solid waste disposal, contributing 49% of the sector's emissions in 2005 and 54% of the sector's emissions in 2010.

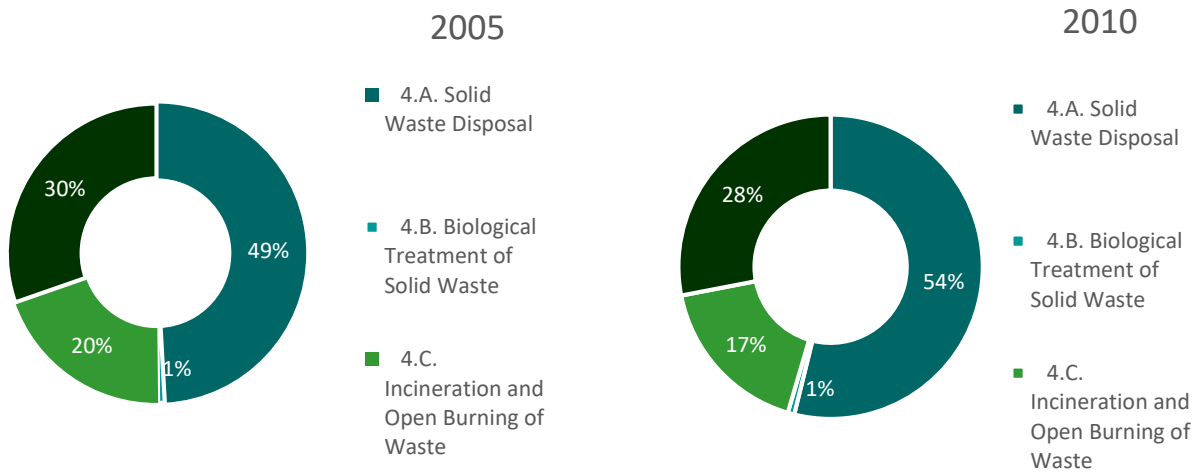


Figure 2.10: Contribution of sub-categories in the Waste sector for the total emissions in 2005 and 2010

2.11 Improvements

Improvement of the GHG inventory system includes improving institutional arrangement, activity data collection, analysis, review, and archive process. The 2006 IPCC Guidelines for GHG Inventory would continue to be used for developing the following GHG Inventory. Efforts would

be concentrated on improving the disaggregation and completeness of the activity data according to the 2006 IPCC guidelines and developing country-specific emission factors for key categories. Below are sector-specific improvement plans. Please refer to the NIR for more details.

For the energy sector, efforts would be taken to improve the time consistency, completeness of the emission sources, collect more disaggregated data, and develop country-specific emission factors for key categories such as road transport.

Activity data related to the IPPU sector mainly were collected from the individual industries. Efforts will be taken to improve the data collection process and provide awareness to measure and report more disaggregated data in the format needed for national communication. Efforts will be continued to collect data on animals under enteric fermentation to more disaggregated levels. Conducting systematic forestry inventory is needed to improve the emission assessment of the Land category. Monitoring fertilizer application practices will also need to be done. Furthermore, efforts will be taken to develop country-specific emission factors for Land Converted to Other lands, Forest Land Remaining Forest Land, Rice Cultivation, and Enteric Fermentation.

For the waste sector, efforts will be taken to collect more disaggregated data on the waste composition, collect more accurate data on waste generation, in-depth data collection on solid waste disposal. Furthermore, to improve the accuracy of the estimations, efforts will be taken to develop country-specific emission factors for solid waste disposal.

3 Vulnerability and Adaptation Assessment

3.1 Introduction

Cambodia is among the countries most vulnerable to climate change globally owing to her low adaptive capacity (Yusuf & Francisco, 2009) and since the majority of the people are reliant on the sectors sensitive to climate variability, such as agriculture. It often experienced damage from natural disasters such as floods, drought, pests, and disease outbreaks, mainly harming rice production and livestock (ROS Bansok, 2011). Almost all provinces in the country are vulnerable or highly vulnerable to climate change due to high exposure to natural disasters, high dependence on climate-sensitive livelihood options such as farming and fishing, and poor coping mechanisms (Yusuf & Francisco, 2009). In the Second National Communication (SNC), there was an emphasis on specific key sectors of high vulnerability, including agriculture, water resources, human health, and coastal areas (GSSD, 2015). Various institutions, including government bodies, donor agencies, private partners, and communities, have been implementing tremendous activities focusing on climate change adaptation at all geographical and institutional levels throughout the country. It is commonly understood that the vulnerability levels would vary both due to the concerted efforts taken place and the natural dynamics of the climate change impacts. Vulnerability status would be improved in some parts of the country, while certain parts would be of critical concern. For the purpose of this Third National Communication (TNC), but not limited to, a rigorous and nationwide Vulnerability and Adaptation (V&A) assessment was carried out. This section elucidates the V&A assessment and its results.

3.2 Objectives and Scope of V&A Assessment

The overall objective of this study is to assess vulnerability to climate change and develop adaptation strategies for Cambodia, particularly in key vulnerable sectors, namely agriculture, water resources, forestry, human health, coastal areas, and gender. The specific objectives are to:

1. Identify historical and future projected climate change in Cambodia using available reconstructed data in the country and the region;
2. Assess the overall vulnerability of Cambodia to climate change;
3. Evaluate the historical and future socio-economic impact of extreme weather events in Cambodian society;
4. Review the impact of climate change and adaptation in key vulnerable sectors, namely agriculture, water resources, forestry, human health, coastal zone, and gender; and
5. Propose adaptation options in the key vulnerable sectors considering the existing technological and institutional context and lessons learnt in the country in and from the region.

This V&A assessment concerned both geographical coverage and sectors that are perceived to be vulnerable to the effects of climate change. It covered the whole national territory of Cambodia. From a country's geographical coverage, a number of specific sites were selected as samples for a case study of field survey to investigate the vulnerability situation and adaptation practices of rural communities at the selected provinces, namely Kampot, Prey Veng, Kratie, and Preah Vihear, which represent the country's different geographical zones, namely coastal areas, low land floodplains, and upland/ mountainous areas, respectively. This geographical selection was based on a review of existing literature, including the SNC report, related sectoral reports of relevant ministries and donor agencies, and discussions with key experts. In addition, through literature reviews of existing studies of the issues, other areas of the country were investigated. Therefore, good coverage of the national territory was considered.

The sectorial focus was put on the vulnerable sectors, including agriculture, forestry, water resources, coastal zone, human health, and gender. However, it is crucial to underscore the limitations regarding the availability of data and technical, financial, and human resources. In this regard, the V&A assessment in these specific sectors used existing, relevant research results from various research institutes and various types of existing papers produced by various organisations operating in the V&A related discipline.

Both bottom-up and top down approaches were taken into account as methodologies of V&A assessment. The selected methodological approaches were firmly in line with the conceptual framework of climate change vulnerability: vulnerability is a function of exposure, sensitivity, and adaptive capacity.

3.3 Observed and Projected Climate Trends in Cambodia

3.3.1 Observed Climate Trends

Cambodia receives a monsoon climate system divided into two distinct dry and rainy seasons. With the accessibility constraints of long-term climate data, the analysis of the observed climate trends of this study was based on the University of East Anglia's Climatic Research Unit Time-Series version 4.02 (CRU TS4.02) and Asian Precipitation – Highly-Resolved Observational Data Integration Towards Evaluation (APHRODITE) dataset sources for the two primary climate variables of temperature and precipitation, respectively.

Figures 3.1 and 3.2 show a trend of average annual temperature between 1901 and 2017, rainfall between 1961 and 2015, and a change in average annual temperature compared to the average baseline (1981-2005). Figure 3.2 illustrates the average annual temperature fluctuated between 26^{o}C and 27.5^{o}C over the period. However, what to notice is that the figures have fluctuated with an upward trend from 26.5^{o}C in 1985 to 27.3^{o}C in 2017. The temperature anomaly/change analysis (Figure 3.3) shows that the change is between -1.7^{o}C and 0.8^{o}C. There was a significant upward trend, from 0.1^{o}C to 0.5^{o}C, over the last four decades since 1980. This trend indicates that Cambodia's temperature has risen compared to the baseline period during this time. However, geographically throughout the country, the variation of temperature range was not significantly different, albeit with slightly higher figures in the north and north-east parts of the country.

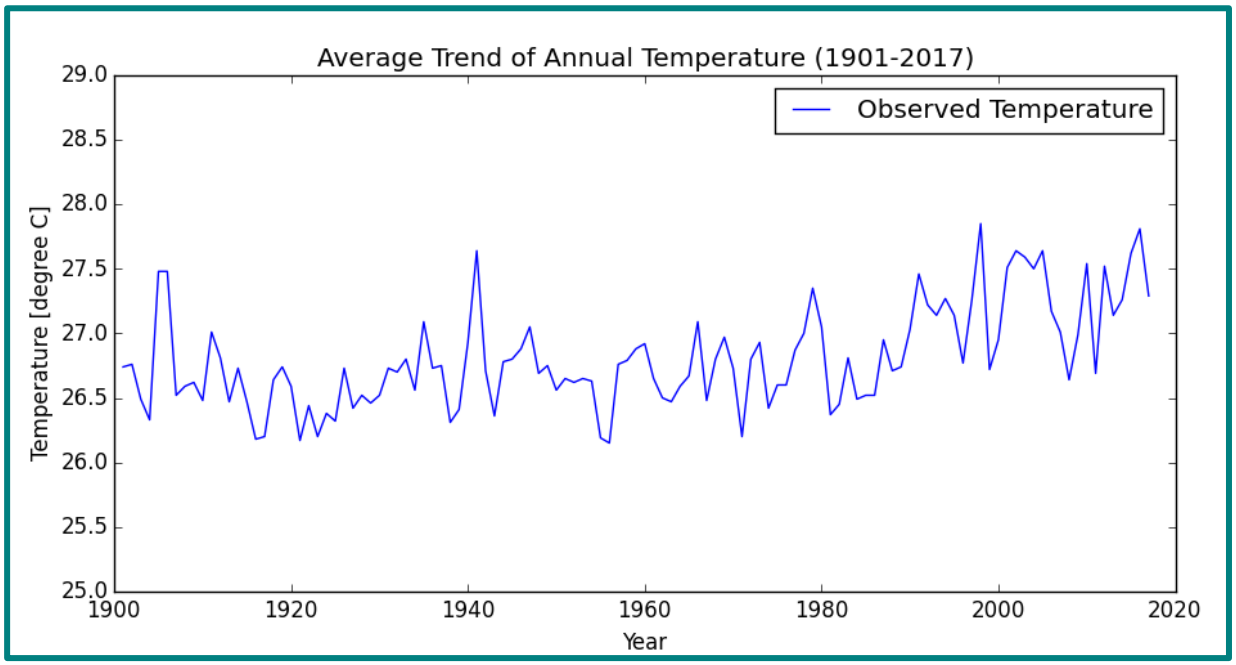


Figure 3.1: Trends of average annual temperature over Cambodia from 1901 to 2017 based on CRU TS4.02 dataset

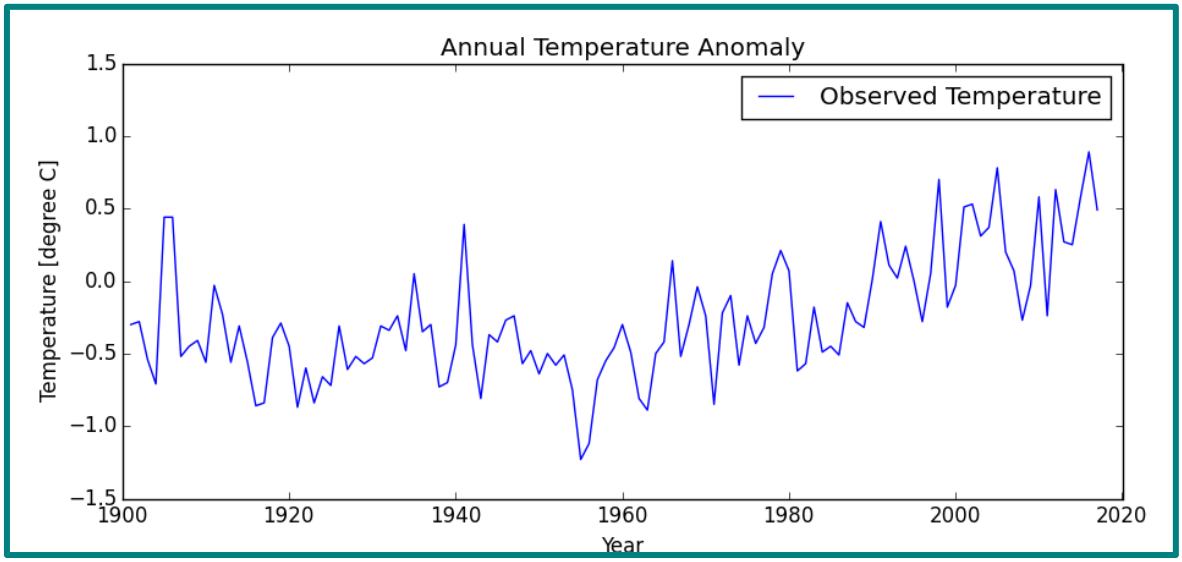


Figure 3.2: Average annual temperature anomaly compared to the average baseline (1981-2005) over Cambodia from 1901 to 2017 based on CRU TS4.02 dataset

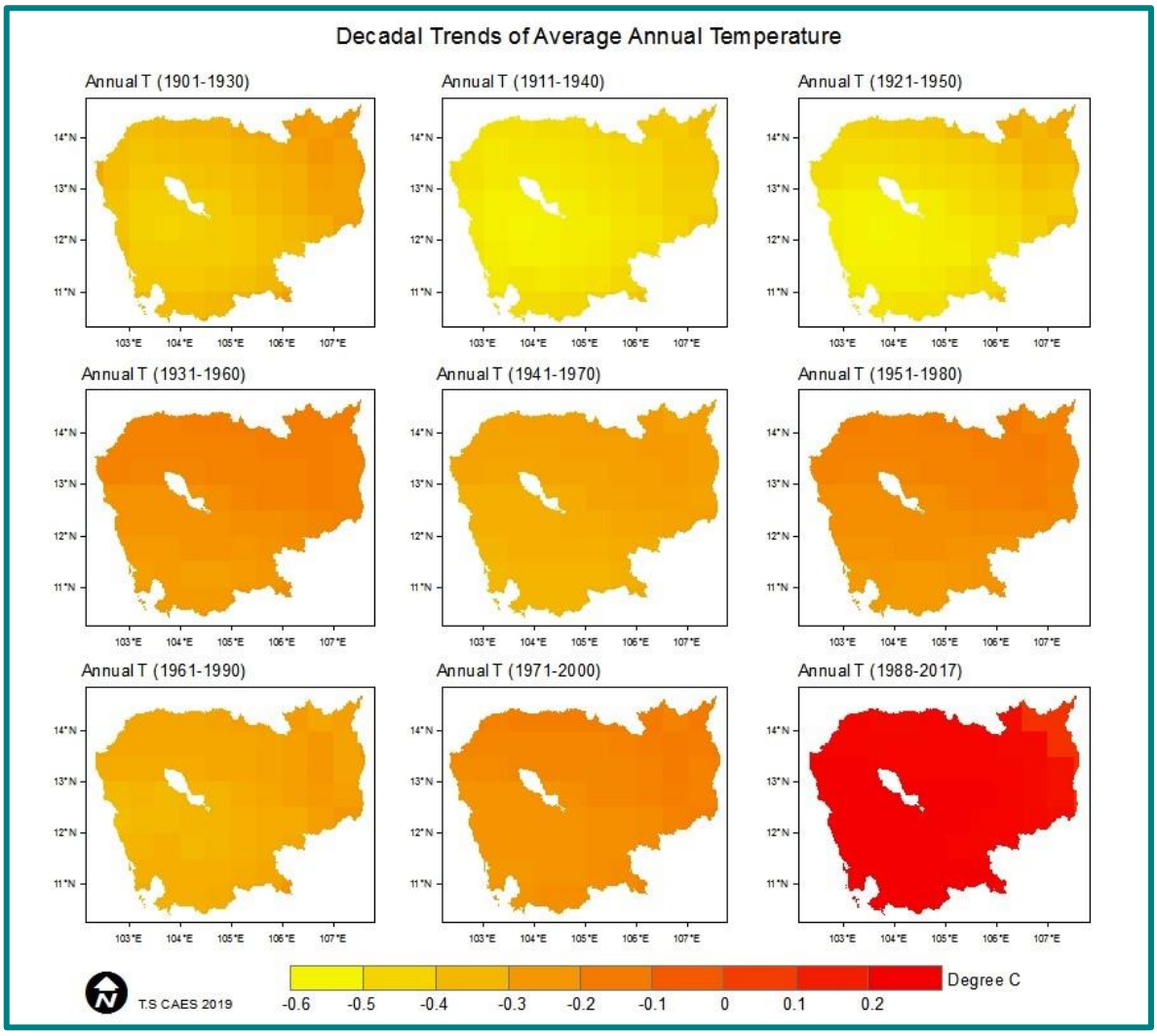


Figure 3.3: Spatially distribution of decadal (30 years) trends in average annual temperature changes compared to the average baseline (1981-2005) over Cambodia from 1901 to 2017 based on the CRU TS4.02 dataset.

Spatial distribution or maps of decadal variations in the average annual temperature, compared with the averaged baseline 1981-2005, measured in nine different 30-year periods between 1901 and 2017, is shown in Figure 3.3. The figure indicates that in the earlier periods, particularly 1901-1930, 1911-1940, and 1921-1950, the average annual temperatures were significantly lower than the average baseline, relatively, between -0.6^{o}C and -0.2^{o}C. Nonetheless, in far later decades, the average annual temperature was greater than the average baseline, signifying it has become hotter in recent years, especially from 1988 to 2017, with a rising temperature from 0.1^{o}C to 0.2^{o}C higher than the baseline period. These data depictions clearly show that Cambodia has been surely suffering the climate change effects of rising temperature, especially in recent years.

3.3.2 Projected Future Climate Change

The projections of climate change were analysed based on the ensembled climate models with a projection extended up to the year 2100, and the selected scenarios of GHG emissions pathways included Representative Concentration Pathway 4.5 (RCP4.5) and Representative Concentration Pathway 8.5 (RCP8.5). With the selected climate variables of temperature and precipitation, the analysis results are illustrated in Figures 3.4, 3.5, 3.6, and 3.7.

Figure 3.4 shows the observed and projected trends of changes in the average annual temperature up to 2100 based on the two climate change scenarios (RCP4.5 and RCP8.5), compared with the baseline period 1981-2005. The average annual temperature is projected to increase in both scenarios, with a more dramatic rise in the RCP8.5.

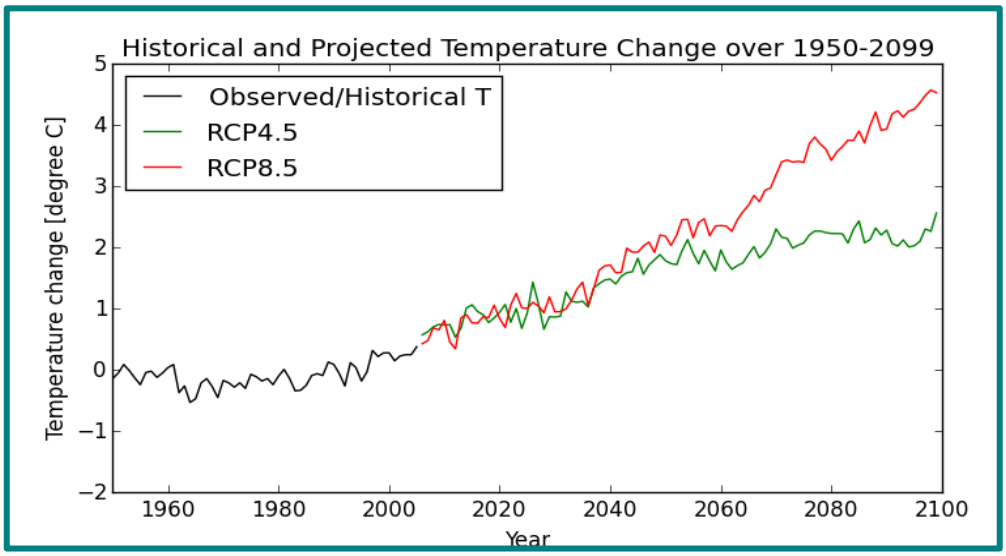


Figure 3.4: Observed and projected trends of changes in average annual temperature up to 2100 based on two different climate change scenarios (RCP4.5 and RCP8.5), based on CRU TS4.02 dataset and different ensembled climate models.

By 2050 or probably earlier, the annual temperature is expected to increase by 1.0^{o}C in both RCPs. While the projection in RCP4.5 is likely to keep increasing slightly to 2.5^{o}C by 2099, the RCP8.5 figures see a catastrophic, dramatic increase up to 4.5^{o}C by the end of the century. Figure 3.5 depicts the nationwide spatial distribution of these climate change projections for the short-term (2026-2050) and long-term (2075-2099) timeframes. Overall, it is clearly seen that a likely greater increase in the average annual temperature is noticed in the northern parts of the country, and the figures in the RCP8.5 is more intent. The long-term projection is expected to be higher in the average annual temperature. In the short term, by 2050, the average annual temperature is projected to increase by 2.5^{o}C in the north and around 1.1^{o}C in the south, and both scenarios are not noticeably different. However, the long-term projection clearly illustrates that the rise in the average annual temperature would fall between 1.5^{o}C and 3.5^{o}C, with lower figures in the south. By 2099 under RCP8.5 scenarios, it is expected to rise sharply, at between 3.5^{o}C and 4.5^{o}C throughout the country.

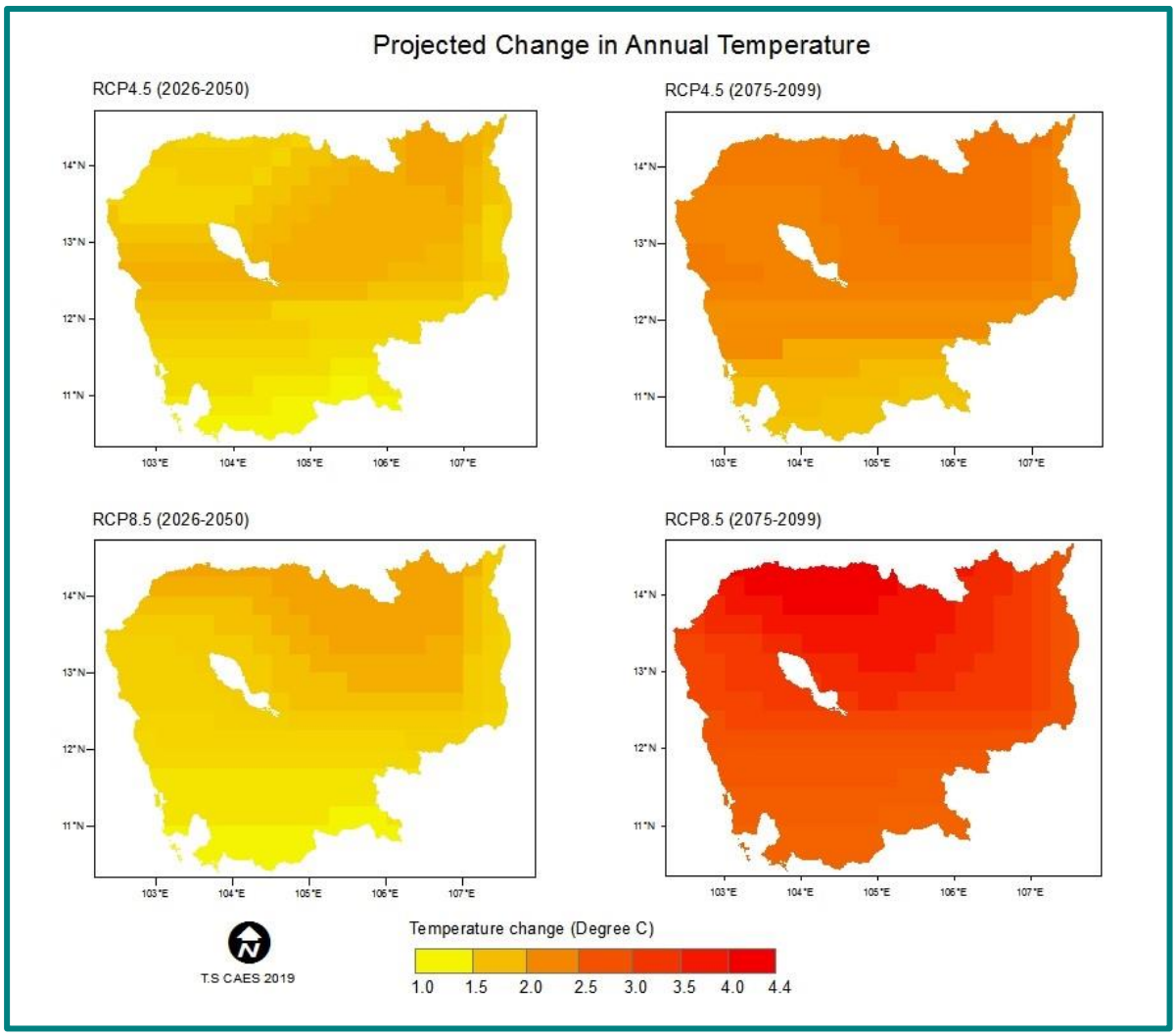


Figure 3.5: Maps of projected climate change in average annual temperature for short-term (2026-2050) and long-term (2075-2099) based on datasets of different ensemble climate models.

Figure 3.6 plots the percentage of changes in average annual rainfall, including the observation and projections relative to the baseline period 1981-2005. It illustrates that the average annual rainfall trends fluctuated approximately around plus/minus 10% in both historical and projected periods. On the regional scale, it is reported that the amount of average rainfall varies significantly in seasonal periods, showing higher intent rainfall in the wet season and drier in the dry season. Figure 3.7 shows that yearly rainfall is predicted to be higher in the southwest, while it will be lower in the east and northeast.

