INDONESIA FIRST **BIENNIAL TRANSPARENCY REPORT** (BTR1)

Under the United Nations Framework Convention on Climate Change

Republic of **Indonesia**

2024

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FOREWORD

Indonesia's First Biennial Transparency Report (BTR1) signifies a significant step in our nation's dedication to meeting the Enhanced Transparency Framework (ETF) obligations established by the Paris Agreement. It is essential that BTR1 adheres to the standards of transparency, accuracy, completeness, and consistency as required by Decision 18/CMA.1 UNFCCC. The ETF mandates that all parties to the Paris Agreement submit Biennial Transparency Reports (BTRs) biennially, commencing on 31 December 2024.

This report outlines Indonesia's progress in achieving the Enhanced Nationally Determined Contributions (ENDC) as of 2022. It includes updates on national circumstances, greenhouse gas inventories, mitigation efforts, and the needs and support received related to finance, technology transfer, capacity building, and adaptation.

This BTR adheres to the Modalities, Procedures, and Guidelines (MPGs) and includes a textual report along with Common Reporting Tables (CRTs) for national inventory data and Common Tabular Formats (CTFs) to systematically monitor and report on Indonesia’s climate progress, as well as its financial, technology transfer, and capacity building needs and contributions. The report contains a separate National Inventory Document (NID) detailing Indonesia greenhouse gas emission level.

I express my sincere gratitude to the representatives from ministries, government institutions, academic communities, private sector stakeholders, civil societies, and international partners for their contributions to the preparation of this report. Their collaboration and expertise have been essential in creating a document that accurately represents Indonesia's collective efforts to address climate change. This report demonstrates our ongoing commitment to the Paris Agreement as we pursue significant actions toward a sustainable, low-carbon, and climate-resilient future for Indonesia and the global community.

Dr. Hanif Faisol Nurofiq, S.Hut., M.P
Minister of Environment /Head of Environmental Management Agency

PREFACE

In accordance with the mandate established by the Conference of Parties (COP) through Decision 18/CMA.1 under the Paris Agreement, Indonesia presents its First Biennial Transparency Report (BTR1). This report signifies a significant advancement in meeting our transparency obligations as a Party to the UNFCCC and the Paris Agreement. This report has been developed in compliance with the Enhanced Transparency Framework (ETF) requirements.

The BTR1 reflects the collaborative efforts of various ministries, institutions, and sectoral experts under the coordination of the Ministry of Environment, highlighting Indonesia's dedication to transparent and accountable climate action reporting. This document presents essential updates regarding Indonesia's National Circumstances and includes a report on the National Greenhouse Gas (GHG) Inventory. The document also addresses Indonesia's mitigation actions and their effects, identifies constraints and gaps concerning financial, technological, and capacity-building needs, and evaluates the support received, along with adaptation efforts.

Indonesia's First BTR serves not merely as a compliance document; it embodies a steadfast commitment to the principles of transparency, accuracy, and consistency, which are crucial for tackling the global climate challenge. This report outlines our progress regarding the targets established in our Enhanced Nationally Determined Contribution (ENDC). This being our initial BTR, we are dedicated to improving our reporting in subsequent submissions. BTR1 outlines targeted improvement strategies aimed at enhancing accuracy, coordination, and data quality in the forthcoming reporting cycle.

I express my sincere appreciation to all stakeholders from diverse ministries, institutions, academic communities, experts, and international partners for their steadfast commitment and significant contributions. Their expertise and commitment have been crucial in the effective preparation of this document, which reflects Indonesia's collective commitment to a sustainable and climate-resilient future.

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LIST OF ABBREVIATIONS

3R	Rewetting, Revegetation, Revitalization
3R	Reduce, Reuse, Recycle
AAWS	Automatic Aerological Weather Stations
ACA	Asuransi Central Asia
ACGF	ASEAN Catalytic Green Finance Facility
AD	Activity Data
ADB	Asian Development Bank
ADCOM	Adaptation Communication
AF	Adaptation Fund
AFD	*Agencé Française de Developpement* / French Development Agency
AFOLU	Agriculture, Forestry, and Other Land Uses
AFR	Alternative Fuel and Raw Material
AGB	Above Ground Biomass
AIIB	Asian Infrastructure Investment Bank
AKKM	*Area Konservasi Kelola Masyarakat*
AKSARA	*Aplikasi Perencanaan dan Pemantauan Rencana Aksi Nasional Rendah Karbon* / Low Carbon Action-Planning Monitoring Application
APBD	*Anggaran Pendapatan dan Belanja Daerah* / Regional Revenue and Expenditure Budget
APBN	*Anggaran Pendapatan dan Belanja Negara* / State Revenue and Expenditure Budget
APIK	*Adaptasi Perubahan Iklim bidang Kesehatan* / Climate Change Health Resilience
APL	*Area Penggunaan Lain* / Other Land Uses
APTMA	*Alat Pemantauan Tinggi Muka Air*
AR	Afforestation dan Reforestation
ARG	Automatic Rain Gauges
ASEAN	The Association of Southeast Asian Nations
ASN	*Aparatur Sipil Negara* / State Civil Apparatus
ASWS	Automatic Surface Weather Stations
ATR/BPN	*Kementerian Agraria dan Tata Ruang*/*Badan Pertanahan Nasional* / Ministry of Agrarian Affairs and Spatial Planning/National Land Agency
AUTP	*Asuransi Usaha Tani Padi*
AUTS/K	*Asuransi Usaha Tani Ternak Sapi / Kerbau*
AWS	Automatic Weather Stations

Bappenas	*Badan Perencanaan Pembangunan Nasional*/National Development Planning Agency
BAST	*Berita Acara Serah Terima* / Handover minutes
BATAN	*Badan Tenaga Atom Nasional* / National Atomic Energy Agency
BAU	Business as Usual
BBG	*Bahan Bakar Gas* / Gas fuel
BBM	*Bahan Bakar Minyak* / Fossil Fuel
BBN	*Bahan Bakar Nabati* / Biofuel
BBPSI	*Balai Besar Pengujian Standar Instrumen*
BBWS	*Balai Besar Wilayah Sungai*
BGB	Below Ground Biomass
BI	*Bank Indonesia* / *Central Bank of Indonesia*
BIG	*Badan Informasi Geospasial* / Geospatial Information Agency
BMKG	*Badan Meteorologi Klimatologi dan Geofisika* / Meteorological, Climatological and Geophysical Agency
BNPB	*Badan Nasional Penanggulangan Bencana* / National Agency for Disaster Management
BOD	Biochemical Oxygen Demand
BOP	Biaya Operasional Penyuluh
BPBD	*Badan Penanggulangan Bencana Daerah* / Regional Disaster Management Agency
BPK	*Badan Pemeriksa Keuangan* / *Financial Audit Board*
BPKH	Balai Pemantapan Kawasan Hutan / Forest Conservation Area Management Units
BPKP	*Badan Pengawasan Keuangan dan Pembangunan* / *Financial and Development Supervisory Agency*
BPN	*Badan Pertanahan Nasional* / National Land Agency
BPP	*Balai Penyuluh Pertanian*
BPPT	*Badan Pengkajian dan Penerapan Teknologi* / Agency for the Assessment and Application of Technology
BPS	*Badan Pusat Statistik* Central Bureau of Statistics
BPSDM	*Badan Pengembangan Sumber Daya Manusia* / Human Resource Development Agency
BPSDTPH	*Balai Pengawasan dan Sertifikasi Benih Tanaman Pangan dan Hortikultura*
BPTPH	*Balai Perlindungan Tanaman Pangan dan Hortikultura*
BRG	*Badan Restorasi Gambut* / Peatland Restoration Agency
BRGM	*Badan Restorasi Gambut dan Mangrove* / Peatland and Mangrove Restoration Agency
BRIN	*Badan Riset dan Inovasi Nasional* / National Research and Innovation Agency
BRT	Bus Rapid Transit

BTR	Biennial Transparency Report
BUMN	*Badan Usaha Milik Negara* / State-Owned Enterprises
BUR	Biennial Update Report
BWS	*Balai Wilayah Sungai*
CAGR	Compound Annual Growth Rate
CB	Capacity Building
CBCA	Community-Based Climate Action
CBIT	Capacity Building Initiative for Transparency
CBTNA	Capacity Building and Technology Needs Assessment
CDD	Consecutive Dry Days
CDM	Clean Development Mechanism
CEWS	Climate Early Warning System
CFS	Climate Field School
CI	Cropping Intensity
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CNG	Compressed Natural Gas
COP	Conference of the Parties
CORDEX	Coordinated Regional Climate Downscaling Experiment
CPO	Crude Palm Oil
CRT	Common Reporting Table
CSA	Climate-Smart Agriculture
CTF	Common Tabular Format
CWD	Consecutive Wet Days
DAS	*Daerah Aliran Sungai*
DBD	*Demam Berdarah Dengue* / Dengue Fever
DFI	Development Financing Institutions
DG	Directorate General
DHIS	District Health Information System
DIPA	*Daftar Isian Pelaksanaan Anggaran* / List of Budget Implementation Items
DJA	*Direktorat Jenderal Anggaran* / Directorate General of Budget
DJKN	*Direktorat Jenderal Kekayaan Negara* / Directorate General of State Assets
DJP	*Direktorat Jenderal Pajak* / Directorate General of Tax
DJPB	*Direktorat Jenderal Perbendaharaan* / Directorate General of Treasury
DJPK	*Direktorat Jenderal Perimbangan Keuangan* / Directorate General of Fiscal Balance
DJPPR	*Direktorat Jenderal Pengelolaan Pembiayaan dan Risiko* / Directorate General of *Financing and Risk Management*