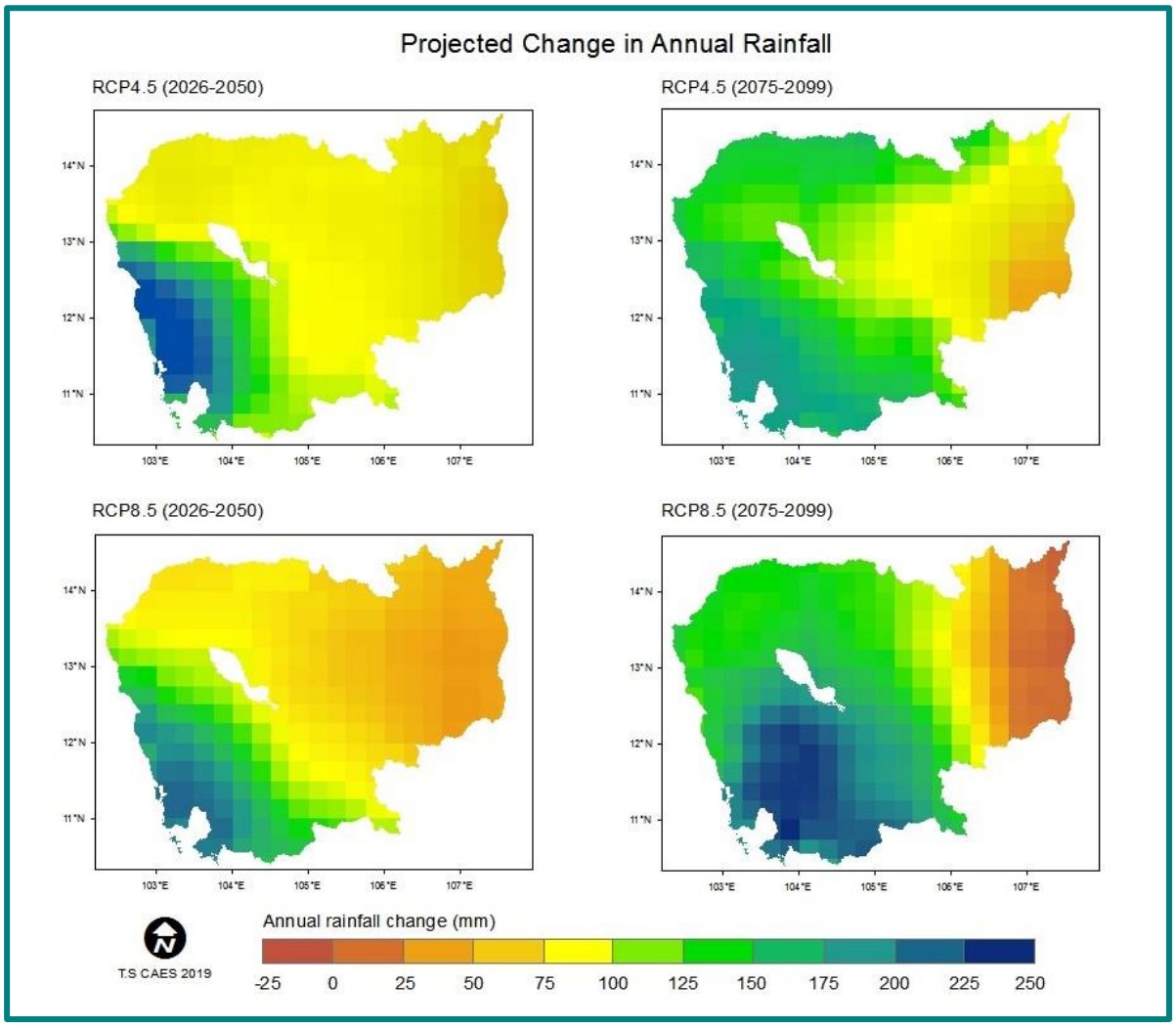


Figure 3.6: Trends of the projected amount of average annual rainfall over Cambodia up to 2100 based on two different climate change scenarios: RCP4.5 and RCP8.5.

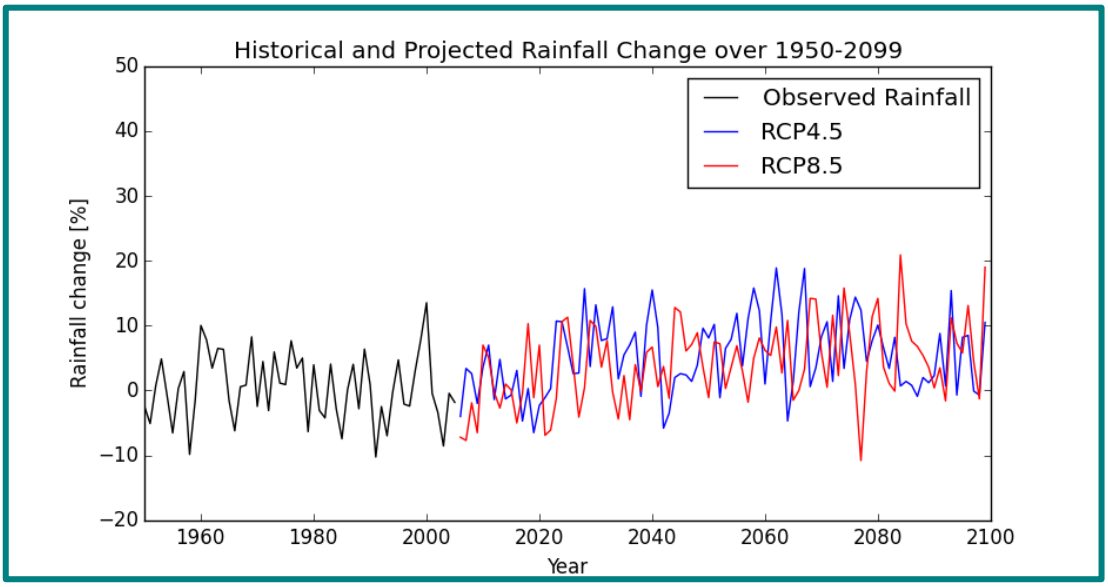


Figure 3.7: Spatial distributions of projected climate change in average annual rainfall up to 2100 based on two different climate change scenarios: RCP4.5 and RCP8.5.

3.4 Climate Change Vulnerability

The vulnerability to climate change at the commune level was assessed using the nationwide commune statistics of 2017 together with a synthetic review of relevant documents and expert judgment and based on the United Framework Convention on Climate Change (UNFCCC) recommended methodological approaches and guidelines. There were eight indicators aggregated in the assessment, including (*i) education level by age groups, (ii) primary occupation types, (iii) household assets and facilities, (iv) remoteness, (v) source of drinking water, (vi) sanitation facility, (vii) dependency ratio, and (viii) frequency of occurrence of climate extreme events*. The assessment complied with the vulnerability framework, being a function of sensitivity, exposure, and adaptive capacity. This assessment shows the current status of climate change vulnerability at the commune administrative level at five scales of the Vulnerability Index: *Very low, Low, Medium, High,* and *Very high*. Figures 3.8 and 3.9 illustrate the results.

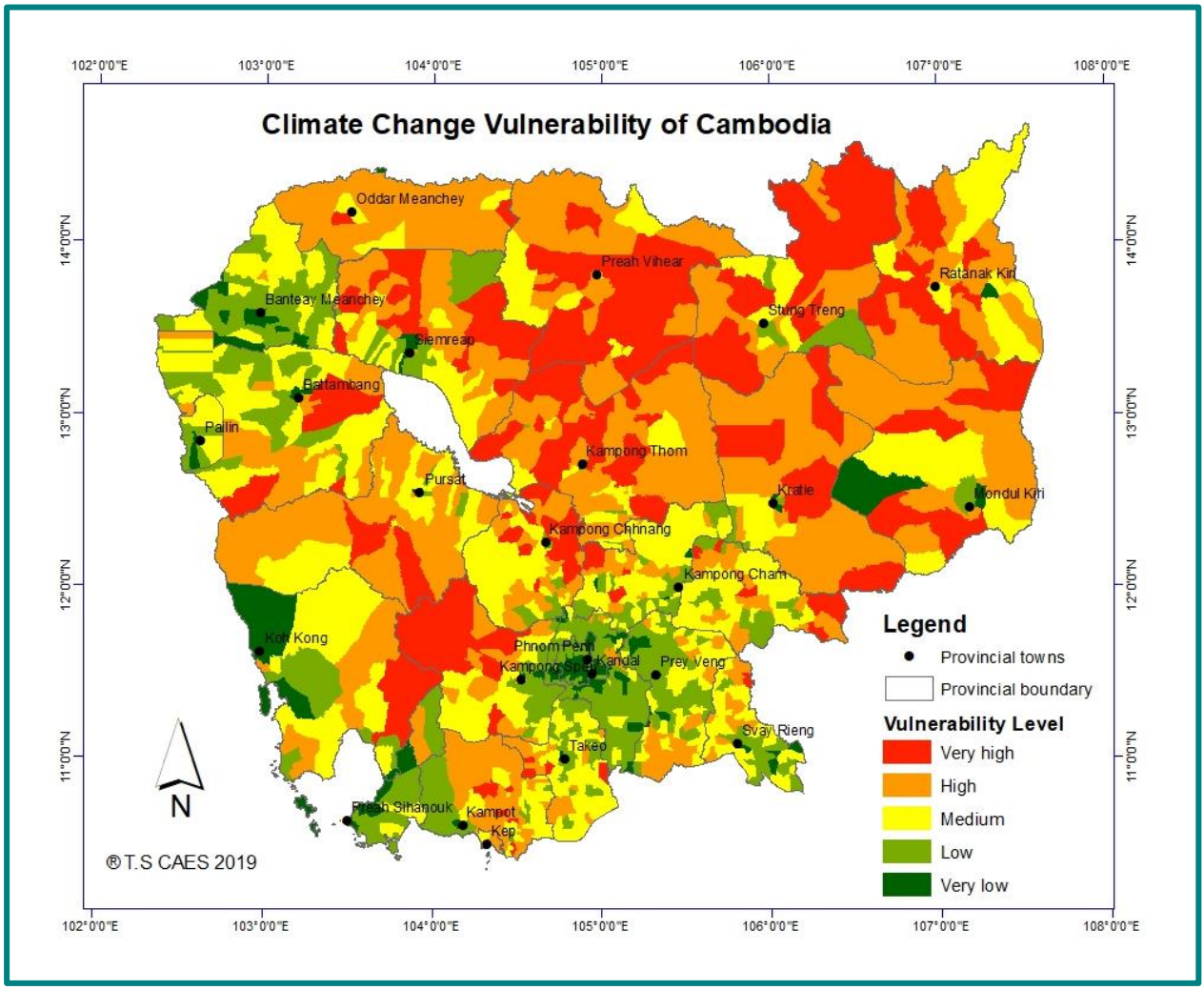


Figure 3.8: Spatial distributions of climate change vulnerability at the commune level. There are five Vulnerability Levels: Very low (dark green), Low (green), Medium (yellow), High (orange), and Very high (red).

It reveals that at least 563 communes (33.5%) of the 1,629 communes fall into the Very high and High categories of climate change vulnerability, with only 185 communes (13.3%) falling into the Very low category. While 468 communes (28.7%) were classified as Medium vulnerable, 413 communes (25.3%) were classified as Low vulnerable. Figure 3.8 depicts the region most sensitive to climate change in the northern and eastern regions of the country, spanning from the country's core region, as Highly and Very highly vulnerable.

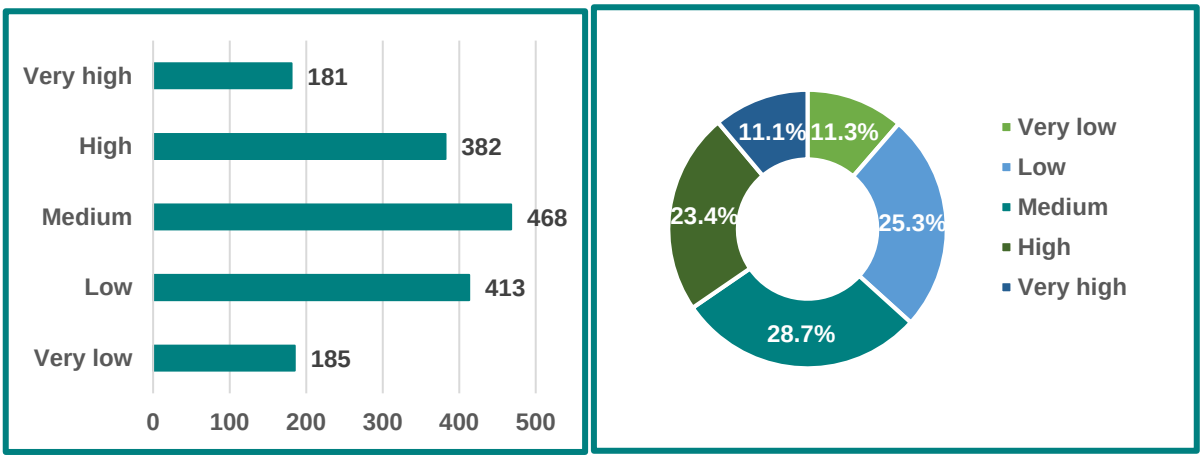


Figure 3.9: Number (left) and percentage (right) of communes regarding vulnerability levels. The total number of communes used in this assessment is 1,629 communes, which is based on the administrative communal-polygon dataset of 2015.

This applies to eight provinces: Kampong Thom, Kratie, Muldul Kiri, Ratanak Kiri, Steung Treng, Preah Vihear, Siem Reap, and Uddor Meanchey. Importantly, the map indicates clearly that the most significant hotspots are within Kampong Thom and Preah Vihear provinces. Furthermore, many communes in Kampong Speu, Kampong Chhnang, and Pursat provinces are also depicted with high and very high spots. The least vulnerable regions are marked in the northwest: Banttey Meanchey and Battambang, Phnom Penh capital and provinces surrounding this capital. Although Koh Kong and Preah Sihanouk provinces are depicted in dark green and green, it would be of attention since the embedded indicators for this vulnerability assessment did not include the risks of sea-level rise due to data availability limitations. Should this factor be integrated (and it is strongly recommended in the next V&A assessment), these coastal provinces would be rendered higher on the vulnerability scale. Another significance of this vulnerability map is a consistent depiction that all the provincial centres/towns are seen as less vulnerable to climate change.

3.5 Climate Change Vulnerability on Specific Sectors

3.5.1 Agriculture, forestry, and fisheries

The country's agricultural resources consist primarily of around 3.7 million hectares of cultivated land, of which 75% is devoted to rice, a primary commodity and source of incomes for the majority of farmers, and 25% to other food and industrial crops, rubber, and freshwater and marine fisheries and aquatic resources employ over three million people (FAO, 2014). This natural-resource-based sector contributed around a quarter to the GDP, 26.3% in 2016 and 24.9% in 2017, and within this sector in the later year, crop productions accounted for 13%, followed by 5.5% of fisheries, 2.6% of livestock and poultry, and 1.6% of forestry and logging productions (MAFF, 2018).

It was stated in the MAFF's annual report that rice production has been gradually increased from 3.163t/ha in 2013 to 3.298t/ha in 2017 (MAFF, 2018a) due to the strong support from the RGC, concerned ministries, various development partners, national and international organisations, sub-national authorities, and active participation by farmers, especially the change from subsistent to commercially oriented production (FAO, 2014). As claimed in the report, such achievement was associated with the application of high-yielding seeds, proper farming technology, soil & water management, extension and demonstration farm trials, and research enhancement.

In pursuit of implementing the NSDP, the MAFF focuses on improving agricultural productivity, diversification and commercialisation by accelerating the implementation of necessary measures,

including building and improving infrastructures support to agricultural production, increasing the provision of technical services to farmers, strengthening the agricultural research and development capacity to increase crop yields and climate change adaptation, improving soil fertility, and strengthening the capacity of agricultural communities and the institutional capacity to promote agricultural development (MAFF, 2018). The MAFF has also accelerated the promotion of livestock and aquaculture by vigorously strengthening the application of rules and regulations to manage natural resources, such as forests, fisheries, and agricultural land, to ensure the sustainability of these resources and the environment. These concerted efforts are implemented to increase the value of agricultural products and incomes for the farmers to promote agribusiness and increase national revenue.

The main focused and vulnerable sub-sectors of agriculture to the impacts of climate change found in this study are rice and crop productions, livestock, fisheries, and aquaculture. The following sections give a synthetic review of the impacts, vulnerability, and adaptation practices and measures in these sub-sectors.

CLIMATE CHANGE IMPACTS AND VULNERABILITY OF AGRICULTURE SUB-SECTORS

Cambodia's agriculture is reported to be highly reliant on rainfall due to the insufficient irrigation systems that could not cover the cultivated land of the whole country. There is no consensus on the areas of total cultivation under an entire irrigation scheme. This study found that by 2017, the areas of cultivation, particularly rice paddy with irrigated schemes, were between 15% and 25% of the total cultivated land, but it was reported that some of these irrigation schemes still faced water shortages especially during the years of prolonged drought. This signifies that rice plantations are highly susceptible to water deficiency, especially under the current acute effects of climate change and in the years to come.

There are several reports and scientific research with respect to the impacts of climate change on agriculture. FAO (2008) states that climate change is expected to affect the productivity of rice systems significantly, thereby worsening the nutrition and livelihoods of millions of people. Furuya et al. (2014) studied the impacts of climate change on the rice market and production capacity and found that the impacts will depress wet season rice production, especially in Cambodia. In addition, Mainuddin et al. (2012) figured out that there will be a significant increase in water productivity of rainfed rice in the lower Mekong basin in Cambodia. In particular, the droughts in 2005 had more intense impacts than those in 2010, reducing Net Primary Production (NPP) by 14.7% and 8.4%, respectively, because of the long drought period and larger precipitation deficit in 2005 than in 2010. The study also confirms a significant variation in vegetation types: less variation in NPP is found for croplands, even under drought conditions, compared to forests, woodlands, and shrublands. The result of that study emphasized that under drought conditions, there are wider uses of irrigation and the exploitation of water sources for farming systems, which means more efforts and costs are required for the production process. Such finding is consistent with that of Furuya et al. (2014), who concluded that climate change impacts would raise production costs of rice farming in Cambodia, Lao, and Vietnam.

The critical concerns of extreme climate events as the effects of climate change impacting the agriculture sector are mainly floods, droughts, and pest and disease outbreaks for crop plantations and other agricultural systems. The section to come is a description of vulnerability status in three key sub-sectors: rice and crop productions, livestock, and fisheries and aquaculture.

RICE AND CROP PRODUCTION

In Cambodia, rice and the dominant crop accounting for over 75% of the country's total crop production, is mainly cultivated in the floodplain regions of the Mekong and the Tonle Sap great lake. Rice and certain crop production systems are extremely sensitive to large year-to-year climate variability.

It was highlighted that a 1ºC increase in temperature would cause the annual mean crop loss by around 10%, indicating that climate change may render cropping agriculture an unprofitable activity for an average farm. However, the agricultural impact of climate change may be felt evenly across the country. Increased wet-season rainfall in drier areas can be beneficial, especially if this coincides with reducing the frequency and duration of drought in the wet season (MoE and UNDP, 2011). In wet areas, the potential increase in flooding tends to make rice plantations unviable in low-lying areas if they are too frequently inundated; in turn, this will likely require a more transformational shift to production systems such as through changing rice cropping into the dry season through irrigation.

The projected impacts of climate change on crop production were emphasised in the MAFF's Climate Change Priority Action Plan 2014-2018. Table 3.1 gives a summary of these projected impacts. In addition, recent research carried out by International Centre for Environmental Management (ICEM) on the vulnerability of main crop productions using climate-crops modelling was published in the *Mekong ARCC Climate Change Impact and Adaptation Study on Agriculture* report (USAID, 2014). In Cambodia, a study focusing on rice and specific commercial cash crops such as soybean, cassava, and rubber in Mondul Kiri (upland and mountainous areas) and Kampong Thom (Tonle Sap flood plains) found that these crop plantations are Highly vulnerable in Kampong Thom and Medium to Highly vulnerable in Mondul Kiri – see Tables 3.2 and 3.3 for a summary of the findings.

Table 3:1: Projected Climate Change Impacts on Crops Productions in MAFF's Climate Change Strategic Action Plan (2014-2018)

Climate Change Effects/Threats	Impacts Summary	Source
Increased Temperature	Reducing the crop yields. The yield of rice decreases by 10% for every 1°C increase in the minimum temperature during the growing season.	Peng et al., 2004
Pest and Diseases Outbreak	The higher growth rate of pathogens due to the long growth cycle and warmer season and the increase in weeds due to the increased atmospheric CO_2 concentration	MAFF (2014)
Sea Level Rise and Saline Water Intrusion	Reduce vegetable crop area at the coastal zones with flooding in the tidally influenced areas and increased are affected by saline water	MAFF (2014)
Increased extreme weather events	Causing frequent droughts and floods devastating crop plantations. The more floods and droughts – more intense and frequent – will make the onset of growing seasons less predictable, thereby affecting productivity, especially rice which is sensitive to the timing of the first rains. Mini droughts in the wet season and unexpected rain in the dry season further affect productivity and the livelihoods of farmers.	MAFF (2014)
Changes in Rainfall Patterns	Wet seasons would be shorter but with higher levels of rainfall, while the dry season will be longer and drier. This will result in shifts in the distribution of rainfall between areas. The changes to the length of seasons, combined with the delayed onset of the wet season after a long dry season, will affect traditional cropping practices	MAFF (2014)

Source: MAFF (2014)

Table 3:2: Main Threats and Vulnerability for Crops in Kampong Thom Province

Vulnerable Crops	Threats	Impact Summary	Vulnerability
Lowland Rainfed Rice	Increased Temperature	More than 75% of the maximum daily temperature is above the optimum zone for lowland rainfed rice.	High
		More than 50% of the maximum daily temperature greater than optimum temperature for irrigated rice.	
Irrigated Rice		High Extreme maximum temperature (<25% of frequency) higher than 35°C during soybean crop High growth.	
Soybean			
Lowland Rainfed Rice	Flooding	Flood prone area around the Mekong and Tonle Sap High Lake in the southwestern part of the province. In October, precipitation is above 500 mm per month, and total precipitation in the wet season is above 1,700 mm.	High
Cassava			
Soybean			
Soybean	Decrease in Water Availability	The decrease in water availability will be between 10% and 4% during the crop growth.	High

Source: ICEM (2013)

Table 3:3: Main Threats and Vulnerability for Crops in Mondul Kiri Province

Vulnerable Crop	Threats	Impact Summary	Vulnerability
Cassava, Soybean, Lowland Rainfed	Storm and increased rainfall	Twenty-one days with rainfall exceeding 100 mm, and one day exceeding 160 mm every year.	Medium to High
Soybean	Increased water availability	A decrease in water availability would be between 18% and 20% during crop season, creating water stress.	High
Rice	Increased temperature	An increase in maximum temperature will fall between 12% and 17% compared to baseline during the growth period. More than 50% of the maximum daily temperatures will be above the optimal zone for rainfed rice.	Medium
Cassava	Increased temperature	Around 15% of the days will be above 35°C as during the growth cycle cassava.	Medium
Rubber	Increased temperature	The dry season (March to May) will have more days above 35°C as daily maximum temperatures, with temperature increases of 17% in May	Medium
Soybean	Increased temperature	Higher maximum temperatures below 35°C in the rainy season will create stress and limit yield. This might be a stress for soybean in the case of the early wet season crop, in April or May.	Medium

Source: ICEM (2014)

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). MAFF's 2019 annual report indicates that in 2018, livestock husbandry increased by 3.6% compared to the previous year. The primary livestock commodities include cows, buffalo, pigs and poultry, which pigs are predominantly raised in the traditional system. Approximately 90-95% of farming households throughout the country have chickens, which are mainly local genotypes raised primarily for meat in scavenging, low-input, low-biosecurity backyard systems (ICEM, 2014).

It has been recognised that small- and medium-scale commercial livestock operations are most vulnerable due to the limited capacity to adapt to the effects of climate change. Commercial livestock production units have increased dramatically in recent decades, and this trend is highly likely to continue. The summary of the vulnerability to climate change of different livestock systems in Cambodia is shown in Table 3.4, emphasised in the MAFF's climate change strategic action plan. This result was also concluded by synthesising various information and expert assessments.

Furthermore, 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. The thermoneutral zone of this species is typically 0-20°C, and the individuals exhibit a significant decline in milk yields at around 21-25°C. This is important for the burgeoning dairy industry, which largely employs Holstein-Friesians. However, relatively wide variation exists between breeds. For example, Brown Swiss milk production is not affected until 30-32°C and will depend on the animal's past experience.

In terms of 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. In their first few days, young pigs are most susceptible to low temperatures. Bigger piglets are better able to cope; hence,

improved sow condition management is a possible means of building resilience to temperature changes.

For poultry, the optimal temperatures are approximately between 25°C and 30°C at all times 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. However, given the capacity of bovines to adapt to different temperatures, minor temperature changes across the region will have impacts at scale but will be difficult to notice or measure in individual animals or herds.

Table 3:4: Vulnerability Level of Livestock to Climate Change Threats in MAFF's Climate Change Strategic Action Plan (2014-2018)

Livestock System	Impact	Adaptive capacity	Vulnerability
Smallholder Cattle/Buffalo	Low	Low	Medium
Dairy/large Commercial Livestock Farms	Very high	High	High
Small Commercial Pig	High	Medium	High
Smallholder Low-Input Pig	Low	Low	Medium
Smallholder Commercial Chicken	Very low	Low	Very high
Scavenging Chicken	Low	Low	Medium
Field Running Layer Duck	Very low	Low	Low

Source: MAFF(2014)

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. The result of the V&A assessment of climate change on livestock, conducted by the ICEM under the United States Agency for International Development (USAID) support, is provided in Table 3.4.

FISHERIES AND AQUACULTURE

This sub-sector includes freshwater and marine fisheries and aquaculture. 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[3]. The average annual fish consumption per person is estimated at 63 kg. According to the MAFF, 2018, in 2018, the total annual productions of fisheries and aquaculture were 910,153t, comprising 535,005t of freshwater fisheries, 121,100t of marine fisheries and 254,048t of aquaculture MAFF (2018).

[3] https://www.worldfishcenter.org/country-pages/cambodia

Any declines in natural productivity would have serious food security implications that other forms of food production could not offset. Short-term climate change impacts on aquaculture can include losses of production and infrastructure arising from extreme events such as floods, increased risks of diseases, parasites and harmful algal blooms. Long-term impacts can include reduced availability of wild seed as well as reduced precipitation leading to increasing competition for freshwater (FAO, 2018).

Furthermore, increased temperatures will have significant impacts on elements of the capture fisheries and aquaculture systems affecting food security and the livelihoods of the people living in these areas. Extreme weather events could further harm Cambodia's fish production by causing loss of aquaculture stock and destroying fishing and aquaculture infrastructure (Chiappa, 2019). Changes in fishery production are likely to impact people who depend on fishing as their primary livelihood activity. As these people are often poorer and more marginal than those who own land and have other primary sources of income, the effects of climate change on fisheries will harm those least equipped to cope[4].

Droughts and reduced water availability through decreased precipitation will be more manageable by some species and aquaculture farmers in some areas but will seriously impact others. Storms and flash flooding will likely affect the viability of aquaculture systems, more so than slow-paced flooding, which allows for greater adaptability. However, fisheries are not only affected by climate change but the infrastructure developments of dams and irrigation systems on the upstream Mekong. By 2030, climate change may raise the wet season flood level of the Tonle Sap lake by 2.3 meters (J. Eastham et al, 2008), extending feeding grounds and encouraging fish production.

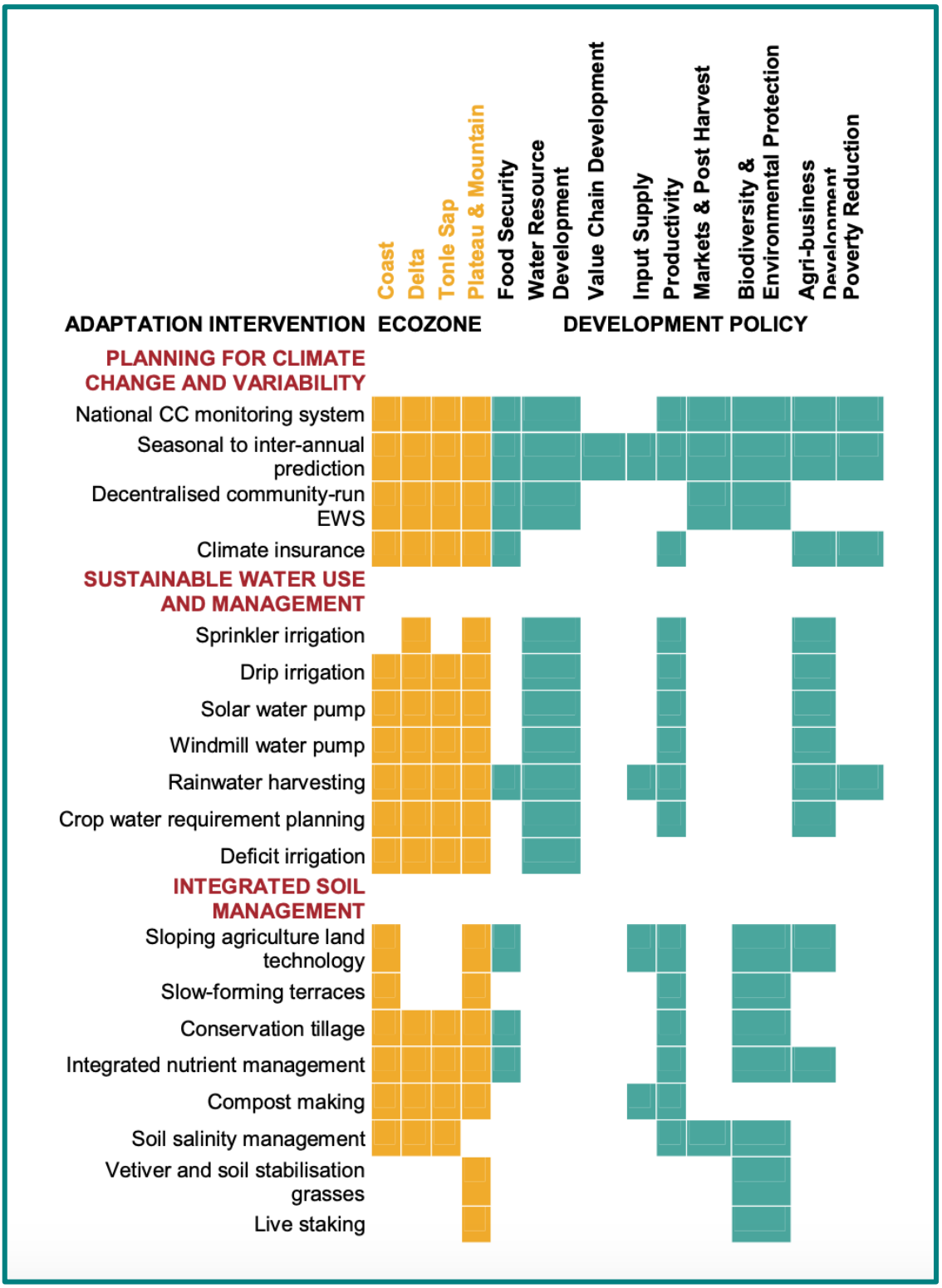
ADAPTATION PRACTICES AND MEASURES

Cambodia's Nationally Determined Contribution (NDC) focuses on adaptation, highlighting that climate change adaptation action requires an integrated, multi-sector approach to be effective and to be able to support national development objectives. The country has made concerted efforts to adapt to the impacts of climate change in various affected sectors, particularly agriculture and its sub-sectors.

ADAPTATION IN CROP PRODUCTION SYSTEMS

Adaptation practices in the agriculture sector have been implemented substantially through various projects coordinated by the concerned ministries, research institutions, universities, and Non-Governmental Organisations (NGOs), including donor agencies. Many farmers have been introduced to some agriculture practices/ technologies to adapt to the effects of climate change, and these technologies are perceived somehow to help the farmers' farming practices be more climate-resilient. Figure 3.10 is a summary matrix of recommended adaptation interventions in different Cambodia's ecozones and the type of intervention policies.

[4] http://publications.iwmi.org/pdf/H042414.pdf


Coast
Delta
Tonle Sap
Plateau & Mountain
Food Security
Water Resource Development
Value Chain Development
Input Supply
Productivity
Markets & Post Harvest
Biodiversity & Environmental Protection
Agri-business Development
Poverty Reduction
ADAPTATION INTERVENTION
ECOZONE
DEVELOPMENT POLICY
PLANNING FOR CLIMATE CHANGE AND VARIABILITY
National CC monitoring system
Seasonal to inter-annual prediction
Decentralised community-run EWS
Climate insurance
SUSTAINABLE WATER USE AND MANAGEMENT
Sprinkler irrigation
Drip irrigation
Solar water pump
Windmill water pump
Rainwater harvesting
Crop water requirement planning
Deficit irrigation
INTEGRATED SOIL MANAGEMENT
Sloping agriculture land technology
Slow-forming terraces
Conservation tillage
Integrated nutrient management
Compost making
Soil salinity management
Vetiver and soil stabilisation grasses
Live staking

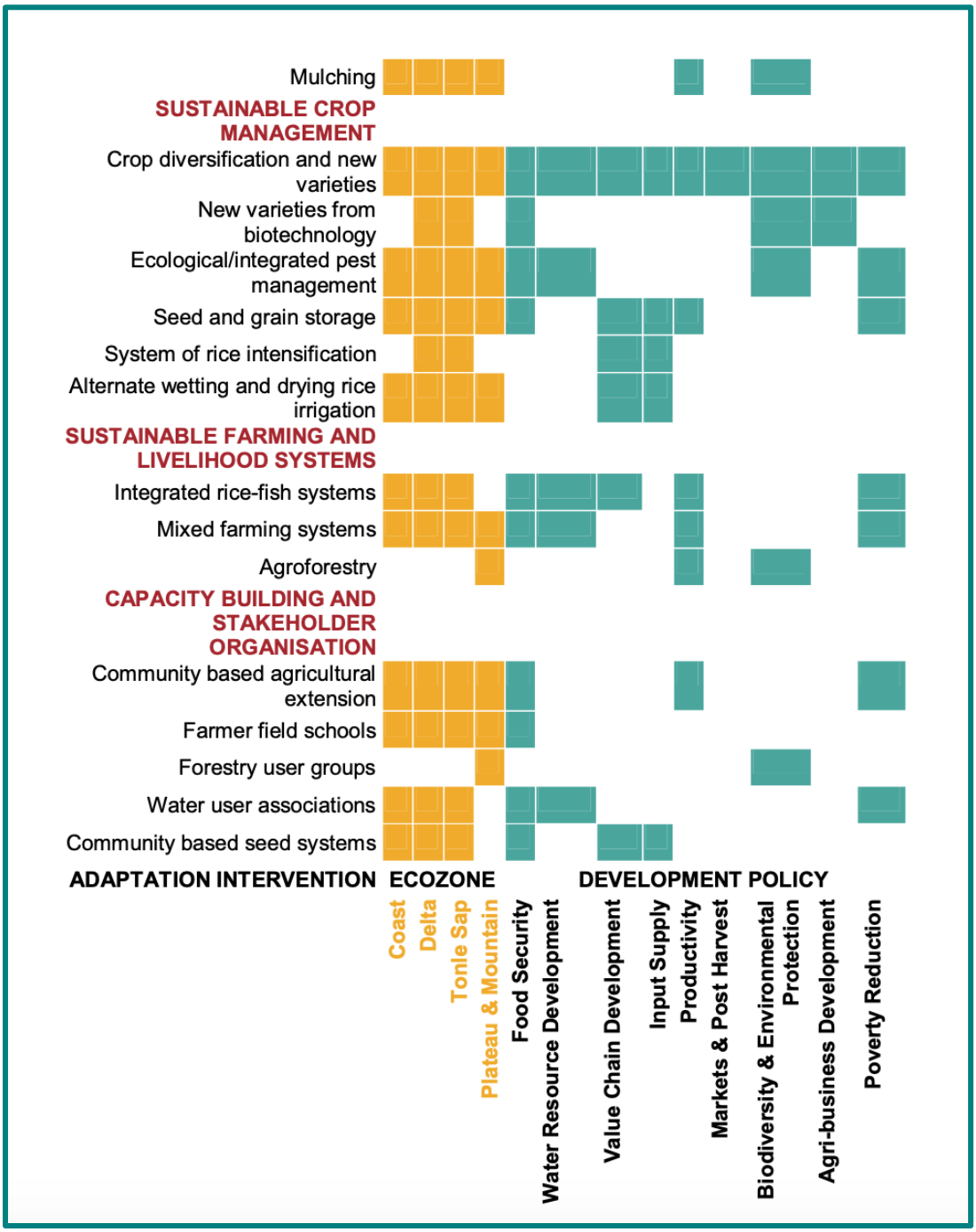


Figure 3.10: Selected adaptation measures and technologies in crop production systems at different ecozones and policy options for agriculture production systems

Source: MAFF (2019)

FISHERIES AND AQUACULTURE

Food and Agriculture Organization (FAO)'s report recognised that the impacts of climate change on the fisheries and aquaculture sector will be determined by the sector's ability to adapt because each specific fishery or fishery/aquaculture enterprise exists within unique contexts, and climate change adaptations must start with a good understanding of a given fishery or aquaculture system and a reliable assessment of potential future climate change (FAO, 2018). The suitable adaptation measures are as follows:

- Enhancing the productivity of rice field fisheries through the protection of dry season habitats for fish;
- Participatory action research in inland small-scale fisheries co-management and wetlands conservation;
- Low input, cost-effective, and nutrition-sensitive small-scale and medium enterprise models for aquaculture production and business enterprise models;
- Climate-Smart Agriculture technologies and practices;
- Adapt by making ponds for conservation, making conservation areas;
- 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;
- Create/build self-help groups;
- Extend/promote understanding of climate change;
- Grow/re-grow forests and the flooded forest;
- Dig ponds, rehabilitate canals, make conservation areas;
- Select livelihoods option to adapt to climate change;
- Build networks and provide information on climate change; and
- Species should be screened, and better-adapted species selected, or strains could be developed that are physiologically more tolerant to the changing environment.

3.5.2 Water resources

BACKGROUND

Cambodia's water resources are highly dependent upon the Lower Mekong River Basin (LMRB), which includes the Tonle Sap basin with 12 tributary sub-basins; the Sekong, Sesan, and Srepok rivers of the northeast; the Cambodian Mekong delta; and several small river systems from the high-rainfall Cardamon and Elephant Mountains in the southwest (MoE and UNDP, 2011). The rivers and streams, lakes, aquifers, and marine water are important sources for national economic development in many sectors including agriculture, manufacturing, and small-scale industries, hydropower, navigation, tourism, environmental protection, and the livelihoods of the population, especially those living along the floodplain regions. The Mekong and Tonle Sap rivers and their systems play vital roles in maintaining aquatic ecosystems and provide natural resource bases for national economic and social development, particularly for agriculture and fisheries, which are the main sources of national and household incomes.

Albeit with plenty of freshwater resources, the country has faced tremendous challenges in water resource management related to the availability and distribution at different periods of the year, across spatial regions and between users. These include floods in the rainy seasons and water shortages in the dry seasons, which not only affects agricultural and fisheries activities (MRC, 2009). Importantly, the seasonal cycling of water levels at Phnom Penh causes the significant water flow reversal to and from the Great Lake via the Tonle Sap, with the associated flooding and drying creating a rich ecology.

Cambodia's water resource management law was approved in 2007, building on the National Policy on Water Resources Management and the Strategic Plan on Water Resources Management and Development (2005-2008). The law includes several Articles that deal with water users' rights, organisation, and participation. It emphasises the integration of farmer water user committees (FWUC) into water resources sustainable management as the most important and decentralised scheme of the RGC for poverty alleviation. The law references the need to integrate environmental

considerations into water management but does not address climate change issues specifically. It highlights the recognition of the cross-sectoral nature of water management, and the need for inter-agency and ministerial cooperation, although realising such cooperation is challenging in practice. This becomes particularly important, including the transboundary coordination between the countries involving the Mekong due to the interconnected and inter influential nature.

IMPACTS AND VULNERABILITY

Climate change is known to exacerbate the existing challenges of the country's water resource management (Bach et al, 2014) . It is also emphasised that climate change will increase water management challenges; less rainfall is anticipated during the dry season and more during the wet season, with more extreme weather events and potentially worse seasonal water shortages and floods (MWRM, 2012). The challenges are more threatening to a developing country like Cambodia, where meteorological systems are not yet able to forecast extreme weather, like flash floods and unpredicted drought, which have often happened in Cambodia.

According to the MoE and UNDP (2011), the changing climate will shift the timing and intensity of rainfall patterns and seasons, change the hydrology of the major rivers and their tributaries, affect ground water aquifers, and increase the frequency and intensity of extreme events like floods and droughts. These changes affect the quantity, quality, availability and distribution of water. Climate change also alters the habitats of the Tonle Sap basin: increasing the open water by 2–21% and reducing rain-fed habitats by 2–5%, and seasonally flooded habitats by 5–11% (Arias et al, 2012). Such distortions are believed to affect key fishery habitats, thereby leading to substantial impacts on human development, as fish is the main source of protein in the local diet. There are no viable substitutions to fish in local diets, so this would worsen the low nutrition levels across rural areas.

The impacts of the present climatic change on natural resources and socio-economic systems are currently less clear but anticipated to become more visible and significant over time, particularly as projected future climate change across the LMB is extreme under some scenarios (MRC, 2018). However, according to Mekong River Commission (MRC) (2018), the impacts of climate change on the water resources, especially the LMB, are specified. Although certain phenomena like drought and floods occurred in specific years, it is unlikely to conclude that such phenomena result from the effects of climate change.

However, models show that significant impacts are highly likely to occur requiring particular attention in the future. It is undeniable that the hydrologic conditions of the Mekong and water systems in Cambodia are affected by climate change and the upstream infrastructure development. It is projected that the largest range of predicted impact at Kratie associated with climate change and 2060 infrastructure development scenarios are: the range of annual river flow change is estimated as -38% to +28%; water level -1.95m to +1.29m; flood season peak flow -30% to +43%; flood season peak level -2.83m to +2.96m, minimum 1-day flow -21% to +79% and minimum 1-day level -0.18m to +0.90m (MRC, 2018). More importantly, the shift in hydrological level and flow will affect other sectors, including agriculture, natural resources, socio-economic systems, particularly fisheries, and ultimately the people whose livelihoods depend entirely upon such activities.

It was conclude that there will be a significant change and decline in ecosystem services that drive ecological productivity: habitat cover, net primary productivity and sedimentation if mitigation and adaptation strategies are not implemented (Arias et al., 2014). They further demonstrate that climate change effects will link to a decline in ecosystem services attributing to lowering the ecological productivity such as NPP, sedimentations, and habitat cover if mitigation and adaptation

strategies are not appropriately implemented. Such hydrological distortions are expected to affect important fish habitats, thereby connecting to substantial impacts on nutrition supply since fish is the major protein source in the diet of local people in the region, especially those of Cambodia, and this will exacerbate the current low nutrition levels across the rural areas (UNDP, 2011). Besides, more frequent and intense floods and droughts also adversely affect agricultural production and livelihoods. For instance, Cambodia has already been tremendously affected by 12 major flood events between 1987 and 2007 (ICEM, 2013). Under the conditions of potentially more frequent and intense floods and droughts, farmers will likely be more exposed to higher risks of crop failure and livelihood burdens.

ADAPTATION PRACTICES AND MEASURES

It has been acknowledged that climate change adaptation is necessary for the water sector in Cambodia. 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. They target 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.

In addition to the MoE's National Adaptation Programmes of Action (NAPA) and CCCSP (2014-2023), the Climate Change Strategic Plan in Water Resources (CCSP-WR) (2013-2017) was published[5], specifying the adaptation policy for water resources of Cambodia. Below is a list of the adaptation measures that this policy highlighted.

- Build foundations for river water use and control;
- Specific awareness-raising 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;
- Capacity building 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 ground water preservation plans and restriction regulation;
- Shore up functions of the river environment, including ecological system preservation and water-familiar functions;

[5] This policy document is available at: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&cad=rja&uact=8&ved=2ahUKEwju9YzyjP3mAhXPR30KHWp1D1YQFjAEegQIBhAC&url=http%3A%2F%2Fwww.camclimate.org.kh%2Fen%2Fdocuments-and-media%2Flibrary%2Fcategory%2F117-sectoral-ccsp.html%3Fdownload%3D531%3Asectoral-ccsp-for-water-resource&usg=AOvVaw3-HUW2wgA-D8PyXmMuWEi5

- Conduct research on what matters most in water resources concerning the impacts of climate change;
- Prioritise climate change coping activities on sustainable water resources development and management; and
- Rehabilitation of canals along Cambodia-Vietnam borderlines.

The mainstream-related activities, such as raising awareness through training, various forms of media and study tours to some places with successful adaptation practices, are particularly important for Cambodia, where mainstreaming adaptation is still minimal (Saito, 2013). They can contribute, though probably insufficient, to behavioural changes required for adaptation. Similarly, staff capacity building within the ministries and other stakeholders is essential for strengthening the institutions, which need to collaborate in the adaptation efforts. Additionally, ecosystem-based adaptation approaches, the good element that the strategy also has, are considered cost-effective as they use local or existing ecosystem services to build resilience (Kerkhoff et al., 2011) and provide multiple benefits socially, economically, culturally, and environmentally through biodiversity conservation (Colls, 2009).

3.5.3 Human health

BACKGROUND

Cambodian's health system comprises public and private sectors (including for-profit and not-for-profit health organisations). The public sector is the prominent provider of preventive services and inpatient admissions, whereas the private sector tends to dominate the provision of outpatient curative consultations. The public health system in the country has three main levels: national, provincial, and operational district levels (Figure 3.11). However, in practice, such a system did not meet the population's essential health needs due to: i) the basic infrastructures, including building and equipment, were in poor conditions; ii) there was a shortage of skilled and motivated staff; ii) commune clinic and district hospital activities were not clearly differentiated; iv) size of population covered by clinic and hospital was either too large or too small; and v) location of facilities was often inappropriate (MoH, 2016).

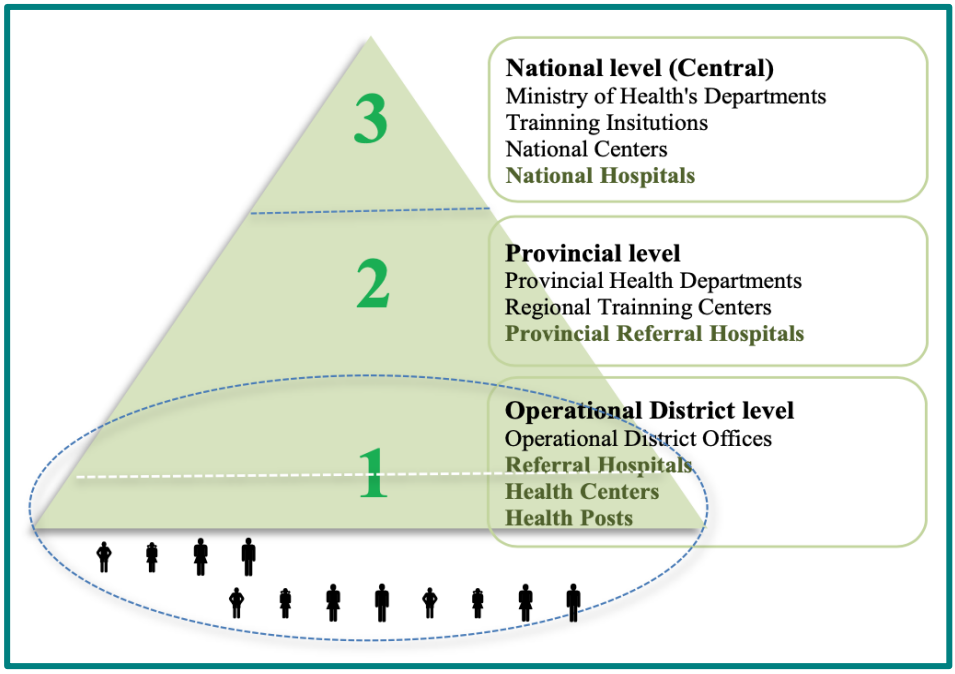


Figure 3.11: Three levels of the public health system in Cambodia
Source: MoH (2016)

The health system faces the dual challenges of the ongoing burden of communicable diseases and a growing epidemic of Non-Communicable Diseases (NCDs). NCDs are already the largest cause of mortality in Cambodia: 32% in 2000 versus 52% in 2013. To cope with the rising burden of NCDs, the existing structures of the health system will need to be strengthened, modified, and expanded in different ways, while consolidating the gains made in other areas such as maternal and child health and communicable diseases control. 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 (MoH, 2016).

People visit private practitioners and clinics more for curative care, whereas preventive activities such as immunisation, tuberculosis (TB) testing, and HIV/AIDS prevention, and control are the domain of the public sector. Wealthier patients tend to use private providers, while the poor depend on providers from the informal sector. The private sector and informal providers account for 61% and 26% of all service provisions, respectively, (MoH, 2016). The government has started strengthening reinforcement of the compliance for facility-based licensure, while enacting a new law on the regulation of health practitioners. Stewardship for the entire health sector, including private health services and those meeting the needs of the poor, is central to health strategy and planning in the coming years.

IMPACTS AND VULNERABILITY

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 (USAID, 2014). An assessment was conducted a time-series analysis between 2001 and 2012 in 16 provinces to evaluate the relation between floods and diarrheal disease incidence in children, found a significant correlation between floods and the increased diarrheal disease incidence in two provinces, and suggest a possible protective effect from toilets and piped water (Davies et al., 2015).

In addition, increased temperatures are projected to increase heat-related conditions for at-risk groups, such as the elderly, pregnant or expecting women, young children, and infants, and deforestation is likely to lead to higher temperatures in cleared areas. 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. Additionally, the combination of climate stressors (e.g., a shift in the timing of the rainy season, increased rain during the wet season, and higher temperatures) and non-climate stressors (e.g., hydropower development throughout the Mekong Basin, deforestation driven by agricultural expansion, illegal logging, and charcoal production) are anticipated to lead to impacts such as changes to the annual flooding of the Tonle Sap and degradation of agricultural land. These impacts could drive increased internal migration from rural to urban areas, which may stress and constrain the efficacy of urban health infrastructure, municipal waste management systems, and water supply infrastructure, all of which could adversely impact health outcomes (USAID, 2019).

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 severe issue in Cambodia. The country faces elevated arsenic levels in groundwater and high rates of diarrheal disease, the latter causes nearly 10,000 deaths annually and could become even more severe due to deforestation and degradation of watersheds. Cambodia is also experiencing more extreme weather events such as widespread flash flooding in 2011 and

2013 and tropical storms like Typhoon Ketsana in 2009. The 2013 flash foods affected 20 out of 24 provinces, a total of 377,354 households, resulting in 168 deaths, while in 2011, flash flooding affected 350,000 households and destroyed 267,000 hectares (ha) of rice fields (USAID, 2019). In addition to direct injury or death, such events further damage essential health services infrastructure and result in the displacement of people, increased standing water, additional strains on food and water supply, and increased risk of the spread of vector- and water-borne diseases.

Furthermore, according to World Health Organization (WHO) (WHO, 2015), Cambodia's human health is profoundly affected by climate change, which threatens to exacerbate today's health problems – deaths from extreme weather events, cardiovascular, and respiratory diseases, infectious diseases and malnutrition – whilst undermining water and food supplies, infrastructure, health systems, and social protection systems. The same report also highlights that deaths from drowning and flooding cause extensive indirect health effects, including impacts on food production, water provision, ecosystem disruption, infectious disease outbreak, and vector distribution. The effects of flooding may include post-traumatic stress and population displacement in the longer term. According to this analysis, heat-related mortality among Cambodia's elderly (65+ years) is anticipated to grow to about 56 deaths per 100,000 by 2080 under a high emissions scenario, up from an estimated baseline of roughly 4 deaths per 100,000 annually between 1961 and 1990. By 2080, Cambodia is anticipated to have about 56 deaths per 100,000, up from an estimated baseline of around 4 deaths per 100,000 between 1961 and 1990.