DK	*Daftar Kegiatan* / Activity List
DKI	*Daerah Khusus Ibukota*
DMAFS	Debt Management and Financial Analysis System
DMPG	*Desa Mandiri Peduli Gambut*
DRAM	*Dokumen Rancangan Aksi Mitigasi Perubahan Iklim*/Climate Change Mitigation Action Project Design Document
DRKH	*Daftar Rencana Kegiatan Hibah*
DRPLN	*Daftar Rencana Pinjaman Luar Negeri* / List of Foreign Loan Plan
DRPPLN	*Daftar Rencana Prioritas Pinjaman Luar Negeri*/List of Priority Plans for Foreign Loans
DRR	Disaster Risk Reduction
DWW	Domestic Wastewater
EbA	Ecosystem-based Adaptation
EBT	*Energi Baru Terbarukan* / New and Renewable Energy
EDAT	Early Diagnosis and Prompt Treatment
EF	Emission Factor
EFB	Empty Fruit Bunch
EFCS	Enhancement of Forest Carbon Stock
EFT	Environmentally Friendly Technologies
EMT	Emergency Medical Team
ENDC	Enhanced Nationally Determined Contributions
ENSO	El Niño-Southern Oscillation
EP	Environmental Permit
EPANJI	*Evaluasi Efektivitas Pengelolaan Jenis Ikan Terancam Punah dan/atau Dilindungi*
ER	Emission Reduction
ESDM	*Energi dan Sumberdaya Mineral*
EVIKA	*Evaluasi Efektivitas Pengelolaan Kawasan Konservasi*
EWRS	Early Warning and Response System
EWS	Early Warning System
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FDI	Foreign Direct Investment
FEWS	Flood Early Warning System
FFB	Fresh Fruit Bunch
FGD	Focused Group Discussions
FNC	First National Communication
FOLU	Forestry and Other Land Use
FRL	Forest Reference Level
FREL	Forest Reference Emission Level

FTC	Financial, Technology and Capacity Building
GAW	Global Atmosphere Watch
GCF	Green Climate Fund
GCM	Global Climate Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GGA	Global Goal on Adaptation
GHG	Greenhouse Gas
GIS	Geographic Information System
GHGI	Greenhouse Gas Inventory
GIZ	German Agency for International Cooperation
GL	General Ledger
GoI	Government of Indonesia
GRDP	Gross Regional Domestic Product
GWP	Global Warming Potential
HCS	High Carbon Stock
HCV	High Conservation Value
HCVF	High Conservation Value Forest
HFC	Hydrofluorocarbon
HK	*Hutan Konservasi* / Conservation Forest
HL	*Hutan Lindung* / *Protected Forest*
HP	*Hutan Produksi* / Production Forest
HPK	*Hutan Produksi Konversi* / Conservation Production Forest
HPT	*Hutan Produksi Terbatas* / Limited Production Forest
IBF	Impact-based Forecasting
IBRD	International Bank for Reconstruction and Development
ICER	Indonesia Certificate Emission Reduction
IDR	Indonesia Rupiah
IHN	Integrated Health Networks
IISIA	Indonesian Iron & Steel Industry Association
IKLH	*Indeks Kualitas Lingkungan Hidup* / Environmental Quality Index
IKP	*Indeks Ketahanan Pangan* / Food Security Index
IKRO	Microclimate Station
INDC	Intended National Determined Contribution
INPRES	*Instruksi Presiden* / Presidential Instruction
IPAL	*Instalasi Pengolahan Air Limbah* / Wastewater Treatment Plant (WWTP)
IPB	*Institut Pertanian Bogor* / IPB University
IPCC	Intergovernmental Panel on Climate Change
IPLT	*Instalasi Pengolahan Lumpur Tinja*

IPPU	Industrial Process and Product Use
IR	Incidence Rate
ISPO	Indonesian Sustainable Palm Oil
ISW	Industrial Solid Waste
ITB	*Institut Teknologi Bandung* / Bandung Institute of Technology
ITMOs	Internationally Transferred Mitigation Outcomes
IWW	Industrial Wastewater
JICA	Japan International Cooperation Agency
JITUPASNA	*Pengkajian Kebutuhan Pascabencana* / Post-Disaster Needs Assessment
KATAM	*Kalender Tanam* / Planting Calendar
KBL	*Kereta Bertenaga Listrik* / Electric-Fueled Train
KCPI	Knowledge Center *Perubahan Iklim* / Climate Change Knowledge Center
KEMENKES	*Kementerian Kesehatan* / Ministry of Health (MoH)
KfW	*Kreditanstalt für Wiederaufbau* / Germany Development Bank
KHG	*Kesatuan Hidrologis Gambut*
KIMONO-CFS	Climate-Smart Technology for Climate Field School
KKP	*Kementerian Kelautan dan Perikanan* / Ministry of Maritime and Fisheries Affairs
KLB	*Kejadian Luar Biasa*
KLHK	*Kementerian Lingkungan Hidup dan Kehutanan* / Ministry of Environment and Forestry (MoEF)
KLHS	*Kajian Lingkungan Hidup Strategis* / Strategic Environmental Assessment
KOMPAK	*Kelompok Masyarakat Penggerak Kawasan Konservasi*
KOTAKU	*Kota Tanpa Kumuh*
KPA	*Kawasan Pelestarian Alam*
KPBU	*Kerjasama Pemerintah dengan Badan Usaha* / Public-Private Partnership
KPH	*Kesatuan Pemangkuan Hutan* / Forest Management Unit (FMU)
KPPN	*Kantor Pelayanan Perbendaharaan Negara* / State Treasury Service Office
KRL	*Kereta Rel Listrik* / Electric Train
KSA	*Kawasan Suaka Alam* / Nature Preservation Area
KPA	*Kawasan Pelestarian Alam* / Nature Conservation Area
KUA	*Kredit Usaha Alat Pertanian*
KUR	*Kredit Usaha Rakyat* / People's Business Loan
L&D	Loss and Damage
LAPAN	*Lembaga Penerbangan dan Antariksa Nasional* / National Institute of Aeronautics and *Spaces*

LCEV	Low-Carbon Emission Vehicle
LCGC	Low-Cost Green Car
LDKPI	*Lembaga Dana Kerjasama Pembangunan Internasional* / International Development *Cooperation Fund*
LEWS	Landslide Early Warning System
LFG	Landfill Gas
LHK	*Lingkungan Hidup dan Kehutanan*
LIPI	*Lembaga Ilmu Pengetahuan Indonesia/* Indonesian Institute of Science
LPG	Liquid Petroleum Gas
LRT	Light Rapid Transit
LULUCF	Land-Use Change and Forestry
M&E	Monitoring and Evaluation
MDB	Multilateral Development Banks
MDB	Multilateral Development Banks
MEMR	Ministry of Energy and Mineral Resources
MEWS	Meteorology Early Warning System
MKG	*Meteorologi, Klimatologi dan Geofisika* / Meteorology, Climate, Geophysic
MMU	Minimum Mapping Unit
MoA	Ministry of Agriculture / Kementerian Pertanian (KEMENTAN)
MoEF	Ministry of Environment and Forestry
MoEMR	Ministry of Energy and Mineral Resources
MoF	Ministry of Finance
MoI	Ministry of Industry
MoPWH	Ministry of Public Work and Housing
MOL	*Mikro Organisme Lokal*
MOMAL	*Makan Obat Malaria Massal*
MONEV	Monitoring and Evaluation
MoU	Memorandum of Understanding
MPG	Modalities, Procedures, and Guidelines
MPTS	Multi-Purpose Tree Species
MRT	Mass Rapid Transit
MRV	Monitoring, Reporting, and Verification
MSG	Melanesian Spearhead Group
MSW	Municipal Solid Waste
NDC	Nationally Determined Contributions
NFI	National Forest Inventory
NFMS	National Forest Monitoring Systems
NPL	Non-Performing Loan
NPS	Non-Party Stakeholders