Table 3:5: Health-Related Risks of Climate Change

Climate change related stressors	Health-Related Risks
Increased temperatures	Increased heat stress resulting in illness or injury such as heat stroke, exhaustion, cramps, or rashes
More intense and/or frequent weather events	Shifts in water- and vector-borne disease burdens
Increased and prolonged droughts	Decreased nutrition and food security; Limited drinking water supply
Increased rainfall and flooding	Decreased water quality impacting health, sanitation and hygiene;

Source: USAID (2019)

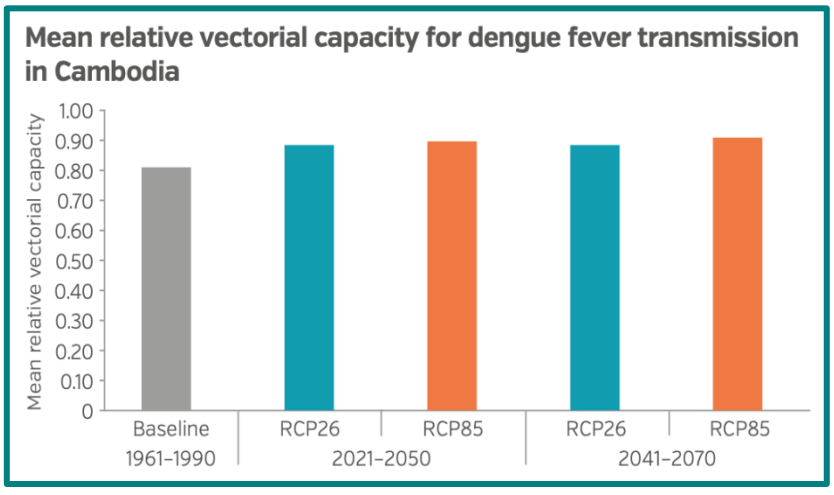


Figure 3.12: Projected mean relative vectoral capacity for dengue fever transmission under the least and worst emission scenarios by 2070

Source: WHO (2015)

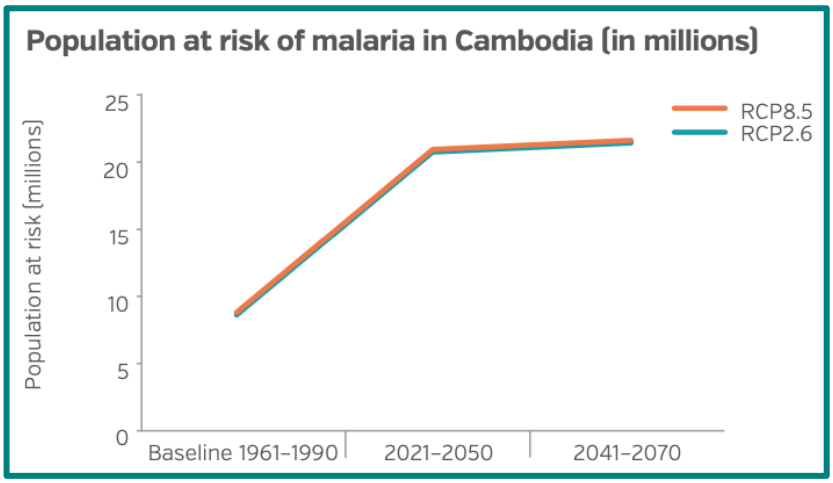


Figure 3.13: Projected population at risk of malaria in the emission scenarios by 2070

Source: WHO (2015)

WHO (2015) further stated the projected risks of dengue fever transmission and malaria in the low and high GHG emissions scenarios. In Figure 3.12, the mean relative vectoral capacity for dengue fever transmission is projected to increase from about 0.82 to about 0.91 by 2070 under both a high and low emissions scenario. By 2070, Figure 3.13, under both a high and low emissions scenario, about 22 million people are projected to be at risk of malaria. Population growth can also cause increases in the population at risk in areas where malaria presence is static in the future.

ADAPTATION PRACTICES AND MEASURES

Adaptation measures to climate change in the health sector were emphasised in the Climate Change Strategic Plan for Public Health (MoH, 2013)of the Ministry of Health (MoH), to reduce morbidity, mortality, injuries, and health vulnerability to climate variability and extreme weather events. The main 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 (MoH, 2013). Table 3.6 lists the most relevant adaptation measures and activities that can be best addressed the health impacts of climate change. It synthesised the reviewed documents and meets with key experts in this particular field. These were categorised into adaptation measures/ activities types, including prevention, control, treatment, public education, capacity, knowledge gathering, and financing.

Table 3:6: Key relevant Climate Change Adaptation Measures and Activities for Health Impacts

Type of Adaptation Measures	Vector-Borne Disease	Water-Borne/Food-Borne Debases	Extreme Weather Events
Prevention	- Use of insecticide-treated mosquito nets	- Sanitation and hygiene - Nutrient and vitamin A supplement - Latrines improvement - Safe and drinking water	- Early warning system instalment and functioning - Sanitation and hygiene - Nutrition and Vitamin A supplement - Safe drinking water

Control	- Use of larvicidal and insecticidal spraying	- Improving infection control procedures to prevent the spread of illness	
Treatment	- Use of appropriate drugs	- Early treatment with oral rehydration fluid - Increasing improved 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 health care facilities, staffing - Research and 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 - V&A assessment of flood and drought - 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
Financing	- Government budget - Health Equity Fund - Safety net - Multiple donors, bilateral - Health insurance	- Government budget - Health Equity Fund - Safety net - Multiple donors, bilateral - Health insurance	- Government budget - Health Equity Fund - Safety net - Multiple donors, bilateral - Health insurance

Source: MoH (2013)

3.5.4 Coastal Zones

BACKGROUND

Cambodia's coastal zone covers a land area of about 17,237 km^2 plus an exclusive economic zone of about 55,600 km^2 and covers the partial territories of Koh Kong, Kampot, Preah Sihanouk, and Kep provinces (GSSD, 2015).Cambodia's coastal zone population growth rate has been increasing steadily since 1981. Statistics by the Ministry of Planning (MoP) have shown that Cambodia's coastal zone population increased from 673,000 in 1994 to 845,000 in 1998 (26%), implying an annual average growth rate of 5.7% (GSSD, 2015). By 2006, the population annual growth rate in the coastal areas decreased to about 3%. The area's main economic activities are agriculture, salt production, tourism, and other services. Agriculture (including forestry and fisheries) is the main economic activity in the area, particularly in Kampot and Kep provinces, wherein in 2005, about 45% and 60% of the area was used for agricultural activities, respectively.

Salt production is significant in Kampot and Kep. About 3,334 ha of saltpans in Kampot, around 60% of which are State-owned, while the community owns the remaining 40%. Annual salt production in Kampot is approximately 70,000-80,000 tons and serves domestic demand. In Kep, there is about 2,000 ha of saltpans. Based on GSSD (2015) indicated that salt production could be expanded to the other coastal provinces. However, an increase in sea level leading to permanent inundation of coastal areas is a potential threat to salt production. The risk of sea-level rise needs to be considered in future development plans.

The tourism sector is of growing importance to Cambodia, with the beaches and islands attracting an increasing number of tourists. A survey has indicated that tourism activity is highest in Kampot and Preah Sihanouk provinces. The sector depends on the coastal zone's ecological quality (coral reefs, beaches, sea grasses, etc.).

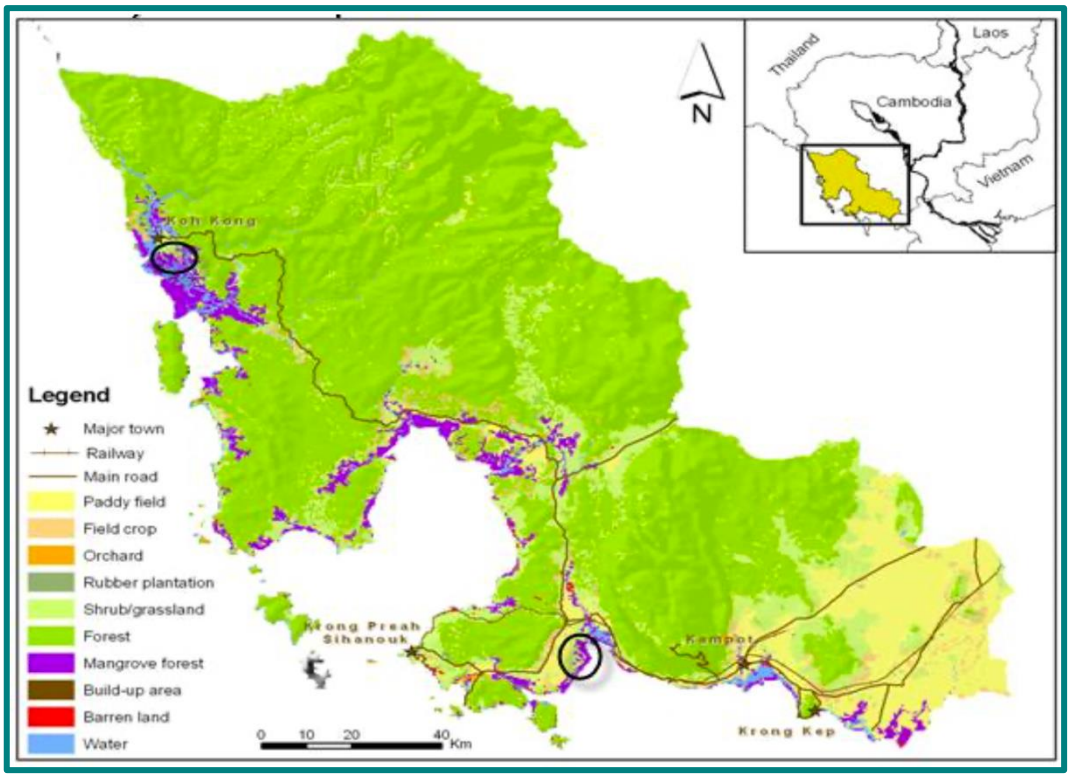


Figure 3.14: Map of the coastal area and its land-use types

Source: CCCA (2012)

In addition, 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). Mangrove forests and mudflats are found throughout the coastal zone. They support both endangered/vulnerable wildlife and species of commercial/livelihood importance, on which many communities living within the area depend.

IMPACTS AND VULNERABILITY

Cambodia's coastal zone is vulnerable to Sea-Level Rise (SLR), seawater intrusion, storms, floods, pests in agriculture production, and contaminated drinking water (GSSD, 2015). Mangrove ecosystems and coastal erosion are especially vulnerable, and their degradation can intensify climate change vulnerability. Poverty levels within the coastal zone are high, with few alternative employment options. Coastal resources are under great pressure, particularly from tourism development, industrialisation and urban expansion. It was projected that a one-meter rise in sea level would result in the permanent inundation of 25,000 hectares of coastal zone within 90 years (MoE, Cambodia's Second Natioanl Communication, 2015). However, modelling sea level rise is notoriously complex, and historical evidence suggests that this figure might be a significant underestimate. Current experience in coastal areas also points to the risks of increased salinisation.

Saltwater intrusion and localised sea surge flooding are already being observed, and with continued future climate change, these issues are expected to intensify. Areas affected by increased salinity are expected to be far greater than the total area of land inundated by SLR. During the dry season, rising sea levels and low river flows will mean that saltwater will extend further into river systems for longer periods, reducing freshwater availability along the coast (MoE, 2005a).

Table 3:7: Main Experienced Climate Change Impacts in the Coastal Areas of Cambodia

Type of climate change related impacts	Climate Change Related Impacts
Sea level rise/ Seawater intrusion	- Salinisation of the land surface as well as the groundwater, impacting the fertility of farming areas as well as freshwater ecosystems - Threat to food security and livelihoods because most agriculture in the coastal zone is concentrated in these flood-prone, low-lying coastal areas - The infrastructure in the coastal zone also comes under pressure, which can lead to an increased vulnerability over time and lost income from tourism.
Storms surge	- The increased frequency of storms affects cultivation, fisheries and coastal erosion. - Destroying households at highly vulnerable locations - In 2011, 38 houses and 14,000 m^2 of mangrove forests were destroyed, two fishing boats sank, and forest fires occurred in about 30 places.
Severe/heavy rainfall and floods	- As a consequence of heavy rainfall, floods destroy property and productive assets, such as crops and livestock.

	- Flooding often leads to poor water supply and unsanitary/unhygienic conditions, causing severe health issues and disease outbreaks. - The heavy rainfall also affects salt production activity
Increased temperature	- Reduce the ability of people to work due to heat stress - It has a detrimental effect on the overall health of people, crops and livestock
Droughts	- A decline in ecosystem functions contributing to food security problems - Droughts or heat waves will ultimately cause problems regarding water scarcity

Source: CCCA (2012)

ADAPTATION PRACTICES AND MEASURES

The mangrove forests and their ecosystems are essential for adaptation to climate change in coastal zones. There are two main reasons: first, the mangrove forests have a vital role in the survival of numerous fish species and other marine organisms and second, the mangrove forests act as the frontline against tropical storms, storm surges, and rises in the sea level, thereby reducing coastal erosion and inundation by creating a buffer zone to protect the coastal zone.

Table 3:8: Climate Change Adaptation Measures Suitable for the Coastal Areas

Climate change related threats	Suitable Adaptation Measures
Sea Level Rise/ Seawater Intrusion	• Construction of saltwater projection dyke saltwater protection dyke • Building small hills for the animals to seek shelter to solve the problems in case of floods • Preparing boats for communities and households • Informing villagers about the importance of cleaning their houses during and after seawater flooding has occurred. • Awareness raising and preparation for emergency relief procedures at all the vulnerable villages • Promoting research to produce saltwater resilient crop species
Severe/Heavy Rainfall and Floods, and Storms Surge	• Conserving and reforestation of mangrove forests • Increasing weather broadcasting system and improving accessibility to the vulnerable groups, for example, through social media • Encouraging local communities to keep up with weather broadcasting news • Planting mangrove forests
Increased Temperature and Drought	• 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

Source: CCCA (2012)

Other adaptation strategies include:

- 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.

3.5.5 Cross-cutting Issues of Gender

BACKGROUND

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. Across the predominant economic sectors, women make up 53% of total employment in agriculture; 73% of those women are found in vulnerable employment situations, meaning that almost three out of four jobs for women in Cambodia are classified as vulnerable. In addition to representing a significant share of the labour force, women owned and managed a large number of business enterprises. According to the Cambodia Economic Census 2011, there are 500,000 business establishments throughout Cambodia, 65% of which are owned and run by women. However, the majority of these are small, informal firms handled by the female proprietor herself, with no or few staff. However, most of these are small, informal firms handled by the female proprietor herself, with no or few staff.

VULNERABILITY AND IMPACTS

Women, especially those living in rural areas, are recognised as the most vulnerable groups to the effects of climate change because women are usually involved in routine tasks sensitive to climate variabilities, such as water collection for household consumption and agricultural work. Women in rural areas are especially 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 (MoWA, 2014). For instance, in drought or water scarcity, more effort is needed to collect, secure, and distribute water resources for family uses (UN Women, 2016). 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 (ADB, 2015).

In addition, (Goh, 2012) found that when food is scarce, often due to floods or droughts, women tend to eat less so that their partners and children have a sufficient amount to eat, resulting in health-related problems for women, including malnutrition.

ADAPTATION PRACTICES AND MEASURES

Gender in climate change is of particular focus by the RGC. In 2013, the MoWAs published the important policies on gender in response to climate change: Gender and Climate Change Strategic Plan (GCCSP) (2013-202)3 and Gender and Climate Change Action Plan (GCCAP) (2014-2018) (MoWA, 2013), which includes the followings:

- 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 decentralised offices and stakeholders;
- Increase the level of capacity of the MoWA and its decentralised 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; and
- Elicit best practices and lessons on gender and climate change for scaling up, learning and sharing.

Moreover, the the GCCAP proposed the following actions:

- 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.

In addition, according to the MoWA (2014), several priority activities have been recommended for action in response to climate change from the perspective of gender issues. These recommended priority actions are as follows:

- Develop a policy framework and program for organic and sustainable agriculture;
- Extension services should proactively target women farmers, especially the vulnerable women;
- Cooperate with relevant institutions to provide technical extension services on organic agriculture and climate change adaptation to women, especially the vulnerable women;
- Create awareness among women entrepreneurs about green growth by providing information on green technology and promoting women's entrepreneurship;
- Promote low carbon economic activities, including new technology, among women, particularly vulnerable women, through green agriculture and small industries;
- Encourage and promote gender equality in sustainable community forest management, including indigenous communities to absorb carbon emissions;
- Women entrepreneurs should be given equal opportunities in public bidding to procure green products and services, especially sustainably produced (organic and chemical-free) food and other products for government offices, schools, hospitals and embassies;
- Introduce Public and Private Partnerships (PPPs) as a key strategy for promoting green growth and entrepreneurship among women;
- Develop an early warning information system including weather forecasts and disseminate updated information, especially among women;
- Use the MoWA's Women's Development Centres (WDCs) for skills training among women, particularly vulnerable women, on adaptation to climate change;
- Research, compile, and encourage the use of renewable energy among families and communities, especially among women, such as solar, wind and biomass digester, and new technology;
- Explore opportunities for using Information and Communication Technology (ICT) among women in agriculture to promote green micro, small and medium enterprises (MSME) and increase access to climate-relevant information;
- Conduct assessments and research on vulnerabilities and the quality of health services for women, particularly vulnerable women and children affected by climate change;
- Collaborate with line ministries, development partners and Civil Society Organizations (CSOs) to ensure that women's health, especially the vulnerable women's and children's, are adequately addressed in the climate change agenda;
- Mainstream gender, and implement strategies and plans at national and sub-national levels, including the disaster preparedness plan, especially related to floods, droughts and storms;
- Set up feedback mechanisms on disasters from affected communities;
- Mainstream gender into the development and implementation of policies and plans related to climate change. Monitor the implementation and budgeting with the participation of relevant institutions to ensure transparency and accountability;
- Allocate an adequate national budget to support the implementation of the policies and action plans on gender and climate change; and
- Establish a monitoring and evaluation framework on gender and climate change.

In building the resilience of women and men in times of climate change, (Actionaid, 2019) recommended the followings with a particular focus on building local resilience of women and men in Cambodia, as elaborated in Table 3.9.

Table 3:9: A Recommended Mechanism to Build Resilience in Gender in Climate Change

1. Invest in Building Resilience at the Local Level: All stakeholders, particularly the government, should allocate resources to build a resilient community and sustainable economy for vulnerable farmers and fisherfolk. Building a self-reliant economy requires investing in protection, conservation, and regeneration of national resources, including productive land, fishery, and forestry, to optimise sustainable food security and income generation. Green development must be prioritised on top of mass development projects. Such investments can improve sustainable livelihoods and climate change adaptation and mitigation simultaneously.	**2. Invest in Building Intuitional Knowledge:** • Building capacity of government disaster management and climate change adaptation structures to improve the development and implementation of disaster management plans, humanitarian assistance, public services delivery in sustainable agriculture and natural resources management, and scientific and technological knowledge at local and sub-national levels. • In partnership with CSOs, enhance the knowledge and resilience capacity of the most marginalised groups at grassroots levels.
3. Invest in Institutional Transformation: • Ensure equality between men and women in disaster management and climate change adaptation mechanisms and women's meaningful participation and leadership in those actions. For example, determine a woman's quota in the disaster management committees. • Development partners and government should prioritise developing and resourcing disaster management plans and Sectoral Climate Change Strategic Plans implementation at the commune and sub-national levels. (iii) CSO should focus their limited resources on building women leaders at local and sub-national levels and facilitate their engagement to influence the planning process and resources allocation at local to national levels.	**4. Enhance Institutional Governance:** • Provide space for women to engage meaningfully in planning, resource allocation and policymaking starting from the commune/Sankat development planning process. • Government should invest in building disaster management and climate change infrastructure at the local level. This infrastructure uplifts the capacity of local stakeholders in preparedness, response, recovery, and adaptation. • The existing Early Warning System should be scaled up (expand its coverage) and scaled out (cover multiple hazards) and ensure that the most vulnerable groups are reached. • Development partners and government must realise their efforts in building resilience from human rights angle instead of humanitarian assistance. This could be done through considering consciousness-raising, empowering women and men to advocate, and government officials to be more accountable and responsive in supporting women and men to access basic services, including sustainable agriculture, natural resources management, social protection, and climate change adaptation.

Source: Actionaid (2019)

3.6 Conclusions

Cambodia has been affected by climate change throughout the country. An analysis based on the historical data between 1961 and 2017, compared to the baseline (1981-2005), sees the changes in average temperature over Cambodia between -1.7^{o}C and 0.8^{o}C. The upward trend was significant over the last four decades from 1980, with the temperature anomaly between 0.1^{o}C and 0.5^{o}C. This signifies that Cambodia's temperature has become hotter in recent years. The projected trend of average temperature in RCP4.5 and RCP8.5 shows that the annual temperature in both RCPs is expected to rise by 1.0^{o}C by 2050 or perhaps sooner. While the RCP4.5 prediction indicates a gradual increase to 2.5 ^{o}C by 2099, the RCP8.5 projection shows a catastrophic, rapid climb to 4.5 ^{o}C by the end of the century. In addition, by 2099 under RCP8.5 scenarios, it is expected to rise sharply, at between 3.5^{o}C and 4.5^{o}C throughout the country's territory. The total average annual rainfall was not statistically changed historically, yet the uneven distributions of the rainfall patterns have been experienced in most parts of the country. It shows that the average annual rainfall trends fluctuated approximately around plus/minus 10% in both historical and projected periods.

Of the five-scale vulnerability index, the vulnerability assessment results confirm that the regions most vulnerable to climate change stand in the northern and eastern parts stretching from the country's central region accounting for over 33.5% of the total communes, depicting as *Highly* and *Very highly* vulnerable. Without substantial support from the government, development partners, and investors to build adaptive capacity and resilience, these communes likely fall into desperate livelihood conditions. Cambodia has put concerted efforts into devising climate change adaptation strategies and action plans in different sectors being impacted. Various adaptation-related projects have been implemented in the country. However, such actions on the ground are insufficient to meet the adaptation demand due to the budget, resources, and expertise constraints. More attention and efforts are required in the climate change adaptation throughout the country, particularly the vulnerable groups, including the marginals and vulnerable women and girls.

4 Measures to Mitigate GHG Emissions

4.1 Introduction

Cambodia is in the process of preparing her mitigation assessment along with the Third National Communication. Mitigation assessment includes mitigation actions covering all five main sectors: Energy, IPPU, Waste, Agriculture, and FOLU. GHG Inventory data for 2010, recorded in second chapter of the TNC is considered as the base year of this mitigation assessment.

The assessment had been carried out with reference to the BAU projections from 2010 until 2050 that focus on historical development trends in each of the five sectors. BAU and Mitigation scenarios for Energy, IPPU, Waste, and Agriculture sectors were assessed from Long-range Energy Alternatives Planning System (LEAP) simulation software, while the FOLU sector is assessed by using EX- Ante Carbon-Balance Tool (Ex-ACT). Assumptions made during the modeling are described under each sector.

A summary of the mitigation actions are collected for assessing the mitigation scenario from NDCs and other national sources. Mitigation actions were identified from the NDC-related information provided by the relevant ministries (MAFF, MISTI, MLMUPC, MME, MoE, MoT, MPWT, and NCDD). The GWP values were used for the assessment from the IPCC's AR4.

4.2 National and Sectoral Policy Framework

This review of national mitigation priorities, strategies, and programs is part of planned activities under Cambodia's preparation of her TNC to the Conference of the Parties (COPs) of the UNFCCC. As per the Convention, each party shall provide to the COP information on the general steps taken or envisaged for formulating, implementing, publishing, and regularly updating national and, where appropriate, regional programs containing measures to mitigate climate change. Based on the national inventory of GHG emissions, the TNC is to provide information on national programs containing measures to mitigate GHG emissions by addressing anthropogenic emissions by sources and removals by sinks.

4.2.1 Nationally Determined Contribution under the Paris Agreement

The INDC illustrated that the country was expected to reduce emissions of around 27%, excluding the AFOLU sector by 2030 compared to the BAU level. In addition, Updated NDC was submitted to the UNFCCC in 2021, outlining the actions planned to reduce GHG emissions by 41.7% compared with the BAU scenario. The emissions reduction of 64.6 million tCO2e/year is expected by 2030. The FOLU sector is expected to provide the major share of 59.1% emission reductions by 2030. Other sectors like energy (21.3%), agriculture (9.6%), industry (IPPU) (9.1%), and waste (0.9%) are also expected to contribute significantly. Table 4.1 presents Updated NDC actions.

Table 4:1: Updated Nationally Determined Contribution under the Paris Agreement

No	Mitigation Actions	Lead Ministry	Sector
1	Promote sustainable energy practices in manufacturing *Garments: 2.291 $MtCO_2e$, 55% by 2030* *Bricks: 1.799 $MtCO_2e$, 44% by 2030* *Food and Beverage: 1.043 $MtCO_2e$, 25% by 2030*	MISTI	Other Industries
2	Urban Planning Tools for Climate Change Mitigation and the urban planning solution in three sub-cities	MLMUPC	Building Residential Building Commercial
3	Application of electrical equipment's labelling & MEPS (Lighting, Cooling & Equipment) *Reduce 1.2 TWh (29.7%) of electricity use in 2030*	MME	Building Residential Building Commercial
4	Improvement of process performance of EE by the establishment of energy management in buildings/industries *Voluntary scheme for other companies, especially for SMEs to reduce 10% in 2030*	MME	Other Industries Building Residential Building Commercial
5	Public awareness campaigns, DTEBP-EE info centers *Reduce 2% of energy consumption in 2030*	MME	Building Residential Building Commercial
6	Building codes and enforcement/certification for new buildings and those undergoing a major renovation *Reduce 10% of electricity consumption in 2030*	MME	Building Commercial
7	Introduction of efficient electrical motors and boilers *Reduce 2.3% of current electricity consumption in 2030*	MME	Building Commercial Other Industries
8	Improve sustainability of charcoal production through enforcement of regulations	MME	Building Residential
9	Roadmap study on Integration of RE (Renewable Energy) resources. *25 % of renewable energy in the energy mix (2.5 GW solar, 80 MW wind, hydro, biomass) by 2030*	MME	Energy Generation
10	New sanitary landfills with LFG extraction and LFG extraction at the Dangkor Landfill *Increase the share of waste disposed at sanitary landfills with LFG extraction from 0% in 2020 to 50% by 2030 and extract LFG from the Dangkor Landfill*	MoE	Waste -MSW Agriculture - Land-Related
11	Composting of biodegradable organic fraction of MSW supplemented with separation of organic waste (at source). *If 10% of all MSW generated is composted by 2030 then up to 0.500 $MtCO_2e$/year of GHG emissions can be avoided by 2030*	MoE	Agriculture - Land-Related

12	Production of Refuse-Derived Fuel (RDF) from either a) fresh MSW or b) old MSW mined from the Dangkor landfill. *GHG ER from RDF + anaerobic digestion up to 0.2 $MtCO_2e$/year*	MoE	Cement Sector
13	Implementation of National 3R strategy	MoE	Waste -MSW
14	Enhance maintenance and inspection of the vehicle (Piloting maintenance and emission inspections of vehicles) *30 vehicle inspection centers in operation by 2030*	MPWT	Passenger Transport
15	Promote integrated public transport systems in main cities	MPWT	Passenger Transport
16	Reducing GHG emission through the off-grid street lightening of the rural municipality *10 Sangkat of Senmonorom municipality, Kep municipality, and Preah municipality integration of climate change into financial management, institutional arrangement, and policy reform by 2028.*	NCDD	Building Commercial Building Residential
17	Bio-digesters construction (85% reduction compared to 2000) (Small size: 2-3-4m^3)	MAFF	Building Residential Waste -MSW
18	Bio-digesters construction (85% reduction compared to 2000) (Medium size: 6-8-10m^3)	MAFF	Energy generation Waste -MSW
19	Bio-digesters construction (85% reduction compared to 2000) (Large size >10m3)	MAFF	Energy Generation Waste -MSW
20	Centralized recycling facility for industrial waste from the garment sector *Reduce 108,472tCO_2e/at an average of 10,847 tCO_2e/year*	MISTI	Waste -MSW
21	Climate-friendly cooling of public sector buildings *Reduce 43 000ton/year*	NCSD	Building Commercial
22	Toward Battambang city to green city *5 Sangkat of Battembang municipality integration of green city by 2025*	NCDD	Building Commercial & Residential
23	Shift long-distance freight movement from trucks to train	MPWT	Freight Transport
24	Emission management from factories *Monitor air quality at 105 factories annually and provide permit letters on air emission to 90 factories. 90% of factories are to be licensed.*	MoE	Other Industry
25	Increasing the effectiveness and sustainability of agricultural land management techniques (Conservation Agriculture)	MAFF	Agriculture land-related
26	Organic input agriculture and bio-slurry; and deep placement fertilizer technology *10 Provinces by 2030*	MAFF	Agriculture land-related

28	Promote manure Management through compost making process to reduce carbon emission *25 provinces and cities by 2030*	MAFF	Agriculture land-related
29	Better management of industrial wastewater in the food & beverage sector *5-10% of total CH_4 emissions*	MISTI	Wastewater
30	Implementation of National Cooling Action Plan *Enhanced MEPS and F-gas transition for room air conditioners and residential refrigerators targeting the new & existing equipment stock in the country.*	MLMUCP/MoE	Building commercial
31	Inclusion of performance requirements of Passive Cooling Systems in Building Energy Code of Cambodia *20% of the newly constructed buildings will comply with Building Energy Code*	MLMUPC/MoE	Building commercial
32	Implementation of "passive cooling" measures in the cities (addressing urban heat island effect), public buildings, and commercial buildings. - *cities (Phnom Penh and Siem Reap) analyzed for mitigating UHIE and projects are implemented* - *2% of the existing public and commercial buildings are retrofitted with passive cooling measures*	MLMUPC	Building commercial
33	FOLU: Reduce 50% of historical emission by 2030 Activities: - 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

4.2.2 National Strategic Development Plan and Rectangular Strategy

The five-year National Strategic Development Plan (NSDP), which focused on macro-economic fundamentals, social development, and poverty alleviation was developed for 2006-2010 and it was updated for 2009-2013 at the time of the global Great Recession, which led to its focus on a more systematic approach to attenuate the negative impacts on financial shocks on the country's economy, in particular exporting industries.

The NDSP (2014-2018) recognizes environmental sustainability and climate change as major challenges to Cambodia's economic growth and social development. The MoE is tasked with implementing a comprehensive development approach toward environmental management. Specific climate change mitigation proposals of the key priority policies and actions of the NSDP (2014-2018) are wide-ranging and cross-sectoral and include research to develop approaches to minimize GHG emissions in agriculture, to promote the use of animal manures for biogas production, to increase the contribution of green cover, forest and wildlife conservation for

agriculture development, sustainable forest financing, to expand low-cost hi-tech clean electricity production, encourage the efficient use of energy to reduce adverse environmental impacts, to implement low carbon development in all sectors. The government is implementing her NSDP (2019-2023).

The Rectangular Strategy (RS) relies on good governance, the rule of law, and institutional building to include social, economic, and human development as well as sustainable management of natural resources. The thematic and sectoral ellipses that pertain directly to climate change mitigation consist of (1) Promotion of Agriculture Sector and (2) Development of Physical Infrastructure of relevance to climate mitigation in agriculture are quadrants 1.1 improved productivity, diversification, and commercialization, and 1.4 sustainable management of national resources. Climate mitigation in the development of physical infrastructure are quadrants 1.1 development of transport and urban infrastructure, and 1.3 electricity power development.

4.2.3 National Strategic Plan for Green Growth

Cambodia is one of eighteen founding members of Global Green Growth Institute (GGGI), an international intergovernmental organization dedicated to supporting and promoting sustainable economic growth in developing countries. GGGI recognizes that developing countries such as Cambodia face pressing economic and social needs and that raising living standards and reducing poverty are critical to national development agendas.

With the support of GGGI, Cambodia established National Council on Green Growth (NCGG), a high-level inter-ministerial body. The NCGG was primarily responsible for mainstreaming green growth across ministries and government agencies. It prepares legislation, policies, and strategic plans related to green growth. The broad mandate of the Council is to integrate green growth principles into natural resource uses, economy and investment, and national development strategies. The NPGG prepared by the NCGG and adopted by the RGC in 2013, provides the basis for green growth implementation in the country. The NPGG aims to develop the Cambodian economy in balance with the environment, society, and culture. The NPGG only sets out general vision, objectives, strategies, and guidance on green growth. Its overarching goal is to improve the well-being and livelihoods of the Cambodian people. In addition, the National Policy on Green Growth was developed to provide a general roadmap for green growth in Cambodia, the National Strategic Plan on Green Growth (NSPGG) focuses on nine specific strategic directions and formulates general priority green growth projects for the country. The strategic directions and the priority projects are divided into short and long-term timeframes, with clearly identified responsibilities for different line ministries and government agencies. Five have direct relevance and impacts on climate change mitigation in Cambodia are listed below.

- Green Investments and Green Jobs Creation: encourage investors to take green growth into account, create jobs with the use of green technologies;
- Green Economic Management in balance with the Environment: green fiscal management, green financial policy, payment for environmental services;
- Green Environment and Natural Resources Management: sustainable use of natural resources, green agriculture, green transport, green tourism;
- Human Resources Development and Green Education: promoting green growth in the education system, exchanging green knowledge, raising public awareness of green growth; and
- Effective Green Technology Management: transferring, developing, and implementing green Technologies.

4.2.4 National Environment Strategy and Action Plan

The National Environment Strategy and Action Plan (NESAP) (2016-2023) is Cambodia's only second national environment plan since the National Environment and Action Plan (NEAP) (1998-2002). The NESAP aims to ensure that environmental protection and sustainable natural resource management are the foundations of socioeconomic development. The NESAP outlines priority policies and financing mechanisms that are necessary to achieve environmentally sustainable economic development. The document is viewed as a strategy for all government ministries, the private sector, civil society, and other development partners, to integrate environmental concerns into economic policies and investments. The NESAP goals are articulated around four strategic objectives: 1) to strengthen cross-sectoral collaboration and legal instruments, 2) to improve resource use efficiency, 3) to develop and implement financing mechanisms, and 4) to raise public awareness, build capacity, and transfer technologies.

More specifically, the NESAP includes a pipeline of $260 million of current and planned environmental projects that cover GHG emissions reductions and a broader range of environmental issues. In the area of climate change mitigation, proposed and planned projects include: 1.3) strengthened land use planning and land use sustainability, 1.4) biodiversity conservation and sustained ecosystem services, 2.2) sustainable cities, 2.3) improved waste management, and 3 Rs (reuse, recycle, reduce), 3.1) proper internalization of environmental costs and the use of fiscal and economic instruments, and 4.1) technology development and transfer for environmentally sound natural resources management.

4.2.5 National Forest Programme 2010-2029

The National Forest Programme (NFP) (2010-2029) 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 macro-economic growth and poverty alleviation particularly in rural areas through conservation and sustainable forest management, with the active participation of all stakeholders. The NFP's reflects the Royal Government's commitment to achieving the sustainable management of forests so that they may provide a continuous stream of environmental services and benefits for improving local livelihoods.

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. Forests are also considered a renewable energy resource that can play a significant role in climate mitigation. Activities that can contribute to GHG mitigation include conservation and protection of forest resources, community forestry, forest rehabilitation, afforestation, forest plantations, and recreational urban forests.

The implementation of the REDD is seen as a key opportunity to strengthen the Cambodian forest sector. The REDD contributes to biodiversity conservation, and poverty alleviation through the creation of employment and income from the sales of carbon credit. A combination of the REDD activities and sustainable logging is the more realistic practical scenario, where Cambodia can rely on a steady stream of carbon and logging revenues.

4.2.6 Cambodia Climate Change Strategic Plan

The Cambodia Climate Change Strategic Plan (CCCSP) (2014-2023) is the first comprehensive policy document addressing climate change issues confronting the country. The CCCSP addresses adaptation and mitigation aspects, reflecting government commitment to reducing the impacts of climate change on national development and to contribute to international efforts to reducing GHG emissions. The priorities are to integrate climate change into national and sub-national planning and to develop financing mechanisms for implementing adaptation and mitigation. The main vision of the CCCSP is that Cambodia develops towards a green, low-carbon, climate-resilient, equitable, sustainable, and knowledge-based society.

The implementation of the CCCSP has been divided into three main phases: immediate term, medium-term, and long term. In the first phase, institutional and financial arrangements are put in place, in parallel to the development of priority action plans for ministries and other government agencies. The second phase focuses on a nationally accredited system for the Adaptation Fund and the Green Climate Fund, along with the integration of climate change mainstreaming. Priority projects and programs were launched in this phase, with an initial focus on adaptation. Successful projects are scaled up in the third phase. In the long term, climate mainstreaming is further expanded to the sub-national administration.

4.3 Baseline Scenario for GHG Emissions and Removal

This section presents an assessment of Cambodia's GHG emissions projection. The assessment had been carried out with reference to the business-as-usual (BAU) baseline projections from 2010 until 2050 that focus on historical development trends in each of the five sectors namely

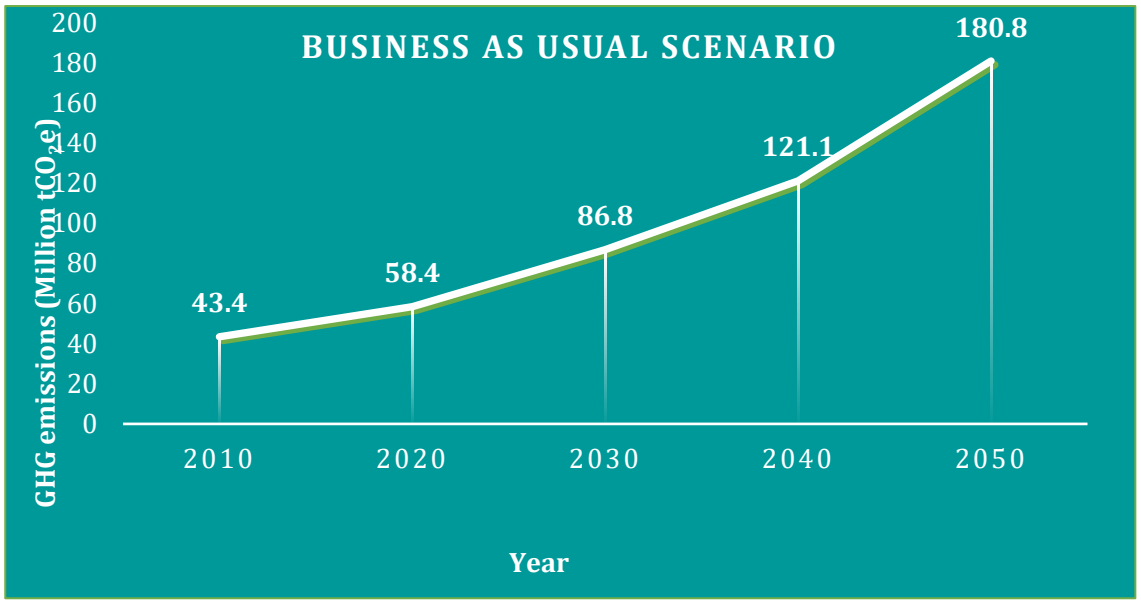


Figure 4.1: BAU Scenario until 2050

Energy, IPPU, Waste, Agriculture, and FOLU sectors. BAU and Mitigation scenarios for Energy, IPPU, Waste, and Agriculture sectors were assessed from Long -range Energy Alternatives Planning System (LEAP) simulation software, while the FOLU sector is assessed by EX- Ante Carbon – Balance Tool (Ex-ACT). Figure 4.1 illustrates the BAU scenario until 2050 by considering the abovementioned sectors. GHG emissions will be reached about 63.7 and 81 million tCO_2e in 2030 and 2050, respectively. The highest emissions contributor is the energy sector, followed by the agriculture sector. The share of emissions contributions of the sectors in 2050 is illustrated in Figure 4.2.

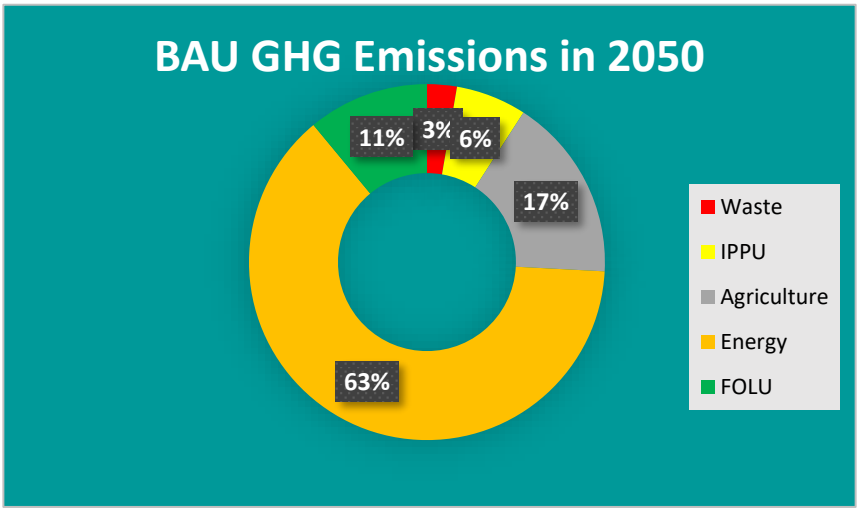


Figure 4.2: GHG emissions (%) in 2050 as per BAU scenario

4.3.1 Energy Sector

The BaU scenario was created for three sub sectors: Energy industries, manufacturing industries and construction and transport. Energy consumption for each source were measured by the GDP growth rate (Georgantopoulos, 2011) based on available resources and it was 10% for 2011-2030 and 6.4% for 2031-2050. According to these predictions, emissions will reach 33 million tonnes of CO_2e by 2030 and 114.2 million tonnes of CO_2e by 2050.

Table 4:2: BAU Development for the Energy Sector

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**

4.3.2 IPPU Sector

The Mineral industry was the main contributor to the IPPU sector, accounting for 75% of the total emission. The second highest contributor (23%) was from Product Use as Substitutes for Ozone Depleting Substances (ODS). Mineral industry (emissions associated with cement manufacturing) is expected to rise to 6.4 million tonnes of CO_2e by 2030 (4% growth rate) as Cambodia is targeting to become a middle-income level country by 2030 and assume that growth will retain the peak level by 2035 as the construction industry will grow to build the infrastructure for the country and will be reduced by -2% from 2035 to 2050. The annual Growth rate for the refrigeration and air conditioning industry will be reached 8.6% through to 2030 and 5.9% from 2030 through to 2050

based on the same assumptions made for the cement industry. According to these predictions, emissions are projected to reach 8.2 million tonnes of CO_2e by 2030 and 11.6 million tonnes of CO_2e by 2050.

Table 4:3: BAU Development for the IPPU Sector

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**

4.3.3 Waste Sector

The BaU scenario was built up for the four sub-sectors: 1) Solid waste disposal 2) Biological treatment of waste 3) Incineration and open burning, and 4) Wastewater treatment and discharge. First Order Decay (FOD) method is used for estimating CH_4 emissions from Solid Waste Disposal Sites (SWDP). This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed. Total MSW generated from year 2016 is 4,239 $GgCO_2e$, while 4,179 $GgCO_2e$ for 2015.

BAU scenario of the waste sector has been projected based on population growth rate by 2030 (1.25%) and 2050 (0.76%) for biological treatment of waste. The growth rate was built using the same amount of municipal solid waste generated per year in a similar economic country in the region for solid waste (1.64% (WKO, 2018) from 2030 to 2050). It was assumed that the growth rate of incineration and open burning is similar to the growth rate of solid waste disposal as solid waste is subjected to the burning process. Emissions of wastewater treatment and discharge are expected to increase by 20% between 2010 and 2030 as per the "Global Methane Initiative Fact sheet (WKO, 2018)" and the growth rate is assumed as 0.96% for 2030 through to 2050. According to these predictions, emissions are expected to reach 3.7 million tonnes of CO_2e by 2030 and 4.9 million tonnes of CO_2e by 2050 for the waste sector.

Table 4:4: BAU Development for the Waste Sector

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**

4.3.4 Agriculture Sector

The BaU scenario was built up for the five sub-sectors rice crop cultivation, enteric fermentation, manure management, urea application direct N_2O emissions from managed soils and indirect N_2O emissions from managed soils. Rice crop cultivation, enteric fermentation and manure

management contribute highly to the emissions in the agriculture sector as discussed in the GHG Inventory of the TNC. The annual growth rates of land area used for cultivation were predicted as 1.86% for 2010-2016, 2.2% for 2016-2030, 1.8% for 2031-2040 and 1.5% for 2041-2050. The land area required for rice cultivation was calculated based on the predicted amount of rice paddy production and the expected rice yield per hectare (MAFF, 2018).

Seed reserve, post-harvest loss and milling rate were considered when deriving the rice production from the projected rice paddy production. In the projection of the rice consumption, the population growth rate was used along with the consumption per person assuming that Cambodia has reached the maximum per person consumption of 140kg/person by 2020. The difference between rice production and rice consumption was taken as export. The BAU projection for the enteric fermentation and manure management which comes under the livestock emissions were calculated based on the growth rate of cattle, pigs and poultry. The growth rates used are as given in Table 4.5.

Table 4:5: Growth Rates Used for Different Animals in BAU Scenario for Livestock Emissions Projections

Time	Type of Animal	Growth Rate
2010-2030	Cattle	1.5%
2031-2050		0.8%
2016-2030	Pig	6.0%
2031-2050		3.0%
2016-2030	Poultry	9.5%
2031-2050		3.0%

These growth rates were calculated based on the meat consumption per person by high income countries and the population predictions.

Table 4:6: BAU for the Agriculture Sector

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**

As shown in Table 3.5, total GHG emissions in the agriculture sector is projected to reach 22 million tCO_2e by 2030 and 30.2 million tCO_2e by 2050.

4.3.5 FOLU Sector

Several studies and national documents published by Cambodia in the past few years have established several BAU scenarios for the FOLU sector. In the past few years, several studies and national documents have established BAU scenarios for the FOLU sector. Therefore, these assessments were considered to develop BAU scenarios for the TNC assessment.

1) The BAU Scenario 1 for the FOLU sector was developed based on Cambodia's TNC.

2) The BAU scenario 2 for the FOLU sector was developed based on Cambodia's Updated Nationally Determined Contribution, 2020.
3) The BAU scenario 3 for the FOLU sector was developed based on Cambodia's Long-Term Strategy for Carbon Neutrality (LTS4CN), 2021.

Table 4:7: Data for BAU Assessment of the FOLU Sector

	Forest Cover (Million Ha)					
Year	**2010**	**2016**	**2020**	**2030**	**2040**	**2050**
BAU Scenario 1 – TNC	10.5	9.9	9.5	8.6	7.6	6.7[6]
BAU Scenario 2 – Updated NDC, 2020	-	7.6	6.1	2.4	0.0[6]	0.0[6]
BAU Scenario 3 – LTS4CN, 2021	-	8.7	8.2	6.9	5.6	4.3

The activity data for the year 2010 in the BAU Scenario 1 was directly taken from the TNC assessment. The projection of the forest cover for future years was calculated based on the assumption that the forest cover depletion rate per year is 0.5 %, which is based on the historical forest cover depletion rate in the country from 2000 to 2010 according to the data given in the TNC assessment. Similarly, the forest cover depletion (deforestation) rate per year considered for the BAU Scenario 2 is 2.02%. In the case of BAU Scenario 3, the activity data for the years were taken from the LTS4CN assessment. The same scenario has a 2.6% annual emission decline from 2016 to 2050.

The calculation of GHG emissions was conducted using EX-ACT tool version, 9.1 by Food Agriculture Organization (FAO). The type of climate and soil were necessary to select the tool to determine the relevant default factors. Therefore, "Tropical" climate was selected for the assessment based on the TNC. The type of soil selected for the assessment is "Low Activity Clay Soil" based on the information and the maps under the EX-ACT tool which is based on the IPCC guidelines. The global warming potentials were used for the calculation of GHG emissions are from the IPCC's AR4. The estimated BAU emissions are reported in Table 4.8.

Table 4:8: BAU developed for the FOLU sector

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

4.3.6 BAU Scenario for all Sectors

The BAU scenario for all sectors is 43.4, 58.4, 86.8, 121.1, and 180.8 million tCO_2e in 2010, 2020, 2030, 2040, and 2050, respectively, (Figure 4.3). The energy sector (114.2 million tCO_2e) is the highest contributor to the emissions in 2050 along with the BAU scenario followed by the agriculture sector (30.2 million tCO_2e).

[6] Forest cover of Cambodia will be zero since 2040 according to the historical deforestation trend.

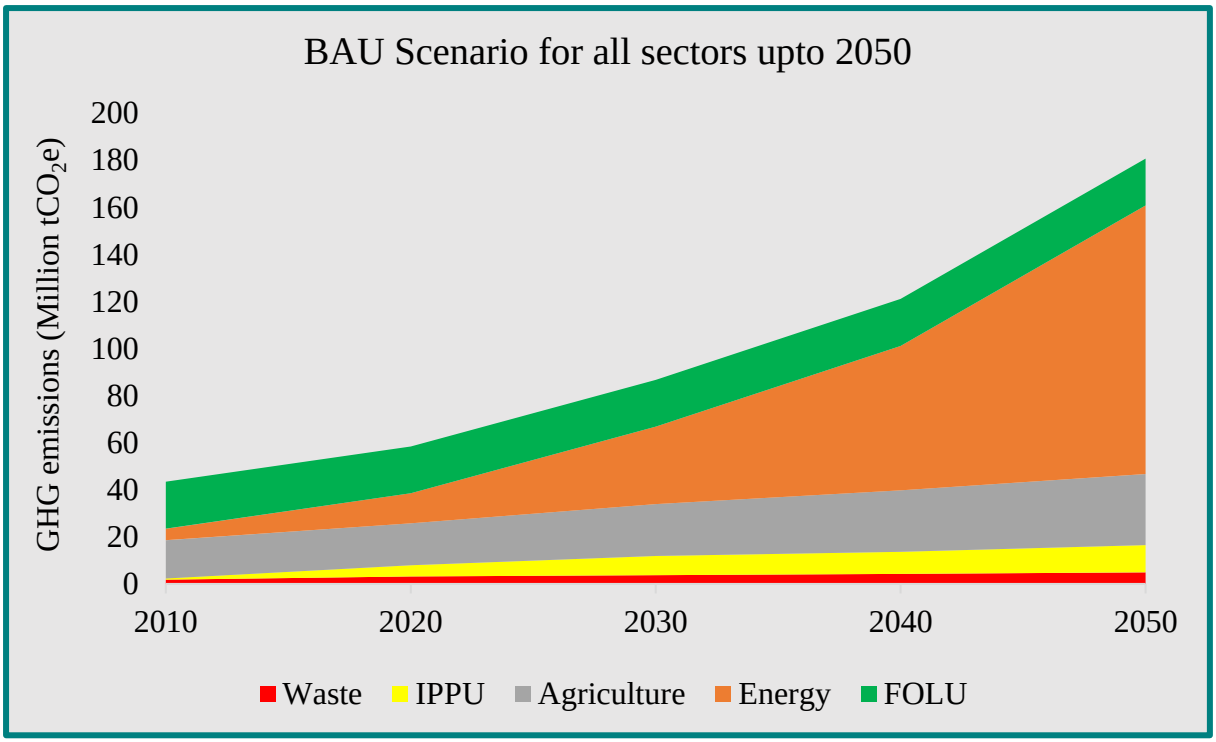


Figure 4.3: BAU scenario for all sectors

4.4 Mitigation Scenarios

Table 4.9 shows the mitigation actions with emissions reductions in 2030 and 2050, which are assessed under mitigation assessment under the TNC. Several factors were considered when prioritizing the mitigation actions: Government priority, GHG mitigation potential, targets, environment, social co-benefits, marginal abatement cost, technology availability, etc. The mitigation projects are distributed among five sectors: Energy, IPPU, Waste, Agriculture, and FOLU.