NTB	*Nusa Tenggara Bara*
NTT	*Nusa Tenggara Timur*
ODA	Official Development Assistance
ODS	Ozone-depleting Substances
OECD	The Organization for Economic Co-operation and Development
OMC	*Operasi Modifikasi Cuaca*
OMDC	Oceans, Marine Debris, and Coastal
OOF	Other Official Flows
OPD	*Organisasi Perangkat Daerah*
OPT	*Organisme Pengganggu Tumbuhan*
ORPA	*Organisasi Riset Penerbangan dan Antariksa* / The Research Organization for Aeronautics and Space
PA	Paris Agreement
PBI	*Pembangunan Berketahanan Iklim*
PBP	Performance-based Payment
PDASRH	*Pengendalian Daerah Aliran Sungai dan Rehabilitasi Hutan*
PDF	Probability Density Function
PEEB	Program for Energy Efficiency in Buildings
PEMDA	*Pemerintah Daerah* / Regional/Local Government
PFC	Perfluorocarbon
PHPL	*Pengelolaan Hutan Produksi Lestari*
PJU	*Penerangan Jalan Umum* / Street Lighting
PLN	*Perusahaan Listrik Negara* / State Electricity Company
PLTA	*Pembangkit Listrik Tenaga Air* / Hydroelectric Power Plant
PLTB	*Pembangkit Listrik Tenaga Bayu* / Wind Power Plant
PLTM	*Pembangkit Listrik Tenaga Minihidro* / Minihydro Power Plant
PLTP	*Pembangkit Listrik Tenaga Panas Bumi/G*eothermal Power Plant
PLTS	*Pembangkit Listrik Tenaga Surya/* Solar Power Plant
PMK	*Peraturan Menteri Keuangan*/Minister of Finance's Regulation
PMU	Project Management Unit
PN	*Prioritas Nasional*/National Priority
PNBP	*Pendapatan Negara Bukan Pajak/* State Revenue Non-Tax
POPT	Pengendali Organisme Pengganggu Tumbuhan
PP	*Peraturan Pemerintah/* Government Regulation
PPP	Public-Private Partnerships
PPTI	*Pusat Pengembangan Teknologi Informasi*/Information Technology Development Center
PPV	Positive Predictive Value
PSDA	Pengelolaan Sumberdaya Air
PT	*Perseroan Terbatas*/Limited Liability Company

PUPR	*Pekerjaan Umum dan Perumahan Rakyat*/ Ministry of Public Work and Public Housing
PV	Photovoltaic
R&DB	Research and Development for Business
R20MM	Annual Count of Days When PRCP≥ 20mm
R50MM	Annual Count of Days When PRCP≥ 50mm
RAPBN	*Rencana Anggaran Pendapatan dan Belanja Negara/* Plant for State Revenue and *Budget*
RBC	Result-Based Contribution
RBP	Results-Based Payments
RCP	Representative Concentration Pathway
RDF	Refuse-derived Fuels
REDD+	Reduction Emission from Deforestation and Forest Degradation, Role of Conservation, Sustainable Management of Forest and Enhancement of Forest Carbon Stock
RENSTRA	*Rencana Strategis*/Strategic Plan
RHL	*Rehabilitasi Hutan dan Lahan*/Forest and Land Rehabilitation
RIL	Reduce Impact Logging
RIPIN	*Rencana Induk Pembangunan Industri Nasional*/ National Industrial Development Master Plan
RJIT	*Rehabilitasi Jaringan Irigasi Tersier*/Tertiary Irigation Network Rehabilitation
RKPD	*Rencana Kerja Pemerintah Daerah/Regional Government Work Plan*
RMS	Remote Monitoring System
RPJMD	*Rencana Pembangunan Jangka Menengah Daerah*/Regional Medium-Term Development Plan
RPJMN	*Rencana Pembangunan Jangka Menengah Nasional/* National Medium-Term *Development Plan*
RPPLH	*Rencana Perlindungan dan Pengelolaan Lingkungan Hidup/Environmental Protection and Management Plan*
RPPLN	*Rencana Prioritas Pinjaman Luar Negeri/* Foreign Loan Priority Plan
RX1DAY	Monthly Maximum 1-day Precipitation
RX5DAY	Monthly Maximum Consecutive 5-day Precipitation
SADEWA	Satellite-based Disaster Early Warning System
SAI	*Sistem Akuntansi Instansi* / Agency Accounting System
SAKTI	*Sistem Aplikasi Keuangan Tingkat Instansi*
SANTANU	*Sistem Pemantauan Hujan*
SDG	Sustainable Development Goals
SFM	Sustainable Forest Management

SIAP	*Sistem Informasi Asuransi Pertanian*
SIAP TANAM	*Sistem Informasi Adaptif untuk Perencanaan Tanam*
SIATAB	*Sistem Informasi Air Tanah dan Air Baku*
SID	*Survey Investigasi dan Desain*
SIDIK	*Sistem Informasi Data Indek Kerentanan*
SILIN	Silvilculture Intensive
SIMONTANA	*Sistem Monitoring Hutan Nasional* / Indonesia National Forest Monitoring System (NFMS)
SIPONGI	*Sistem Pengawasan Kebakaran Hutan dan lahan*
SIPSN	*Sistem Informasi Pengelolaan Sampah Nasional*
SIRAMI KEBUNKU	*Sistem Informasi Rencana Tanam dan Infrastruktur Air Perkebunan Komoditas Utama*
SISMAL	*Sistem Informasi Malaria*
SKDR	*Sistem Kewaspadaan Dini dan Respon*
SKEM	*Standar Kinerja Energi Minimal*
SLCN	*Sekolah Lapang Cuaca Nelayan*
SLI	*Sekolah Lapang Iklim* / Climate Field School (CFS)
SLM	Sustainable Landscape Management
SME	Small Medium Enterprise
SNI	*Standar Nasional Indonesia*/Indonesia National Standard
SOE	State-owned Enterprises
SPAB	*Satuan Pendidikan Aman Bencana*
SPALD	*Sistem Pengelolaan Air Limbah Domestik*
SPE	*Sertifikasi Penurunan Emisi Indonesia*/Indonesia Certification Emission Reduction
SRF	Solid Recovered Fuel
SRGI	*Sistem Referensi Geospasial Indonesia*
SRMI	Sustainable Renewables Risk Mitigation Initiative
SRN	*Sistem Registri Nasional/* National Registry System
SSP	Shared Socio-economic Pathways
ST	Settlement
SWDS	Solid Waste Disposal Site
TA	Technical Assistance
TCK	*Tenaga Cadangan Kesehatan*
TGC	Tim Gerak Cepat
THPB	*Tebang Habis Permudaan Buatan*
TMC	*Teknologi Modifikasi Cuaca* / Weather Modification Technology
TNA	Technology Needs Assessment
TNC	Third National Communication
TOE	Ton Oil Equivalent

TOW	Total Organically Degradable Material in Wastewater
TPA	*Tempat Pemrosesan Akhir* / Final Processing Site
TPES	Total Primary Energy Supply
TPT	*Tingkat Pengangguran Terbuka*
TTD	Technology Transfer and Development
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UPT	*Unit Pelaksanaan Teknis*
UU	*Undang-Undang* / Act
VAWS	Vessel Automatic Weather Station
VUB	*Varietas Unggul Baru*
WG	Working Group~~s~~
WMT	Weather Modification Technology
WWT	Waste Water Treatment
WWTP	Waste Water Treatment Plant
ZOM	*Zona Musim*

EXECUTIVE SUMMARY

Indonesia as a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC), fulfills one of its commitments to implement the Convention by presenting its First National Communication (NC1) in 1999, Second National Communication (NC2) in 2010, First Biennial Update Report in 2016, Third National Communication (NC3) in 2017 (MoEF, 2017), Second Biennial Update Report (BUR2) in 2018, and Third Biennial Update Report (BUR3) in 2021 (MoEF, 2021a). Indonesia hereby submits its First Biennial Transparency Report (BTR1) following Decision.18/CMA.1. Indonesia's BTR1 is prepared consistent with the Modalities, Procedure and Guideline outlines in Decision 18/CMA1 and Guidance on its operationalization in Decision 5/CMA3. Development of this BTR1 document is supported by Global Environment Facility (GEF).

This BTR1 includes updates on national circumstances, national greenhouse gas inventories, information on mitigation, financial, technology transfer and capacity-building needs and supports received, and information on adaptation. The BTR1 also includes supports that Indonesia has provided and mobilized for other developing countries. Nevertheless, Indonesia has not fully fulfilled the reporting requirements and has adopted certain flexibility provisions under Article 13, taking into account the available resources and capacities.

1.1. National Circumstances and Institutional Arrangement

National Circumstances

Indonesia is strategically positioned between the Indian and Pacific Oceans, serving as a link between Asia and Australia. Located on the equator, Indonesia is defined by a tropical climate and hosts diverse ecosystems. Indonesia is the world's largest archipelagic nation with 38 provinces and possessing the second-longest coastline at 95,181 kilometers. The marine waters extend over 5.8 million square kilometers.

The geological landscape of Indonesia is influenced by the convergence of three primary tectonic plates: the Eurasian, Pacific, and Indian-Australian plates. This interaction leads to significant volcanic activity and presents seismic risks, such as earthquakes, tsunamis, and landslides. The tropical climate is defined by limited seasonal temperature variations and distinctive rainfall patterns shaped by phenomena such as the El Niño and Indian Ocean Dipole, which are influenced by warm ocean waters. The highlands of Papua receive the highest annual rainfall ranging from 1,800 and 6,000 mm.

In 2024, Indonesia's population reaches 281.6 million, with a demographic bonus and a declining growth rate. This is largely attributable to the population substantial in productive age (15-64 years). This shift has led to a reduced economic dependency ratio, potentially stimulating economic growth. Recent years have seen an increase in manufacturing, trade, and services, while agriculture's share has decreased. Gross Domestic Product (GDP) reached IDR 12,301 trillion in 2023, which indicates an annual growth rate of nearly 5% prior to the pandemic. Nonetheless, it experienced negative impacts due to COVID-19 in 2020, leading to economic disruptions.

Institutional Arrangements

The institutional arrangement for the implementation of Enhanced Transparency Framework (ETF) under Article 13 of the Paris Agreement is regulated by Presidential Regulation No. 98 Year 2021 regarding 'The Implementation of Carbon Pricing to Achieve Nationally Determined Contribution (NDC) Target and Control Over GHGs Emissions in the National Development" (Articles 60 to 77). The regulation mandates that the NDC target be achieved in accordance with the principles of accuracy, consistency, transparency, sustainability, and accountability. This is accomplished through Measuring, Reporting, and Verification (MRV) System, National Registry System for climate actions and supports/resources (SRN-PPI), and certification of GHGs emission reduction. Ministerial Regulation (MoEF) No. 12 Year 2024, concerning 'The Implementation of NDC', provides further guidance on the operationalization of institutional arrangement for: (i) MRV (Articles 79 – 99), (ii) SRN-PPI (Articles 100-109), and (iii) certification of GHGs emission reduction (Articles 110), which is associated with Ministerial Regulation No. 21 Year 2022 on Procedure for Implementation of Carbon Pricing. The "One GHG Emission and Climate Resilience Data" policy is reflected in the SRN-PPI as the backbone of Transparency Framework in Indonesia. The SRN-PPI features interlinkages and interoperability with relevant information systems across ministries and agencies. SRN-PPI is executed by responsible organizations and actors at the action level, encompassing ministries, agencies, sub-national entities, private sector, and community groups. Additionally, these entities, along with the operator of the SRN-PPI at Directorate General of Climate Change of MoEF and the public as users, engage in collaborative joint actions undertaken by responsible organizations. The information registered and provided by SRN-PPI relates to actions encompassing adaptation, mitigation, GHG Inventory, carbon pricing, joint adaptation and mitigation efforts, reduction from deforestation and forest degradation (REDD)+, and additional resources. The framework encompasses support mechanisms including funding sources, technology transfer and development, capacity building, and technical assistance/expertise.

1.2. National GHG Inventory

GHG Emission and Removals in 2022

In 2022, the total emissions reached 1,382,854.50 kt CO2e, with non-LULUCF (Land Use, Land-Use Change, and Forestry) emissions at 1,070,542.93 kt CO2e (Table 2-32). LULUCF contribution to the total emissions was 22.58%, which is lower than the energy sector's 53.42%. The waste sector was responsible for 10.04%, agriculture for 9.80%, and Industrial Process and Product Use (IPPU) for 4.15%. CO_2 comprised 77.75% of greenhouse gases, followed by CH_4 (18.12%), N_2O (4.13%), and PFCs (0.004%). In the energy sector, fuel combustion dominated emissions (96.84%) with energy industries, manufacturing, and transport contributing 92.11%. Within the IPPU sector, mineral and metal industries were responsible for 72.90% of emissions. In the agriculture sector, enteric fermentation, rice cultivation, and soil comprised 83.88% of sector emissions. The leading emitter in the LULUCF sector was cropland, which released nearly twice the carbon as forests, primarily due to peat decomposition and fires. In the waste sector, wastewater treatment accounted for 80.9% of emissions, followed by domestic solid waste disposal.

Table 1. Summary of GHG emission and removal in 2022

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs	PFCs	Unspeci-fied mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_X	Total GHG emissions/ removals
	kt CO_2e												
Total national emissions and removals (with LULUCF)	**1,075,194.99**	**250,509.94**	**57,093.96**	**FX**	**55.61**	**FX**	**FX**	**FX**	**30.60**	**876.22**	**IE,NA, NE,NO**	**IE,NA, NE,NO**	**1,382,854.50**
Total national emissions and removals (without LULUCF)	**777,299.21**	**241,455.69**	**51,732.42**	**FX**	**55.61**	**FX**	**FX**	**FX**	**3.74**	**63.08**	**IE,NA, NE,NO**	**IE,NA, NE,NO**	**1,070,542.93**
1. Energy	**712,371.82**	**21,813.50**	**4,568.07**						**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**738,753.39**
1.A. Fuel combustion	707,721.11	3,163.12	4,560.51						NE	NE	NE	NE	715,444.74
1.A.1. Energy industries	314,393.28	111.07	1,090.08						NE	NE	NE	NE	315,594.43
1.A.2. Manufacturing industries and construction	204,612.78	807.54	1,103.20						NE	NE	NE	NE	206,523.52
1.A.3. Transport	154,955.56	1,255.10	2,128.74						NE	NE	NE	NE	158,339.40
1.A.4. Other sectors	33,759.49	989.40	238.50						NE	NE	NE	NE	34,987.39
1.A.5. Not-specified	NE,NO	NE,NO	NE,NO						NE	NE	NE	NE	NE
1.B. Fugitive emissions from fuels	4,650.71	18,650.38	7.56						NE,NO	NE,NO	NE,NO	NE,NO	23,308.65
1.B.1. Solid fuels	NE,NO	4,243.97	NE						NE,NO	NE,NO	NE,NO	NE,NO	4,243.97
1.B.2. Oil and natural gas and other emissions from energy production	4,650.71	14,406.42	7.56						NE	NE	NE	NE	19,064.69
1.C. CO_2 Transport and storage	NE,NO												NE,NO
2. Industrial processes and product use	**56,337.73**	**102.84**	**865.45**	**FX**	**55.61**	**FX**	**FX**	**FX**	**NE**	**NE**	**NE**	**NE**	**57,361.63**
2.A. Mineral industry	31,480.03	NO	NO						NO	NO	NO	NO	31,480.03
2.B. Chemical industry	9,366.80	102.84	865.45	NO	NO	NO	NO	NO	NO	NO	NO	NO	10,335.09
2.C. Metal industry	10,981.37	NO	NO	NO	55.61	NO	NO	NO	NO	NO	NO	NO	11,036.98

2.D. Non-energy products from fuels and solvent use	4,358.07	NO	NO						NO	NO	NO	NO	4,358.07
2.E. Electronic industry			NO	NO	NO	NO	NO	NO					NO
2.F. Product uses as substitutes for ODS				FX	FX	FX	FX	FX					FX
2.G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.H. Other	151.46	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	151.46
3. Agriculture	**6,206.43**	**86,197.38**	**43,162.03**						**3.74**	**63.08**	**IE,NA, NE,NO**	**NE,NO**	**135,565.84**
3.A. Enteric fermentation		36,720.88											36,720.88
3.B. Manure management		2,530.56	12,962.28								IE,NE		15,492.83
3.C. Rice cultivation		46,841.59									NE		46,841.59
3.D. Agricultural soils		NA	30,146.09						NA	NA	NA		30,146.09
3.E. Prescribed burning of savannas		103.38	52.81						3.70	61.68	NE	NE	156.19
3.F. Field burning of agricultural residues		0.98	0.85						0.04	1.40	NE	NE	1.83
3.G. Liming	2,159.22												2,159.22
3.H. Urea application	4,047.21												4,047.21
3.I. Other carbon-containing fertilizers	NE												NE
3.J. Other	NO	NO	NO						NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	**297,895.78**	**9,054.25**	**5,361.54**						**26.86**	**813.13**	**NA,NE**	**NA**	**312,311.57**
4.A. Forest land	-266,741.53	2,371.39	5,018.35						3.12	202.99	**NE**		-259,351.80
4.B. Cropland	412,258.89	5,585.53	156.45						10.65	392.02	NE		418,000.87
4.C. Grassland	86,099.06	1,077.74	186.74						13.09	218.12	NE		87,363.54
4.D. Wetlands	1.66	19.60	NA,NE						NE	NE	NE		21.26
4.E. Settlements	1,994.71	NE	NA,NE						NE	NE	NE		1,994.71
4.F. Other land	64,283.00	NE,NO	NE,NO						NE	NE	NE		64,283.00
4.G. Harvested wood products	NE,NO												NE,NO

4.H. Other	NO	NO	NA,NO						NA,NE	NA,NE	NA,NE	NA	NA,NO
5. Waste	**2,383.23**	**133,341.96**	**3,136.87**						**NA**	**NA**	**NA**	**NA**	**138,862.07**
5.A. Solid waste disposal		**21,724.54**							**NA**	**NA**	**NA**		21,724.54
5.B. Biological treatment of solid waste		2.09	34.06						**NA**	**NA**	**NA**		36.15
5.C. Incineration and open burning of waste	**2,381.81**	**21,724.54**							**NA**	**NA**	**NA**	NA	4,635.09
5.D. Wastewater treatment and discharge		2.09	34.06						**NA**	**NA**	**NA**		112,292.62
5.E. Other	1.43	2,019.29	233.99						**NA**	**NA**	**NA**	NA	173.68
6. Other *(please specify)*	**NE**	109,423.80	2,868.82	**FX**	**NE**	**FX**	**FX**	**FX**	**NE**	**NE**	**NE**		**FX,NE**
Other sources of emissions/removals	NE	172.25	NO	FX	NE	FX	FX	FX	NE	NE	NE		FX,NE
Memo items:													
1.D.1. International bunkers	NE,NO	NE,NO	NE,NO						NE	NE	NE	NE	NE,NO
1.D.1.a. Aviation	NE	NE	NE						NE	NE	NE	NE	NE
1.D.1.b. Navigation	NE,NO	NE,NO	NE,NO						NE	NE	NE	NE	NE,NO
1.D.2. Multilateral operations	NE	NE	NE						NE	NE	NE	NE	NE
1.D.3. CO_2 emissions from biomass	73,181.06												73,181.06
1.D.4. CO_2 captured	NE												NE
5.F.1. Long-term storage of C in waste disposal sites	113,680.44												113,680.44
Indirect N_2O			NE										NE
Indirect CO_2	NE												NE