Table 4:9: Estimated Emissions Reductions in 2030 and 2050

Sector	Mitigation Measures	GHG Reduction (Million tCO_2e)	
		2030	2050
Energy	1. Switch charcoal to renewable energy 2. Application of electrical equipment labelling 3. Public awareness campaigns 4. Building codes and enforcement certificates to the new buildings 5. Off-grid connected street lighting rural areas 6. Promote Electrical vehicles 7. Switch coal to renewable energy 8. Shift long-distance freight movement from trucks to train 9.Enhance maintenance and inspection of the vehicles 10. Increase of public transport 11. Introduction of efficient industrial motors	2.0	6.4

IPPU	1. Clinker substitution in the Cement industry 2. Carbon Capture and Storage (CCS) in the Cement industry 3. Recycled Aggregate Concretes in the Cement industry 4. Promoting low GWP refrigerants 5. Regular Inspection of Refrigeration & Air-conditioning equipment and mandatory recovery of spent refrigerants	3.3	8.8
Waste	1. Landfill Gas Capture 2. Reduce Waste Generation (3R) 3. Refuse Derived Fuel (RDF) 4. Organic Composting 5. Anaerobic Digestion (AD) Treatment 6. Centralized recycling facility for industrial waste from the garment sector 7. Better Management of Industrial Wastewater in the Food & Beverage	1.9	3.8
Agriculture	1. Less methane intensive cultivars 2. Direct seeding practices 3.Alternate wetting and drying practices 4. Improve feed quality and fodder management 5. Feed additives to cattle-3NOP 6. Promote organic fertilizer 7. Composting technology 8. Deep fertilizer technology	4.4	15.2
FOLU	FOLU: Reduce 50% of historical emission by mitigation activities: • 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 With BAU scenario 1 – TNC	10	10
Total		**21.6**	**44.2**

4.4.1 Energy Sector

Mitigation actions of the energy sector are consisted of renewable energy, transport, and energy efficient practices. There are 11 mitigation actions collected from existing national and sectoral policies, strategies, and action plans. Table 4.10 provides the emissions reductions mitigation actions for the energy sector.

Table 4:10: Emissions Reductions for Mitigation Actions in the Energy Sector

Mitigation Scenario LEAP – Energy				
Mitigation Action	**Million tonnes of CO_2e**			
	2020	**2030**	**2040**	**2050**
Switch charcoal to renewable energy		0.094	0.26	0.65
Application of electrical equipment labeling		0.66	0.72	0.77
Public awareness campaigns		0.13	0.49	1.39
Building codes and enforcement certificates to the new buildings		0.168	0.63	1.77
Off grid-connected street lighting rural areas		0.014	0.052	0.14
Promote Electrical vehicles	0.0008	0.006	0.15	0.34
Introduction of efficient electrical industrial motors and transformers		0.21	0.42	0.62
Switch coal to renewable energy		0.12	0.55	1.63
Shift long-distance freight movement from trucks to train		0.36	0.52	0.67
Enhance maintenance and inspection of the vehicles	0.1	0.26	0.4.8	0.88
Increase of public transport	0.0008	0.006	0.014	0.03
Total	**0.10**	**2.03**	**3.08**	**6.35**

- Switch charcoal to renewable energy

According to the Cambodia Basic Energy Plan prepared by the General Department of Energy with input from the General Department of Petroleum of the MME (hereafter referred to as Cambodia Basic Energy Plan), it is predicted that the electricity demand will increase by 7.5 times from 2015 to 2040. They have recommended incorporating renewable energy resources (solar, wind, hydro, etc.) into the energy mix by 25% in 2030 and 50% in 2050. The estimated emissions reductions from switching charcoal to renewable energy are 0.09 million tCO_2e by 2030 and 0.65 million tCO_2e by 2050 compared with the BAU scenario.

- Application of electrical equipment labeling

The Government is prioritizing the increase of the market share of higher-class efficient appliances through this action, and it is expected to reduce about 29.7% of the electricity use by 2030 and 35% by 2050. Cambodia Basic Energy Plan mentioned that an inspection laboratory will need to be set up to inspect the standards and labeling systems. The estimated emissions reductions from the application of electrical equipment labeling are 0.66 million tCO_2e by 2030 and 0.77 million tCO_2e by 2050 compared with the BAU scenario.

- Public awareness campaigns

Raising awareness and promoting public participation are the main investments in energy efficiency to decrease energy consumption unnecessarily. Creation of both in relation to the use of energy efficient appliances, as well as concerning the features of the buildings. As per the general assumptions made from updated NDC, the percentage of electricity consumption reductions potential from public awareness campaigns is 2% by 2030 and 7% by 2050. Based on the above assumptions, the estimated emissions reductions from public awareness campaigns are estimated as 0.13 million tCO_2e by 2030 million and 1.4 tCO_2e by 2050 compared with the BAU scenario.

- Building codes and enforcement certificates to the new buildings

Energy efficiency standards, laws and regulations concerning building energy codes are being elaborated and promulgated by the MME. It will be reduced 10% and 30% of electricity consumption in 2030 and 2050, respectively. The estimated emissions reductions from building codes and enforcement certificates to the new buildings are estimated as 0.17 million tCO_2e by 2030 and 1.8 million tCO_2e by 2050 compared with the BAU scenario.

- Off-grid connected street lighting rural areas

Off-grid street lighting of the rural municipality is one of the mitigation actions coming from the CCCSP (2014-2023). The percentage of electricity consumption by grids in a rural area in Cambodia is about 40%. Emissions reductions of off-grid connected street lighting was calculated based on population, Grid connectivity and average electricity consumption of streetlights. This mitigation action is to reduce 0.014 million tCO_2e GHG emissions by 2030 and 0.14 million tCO_2e GHG emissions by 2050.

- Promote electrical vehicles

The MPWT has introduced E-mobility as a mitigation action to reduce the GHG emissions from the transport sector. Nine vehicles are registered in Cambodia by 2020. It was assumed that registered vehicles will be increased by 30% in 2030 and 50% by 2050. The estimated emission reductions from promoting electrical vehicles are 0.006 million tCO_2e by 2030 and 0.34 million tCO_2e by 2050 compared with the BAU scenario.

- Switch coal to renewable energy

Cambodia has recommended incorporating renewable energy resources (solar, wind, hydro, etc.) into the energy mix by 25% in 2030 based on Cambodian NDC and 100% by 2050 (Assumption made based on the decarbonization promised and the measures seen in the practice and Cambodia were agreed to no more coal plant by 2050. The estimated emission reductions from switching coal to renewable energy are 0.1 million tCO_2e by 2030 and 1.6 million tCO_2e by 2050 compared with the BAU scenario.

- Shift long distance freight movement from trucks to train

The MPWT has proposed to shift long distance freight movement by 40% and 75% from trucks to train by 2030 and 2050, respectively. Emissions reductions was calculated based on the average mileage of tracks, train and their average loading capacities. The estimated emissions reductions from shifting freight movement from trucks to trains are 0.4 million tCO_2e by 2030 and 0.7 million tCO_2e by 2050 compared with the BAU scenario.

- Enhance maintenance and inspection of vehicles

According to CCCSP (2014-2023), RS, NSPGG, and current activities on transport policy in Cambodia (Sophearith, 2019), maintenance and inspection of vehicles will be enhanced in order to reduce the maintenance cost, reduce traffic accidents, injuries and fatalities, reduce air pollution and reduce GHG emissions. 20 or 30 vehicle inspection centers will be in operation by 2030 and emissions reductions calculation was conducted based on shifting the higher Euro codes of the vehicles. The vehicle inspection is calculated by considering the difference between vehicle forecast of the inspected vehicles and the capacity of inspection centers. The estimated emissions reductions of this mitigation action are 0.3 million tCO_2e by 2030 and 0.9 million tCO_2e by 2050 compared with the BAU scenario.

- Increase of public transport

Promoting an integrated public transport system in main cities is the mitigation action proposed by the Ministry of Public Works and Transport. It is aligned with Cambodia Climate Change Strategic Plan 2014-2023, Rectangular Strategy and National Strategic Plan for Green Growth. Emissions reductions was calculated based on the urban population, average mileage of motor vehicles and buses, average occupancy in the bus and motor vehicles (project implementation-30% by 2030 and 50% by 2050). The estimated emissions reductions of promoting public transport are 0.006 million tCO_2e by 2030 and 0.03 million tCO_2e by 2050 compared with the BAU scenario.

- Introduction of efficient industrial motors and transformers

Enforcement of efficient electrical transformers/ motors in utilities/buildings/industries, which reduce electricity consumption is the mitigation action identified as improvement of process performance by the Ministry of Mines and Energy. It will be reduced 10% and 30%of current electricity consumption by 2030 and 2050, respectively. The estimated emissions reductions of this action are 0.21 million tCO_2e in 2030 and 0.62 million tCO_2e in 2050 against the BAU scenario.

4.4.2 IPPU Sector

Emissions will be reduced through the Cement industry including 1) Clinker Substitution, 2) Carbon Capture and Storage (CCS), and 3) Recycled Aggregated Concrete. Promote low GWP refrigerants and Regular inspection of ODS and Mandatory Recovery and Reclamation/ Destruction of spent refrigerants used as reduction of GHG emissions from refrigerants. Table 4.11 provides information for the emissions reductions by mitigation actions in the IPPU sector.

Table 4:11: Emissions Reductions for Mitigation Actions in the IPPU Sector

Mitigation Scenario LEAP – IPPU				
Mitigation Action	**Million tonnes of CO_2e**			
	2020	**2030**	**2040**	**2050**
Clinker Substitution	-	1.6	1.7	1.8
Carbon Capture and Storage (CCS)	-	0.8	2.4	2.8
Recycled Aggregate Concrete	-	0.1	0.1	0.1
Promoting Low GWP Refrigerants and Regular Inspection of Refrigeration & Air-conditioning Equipment and Mandatory Recovery of Spent Refrigerants	-	0.8	2.1	4.1
Total	**-**	**3.3**	**6.3**	**8.8**

- Clinker Substitution

Production of clinker accounts for the highest CO_2 emissions in the cement industry. According to the data of Kampot Cement Company (KCC) Cambodia, which was provided by sector experts, clinker share in cement in 2016 is about 87% and the emission factor of cement is 0.52tCO_2 per tonne of clinker (IPCC Guideline 2006).

In this mitigation action, the clinker amount in cement will be reduced which will result in the emissions reductions in cement production. The clinker share in cement will be reduced to 65% and 60% by 2030 and 2050, respectively. These targets were assumed based on the BS-EN-197-1: 2011 Standard for Cement. Clinker substitutes or Supplementary Cementitious Materials (SCMs) are a wide range of both naturally occurring and industrial byproduct materials that can be used to replace a proportion of the clinker in Portland cement, without adversely impacting the performance of the cement. Slag, a waste product of steel manufacturing, and fly ash, arising from coal fired power generation, have cementitious properties and can be used to supplement clinker in cement. Substitution of clinker in the cement industry can result in an emissions reductions of around 1.6 million tCO_2e in 2030 and 1.8 million tCO_2e in 2050.

- Carbon Capture and Storage (CCS)

The emissions of CO_2 will be unavoidable in some industries due to their process of production. In such industries, CCS technology will be useful. In CCS technology, the emitted CO_2 will be captured and stored, and later this CO_2 can be utilized. This technology has a high cost for energy. Therefore, it is important to explore the low-cost CO_2 capture and separation methods if this is to be implemented. Under this mitigation action, cement plants will be gradually implementing the CCS system. Based on the set targets of Heidelberg Cement- Norway's world's first full-scale CCS facility in a cement plant, it is assumed that one plant can capture up to 0.4 million tCO_2. As CCS is a new technology for the cement industry of the country, technical (due to knowledge gap) & Economic Feasibility Assessments should be conducted to determine carbon capture readiness in the country, and bare lands should be allocated for secure storage of captured Carbon. Therefore, by keeping provision for such requirements, capturing is assumed to be implemented in 2025, starting from capturing 0.4 million tCO_2e and 0.8 million tCO_2 in 2030 and 2.8 million tCO_2 in 2050 compared with the BAU scenario.

- Recycled Aggregate Concrete

CO_2 emissions in cement production occupy the highest percentage in the emissions from the IPPU sector. When the recycled aggregate concrete is used for road construction purposes, it will reduce the demand for fresh cement demand. It will result in a reduction of clinker production, which will reduce the direct CO_2 emissions that will occur due to the decomposition of limestones.
It is assumed that this mitigation action is expected to reduce the total emissions by 2% each year. The estimated emission reduction from Recycled Aggregate Concretes is 0.1 million tCO_2e in 2050 compared with the BAU scenario.

- Promoting low GWP refrigerants and Regular Inspection of Refrigeration & Air-conditioning equipment and mandatory recovery of spent refrigerants

In Cambodia, Refrigeration and Air Conditioning account for the second highest $_{CO2e}$ emissions in the IPPU (Inventory year, 2010). HFC gases are mainly used for this purpose and due to the high GWP of HFC gases, refrigeration, and air conditioning contribute highly to the CO_2e emissions in the country. HFC-125, HFC-134a, HFC-143a, and HFC-32 are the main types of HFC gases used in refrigeration and air conditioning in Cambodia. Cambodia has approved Kigali Amendment to

the Montreal Protocol on 8th April 2021. As per the Kigali Amendment, Cambodia will reach to the peak of HFC emissions by 2024 and will reduce HFCs in 4 steps. HFC Reduction against the base year consumption (Average consumption of the base year of 2020-2022) will be as follows:

- 1st step (2024-2029)-10% reductions
- 2nd step (2029-2035)- 30% reductions
- 3rd step (2035-2040)- 50% reductions
- Plateau (2045)- 80% reductions

4.4.3 Waste Sector

The emissions will be removed from four sub-sectors: 1) Solid waste disposal; 2) Biological treatment of waste; 3) Incineration and open burning; and 4) Wastewater treatment and discharge.

Table 4:12: Emissions Reductions for Mitigation Actions in the Waste Sector

Mitigation Scenario LEAP – Waste				
Mitigation Action	**Million tonnes of CO_2e**			
	2020	**2030**	**2040**	**2050**
Landfill Gas Capture	-	0.8	1.4	2.1
Reduce Waste Generation (3R)	-	0.4	0.4	0.4
Refuse Derived Fuel (RDF)	-	0.5	0.8	1.1
Composting of Biodegradable Organics	-	0.01	0.01	0.02
Anaerobic Digestion (AD) Treatment	-	0.2	0.2	0.2
Centralized Recycling Facility for Industrial Waste from the Garment Sector	-	0.005	0.007	0.01
Better Management of Industrial Wastewater in the Food & Beverage Industries	-	0.006	0.01	0.02
Total	**-**	**1.9**	**2.8**	**3.8**

- Landfill Gas Capture

There is some potential for private sector engagement in the financing, constructing, and operating of sanitary landfills with the LFG system. A new sanitary landfill with LFG extraction at the Dangkor landfill is one of the proposed mitigation actions by the Ministry of Environment. Around 38% (MoE, 2020) of solid waste is subjected to landfills. This action aims to increase the share of waste disposed at sanitary landfills with LFG extraction from 0% in 2020 to 50% by 2030 and extract LFG from the Dangkor Landfill. It was assumed that it will be increased up to 100% by 2050. Estimated emissions reductions from landfill gas capturing are 0.8 million tCO_2e in 2030 and 2.1 million tCO_2e in 2030 compared with the BAU scenario.

- Reduce Waste Generation (3R)

Cambodia has taken action step by step to improve existing waste management practices through policy and strategy development, capacity building, legal instruments, and awareness raising, all of which include a part of the 3R reduce, reuse, and recycle) principles. GHG emissions reductions per year will be 0.42 $MtCO_2e$. It was assumed that 90% and 99% will be implemented by 2030 and 2050, respectively. Estimated emissions reductions from reducing waste generation are 0.4 million tCO_2e in 2030 and 0.4 million tCO_2e in 2050 compared with the BAU scenario.

- Refuse Derived Fuel (RDF)

Production of Refuse-Derived Fuel (RDF) from either a) fresh MSW or b) old MSW mined from the Dangkor landfill. The mechanical and biological separation and treatment of waste will be combined with an anaerobic digestion plant (generation of biogas from organic waste) to power facilities at the landfill. The produced RDF can be sold to e.g., cement industry as fuel. The private sector can invest in and manage the RDF and anaerobic digestion plant. 1,100 tons of fresh and landfill mining municipal solid waste will be targeted to process per day. The estimated emissions reductions of this action are 0.5 million tCO_2e in 2030 (50% for implementation plan) and 1.1 million tCO_2e in 2050 (100% for implementation plan) against the BAU scenario.

- Composting of Biodegradable Organics

Composting of biodegradable organic fraction of MSW supplemented with separation of organic waste (at source). It can be done at different stages in the waste management value chain, either at household, community level or at the landfill site. The private sector can invest in and operate the composting facilities. 10% of all MSW generated is composted by 2030 (depending on BAU and operational practices during composting). The estimated emission reductions of this action are 0.01 and 0.02 million tCO_2e in 2030 and 2050, respectively, against the BAU scenario.

- Anaerobic Digestion (AD) Treatment

Installation of an anaerobic digestion system with methane recovery for the treatment of organic wastewater generated by an existing ethanol manufacturing plant. As per updated NDCs of Cambodia in 2020, emissions reductions of anaerobic digestion will be up to 0.2 $MtCO_2e$/year. The estimated emissions reductions from anaerobic digestion are 0.2 million tCO_2e in both years of 2030 and 2050 compared with the BAU scenario.

- Centralized Recycling Facility for Industrial Waste from the Garment Sector

The Ministry of Industry, Science, Technology, and Innovation (MISTI) has proposed to reduce GHG emissions by installing a centralized recycling facility for the industrial waste from the garment sector. The GHG benefit targeted from the action is 0.11 million tCO_2e from 2021-2030 at an average of 0.01 million tCO_2e per annum. 50% and 100% of suitable garment waste captured for recycling in 2030 and 2050, respectively. Estimated emissions reductions from centralized recycling facilities are 0.005 million tCO_2e in 2030 and 0.01 million tCO_2e in 2050 compared with the BAU scenario.

- Better Management of Industrial Wastewater in the Food & Beverage Industries

One of the best ways to reduce GHG emissions is to capture the methane generated by anaerobic Industrial Wastewater (IWW) treatment processes. However, this can be only economically feasible for large scale operations. A study in China targeting IWW with a high concentration of organics treated with anaerobic systems indicated that the amount of gas recycled in 2010 was only 5.4% of total CH_4 emissions. Therefore, a target of 5-10% for Cambodia may be realistic as a starting point. Estimated emissions reductions from better management of industrial wastewater are 0.006 million tCO_2e in 2030 (50% of implementation plan) and 0.02 million tCO_2e in 2050 (100% of implementation plan) compared with the BAU scenario.

4.4.4 Agriculture Sector

Emissions will be removed from the main three sub-sectors of Agriculture. They are 1) Rice Crop Cultivation, 2) Livestock, and 3) Urea Application. Less Methane Intensive Rice Cultivars, Direct Seeding Practices and Alternate Wetting and Drying Practices are coming under Rice Crop

Cultivation. Feed additives to cattle-3NOP, Improve Feed Quality and Fodder Management and Composting Technology are in Livestock, while Promote Organic Fertilizer and Deep Fertilizer Technology are in Urea Application. Emissions reductions potential for each mitigation action of the agriculture sector is listed in Table 4.13.

Table 4:13: Emission Reduction for Mitigation Actions in the Agriculture Sector

Mitigation Scenario LEAP - Agriculture				
Mitigation Actions	**Million tonnes of CO_2e**			
	2020	**2030**	**2040**	**2050**
Less methane intensive cultivars	-	5.3	9.8	12.0
Direct seeding practices	-	1.4	3.7	6.0
Alternate wetting and drying practices	-	2.5	6.2	8.4
Improve feed quality and fodder management	-	0.8	1.1	1.5
Feed additives to cattle-3NOP	-	0.7	0.8	1.2
Promote Organic fertilizer	-	0.2	0.4	0.5
Composting technology	-	0.03	0.07	0.12
Deep fertilizer technology	-	0.9	1.2	1.6
Combined Emission reductions of 8 MAs	**-**	**4.41**	**12.38**	**15.21**

- Less Methane Intensive Rice Cultivars

Rice is mainly cultivated in warm, flooded paddy fields which provide optimum conditions for the methane-producing microbes. The amount of methane produced during rice cultivation will depend on many factors and one out of them is the rice cultivar. In this mitigation action, rice crops with two daily emissions factors are introduced to two irrigation methods and are shown in Table 4.14. This will replace the rice crops with a daily emission factor of 1.3.

Table 4:14: Daily Emission Factors of Crops under the Mitigation Action

Method of Irrigation	Daily Emission Factor
Irrigated continuously flooded	0.90
Rainfed and deep water	0.91

This mitigation action can reduce the emissions by 30% each year. The estimated emissions reductions from fewer Methane cultivars is 5.3 million tCO_2e by 2030 and 12 million tCO_2e by 2050 compared with the BAU scenario.

- Direct Seeding Practices

Direct seeding practices means obtaining rice crops from seeds in the field rather than transplanting seedlings from a nursery. Implementation of direct seeding practices in rice cultivation can provide many advantages. It will reduce the water requirement, early crop maturity, provide better soil conditions and will reduce the production cost compared to plant transplanting.

In this mitigation action, it was assumed that due to the direct seeding, the cultivation period will reduce from 150 days to 141 days (Kaur, 2017). The estimated emissions reductions from Direct Seeding practices are 1.4 million tCO_2e by 2030 and 6 million tCO_2e by 2050 when compared with the BAU scenario.

- Alternate Wetting and Drying Practices

Alternate wetting and drying is a water management technique. This is practiced cultivating irrigated lowland rice with less water than used in the usual condition. Usually, the water regime scaling factor will be 1 and 0.28 for irrigated continuously flooded and rainfed and Deepwater irrigation methods respectively and this will be reduced to 0.6 and 0.27, respectively, through this mitigation action. This mitigation action can reduce emissions by 44% each year. The estimated emissions reductions from Alternate Wetting and Drying practices are 2.5 and 8.4 million tCO_2e by 2030 and 2050, respectively, compared with the BAU scenario.

- Feed Additives to Cattle-3NOP

CH_4 is produced during the enteric fermentation process. This can be reduced through feed additives. Several feed additives are available to act as a methane inhibitor in enteric fermentation and 3NOP shows significant benefits compared to other additives. 3NOP feed additive can act as a methane inhibitor and can reduce the methane emissions by 24-28%. It was assumed that 63%, 70%, and 90% of the implementation plan will be covered by 2030, 2040, and 2050, respectively. This mitigation action can reduce the emissions by 0.7 and 1.2 million tCO_2e by 2030 and 2050, respectively.

- Improve Feed Quality and Fodder Management

Feed quality can be improved through the introduction of feed additives that will inhibit the CH_4 producing bacteria in the digestive system of animals. This will reduce the CH_4 production through enteric fermentation.

Fodder management can reduce the global GHG emissions in three ways; by capturing atmospheric CO_2, by reducing the CH_4 emissions due to enteric fermentation through improving the quality of fodder and by reducing the N_2O emissions. 63%, 70%, 90% of activity will be implemented in 2030 (RGC, 2019), 2040, and 2050, respectively. The estimated emission reductions from Improving feed quality and fodder management are 0.8 million tCO_2e by 2030 and 1.5 million tCO_2e by 2050 compared with the BAU scenario.

- Composting Technology

Composting technology can reduce CH4 emissions from manure. 27% gross emissions reductions in terms of CH_4 GHG potential occurs when 76% reduction of CO_2 production occurs in composting process. This mitigation action can be reduced the emissions by 0.03 million tCO_2e (25% of implementation plan) by 2030 and 0.12 million tCO_2e (75% of implementation plan) by 2030.

- Promote Organic Fertilizer

Urea is one of the main fertilizers used in Cambodia. Usually, these fertilizers are applied two to three times during the growth of the crop. 66% of Phosphate and 28% of urea are used in the first application, 60% of urea, 28% of Phosphate and 7% of Nitrate are used in the second application and 40% of urea and 40% of locally made organic fertilizers are used in the third application of fertilizer (RGC, 2019). Urea and Urea Ammonium Nitrate (UAN) are the two main types urea containing fertilizers used in Cambodia under the BUR. Urea has an emissions factor of 0.2tC/t urea and Urea Ammonium Nitrate contains about 50% of urea with an emission factor of 0.1tC/t UAN. Organic fertilizer can be a better solution to reduce the CH_4 emissions due to organic waste in landfills. It can facilitate carbon sequestration which will reduce the CO_2 content in the atmosphere. The estimated emission reductions from organic fertilizer are 0.2 million tCO_2e by

2030 (25% of implementation plan) and 0.5 million tCO_2e by 2050 (75% of implementation plan) compared with the BAU scenario.

- Deep Fertilizer Technology

Through this technology, the emission factor will be reduced to two thirds of its value (IPCC, 2006). This mitigation action has 30% targets of implementation by 2030, 74% for 2040, and 100% for 2050 as per National Action Programme to combat land degradation. The estimated emissions reductions from deep fertilizer technology are 0.9 and 1.6 million tCO_2e by 2030 and 2050, respectively, compared with the BAU scenario.

4.4.5 FOLU Sector

There are several mitigation scenarios available for the FOLU sector due to the same reason as for the BAU scenario development. In consideration of these mitigation scenarios, the following TNC mitigation assessment has been conducted for the country.

1. Mitigation scenario 1: Reduce 50% of historical emissions by 2030 Activities:
   - 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
   - In comparison to BAU scenario 1 – TNC

2. Mitigation scenario 2: Reduce 50% of historical emissions by 2030 Activities:

   - 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
   - In comparison to BAU scenario 2 – Updated NDC, 2020

3. Mitigation scenario 3: LTS4CN (Green Highway Scenario)

   Activities:

   - Deforestation action goes beyond REDD+ strategy and NDC (50% reduction in deforestation rate by 2030)
   - Higher forest cover by 2040
   - Major expansion of plantations (2.7 million ha by 2050)
   - Climate finance is available and accessible to Cambodia by 2022

The same mitigation action was considered for the development of mitigation scenario 1 and 2, with different activity data sets from two different sources. The activity data used for mitigation scenario 1 are based on the TNC assessment (0.26% forest cover reduction rate per year) and for mitigation scenario 2 is based on updated NDC assessment (1.01% forest cover reduction rate per year). The last mitigation scenario is based on the LTS4CN assessment published in the year 2021.

Table 4:15:Data for Mitigation Assessment of the FOLU Sector

	Forest Cover (Million Ha)			
Year	**2020**	**2030**	**2040**	**2050**
Mitigation scenario 1: Reduce 50% of historical emission by 2030 (TNC)	9.5	9.0	8.6	8.1
Mitigation scenario 2: Reduce 50% of historical emission by 2030 (Update NDC)	6.1	4.3	2.4	0.6
Mitigation scenario 3: Green Highway scenario (LTS4CN)	8.3	8.1	8.5	8.9

The mitigation scenarios emissions were also calculated using EX-ACT tool version, 9.1 by Food Agriculture Organization (FAO). Same climate type, moisture, soil type and GWP values were used for the mitigation assessment as BAU assessment.