"FX" (flexibility), NA" (not applicabe), "NE" (not estimated), "NO" (not occurring), "IE" (included elsewhere)

GHG Emission and Removal Trends

The total emissions increased by approximately 62% from 2000 and 2022. The energy sectors experienced the highest increase (142%), followed by waste (134%), IPPU (44%), and agriculture (26%). Emission from LULUCF decreased by 9% (Table 2). The energy sector experienced the most significant rise in emissions, particularly within energy industries. In the IPPU sector, emissions from metal industries and from non-energy products from fuels and solvent use in 2022 surpassed those in 2000 by more than fourfold. In agriculture sector's, most significant increase in emissions is primarily linked to prescribed burning of savanna, with rice cultivation and enteric fermentation following in significance. In the waste sector, emissions from the primary source (wastewater treatment and discharge), increased nearly threefold during this period.

Table 2. Trends in GHG emissions and removals by category from 2000 to 2022

Source and Sink Category of GHG Emissions	2000	2022	Change from 2000 to the latest reported year (2022)
	kt CO_2e		%
1. Energy	305,290.56	738,753.39	142%
2. Industrial processes and product use (IPPU)	39,804.94	57,361.63	44%
3. Agriculture	107,188.93	135,565.84	26%
4. Land use, land-use change and forestry	342,991.31	312,311.57	-9%
5. Waste	59,227.57	138,862.07	134%
Total CO_2 equivalent emissions without LULUCF	511,512.00	1,070,542.93	109%
Total CO_2 equivalent emissions with LULUCF	854,503.31	1,382,854.50	62%

1.3. Track Progress Made in Implementing and Achieving the Enhanced NDC

Description of the Enhanced NDC

On September 23, 2022, Indonesia submitted its Enhanced NDC (ENDC) to the UNFCCC Secretariat, as mandated by Decision 1/CMA 3 (GoI, 2021). The updated targets reflect an increase in emission reduction goals from 29% in the First NDC and Updated NDC to 31.89% unconditionally (CM1 or with measures) and from 41% to 43.20% conditionally (CM2 or with additional measures) relative to its Business as Usual (BAU) emissions in 2030 (GoI, 2022). In the BAU baseline scenario, greenhouse gas emissions are projected to rise, across all sectors, with the exception of the forestry sector. Emissions are expected to reach 2.869 Gt CO_2e by 2030. Under measures (CM1), emission growth declines, resulting in an emission level of 1.953 Gt CO_2e in 2030. With additional measures, this level further decreases to 1.632 Gt CO_2e (Table 3).

Table 3. Projections of emissions under BAU and the Emission Reduction Targets for CM1 and CM2 by sector in the Enhanced NDC

Sector	Emission 2010 ($MtCO_2e$)	GHG Emission Level 2030			GHG Emission Reduction			
		$MtCO_2e$			$MtCO_2e$		% of Total BAU	
		BAU	CM1	CM2	CM1	CM2	CM1	CM2
1. Energy*	453	1,669	1,311	1,223	358	446	12.5%	15.5%
2. Waste	88	296	256	253	40	44	1.4%	1.5%
3. IPPU	36	69.6	63	61	7	9	0.2%	0.3%
4. Agriculture	111	120	110	108	10	12	0.3%	0.4%
5. Forestry and Other Land Uses (FOLU)**	647	714	214	-15	500	729	17.4%	25.4%
TOTAL	**1,334**	**2,869**	**1,953**	**1,632**	**915**	**1,240**	**31.89%**	**43.20%**

In accordance with Decision 18/CMA.1, Parties are required to utilize the 100-year time-horizon global warming potential (GWP) values specified in the IPCC Fifth Assessment Report. The metrics used in the development of ENDC is derived from the IPCC Second Assessment Report. The ENDC emission projection has been modified in alignments with the related Decisions. Furthermore, in the forest and other land use and waste sector, adjustments were made not only due to changes in metrics but also due to alterations in activity data and emissions. Following adjustment, the emission reduction targets are found to be lower than the submitted ENDC (Table 4). The adjusted emission projection is detailed in Table 5.

Table 4. Adjustment of emission projections for the BAU scenario and the Emission Reduction Targets of CM1 and CM2 by sector in the Enhanced NDC

Sector	Emission 2010* ($MtCO_2e$)	GHG EmissionLevel 2030			GHG Emission Reduction			
		$MtCO_2e$			$MtCO_2e$		% of Total BAU	
		BAU	CM1	CM2	CM1	CM2	CM1	CM2
1. Energy*	430	1,632	1,274	1,186	358	446	13.78%	17.17%
2. Waste	89	327	277	273	50	54	1.92%	2.07%
3. IPPU	36	73	65	61	9	12	0.33%	0.46%
4. Agriculture	124	134	122	122	12	12	0.47%	0.45%
5. Forestry and Other Land Uses (FOLU)**	388	432	73	-24	360	456	13.84%	17.57%
TOTAL	**1,067**	**2,598**	**1,810**	**1,619**	**788**	**980**	**30.34%**	**37.70%**

Table 5. Adjusted projection of emission of the ENDC

Scenario	Sector	2010	2015	2020	2025	2030
kt CO_2e						
BAU (Without Measures)	Energy	429,521.23	556,253.54	836,683.48	1,196,692.83	1,631,835.23
	IPPU	36,188.43	52,206.34	63,623.20	68,947.65	73,268.71
	Waste	88,614.84	116,199.86	157,942.68	208,637.45	327,066.62
	Agriculture	123,704.46	126,634.50	129,060.73	130,855.91	134,076.09
	FOLU	388,847.22	553,188.32	532,573.66	462,955.73	432,041.70
	Total	1,066,876.19	1,404,482.56	1,719,883.75	2,068,089.57	2,598,288.35
CM1 (With Measures)	Energy	429,521.23	544,688.49	766,533.48	1,014,482.83	1,273,815.23
	IPPU	36,188.43	50,126.61	59,696.83	62,763.26	64,566.26
	Waste	88,614.83	115,441.68	156,104.88	191,236.67	277,094.56
	Agriculture	123,704.46	124,979.36	124,485.72	122,976.09	121,985.67
	FOLU	388,847.22	323,345.20	260,898.81	142,926.77	72,517.62
	Total	1,066,876.18	1,158,581.34	1,367,719.71	1,534,385.62	1,809,979.34
CM2 (With Additional Measures)	Energy	429,521.23	544,688.49	766,533.48	1,014,482.83	1,185,815.23
	IPPU	36,188.43	49,325.00	58,183.27	60,454.46	61,439.20
	Waste	88,614.83	115,441.68	156,104.88	189,413.04	273,295.46
	Agriculture	123,704.46	124,564.91	124,194.97	123,195.90	122,460.29
	FOLU	388,847.22	205,721.88	93,637.48	-8,097.80	-24,401.36
	Total	1,066,876.18	1,039,741.96	1,198,654.08	1,379,448.44	1,618,608.83

Progress in the Implementation and Achievement of NDC

To evaluate the achievement of targets set by the Enhanced NDC and the need for reviewing or modifying associated activities, various quantitative indicators have been developed. The CRT (Annex II Decision 5/CMA.3) outlines these indicators, providing relevant information regarding the selected indicators for monitoring the NDC. The tables present the mitigation indicators, detailing their association with the NDC, along with their values and baselines, current inventory values, and projections up to 2030. Indonesia **has successfully achieved** its unconditional and conditional emission reduction targets (CM1 & CM2) over the last three years (2020-2022). The period from 2011-2019 reflects the level of national emission (all sectors) over the past three years (2020-2022). During the period from 2011 to 2019, the national emission levels across most sectors remained consistently above the unconditional target, as illustrated in Table 6 and Figure 1. The high level of emissions from FOLU or LULUCF significantly offset the achievements of other sectors. Without LULUCF, emissions have remained below the conditional emission level for the past decade (2016-2022; Table 7 & Figure 2).

Table 6. Projection of adjusted Baseline, CM1 and CM2 of ENDC emissions and GHG Inventory with LULUCF from 2010 to 2022

Scenario	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Million tonnes CO2e													
BAU	1,066.88	1,280.98	1,311.60	1,342.57	1,376.15	1,404.48	1,466.65	1,534.94	1,599.50	1,661.17	1,719.88	1,754.21	1,827.44
CM1	1,066.88	1,087.71	1,105.03	1,122.90	1,143.34	1,158.58	1,198.48	1,247.41	1,290.60	1,330.80	1,367.72	1,376.75	1,426.28
CM2	1,066.88	1,008.13	1,015.81	1,023.95	1,034.38	1,039.74	1,069.77	1,108.25	1,141.49	1,171.74	1,198.65	1,184.72	1,241.93
GHGI (with LULUCF)*	1,033.80	1,142.30	1,313.54	1,147.15	1,553.72	1,870.55	1,540.10	1,355.61	1,180.55	1,490.77	1,203.37	1,195.08	1,296.32

Note: Emission from LULUCF exclude categories which are not covered in the ENDC, i.e. emission of non-CO_2 from drained peat, CO_2 emission from living biomass for GL, WL, OL and ST as there are no emissions or removals recorded in these categories according to the ENDC.

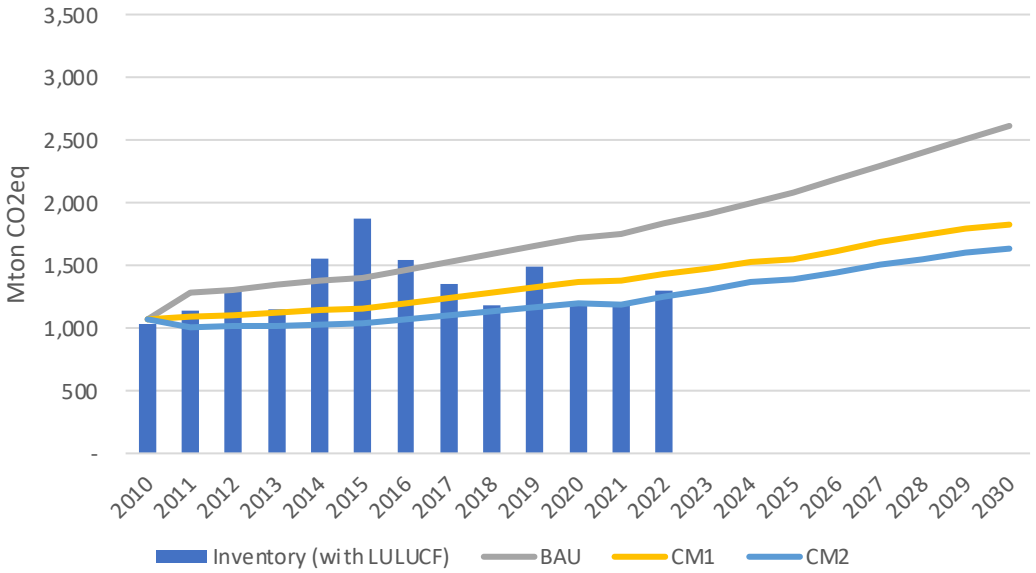


Figure 1. Comparison between GHG Inventory and emission projections of ENDC with LULUCF (2010-2022)

Table 7 Projection of adjusted ENDC emission and GHG Inventory without LULUCF from 2010-2022

Scenario	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Million tonnes CO2e													
BAU	678.03	708.43	743.64	779.35	817.85	851.29	918.77	988.06	1,057.17	1,123.61	1,187.31	1,268.71	1,346.54
CM1	678.03	705.14	737.22	769.84	805.10	835.24	890.10	946.81	1,003.18	1,056.62	1,106.82	1,179.07	1,241.11
CM2	678.03	704.93	736.88	769.32	804.15	834.02	888.67	945.34	1,001.60	1,054.94	1,105.02	1,177.13	1,238.30
GHGI (without LULUCF)	683.25	754.48	791.88	767.58	794.60	825.54	818.62	872.17	911.97	969.03	917.79	957.86	1,070.54

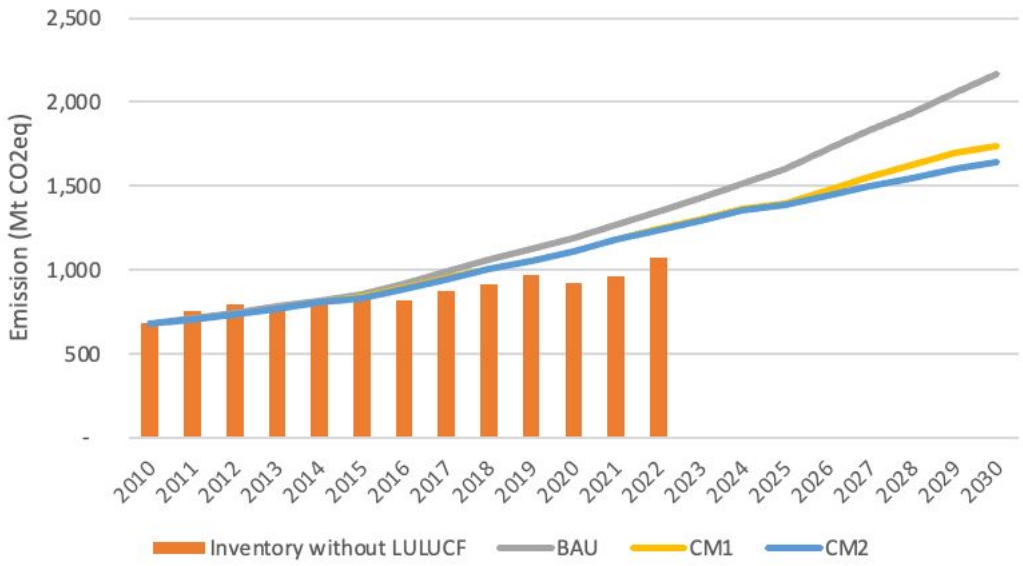


Figure 2. Comparison between GHG Inventory and emission projections of ENDC without LULUCF (2010-2022)

Mitigation in energy sector has focused on renewable energy, energy efficiency, low-carbon energy, and clean technology in power plants, achieving emission reductions of 231,317 kt CO2e in 2020, 285,559 kt CO2e in 2021, and 241,934 kt CO2e in 2022 if it is estimated by comparing baseline emissions and GHGI. It can be seen that emission reductions in 2020-2021 were relatively higher compared to those in 2022 due to lower energy consumption during COVID-19. The emissions reduction calculated by comparing emissions level of GHGI and baseline emissions are usually much higher compared to the monitoring report of emission reduction from mitigation actions since GHGI cannot represent riel achievement of mitigation actions. The monitoring report from MEMR verified by KLHK showed that emissions reduction under CM1 during 2020 - 2022 are 75,507.4 kt CO2e in 2020, 91,482.6 kt CO2e in 2021, and 123,219 kt CO2e in 2022. However, the emission reduction have exceeded the CM1 ENDC target of energy sector, i.e. 70,150 kt CO2e in 2020, 77,990 kt CO2e in 2021, and 91,870 kt CO2e in 2022. It should be noted that the emission reduction cannot only be estimated by comparing emissions level of GHGI and baseline emissions of ENDC.

The IPPU sector aims to mitigate emissions of CO2 from cement, ammonia, and iron/steel production; PFCs from aluminum; and N2O from nitric acid, achieving reductions of 8,649 kt CO2e in 2020, 7,087 kt CO2e in 2021, and 8,713 kt CO2e in 2022 if it is estimated by comparing GHGI and baseline emissions projection of ENDC (using GWP 5th AR).

The monitoring report from MoI verified by KLHK showed that emissions reduction under CM1 during 2020-2022 from cement industries and ammonia production accounted for 2,731 kt CO2e in 2020, 2,786 kt CO2e in 2021, and 4,613 kt CO2e in 2022. This reduction have exceeded the unconditional target (CM1) of IPPU sector i.e. 3,483 kt CO2e in 2020, 3,762 kt CO2e in 2021, and 4,314 kt CO2e in 2022, which both of the verified achievement and target was calculated using GWP 2nd AR.

In agriculture sector, including low-emission technologies for rice paddies and livestock, reduced emissions by about 51 Mt CO_2e from 2011-2022, though emissions in 2021-2022 neared baseline levels, missing targets. Strategies in the FOLU sector emphasize deforestation prevention, sustainable forest management, land rehabilitation, and peatland management. While certain targets were exceeded (Table 8), such as sustainable forest management (SFM) practices and timber plantation establishment, the overall target has not yet been fully met. In 2022, the waste sector achieved a reduction of 42.56 Mt CO_2e, mainly attributed to advancements in industrial waste treatment, particularly through notable enhanced EFB (Empty Fruit Bunch) treatment at CPO mills.

Table 8. The achievement of NDC target in FOLU sector

Mitigation Activities	Achievement
Avoid deforestation*	On track (Slightly higher than CM1)
Avoid forest degradation*	Off target (Slightly lower than BAU)
SFM (implementation of RIL-C and SILIN)**	Over target
Establishment of timber plantation*	Off target (Lower than BAU)
Land rehabilitation without rotation*	Off target (Lower than BAU)
Land rehabilitation with rotation*	Off target (Lower than BAU)
Peat restoration*	On track (Slightly higher than CM1 but less than CM2)
Peat water management***	Over target (More than CM2)

Note: *Based on satellite, ** Based on APHI (2019), *** Based on Performance Report from BRGM & PPKL (2023)

In 2022, the waste sector achieved a significant reduction, mainly attributed to advancements in industrial waste treatment, particularly through notable enhanced EFB (Empty Fruit Bunch) treatment at CPO mills which was driven by market mechanism (not included in CM1 target). Mitigation reduction targets of waste sector in the ENDC for unconditional scenario (CM1) is 49,972 kt CO_2eq in 2030. The ENDC target (using GWP AR2) of CM1 (unconditional) for the waste sector were 1,560 kt CO2e (2020); 2,315 kt CO2e (2021); 3,043 kt CO2e (2022). The verified GHG emissions reductions (by KLHK) during 2020 - 2022 (GWP in 2AR) are 1,359.6 kt CO2e, 1,692.1 kt CO2e and 1,694.7 kt CO2e. It can be seen that mitigation actions 2020-2022 had never exceeded CM1 reduction target. However, if the emissions reduction is estimated by comparing the baseline emissions and the inventory, the reduction in 2022 was accounted of 31,596 kt CO_2eq (using GWP AR5). The estimation is calculated using the base line emission in 2022 which was about 170,459 kt CO_2eq and the GHG Inventory in the same year which was 138,862 kt CO_2eq.