Table 4:16: Emissions Reductions for Mitigation Assessment of the FOLU Sector

Mitigation Scenario Ex-ACT (FOLU)	**Emissions Reductions (Million tCO_2e)**			
Year	2020	2030	2040	2050
Mitigation scenario 1: Reduce 50% of historical emission by 2030 (TNC)	N/A	10	10	10
Mitigation scenario 2: Reduce 50% of historical emission by 2030 (Update NDC)	N/A	38.1	38.1	38.1
Mitigation scenario 3: Green Highway scenario (LTS4CN)	0.9	31.1	63.2	71.3

4.4.6 Mitigation Scenario Developed for All Sectors

Prioritized mitigation actions planned to reduce GHG emissions by 24% in 2050 compared with the BAU scenario. The emissions reductions of 21.6 million tCO_2e/year is expected by 2030, while 44.2 million tCO_2e by 2050. The agriculture sector is expected to provide the major share of 34.4% emissions reductions by 2050.

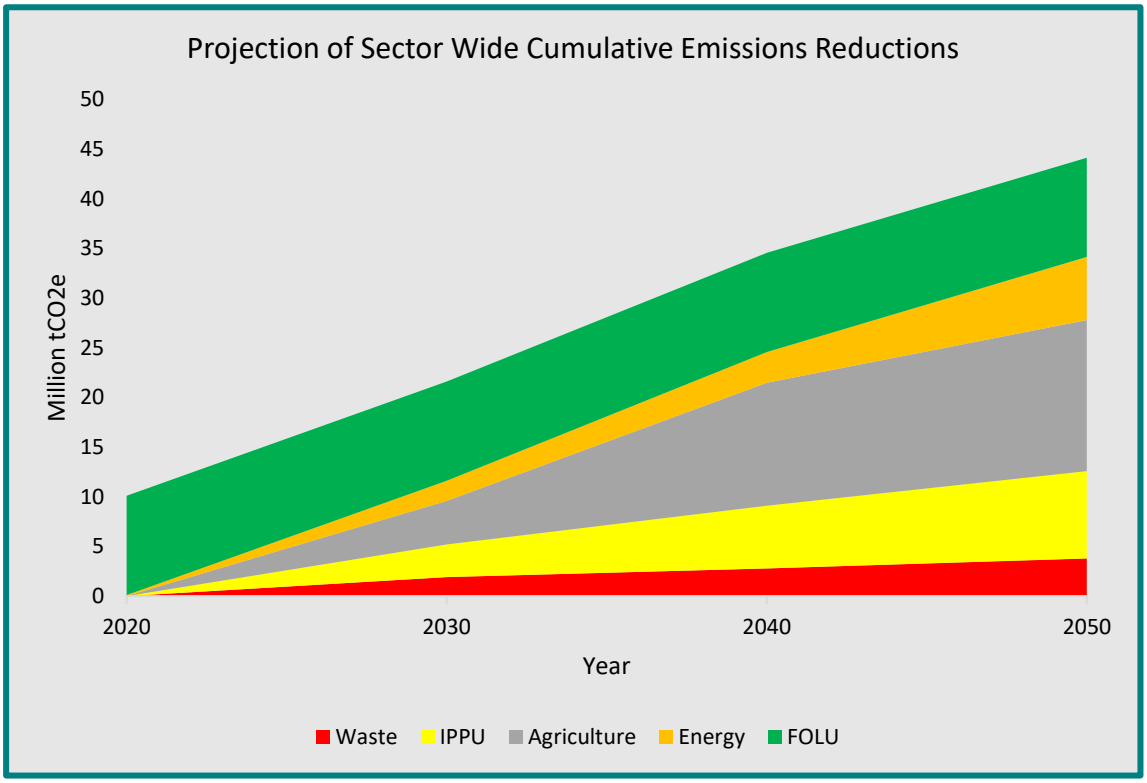


Figure 4.4: Projected cumulative emissions reductions for all sectors

4.5 International Market Mechanisms

For the market mechanism, Cambodia participated in the CDM under the Kyoto Protocol, Voluntary Carbon Market and JCM. The GHG emissions reductions from the market mechanism is not accounted as part of the national mitigation actions.

4.5.1 Clean Development Mechanism

Cambodia is strongly committed to the Kyoto Protocol and views CDM as an opportunity to achieve national sustainable development and poverty reduction objectives, while at the same time reducing GHG emissions. The MoE is the Designated National Authority for CDM project activities in Cambodia. The DCC carries out the technical assessment of CDM projects in coordination with other relevant government agencies.

Due to low electrification rates and national power system efficiency, Cambodia has made strident efforts to implement a sustainable energy efficiency programme aimed at meeting her domestic energy needs. Therefore, the CDM projects portfolio can complement the Government´s aim to achieve these goals, as well as improve individual well-being. 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 tonnes 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 4:17: 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. AMS-I.C. ver. 17	Biogas	7-Apr-11	26,592
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 South East Asia LDCs programme of activities- PoA	AMS-I.A. AMS-I.B. AMS-I.D.	Biomass	14-Mar-16	549

4.5.2 Joint Crediting Mechanism

The JCM was established to promote investment and deployment of low carbon technologies, products, systems, services, infrastructure, and capacity building leading to low carbon and sustainable growth in Cambodia. Verified reductions or removals from mitigation projects including the forestry sector under the JCM can be used as a part of Japan's internationally pledged GHG mitigation efforts and Cambodia's NAMA. Both parties ensure utilizing the JCM´s robust methodologies, transparency, and environmental integrity and maintain the JCM simple and practical to promote concrete actions for global greenhouse gases emissions reductions or removals. The Table 4.18 summarizes the JCM projects planned, started, and completed and the expected annual GHG emissions reductions.

Table 4:18: JCM Projects in Cambodia

Mitigation Action	Implementing Institution	Project Status	Sectors	Expected Emission Reductions (tCO_2/year)
Introduction of High Efficiency LED Lighting Utilizing Wireless Network	Minebea Co., Ltd. Overseas Cambodian Investment Corporation (OCIC) Siem Reap Provincial Hall APSARA	Completed	Energy Sector	3,590
Introduction of Ultra-lightweight Solar Panels for Power Generation at International School Project	Asian Gateway Corporation International School of Phnom Penh	Completed	Energy sector	149
Introduction of 1MW Solar Power System and High Efficiency Centrifugal Chiller in Large Shopping Mall	AEON MALL Co., Ltd. AEON MALL (CAMBODIA) CO., LTD	Completed	Energy sector	1,688
Energy Saving by Inverters for Distribution Pumps in Water Treatment Plant	METAWATER Co., Ltd. Phnom Penh Water Supply Authority	Completed	Energy sector	407
Provincial Water Supply and Sanitation Project	ADB	Not Started	Energy sector	6,371
JCM – REDD+ Prey Lang	Mitsui & CO. Ltd.	Installation Phase	Forestry	1,136,158

4.5.3 Voluntary Emission Reductions

A few local organizations have implemented voluntary carbon standards as viable alternatives to the CDM. There are six Voluntary Emissions Reductions (VERs) projects, including four REDD+ projects and two energy projects. Five of them are registered on Verra standard and one on Gold Standard.

Table 4:19: VER Projects in Cambodia

Name	Standard	Implementing Institution	Project Type	Status	Estimated Annual Emissions Reductions (tCO_2e)	Methodology
Cleaner Cooking Solutions Program	VERRA	C-Quest Capital Stoves Asia Limited	Energy industries (renewable/non-renewable sources)	Under development	380,000	VMR0006
Fuel-Wood Saving with Improved Cookstoves in Cambodia	VERRA	GERES (Group Energies Renewables & Environment)	Energy demand	Registered	192,600	AMS-II.G.
Southern Cardamom REDD+ Project	VERRA	MoE	Agriculture Forestry and Other Land Use	Registered	3,867,568	VM0009
Tumring REDD+ Project	VERRA	FA	Agriculture Forestry and Other Land Use	Registered	378,434	VM0009
Reduced Emissions from Deforestation and Degradation in Keo Seima Wildlife Sanctuary	VERRA	MoE	Agriculture Forestry and Other Land Use	Registered	1,426,648	VM0015
Reduced Emissions from Deforestation and Degradation in Community Forests – Oddar Meanchey, Cambodia	VERRA	FA	Agriculture Forestry and Other Land Use	Registered	204,792	VM0006
Fuel - Wood Saving with Improved Cookstoves in Cambodia	VERRA	CDC	Energy demand	Registered	192,600	AMS-II.G.
Bio-digester Programme	Gold Standard	MAFF	Energy	Registered	10,000	

4.6 Plan for Improvement

Following key improvement will be supported to achieve estimated emissions reductions by 2050.

4.6.1 Legal Framework

CHALLENGE 01

The current national-level legislation does not have a more focus approach especially with regard to the implementation of GHG emissions reductions projects. It was observed that the legal framework of the national and sub-national level was inadequate to a sound enabling environment to manage the GHG emissions mitigation activities effectively. Moreover, the existing legal requirements do not provide provisions to make mandatory reporting of public/ private institution-wise climate-related data such as GHG emissions and mitigation potential of the relevant activities.

RECOMMENDATION 01

It may be necessary to develop an integrated legal framework that includes not only the legislation itself but also the broader system of governance that determines the distribution of political and administrative authorities, as well as regulatory and enforcement instruments considering the national and sub-national system of Cambodia. Legal frameworks for GHG emissions reductions should facilitate the integration of environmental, and development policies, and provide a framework and means for their implementation and enforcement, especially at the sub-national and sectoral level.

4.6.2 Institutional Arrangements

CHALLENGE 02

The existing institutional arrangements at the national, sub national or sectoral level was not properly organized. It was observed that coordination among the institutions having a proper allocation of tasks has not been done effectively as local agencies tend to work in relative isolation, even though they often introduce policies and invest in projects that have a major impact on the responsibilities and work of other agencies. In the current context, it was found that the proper interconnection among the agencies has not properly organized having mechanisms to develop public and private partnerships paving the way to pool the resources to optimize resource efficiency to implement and manage the GHG emissions reductions projects efficiently.

RECOMMENDATION 02

It is necessary to develop an integrated institutional framework at the national, sub national or sectoral level to ensure the effective management of GHG emissions reductions projects. The integration framework requires to cover horizontal integration which includes interrelation and interconnection among the relevant institutions so that it helps to manage the GHG emissions projects without having any duplications, redundancies, or conflicts by having a proper allocation of tasks and responsibilities. Moreover, within this framework, it is necessary to develop private and public sector cooperation by using different concepts like joint councils and industry associations, etc., which help to maximize resources and to encourage private sector involvement in GHG emissions reductions activities.

Furthermore, vertical integration having a link with the national level institutions and sub-national level institutions is also important to build to have a speedy communication flow and to create a macro environment where the approach would enhance to share best practices to assure effective implementation of GHG emissions projects. The implementation of new policies or changes to existing policies should be done in a phased-out manner gradually, while providing time for affected private and public sector organizations to adjust. Moreover, transparency and accountability within public administration, of the sub national level plays an important role to develop confidence among the private sector that encourage private sector organizations more involvement in GHG emissions reductions activities.

4.6.3 Creating an Enabling Environment

CHALLENGE 03

Moreover, sub national or sectoral organization often are not given adequate resources or information support needed to take on their new responsibilities. It was observed that there is no balanced approach to what responsibilities are retained at the national level and what is devolved

to local levels. Moreover, it was further found that strengthening the capacity and capability of sub national level, staff training, establishing appropriate funding & reporting mechanism, sharing information among national level and local agencies to promote understanding of interconnected responsibilities to promote GHG emissions reductions projects have not been in place properly. There is a need to establish sector wise climate data portals for various data needs like national communications, BURs, NDC, etc.

RECOMMENDATION 03

Policymakers need to be made aware of the importance and benefits of having GHG emissions reductions projects as that creates an enabling environment to have more successful GHG emissions activities. Moreover, it may require developing the capacity and capability of the relevant institutions so that the institutions can actively take part in the GHG emissions reductions activities in an organized manner paving the way to contribute the NDCs also. It is also required to identify the specific responsibilities of sectoral organizations as that support to avoid any conflicting situations and to implement the GHG emissions related tasks in a very focus manner. Moreover, need is there to obtain the support of the financial institutions so that the funding barrier can overcome and that would be an encouragement for interested parties to work out on GHG emissions reductions projects.

4.6.4 Supporting Private Sector-Led Initiatives

CHALLENGE 04

Presently the private sector and public sector do not have sound cooperation to share the resources to make GHG programs more efficient. It was observed that very little focus is there for private sector involvement on GHG mitigation projects where public sector encouragement was not noted.

RECOMMENDATION 04

The private sector-driven approach related policy is very much important to develop sound GHG emissions projects. In this regard, it may be necessary to establish and develop public and private sector partnership programs then that will encourage the private sector to get more involved in such projects. Furthermore, different encouragement packages for the private sector, concessions for raw materials and funding facilities for R & D work, etc., are some of the instruments that can be considered as part and parcel of the policy interventions

5 Other Information

5.1 Introduction

Cambodia's economy has experienced robust growth over the last two decades, with an average annual growth rate of 7.7% between 1995 and 2019. The share of agriculture in Cambodia's GDP was 17.1%, the industry contributed approximately 36.8%, and the services sector contributed about 39.0% in 2019 (RGC, 2019). The per capita GDP has increased from $322 in 1995 to $1,679 in 2019 (RGC, 2019). Cambodia aims to become an upper-middle-income country by 2030 and a high-income country by 2050.

The rapid economic development, improved income, and population growth over the past decades have contributed to an increase in GHG emissions. In 2000, per-capita GHG emissions were about 0.2 tCO_2e per year; however, it is projected to rise to about 1.3 tCO_2e per year in 2050 (GSSD, 2015).

Therefore, the RGC is committed to combating climate change and accelerating the transition to climate-resilient, low-carbon, sustainable modes of development. The RGC joined the global efforts against climate change by being a Party to the UNFCCC and adopting and ratifying the Kyoto protocol (2002) and the Paris Climate Agreement (2017). The RGC also submitted the Initial National Communication in 2002 and the Second National Communication in 2015 and currently developing the Third National Communication (TNC), showing the continued involvement and interest in combating climate change. Besides, the country submitted her INDC on 30 September 2015, the fBUR on 13 August 2020, the Updated NDC on 31 December 2020, and LTS4CN on 30 December 2021.

5.2 Technology Transfer

Article 4.5 of the UNFCCC imposes an obligation on developed countries to provide, promote, facilitate, and finance the Transfer of Environmentally Sound Technologies (ESTs) and know-how to developing countries.[7] More importantly, Article 4.7 of the UNFCCC points out the roles of developed and developing countries in technology transfer by stating that "the extent to which developing country parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments related to financial resources and transfer of technology".[8]

Cambodia also ratified the 2015 Paris Agreement in 2017. In its essence, the Paris Agreement aims to restrict the increase of temperatures to 2°C above pre-industrial levels at an absolute maximum and to facilitate action further to increase this limitation to 1.5 °C above pre-industrial levels. Article 10 of the Paris Agreement addresses the topic of technology (Rimmer, 2018) in which Article 10.1 provides that "Parties share a long-term vision on the importance of fully realising technology development and transfer to improve resilience to climate change and reduce GHG emissions".[9] These provisions explicitly indicate a legal basis for Cambodia to make a direct demand for the technology transfer from developed countries.

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 and mainstreaming efforts on adaptation. 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.

[7] Article 4.5 of the UNFCCC.
[8] Article 4.7 of the UNFCCC.
[9] Article 10.1 of the Paris Agreement.

5.3 Research, Information Sharing, and Systematic Observation

5.3.1 Climate Change Research

The key higher education institutions in Cambodia involved in climate change research are 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). Climate change relevant research is carried out at the RUPP, especially by the Department of Environmental Science, and the Department of Biology of the Faculty of Science, and the Department of Natural Resources Management and Development of the Faculty of Development Studies. Besides, undergraduate courses relevant to climate change research, the RUPP also offers graduate programmes in climate change and biodiversity conservation to enhance the capacity for climate change research in Cambodia. The RUA also undertakes climate change related research, such as a study on agroforestry and climate change. The RUA also offers introductory courses in climate change related to specific topics such as $REDD^{+}$ and Payment for Ecosystem Services (PES). The ITC has also conducted research on climate change, especially in the Faculty of Hydrology and Water Resource Engineering and the Faculty of Industrial and Mechanical Engineering. The research work conducted by these two faculties mainly focuses on water resources in climate change and the impact of heat stress on productivity in the factory. The PNCA is also one of Cambodia's top research institutions in climate change and agriculture. The PNCA research mainly focuses on the resilience of agriculture in the face of climate change, soil carbon management, and exploring innovative methods in dealing with climate change impact on the agriculture sector.

The following research on CC and different aspects of its impacts on different sectors have been widely researched:

- Water and food security;
- Building capacity of government institutions to help farmers adapt to CC;
- Climate-smart agriculture;
- Farm conservation and sustainable use of cereals diversity;
- Economics of adaptation in the Agriculture sector;
- Historical climate change, climate vulnerability and climate change projection in Cambodia;
- Water governance and climate change adaptation;
- Rehabilitation of native species in Cambodia;
- Climate resilience and disaster risk reduction;
- Develop an allometric equation to calculate carbon stock in forests;
- Identification of natural hazards;
- Impact of CC on the Agriculture sector;
- Impact of drought on rural livelihoods;
- Study of CH_4 emission from enteric fermentation using INVITRO SYSTEM;
- Producing CH_4 gases using waste from vegetables, fruits, and animal fertiliser
- Module for GHG emission from animal raising; and
- Improving community livelihood through CC adaptation and mitigation.

Currently, the following research related to climate change is being conducted:

- 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;
- Effects of forest restoration on water availability for smart agriculture: a case study of Cambodia (FRAWSA) funded by the Swedish Government;

- Building Adaptive Capacity through the Scaling-up of Renewable Energy Technologies in Rural Cambodia (S-RET) funded by the IFAD;
- Enhancing Climate Change Resilience of Rural Communities Living in Protected Areas in Cambodia funded by MoE/UNEP;
- 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.

Since 2011, the DCC, with support from Danida, Oxfam, and UNDP, commissioned the Research and Learning Group at the BBC World Service Trust to conduct a nationwide research study to explore Knowledge, Attitudes, and Practices (KAP1) about climate change. The study gathered and documented experiences related to people's perceptions of changes in climate, environment and natural resources. Information collected has been used to inform policy priorities and actions in the CCCSP and subsequent sector-specific climate change plans. The KAP2 was conducted in 2014-2015 through the support of the CCCA with three aims: to validate KAP 1, to evaluate change measures implemented since KAP1, and to assess the impact and effectiveness of public awareness-raising activities undertaken since KAP1. KAP3 just finalized and approved, aiming to inform the design of future awareness-raising efforts and of mechanisms and interventions to engage different groups of Cambodia's society to be effective agents of change in responding to climate change challenges.

5.3.2 Dissemination and Information Sharing

As the national contact point, the DCC of the NCSD/ MoE is the key player responsible for climate change activities in Cambodia. Cambodia has made efforts to improve the dissemination and sharing of climate change information, including capacity-building activities. The establishment of a national network and the participation in regional networks have contributed to enhanced cooperation and research in the areas related to climate change, facilitating the transfer of knowledge and information-sharing on climate change mitigation and adaptation, including the dissemination of success stories good practices and lessons learned. The establishment of the Climate Change Technical Working Group (CCTWG) in 2017 aims to provide technical support to the NCSD and exchange information between ministries and agencies. At the regional level, Cambodia participated in a number of regional information-sharing platforms and forums, such as the Southeast Asia Regional Climate Downscaling (SEACLID), Asia Pacific Adaptation Network (APAN), Southeast Asia START Regional Center (SEA-START), and ASEAN Working Group on Climate Change (AWGCC).

With growing public access to the internet, online information websites and portals on climate change are frequent tools to disseminate and share knowledge, information and networking. The use of online services and the creation of dedicated websites significantly contribute to the dissemination of information on climate change. In this respect, the DCC plays an important role as the coordinating body for climate change activities, including information, knowledge sharing, and networking. The NCSD's website (http://ncsd.moe.gov.kh/) was established and hosted by the NCSD to disseminate information on climate change in Cambodia. In particular, the website contains the latest publications, news, and relevant information of climate change in Cambodia. The MoE's website (https://www.moe.gov.kh/en) also provides relevant climate change information, such as in the Environmental Magazine.

5.3.3 Systematic Observation

Systematic observations are instrumental in the successful implementation of the Convention. Article 5 of the Convention called on all Parties to support international efforts to strengthen systematic observation and national scientific and technical research capacities and capabilities. The Global Climate Observing System (GCOS) was established to coordinate the international undertaking in observing Essential Climate Variables (ECVs) in atmospheric, oceanic, and terrestrial domains. Several platforms exist to coordinate climate change research, such as the World Climate Research Programme (WCRP). Cambodia continually contributes observations through GCOS and actively collaborates with international communities in climate change research programs. At the same time, Cambodia also strives to increase her capacity in environmental surveillance and research on climate variability and change, impact and adaptation, and climate change mitigation in response to the country's specific needs. This is consistent with Article 7, paragraph 7(c) of the Paris Climate Agreement, which called on Parties to strengthen scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems. It needs to be in a manner that informs climate services and supports decision-making. The GCOS 2016 Implementation Plan broadens the scope of observations for adaptation and mitigation.

METEOROLOGY AND HYDROLOGY

Systematic observation involving the recording of hydrological and meteorological data is the responsibility of the MoWRAM.

From the 1910s until the early 1970s, data for hydrological and meteorological stations were recorded daily at 50 hydrological stations on the Mekong, the Tonle Sap, and the tributaries. Only about 20 hydrological stations have been repaired since the mid-1980s. The water quality database from 1985 to 1997 has data relating to the stations, the chemical data of each sample and the river discharge and temperature value of each sample. Cambodia now has 13 stations for recording data related to water quality. The Department of Meteorology (DoM) of the MoWRAM has 38 meteorological stations that record rainfall, 23 that record evaporation and 14 stations that record wind speed. As it is the situation with the hydrological stations, the meteorological stations were destroyed during the war. LWS, an international NGO, assisted with the reparation of the stations in the early 1990s, but the instrumentation is limited. Data is recorded manually at 20 stations and sent to Phnom Penh periodically for inclusion in the database. The former nine automated stations are out of operation. A proposal has been developed to rehabilitate and modernise these stations (MoWRAM/DoM 2009). In Cambodia, meteorological data collection is still limited. The number of manually operated rainfall stations is about 200; it should be increased. In the DoM, stations send data to the provincial centre once per month by post or messenger for data processing purposes. Provincial centres send collected data from stations to the DoM monthly in the same manner. For forecasting purposes, key stations send data (weather forecasts) daily to the DoM by radio and television year-round. Only two main stations observe rainfall, air temperature, wind direction, and relative humidity (Pochentong and Sihanoukville). Since 2012, a radar station is operational in Phnom Penh: The Techno Sen. The station is equipped with high-performance facilities to enable the DoM to produce and broadcast weather forecasts.

LAND USE AND FOREST COVER DATA

In cooperation with the MAFF and with financial support from the UNDP and the FAO, the Mekong Secretariat prepared the first-ever Cambodia Land Cover Atlas 1985/87-1992/93. Two sets of LANDSAT-MSS images and one set of LANDSAT-TM images false colour composite

obtained during the dry season at a scale of 1:250,000 were used to prepare maps of the atlas. Topographic maps at a scale of 1:50,000 and a scale of 1:250,000 covering Cambodia were used as references during the interpretation of images and digitising of the interpretation results. Panchromatic aerial photographs at a scale of 1:25,000 to 1:27,000 taken during the 1992/93 dry season were used as references and as "ground truth data" to develop the interpretation keys and check the interpretation. The classification of 27 land cover types was mainly based on the existing classification of vegetation types in tropical Asia.

AGRICULTURAL DATA

The MAFF has recorded the most detailed data relating to agriculture in Cambodia in cooperation with the FAO, the WFP and the CARDI. The FAO/WFP estimated 1995/96 production of wet and dry season rice and cereals in 1996, undertaking a survey of communities and reviewing data from various sources. In 1998/99, the MAFF, in collaboration with the WFP, made a more detailed assessment by surveying wet-season paddy production in 1,312 communities in 15 provinces (out of 23), which accounts for more than 97% of the country's rice production. Information collected included planted area, harvested area and damaged area, the nature of the damage, and yields. The FAO supported a study of wood energy consumption in 1996, which found that an estimated 0.6 cubic meters/person/year or 6 million cubic metres of fuelwood is used per year.

CENSUS DATA

With the support of the UNFPA, the National Institute of Statistics (NIS) carried out the national census in 1998. The census information, compiled and available to the public in both hard and digital copies, is the only comprehensive data set available in Cambodia. One of the advantages of the database is that the geographic codes used are compatible with existing GIS data, allowing the extraction of useful census information for data analysis on natural resources and environmental management.

5.4 Education, Training and Capacity Building, and Public Awareness

Article 6 of the UNFCCC and Article 10(e) of the Kyoto Protocol require all parties to promote and facilitate, at the national, sub-regional and regional levels, the development and implementation of educational and public awareness programmes, public access to information, and training for scientific, technical and managerial personnel about climate change and its effects.

5.4.1 Education on Climate Change

Mainstreaming climate change knowledge and information into formal and non-formal education is the key principle to sustaining climate change awareness for green, equitable and climate-resilient society. It is important to create an enabling environment for climate change education and awareness by developing and enhancing communication structures, systems and tools.

With support from the European Union, Sweden, and the UNDP have encouraged a push for a better climate and environmental education in Cambodia. As part of a broader effort to promote science and technology, Climate Change Education (CCE) has been integrated into a new and expanded earth science curriculum for higher secondary schools, which will be introduced by 2020, with an enrolment of over half a million students.

Students from grades 10 to 12 will learn about the country's vulnerability profile; factors that drive climate change; key approaches and technologies to adapt to climate change impacts and reduce

GHG emissions. In addition, the MoE has collaborated with the Ministry of Education, Youth and Sport (MoEYS) to initiate an 'eco-school' project supported by the CCCA. Fifteen pilot schools have received additional teaching on climate change and participated in practical 'climate resilience' projects such as tree planting and climate-smart agriculture. These educational initiatives reflect Cambodian efforts to leverage the potential of the next generation for the transition to a more resilient, low-carbon economy.