There is significant difference in the results of calculating emission reduction of mitigation actions from the approaches using verification mitigation action (project basis) with those using baseline and inventory comparisons. The main differences may happen due to the existence of emission reductions from activities that were not covered by ENDC CM1 such as the avoidance of CH4 emission formation due to the utilization of empty fruit bunches (EFB) that are usually dumped at the factory site by various consumers through market mechanisms. The GHG emissions reduction potential from the utilization of EFB is estimated to be 28,394 kt CO_2eq.

1.4. Climate Change Impact and Adaptation

Climate Challenges

Indonesia has experienced a 0.6°C increase in average annual air temperature over the past 30 years, with regions such as Banten, East Java, and West Kalimantan observing increases above 1°C. Projections for 2040–2050 estimate maximum temperature rises of up to 1.2°C, with minimum temperatures increasing by as much as 1.8°C. Under the most extreme recent climate scenarios, Indonesia may experience an average temperature rise of 4.3°C by 2100. Rainfall patterns exhibit significant variability, with increases up to 300 mm in many regions, while reductions exceeding 300 mm are noted in Central and East Java. Projections indicate higher temperature and more extreme rainfall, raising the risks of heat stress, drought, floods and landslides.

Climate changes are significantly impacting Indonesia's climate-sensitive sectors, with projected economic losses of up to 3.45% of GDP by 2050, as reported in the Adaptation Communication (2022). Additional compilation from literatures presents the sectoral impacts as follows:

1. **Food Security**: Extreme weather events have lowered Indonesia's Food Security Index from 2018 to 2022. Rice production dropped by 1.37% annually from 1981 to 2020 due to increasing air temperature, changing rainfall, and sea level rise, affecting agricultural production. Horticultural production such as cocoa, coffee, and plantation crops such as oil palm are projected to decline due to the climate change impacts.
2. **Water Resources**: Climate shifts have altered precipitation, increasing rainy season rainfall by 20-30% and decreasing dry season rainfall by 10-20%, leading to water scarcity and quality issues, projected to drop by 50% by 2030. Java, with high population density, faces the lowest raw water availability, expected to decline by 439.21 m^3 per capita annually through 2045.
3. **Health**: Climate change raises risks of infectious diseases like Acute Respiratory Infections (ARI), dengue, malaria, and diarrhea. ARI costs the health sector 0.10% of GDP, potentially reaching 1.8%. In 2022, 143,266 dengue cases and 1,237 deaths were reported. Malaria remains high in Papua, and pneumonia rates are notable in West Papua, Jakarta, and Bali.
4. **Ecosystems**: Climate impacts on forests and other land ecosystems, freshwater, and coastal and marine ecosystems are reducing biodiversity. Over one-third of mangrove ecosystems have been degraded since 1980, with continued threats to coral reefs, peatlands, low-lying areas, and key species such as the Javan Hawk-eagle and Bornean orangutan.

Addressing the identified climate change impacts, the government has implemented early warning systems, ecosystem-based approaches, and resilience-building initiatives under Article 8 of the Paris Agreement. The Coordinating Ministry for Human Development and Cultural Affairs / *Kementerian Koordinasi Pembangunan Manusia dan Kebudayaan* (Kemenko PMK) oversees key agencies, i.e. National Disaster Risk Management Agency / *Badan Nasional Penanggulangan Bencana* (BNPB), Meteorology, Climatology, and Geophysical Agency / *Badan Meteorologi, Klimatologi, dan Geofisika* (BMKG), and Ministry

of Environmental and Foresty (MoEF) / *Kementerian Lingkungan Hidup dan Kehutanan* (KLHK), for disaster management, though gaps remain in addressing slow-onset and non-economic losses, highlighting the need for new policies to strengthen climate resilience.

Adaptation Framework and Priorities

Indonesia's climate adaptation focuses on food security, water security, energy security, health resilience, and ecosystems resilience under Presidential Regulation No. 98 Year 2021, coordinated by key ministries: MoEF, Ministry of Agriculture (MoA)/*Kementerian Pertanian* (Kementan), Ministry of Health (MoH)/*Kementerian Kesehatan* (Kemenkes), and Ministry of Public Works and Housing/*Kementerian Pekerjaan Umum dan Perumahan Rakyat* (Kemen PUPR). MoEF as the National Focal Point (NFP) oversees adaptation through development and implementation of strategies for climate change adaptation and coordinates with various stakeholders, to enhance adaptation efforts toward climate resilience, adaptation through SRN-PPI, while Ministry of National Development Planning/*Kementerian Perencanaan Pembangunan Nasional* (Bappenas) integrates adaptation into national planning. Local governments, with private, civil, and academic support, tailor policies to regional needs. For this Indonesia's First Biennial Transparency Report (BTR1), the reported priority areas include food, water resources, health, and ecosystems. The energy is not included in this BTR1 for Adaptation even though it is considered as a priority sector knowing its vulnerability to climate change. It would be included in next submission. This BTR1 highlights key adaptation actions as follows:

1. Food Security: MoA promotes climate-resilient practices, improved irrigation, and farmer support to mitigate risks from floods, droughts, and pests.
2. Water security: Kemen PUPR focuses on addressing climate pressures challenge water sustainability, particularly in Java and Bali. Government Regulation No. 22/2021 prioritizes conservation and flood/drought risk reduction.
3. Health resilience: MoH addresses climate-sensitive diseases, enhancing disease surveillance and resilience, crucial amid rising dengue and malaria cases.
4. Ecosystem resilience: MoEF, Kemen PUPR, and Peatland and Mangrove Restoration Agency / *Badan Restorasi Gambut dan Mangrove* (BRGM) focus on ecosystem protection, mangrove restoration, and community-led conservation to preserve forests and marine habitats.

Adaptation Strategies

Climate change impacts demand effective adaptation in Indonesia, guided by strategies to reduce risks and build resilience. Key actions include multi-sectoral policy coordination, embedding adaptation in development plans, promoting climate literacy, landscape-based spatial approaches, and enhancing local adaptive capacity with culturally relevant practices, particularly in rural areas. Specific adaptation objectives are:

1. **Food**: Sustainable agriculture and technology protect crop yields.
2. **Water**: Structural and non-structural measures improve drought and flood resilience, focusing on fair water distribution, especially in Java and Nusa Tenggara.

3. **Health**: Disease prevention, robust surveillance, and better infrastructure aid underserved areas.
4. **Ecosystems**: Ecosystem-based solutions, such as reforestation and mangrove restoration, support biodiversity and disaster resilience.

In line with the Paris Agreement's, Indonesia's Enhanced NDC integrates early warning systems, accessible climate data, and transparent progress monitoring. Platforms like *Sistem Informasi Data Indeks Kerentanan* (SIDIK), INARISK, and AKSARA support data sharing and vulnerability mapping, aiding informed decisions. Climate-Resilient Development in the 2020–2024 *Rencana Pembangunan Jangka Menengah Nasional* (RPJMN) weaves adaptation into national planning, ensuring regionally relevant, actionable policies.

Tracking on Adaptation Implementation

Indonesia has made notable progress in executing climate change adaptation measures, guided by a framework that emphasizes economic, social, and ecosystem resilience. Since the First NDC in 2016, adaptation strategies have progressed with updates in the Enhanced NDC (ENDC) in 2022, incorporating stakeholder engagement including customary communities and local communities and private sector. The multi-layered approach is integrated into national planning documents, such as the 2020-2024 RPJMN and Vision 2045, reflecting Indonesia's dedication to sustainable adaptation. Essential programs encompass food security, disaster management, and ecosystem preservation initiatives, featuring actions like agroforestry in rural regions and water management technologies in coastal areas. The Disaster Resilient Village program, People's Business Loan (KUR) for farmers, and Weather Modification Technology represent significant initiatives aimed at mitigating vulnerabilities across various sectors.

The BTR1 monitors progress through measurable achievements and tracking systems that correspond with ENDC objectives, highlighting both current and future initiatives. In 2022, six economic resilience programs documented 20 ongoing actions with measurable outcomes, including the rehabilitation of 3,000 irrigation networks and the promotion of climate-smart agriculture. Social resilience initiatives encompass community-based climate action through Climate Village Program (ProKlim), which involves communities in climate action across 4186 locations in 2022, and infrastructure programs such as Slum-Free Cities (KOTAKU) that enhance water access. The Social Forestry and Peat Care Village programs engage local communities in sustainable forest management and water conservation to enhance ecosystem resilience. These initiatives underscore Indonesia's dedication to climate adaptation through collaborative efforts involving national and sub-national/local governments, grassroot communities, civil society, and the private sectors.