In 2018, the Climate Change Textbook for Upper Secondary School was published under the cooperation of the MoEYS, the NCSD/the CCCA to support teachers in preparing climate change lessons and teaching students the impacts of climate change the mitigation and adaptation measures.

5.4.2 Training and Capacity Building on Climate Change

Since 2000, about 80 trainings, workshops, public awareness, and other capacity building activities related to climate change have been conducted in Cambodia. This figure may be much lower than the actual activities, as many climate change capacity building activities have not been recorded. There is no system in place to record and monitor the outcome of the activities. Most capacity building activities were supported by Japan, Korea, the Netherlands, Denmark, UNDP, UNEP, ADB, EU, World Bank, and Other NGOs.

From 2003 to 2005, Cambodia participated in implementing a global project entitled "Capacity Development for the Clean Development Mechanism (CD4CDM)". The project was financially supported by the Netherlands' Ministry of Foreign Affairs via the UNEP. The overall development objective of this project was to generate, in selected developing countries, a broad understanding and develop institutional and human capacity to "fully participate as equal partners with developed countries in the formulation and implementation of the CDM".

Since October 2003, the Institute for Global Environmental Strategies (IGES) of Japan has supported the capacity building programme for the CDM and the new market mechanism in Cambodia. Several workshops and trainings were conducted under this support, which aims to build the capacity of the Cambodian DNA and project developers.

In 2009, Danida and Oxfam America supported the Climate Change Capacity Strengthening and Awareness Raising Programme in Cambodia. Under this supported project, extensive climate change awareness-raising activities were conducted, including provincial seminars, debates on TV and radio, newspaper articles, climate change campaigns, drawing contests among students, climate change material development, etc.

Most of the capacity building activities undertaken in Cambodia are integral to other climate change projects and programs. Capacity-building activities aim primarily to strengthen the country's institutional, systematic, and individual capacities to formulate, coordinate, and implement diverse mitigation and adaptation-related actions. In recent years, particular attention has been devoted to programs and activities relating to the preparation of Nationally Appropriate Mitigation Action (NAMA), NDCs, Cambodia's First BUR, and other capacity-building areas emerging as a result of the evolving nature of climate science and policy.

Recent examples of capacity building activities carried out in Cambodia as part of global/regional international-supported programs include the Green Climate Fund (GCF) Readiness Support to Strengthen the National Designated Authority (NDA), Cambodia's First BUR to the UNFCCC, and the MRV System for Renewable Energy Policies.

A list of recorded trainings conducted between 2018 and 2020 is provided as followings.

- The Training Workshop on the CCCA Grant Implementation Guidelines (GIG)-28 October 2020;
- The Training on GHG Inventory in Energy Sector-August 28, 2020;
- The Training Workshop on Gender and Climate Change-January 29, 2020;
- Basic Training Workshop on Strengthening the Governance of Climate Change Finance to Enhance Gender Equality in Cambodia-December 16, 2019;
- Training on Operational Manual for the National Designated Authority of Cambodia to the Green Climate Fund-July 05, 2019;
- Second Training on Submission of Research Proposals and Preparation for Launching of Climate change Research Projects-June 12-14, 2019;
- Training Workshop on Climate Change Vulnerability, Impact and Adaptation Assessment-April 3-5, 2018;
- Training Workshop on Media and Climate Change-March 21, 2018; and
- Training Workshop on Grant Implementation Guidelines-March 19, 2018.

At the regional level, the Asia-Pacific Network for Global Change Research (APN) is an active inter-governmental network, regularly supporting and implementing research, capacity building and science-policy interaction in the Asia-Pacific region. Cambodia also participated in a regional training course on "Climate Change and Sustainable Development" for ASEAN countries.

5.4.3 Public Awareness on Issues and Solutions of Climate Change

The engagement of households and communities is key to developing effective local responses to climate change that address poverty and the vulnerability faced by the poor. A national survey of climate change perceptions and awareness undertaken in 2007 found that 85% of respondents believed that Cambodia's climate is changing, but only 59% of respondents (including 82% of farmers) had heard of the term 'climate change' and associated the change with human practices. Of those aware of climate change, 97% believed they would be affected, and 61% were very concerned. However, respondents had a generally low awareness of the specific causes and impacts of climate change or that it was a global issue. Location, age, gender and occupation were significant factors in determining awareness. The young and educated had higher levels of awareness, and men had higher 76 levels of awareness than women. Television and the radio were found to be the most common sources of receiving information on health and the environment.

There have been initiatives to raise the general awareness of climate change in Cambodia. With support from UNDP, UNEP, Danida, Oxfam America, and other NGOs, the Climate Change Department of the MoE organised a series of climate change awareness campaigns using Khmer media, essentially television and radio broadcasts as well as local newspapers. The campaign used original content and translation into Khmer of short films, documentaries, and other available multi-media resources such as student debates, video spots, radio talk shows, posters, newspaper and magazine articles, drawing contests and exhibitions.

A survey was conducted to assess the level of understanding of climate change and identify knowledge gaps and training needs with government ministries, committees, academic institutions and the media. The survey found that only around 10% of respondents had a good understanding of climate change and the vulnerability of their sector. It is suggested that greater knowledge is needed to successfully mainstream climate change into sectoral policy, plans, programmes and projects. Most respondents had a fair understanding of adaptation and general knowledge of climate change but a greater understanding of GHG mitigation.

5.4.4 Media Coverage

In recent years, the media has played an increasingly larger role in helping to raise public awareness of climate change problems and solutions in Cambodia. A wide range of tools, such as websites, radio and television programmes, newsletters, social media, web blogs, movies, video games, advertisements, posters, exhibitions, conferences, seminars, awards and days, weeks and months of actions and campaigns have been used for the public awareness activities. The MoE and its networks usually launch country-wide awareness-raising campaigns and activities on climate change as part of international environment-related events, such as World Environment Day, Earth Day and "60+ Earth Hour Campaign", etc.

5.5 Mainstreaming Climate Change into Socio-economic Development Policies and Plans

Cambodia recognizes the importance of integrating climate risk into national and sector policy, planning and budgetary processes, and individual projects' design. Such integration faces a range of barriers and is limited at both national and sub-national levels. However, several proposed initiatives focused on developing the capacity and information needed to address this.

The CCCSP (2014-2023) has been developed to fill the policy gap, complement ongoing efforts, and meet the emerging challenges of development, environment and climate change issues.

The NSDP (2019-2023) stresses the need to improve agricultural productivity by expanding irrigation and managing water resources to reduce vulnerability to disasters. In addition, the NSDP is formulated to address environmental weaknesses inherent to the past economic model and protect the natural resource endowment by nudging/incentivising greener production and consumption. In parallel, it also meets Cambodia's commitments to climate change action, including de-carbonisation of the economy and alongside measures.

The Rectangular Strategy, Phase 4 stresses the RGC's commitment to mobilising resources to address climate change. The NSDP Update 2019-2023, adopted in 2019, stresses that climate change is a major priority of the RGC and focuses on key climate change actions such as institutional capacity strengthening, sectoral mainstreaming, strategy and action plan development, financing, actual project implementation, education and awareness-raising.

Climate risk management has gradually been integrated into provincial policy, planning and budgeting processes at the sub-national level. Such processes face several barriers, including a lack of budget, limited understanding of climate risks and a lack of technical capacity. There has been limited training at the provincial and community levels to develop this capacity. However, the National Programme for Sub-National Democratic Development (NPSNDD) (2010-2019) is expected to enhance opportunities for sub-national governments to integrate climate resilience in their actual local development activities.

Several key projects target the integration of climate change policies into policies and plans at various government scales. A key initiative is the Pilot Programme on Climate Resilience (PPCR) under the Strategic Program for Climate Resilience. This programme is designed to pilot and demonstrate ways to integrate climate risk and resilience into developing countries' core development policies and planning. Cambodia is one of nine countries worldwide selected for participation in the programme. The PPCR in Cambodia was to be jointly implemented by the World Bank Group and ADB, with the International Finance Corporation (IFC) participation.

The CCCA programme was designed to be fully aligned with and strengthen the national institutional framework for climate change. It plays a unique role in strengthening the national institutional framework for coordinating the climate change response. It is implemented by the MoE in its capacity as Chair and Secretariat of the NCSD. In 2019, the RGC launched a new Strategic National Action Plan for Disaster Risk Reduction 2019-2023 (SNAP-DRR). The SNAP covers several themes that overlap with the climate change agenda, including mainstreaming disaster risk reduction into national, sectoral and local development policies and plans; national and local risk assessments; improved flood forecasting and early warning capabilities; education and awareness-raising; and the promotion of structural and non-structural measures to enhance resilience.

Based on NSDP (2019-2023), the RGC will give priority to continue to implement the "National Strategic Plan on Green Growth 2013-2030", "Cambodia Climate Change Strategic Plan 2014-2023", "National Environment Strategy and Action Plan 2016-2023", "National REDD+ Strategy 2017-2026"; and use social and environmental funds effectively to ensure economic development with low-carbon emission and resilience to climate change (MoE, 2017).

5.6 International Exchange and Cooperation

Cambodia is ranked as one of the most climate-vulnerable countries in Southeast Asia and the world. Based on extreme weather events, the Climate Risk Index ranks the countries most affected by climate change from 1996 to 2015. Cambodia ranked 13th out of 181 countries.
The adverse impacts of climate change require robust inter-governmental cooperation and the technological and financial support of international cooperation, organisations and developing countries. After the ratification of the UNFCCC (18 December 1995), Kyoto Protocol (2002) and the Paris Agreement on Climate Change (2017) by the National Assembly, the opportunities for expanding the international cooperation and exchange in the areas of climate change has been increasing since then.

The European Union, the Government of China, Japan, Korea, Australia, the USA, Sweden, France, and Germany, The Global Environment Facility (GEF), Asian Development Bank (ADB), World Bank (WB), the UNDP, the United Nations Environment Program (UNEP), International Fund for Agricultural Development (IFAD), Food and Agriculture Organization (FAO), and United Nations Industrial Development Organization (UNIDO) are key partners of Cambodia in the areas of climate change cooperation. In addition, it is crucial to cooperate and receive technical and financial support from the Adaptation Fund, Green Climate Fund and Technological centres and networks within the UNFCCC and its Kyoto Protocol. The main developing partners providing funding for climate change in 2018 are ADB (41%), China (19%), Japan (12%), IFAD (5%), UNDP (4%), and 3% for the Republic of Korea, Australia, EU/EC (MEF, 2020).

6 Constraints and Gaps, and Support Needs

6.1 Introduction

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 0.013^{o}C to 0.036^{o}C 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.

6.2 Constraints and Gaps

After the ratification of the UNFCCC (1996), Kyoto protocol (2002), and Paris Agreement on Climate Change (2017), 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 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 Planreceived 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.

6.2.1 Human Resources

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 climate 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.

6.2.2 Financial Gaps

As a party to the UNFCCC, Kyoto protocol, and Paris Agreement, 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. 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 USD 865.5 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 6:1: Proportion of Climate Change Expenditure to the Total Public Expenditure and the GDP

CC Expenditure/year	2009	2010	2011	2012	2013	2014	2015	2016
CC Public Expenditure (weighted) vs. Total Expenditure	3.30%	3.50%	3%	3.30%	3.70%	4.40%	3.80%	3.10%
CC Public Expenditure (weighted) vs. the GDP	0.90%	1.00%	0.80%	0.90%	1.20%	1.40%	1.20%	0.90%

Source: MEF (2018)

Table 6:2: Financing Gap Analysis to Implement Climate Change Adaptation Plans by Key Line Ministries

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)

6.2.3 Technology Transfer

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.

6.2.4 GHG Inventory

Cambodia has conducted three national GHG inventories under the first and second national communications with inventory years in 1994 and 2000, respectively, while the third one is under the process, and the methodology used is based primarily on the Intergovernmental Panel on Climate Change (IPCC) 1996 Revised Guidelines and IPCC Good Practice Guidance (MoE, 2002 and GSSD, 2015). The GHG inventory mainly under national communications relied mainly on assumptions, expert judgment, and default value of the IPCC. The estimation of emissions was conducted for three gases (CO_2, CH_4, and N_2O) by sources and removals. Thus far, Cambodia has still acknowledged her limited reliable data and information as well as the expertise necessary to conduct the GHG inventory. Some of the constraints for the GHG inventory include:

- Limited activity data and local emission factors (use IPCC default values);
- Data classification is different from IPCC Guideline categories, in particular for the Land Use, Land Use Change, and Forestry (LULUCF);
- Limited sustainable GHG inventory system;
- Limited financial support for regular inventory preparation; and
- Limited national experts for GHG inventory preparation.

6.2.5 Nationally Appropriate Mitigation Action

Thus far, the country has developed only two NAMAs, covering the NAMA on Energy Efficiency in the Garment Industry in 2015, which aims to improve efficiency in the industrial sector and to build capacity in the field of energy efficiency (MIH, 2015) and the NAMA on Sustainable Charcoal Value-Chains of the Groupe Energies Renouvela Bles, Environment et Solidarités (GERES). Under the NAMA, other sectors should also be taken into account such as transport, energy, waste, etc. Cambodia has faced a number of challenges for implementing and extending to other sectors because of the following constraints:

- Limited understanding of the NAMA;
- Inadequate national and sectoral policies to develop and implement the NAMA;
- Line ministries, academia, research institutes, and private sectors have faced with limited capacity in applying environmentally sound technologies and implementing the NAMA;
- Limited effective coordination mechanism among line ministries and other key stakeholders to develop and implement inter-sectoral NAMAs; and
- NAMA developers face difficulties in accessing financial sources from both domestic and international donors.

6.3 Financial, Technology, and Capacity Needs

Cambodia has received substantial supports from development partners, funding institutions, and donor country in the fields of financial, technological, and capacity development support. However, it has been observed that over the past several years, Cambodia has put a lot of emphasis on integrating climate change into the development planning process, at the national, sectoral and sub-national level, as well as piloting potential approaches, mostly in adaptation (RGC, 2013 and 2014a). The government is shifting towards full-scale climate change response implementation, including mitigation aspects. Therefore, Cambodia still has financial, technological, and capacity needs to address constraints, gaps, and adaptive capacity to the adverse effects of climate change.

6.3.1 Financial Needs

As discussed previously, Cambodia has to mobilize around 92% (USD802.63 million) of the total expense (USD865.47 million) for climate change impacts from other sources of funds in order to complement proposals raised by the line ministries and to translate all those actions into concrete implementation. Therefore, 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 has to 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.

6.3.2 Technology needs

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 6:3: 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)

APPLICATION OF CLIMATE CHANGE MITIGATION TECHNOLOGIES BY SECTORS

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 6:4: Priority Actions by Sectors for GHG Mitigation

Sector	Priority Actions	GHG Reduction ($MtCO_2e$) in 2030
Energy Industries	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 home systems, hydro (pico, mini); and Promoting energy efficiency by end-users	1,800 (16%)
Manufacturing Industries	Promoting use of renewable energy and adopting energy efficiency for garment factories, rice mills, and brick kilns.	727 (7%)
Transport	Promoting mass public transport; and 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	Promoting energy efficiency for buildings and more efficient cookstoves; and	155 (1%)
	Reducing emissions from waste through the use of bio-digesters and water filters	
Total Savings		**3,100 (27%)**

Source: GSSD (2015)

The followings are detailed descriptions of GHG mitigation actions by sectors needed to be addressed:

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 in order to define the optimal mitigation options;
- Renewable energy investments should be increased and facilitated; and
- Develop government strategies to support a low carbon economy.

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.

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.

LAND USE, LAND-USE CHANGE, AND FORESTRY

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.

APPLICATION OF CLIMATE CHANGE ADAPTATION TECHNOLOGIES BY SECTORS

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 6:5: 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 dykes 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 dykes 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, taking into account 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)

6.3.3 Capacity Needs

Having ratified the UNFCCC, the Kyoto protocol, Paris Agreement, Cambodia has provided a great window of opportunities for capacity building and institutional arrangement and enhancement. 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 in order 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.

6.4 Information Related to the Achievement of the Objectives of the Convention

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 6.6.

Table 6:6: 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	N/A
15	Strengthening the Adaptive Capacity and Resilience of Rural Communities Using Micro Watershed Approached to Climate Change and Variability to Attain Sustainable Food Security	5,200,000	LDC-F	N/A
16	Building Adaptive Capacity through the Scaling up of Renewable Energy Technologies in Rural Cambodia	4,600,000	SCC-F	N/A
Total		**137,489,222**		

7 Appendix

Appendix I: Social & Economical Indices

Human Development Index in ASEAN Member States in 2004

HDI Rank	Human Development Index (HDI) Value	Life Expectancy at Birth	Adult Literacy Rate (% ages 15 and older)	Combined Gross Enrolment Ratio - Primary, Secondary and Tertiary School (%)	GDP Per Capita (ppp$)
25 Singapore	0.916	78.9	92.5	87	28,077
34 Brunei Darussalam	0.871	76.6	92.7	77	19,210
61 Malaysia	0.805	73.4	88.7	73	10,276
74 Thailand	0.784	70.3	92.6	74	8,090
84 Philippines	0.763	70.7	92.6	82	4,614
108 Indonesia	0.711	67.2	90.4	68	3,609
109 Vietnam	0.709	70.8	90.3	63	2,745
129 Cambodia	0.583	56.5	73.6	60	2,423
130 Myanmar	0.581	60.5	89.9	49	1,027
133 Lao PDR	0.553	55.1	68.7	61	1,954

Human Development Index in ASEAN Member States in 2014

HDI Rank	Human Development Index (HDI), Value	Life Expectancy at Birth, Years	Expected Years of Schooling, Years	Mean Years of Schooling, Years	Gross National Income (ppp$) (GNI) per Capita
11 Singapore	0.912	83	15.4	10.6	76,628
31 Brunei Darussalam	0.856	78.8	14.5	8.8	72,570
62 Malaysia	0.779	74.7	12.7	10	22,762
93 Thailand	0.726	74.4	13.5	7.3	13,323
110 Indonesia	0.684	68.9	13	7.6	9,788
115 Philippines	0.668	68.2	11.3	8.9	7,915
116 Viet Nam	0.666	75.8	11.9	7.5	5,092
141 Lao PDR	0.575	66.2	10.6	5	4,680
143 Cambodia	0.555	68.4	10.9	4.4	2,949
148 Myanmar	0.536	65.9	8.6	4.1	4,608

GDP at Current Prices by Economic Activity from 1990 to 2016 (% Share of GDP)

Sectors	1990[a]	1994[a]	1998[b]	2000[c]	2002	2004	2006	2008	2010	2012	2014	2016
Agriculture, Forestry and Fisheries	51.5	45.2	45.2	37.9	33.2	30.5	29.5	23.6	27.8	28.8	25.6	24.4
Industry	11.6	18.3	17.2	23.0	26.1	28.6	30.1	36.7	34.5	35.3	32.6	33.8
Services	36.9	36.5	33.6	39.1	40.7	40.9	40.4	39.7	37.7	35.9	41.8	41.8
Total GDP	100	100	100	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: [a]MoE (2002); [b]NIS (2003); and [c]MEF (2006), RGC (2010 and 2014), and MoP (2010 and 2014)

Economic Significance of the Industry Sector in Cambodia

Items	2000	2001	2002	2003	2004	2005	2006e	2007p	2008p	2009p	2010p
Mining	8.6	10.1	12.1	14.5	18.3	22.9	25.2	27.1	29.1	31.3	33.6
Manufacturing	578.9	671.2	755.7	849.3	1004.0	1101.7	1266.5	1398.9	1529.0	1672.5	1830.2
Food, Beverages, Tobacco	115.4	121.2	120.6	126.8	136.2	158	170.8	181.9	193.7	206.2	219.5
Textile, Wearing Apparel and Footwear	333	427.7	500.8	573.4	705.2	759.2	893	997.2	1097.1	1208	1330.4
Wood, Paper, Publishing	34	26.2	28.4	26.2	29.6	34.7	37.8	40.5	43.4	46.5	49.8
Rubber Manufacturing	17.8	15.7	18.7	27.7	29.5	30.2	34	37.4	41.1	45.3	49.9
Other Manufacturing	78.7	80.3	87.2	95.2	103.5	119.7	130.9	141.9	153.7	166.6	180.6
Electricity, Gas, Water	14.9	17.7	21.7	25.9	29.8	31	34.8	38.5	42.4	46.8	51.5
Construction	187.8	190.9	250.1	276.6	318.9	385.8	444.6	506.6	580.6	660.8	747

Source: NIS (2008) and MEF (2006) and Note: E- Estimates and P- Preliminary Estimates

Economic Significance of the Garment Textile and Footwear Industry in Cambodia

Year	Factories Number	Employee	Garment Export
		1000	Million $
1995	20	18.7	26.2
1996	24	24.0	106.4
1997	67	51.6	223.9
1998	129	79.2	355.3
1999	152	96.6	653.0
2000	190	122.6	965.0
2001	185	188.1	1,143.8
2002	188	210.4	1,330.2
2003	197	234.0	1,596.5
2004	219	259.8	1,958.8
2005	247	283.9	2,167.2
2006	290	334.9	2,626.9
2007	292	353.0	2,840.4
2008	284	324.9	2,942.8
2009	243	281.9	2,388.4
2010	262	319.4	2,994.6
2011	309	335.4	3,996.7
2012	436	447.9	4,445.7
2013	528	533.5	4,967.0
2014	626	580.7	5,391.0
2015	699	646.9	5,741.0

Source: GMAC (2015); MoC (2011); BFC (2016); and ILO (2016)

Balance of Payment for the Share of the GDP

Items	Unit	2011	2012	2013	2014	2015	2016	2017
Export	%	28.9	40.1	42.9	44.1	46.8	46.2	46.2
Import	%	55.4	57.9	64.0	63.2	66.0	64.1	63.0
FDI	%	10.4	12.1	12.0	10.0	9.1	10.3	10.5
Trade Balance	%	-14.3	-17.8	-21.1	-19.1	-19.2	-17.9	-16.8
Current Account Balance	%	-5.9	-8.2	-13.0	-9.8	-9.6	-9.1	-8.5

Source: MEF (2016) and NBC (2016)

Appendix II: Comparison of Re-calculated Values in the First BUR of Cambodia with the INC and SNC Values

The following tables compare GHG emissions in the INC for 1994 inventory year and SNC for 2000 inventory year with the re-calculated values in First BUR for same inventory years.

Comparison of CO_2 Emissions of the INC, SNC, and the First BUR

Emissions Source		CO_2 Emissions (Gg)			
		1994 Inventory Year		2000 Inventory Year	
		BUR	INC	BUR	SNC
1A1	Energy Industries	48.28	331.31	86.02	383.59
1A2	Manufacturing Industry	114.84	6.53	161.5	313.66
1A3	Transport	1852.05	825.25	1963.09	704.76
1A4	Other	91.55	26.5	157.36	188.19
1A5	Residential	NE	82.49	NE	NE
2A1	Cement Production	NO	49.85	NO	NO
2D1	Lubricants	3.81	NE	6.04	NE
2F	Subst. for ODS	NA	NA	NA	NA
3A	Livestock				
3B	Land	27018.62	-19635.96	27018.62	22858.73
3C	Aggregate Sources and non-CO_2 Emissions Sources on Land	1.61	NE	1.65	NE
3D	Other				
4A	Solid Waste Disposal				
4B	Biological Treatment of Solid Waste				
4C	Incineration and Open Burning of Waste	623.2	NE	708.13	NE
4D	Wastewater Treatment and Discharge				
	Total	**29,753.96**	**-18,314.03**	**30,102.41**	**24,448.93**

Comparison of CH_4 Emissions of the INC, SNC, and the First BUR

Emissions Source		CH_4 Emissions (Gg)			
		1994 Inventory Year		2000 Inventory Year	
		BUR	FNC	BUR	SNC
1A1	Energy Industries	10.01	0.02	14.57	0.02
1A2	Manufacturing Industry	1.1	0	1.16	0.1
1A3	Transport	0.51	0.14	0.45	0.11
1A4	Other	7.83	0	9.03	27.95
1A5	Residential	NE	0.01	NE	0.03
2A1	Cement Production	NA	NA	NA	NA
2D1	Lubricants	NA	NA	NA	NA
2F	Subst. for ODS	NA	NA	NA	NA
3A	Livestock	188.84	184.79	199.49	186.19
3B	Land	NE	74.77	NE	32.06
3C	Aggregate Sources and non-CO_2 Emissions Sources on Land	186.85	154.47	242.74	689.33
3D	Other	NO		NO	
4A	Solid Waste Disposal	21.57	5.9	27.74	9.69
4B	Biological Treatment of Solid Waste	0.21	NE	0.25	NE
4C	Incineration and Open Burning of Waste	7.24	NE	8.22	NE
4D	Wastewater Treatment and Discharge	11.45	0.87	13.28	0.49
	Total	**435.61**	**420.97**	**516.92**	**945.97**

Comparison of N_2O Emissions of the INC, SNC, and the First BUR

Emission sources		N_2O Emissions (Gg)			
		1994 Inventory		2000 Inventory Year	
		BUR	FNC	BUR	SNC
1A1	Energy Industries	0	0	0	0
1A2	Manufacturing Industry	0.15	0	0.16	0.01
1A3	Transport	0.09	0.01	0.1	0.01
1A4	Other	0.09	0	0.1	0.37
2A1	Cement Production	NA	NA	NA	NA
2D1	Lubricants	NA	NA	NA	NA
2F	Subst. for ODS	NA	NA	NA	NA
3A	Livestock	2.18	3.88	2.32	1.11
3B	Land	NE	0.51	NE	0.22
3C	Aggregate Sources and non-CO_2 Emissions Sources on Land	3.89	7.2	4.31	7.69
3D	Other	NO	NO	NO	NO
4A	Solid Waste Disposal	NA	NA	NA	NA
4B	Biological Treatment of Solid Waste	0.01	NE	0.02	NE
4C	Incineration and Open Burning of Waste	0.11	NE	0.12	NE
4D	Wastewater Treatment and Discharge	0.29	NE	0.42	0.05
	Total	**6.8**	**22.67**	**7.54**	**9.46**

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