Challenges and Direction

Indonesia's climate adaptation faces institutional, financial, technical challenges, and stakeholders' engagement, compounded by limited knowledge and technology access. Sub-national/local governments vary in capacity, leading to inconsistent climate responses; better coordination among MoEF, MoA, MoH, and Kemen PUPR and other stakeholders is needed. Financially, limited national budgets hinders adaptation action sustainability, while insufficient of high-resolution climate data complicates rural risk assessments. Weather and climate

observation stations require expansion to improve data accuracy, and scaling adaptation initiatives demands greater investment and cross-sector collaboration. Socio-economic factors like poverty and gender inequality increase vulnerability. The stakeholders, i.e. *Adat* communities and local communities, private sector, and civil society, shall be engaged to ensure adaptation actions. Inclusive participation, involving women, children, youth and vulnerable groups, strengthen the implementation of adaptation actions toward climate resilience.

An effective monitoring and evaluation framework is crucial for tracking adaptation progress and improving strategies. MoEF oversees the SRN-PPI to integrate adaptation data, assess progress, and report on compliance with national objectives. Indonesia intends to enhance adaptation efforts by incorporating resilience into key sectors, including food, water resources, energy, health, and ecosystems. This initiative will be bolstered by investments in adaptive technologies, capacity building for sub-national governments, and the encouragement of public-private partnerships.

1.5. Finance, Technology and Capacity Building Provided and Mobilized

The Indonesian government, in an ad hoc basis, has collaborated with other developing countries through grants and technical assistance. Along with the improvement of overall governance, through the Government Regulation No. 48 of 2018 (amended by No. 57 of 2019), Indonesia has established a structured approach for providing grants to foreign governments and institutions.

This framework introduced a fund management unit, operating as a public service agency, to manage and streamline grant distribution. A cross-ministerial Steering Committee is tasked to provide strategic guidance to ensure effective fund allocation. The International Development Cooperation Fund (LDKPI), also known as Indonesian AID, has been established by the Ministry of Finance to enhance cooperation with international partners. This new mechanism is expected to expedite grant processes and enable self-financing in the near future.

Financial Support Mobilized and Provided by Indonesia

The Indonesian government has been spent a total of USD 3.2 million since 2021-2022. Funded projects priorities humanitarian assistance and the reduction of disaster impacts, encompassing food crises, storms, droughts, and flash floods. All funds have been allocated and utilized for sectors vulnerable to climate change, including agriculture, disaster management, air sanitation, and fisheries, with a primary focus on adaptation to climate-related disasters. This illustrates Indonesia's contribution to supporting developing countries in mitigating the impacts of climate change. The Indonesian government will mobilize a total of USD 2 million by 2023-2024

Aid is provided through bilateral mechanisms to recipient countries such as Afghanistan, Antigua and Barbuda, Madagascar, Mozambique, Zimbabwe, Pakistan, and the member nations of the Melanesian Spearhead Group: Fiji, Papua New Guinea, Solomon Islands, and Vanuatu.

Financial, Technology Development and Transfer, Capacity Building Support Provided

Indonesia conducted a fisheries capacity building training program in 2021-2022 for the member countries of the Melanesian Spearhead Group (MSG), which includes Fiji, Papua New Guinea, Solomon Islands, and Vanuatu. The program focused on facilitating climate change adaptation in the fisheries sector and has been successfully completed. The training aims to improve the capabilities of MSG countries in tackling climate change issues within the fisheries sector by strengthening technical and managerial skills.

1.6. Finance, Technology and Capacity Building Needs and Support Received

Indonesia has established policies and systems to manage international support for financial, technological, and capacity-building initiatives. Loans and grants are regulated by Government Regulation No. 10 of 2011 at the central level and No. 2 of 2012 at the sub-national level, with assets classified as state property and managed accordingly. These regulations ensure that international support aligns with national priorities, including climate action, poverty alleviation, and economic growth. Oversight is provided by the Ministry of Finance and the Ministry of National Planning and Development, requiring all relevant agencies to adhere to established procedures.

Key institutions such as the Ministry of Foreign Affairs, the National Planning and Development Agency, and the Ministry of Finance coordinate international support, guided by regulations to align with national goals. A formal forum, such as the National Committee for Coordinating Foreign Assistance, brings together the government and donors. Comprehensive monitoring and evaluation ensure accountability, involving entities such as the Inspectorate General and the Financial and Development Supervisory Agency. Continuous improvement on the mechanisms and approaches is in the government agenda in order to better manage climate-related supports within overall international contributions.

Technological support is managed and documented by the Foreign Cooperation Bureau within each ministry, involving multiple ministries for execution and reporting in the SRN-PPI (*National Registry System*). Capacity building, documented similarly, includes support for individuals, institutions, and policies, with all activities reported in the SRN-PPI to ensure a coordinated approach.

Methodologies & Limitations

Indonesia provides an account of the financial, technology transfer, development, and capacity building support required and obtained in accordance with Articles 9, 10, and 11 of the Paris Agreement, adhering to the Modalities, Procedures, and Guidelines (MPGs) specified in Decision 18/CMA.1 and Decision 5/CMA.3. Nonetheless, supports identified within BTR1 are currently concentrated on government-managed system, whereas those received by non-governmental organizations (NGOs) and the private sector are excluded because of data

unavailability. A mechanism to report and record direct supports for addressing climate change from international entities to NGOs and the private sector is yet to be established.

Finance

Indonesia uses two reporting systems to track and report support from development partners: the first one is under Government Regulation No. 10 Year 2011 for foreign loans and grants, and the other under Government Regulation No. 74 Year 2012 for the Indonesia's Environment Fund (IEF/BPDLH). The Ministry of Finance system reports only government-directed climate finance, excluding non-governmental flows. All disbursements are audited annually, with the BTR1 report covering audited loans and grants from 2021 to 2022.

From 2021 and 2022, Indonesia received USD 1,782.31 million in financial support for programs addressing mitigation, adaptation, and cross-cutting sectors. Of this amount, 46% (USD 732.12 million for adaptation, USD 82.83 million for mitigation, and USD 9.89 million for cross-cutting initiatives) was directly aligned with achieving Enhanced NDC targets. The remaining 54% (USD 929.71 million for adaptation and USD 27.76 million for mitigation) was categorized as "may lead" to contributing toward Enhanced NDC targets.

Adaptation funding primarily targeted strengthening economic resilience, ecosystem and landscape restoration, and social resilience initiatives. In the "may lead to adaptation" category, significant resources were allocated to developing basic services and infrastructure, integrated watershed management, and disaster rehabilitation efforts. While mitigation funding supported primarily projects in forestry, solid waste management, and transportation. Smaller portion allocated to the sewerage sector under the "may lead to mitigation" category.

International support includes USD 200.31 million from bilateral donors and USD 1,505.43 million from multilateral donors, with loans making up 95% of the total and grant only 5%. The top recipients are the Ministry of Public Works and Housing (USD 1,517.22 million), followed by the Ministry of Agriculture and joint project with Ministry of Public Work Housing (USD 72.91 million), followed by Ministry of Transportation the third place (USD 48.56 million) and Ministry of Environment and Forestry (USD 43.15 million).

To meet NDC targets in 2030, in its Third Biennial Update Report (BUR3) Indonesia estimated funding need of USD 281 – USD 285 billion for mitigation, on adaptation initial estimation shows total funding needs of USD 816.52 million refer to Roadmap NDC Adaptation

Furthermore, Indonesia needs about USD 14.10 million up to 2030 for the implementation of Article 13 of the Paris Agreement and associated transparency-related activities, covering transparency-related activities and capacity building. Key activities include:

- Establishing a Climate Transparency Institutional Mechanism
- Strengthening the commitment of Party and Non-Party Stakeholders
- Policy development
- NDC tracking and adaptation transparency
- The development of robust systems for GHG Inventory and MRV systems
- Data collection and local emission factors
- Operation and maintenance of advanced MRV
- Expansion to Include Co-benefits

Currently, support for the preparation of reports in accordance with Article 13 is provided by GEF, amounting to approximately USD 4.75 million. The support is provided under two projects: (1) the Fourth National Communication and the 4th Biennial Update Report to the UNFCCC, and (2) the Strengthening the Capacity of Institutions in Indonesia to comply with the Transparency Requirements of the Paris Agreement (CBIT). This project will be reported according to the realization of the grant during the period 2023–2024. During the period of 2021-2022, no grant realization was reported.

Technology Transfer and Development

Indonesia's Act Number 19 Year 2019 defines technology as tools, methods, or processes for applying scientific knowledge to improve quality of life. Technology transfer involves sharing the ability to use and master technology across institutions, domestically or internationally. The MoEF, as the UNFCCC National Focal Point, coordinates national reports on climate-related technology transfer and development.

The MoEF, as the National Designated Entity (NDE) for the Climate Technology Center and Network (CTCN), is essential in ensuring that requests submitted to the CTCN align with Indonesia's National Circumstances and priorities. The MoEF coordinate the supports with other climate initiatives involving ministries, the private sector, civil society, and academia. MoEF also works with BRIN to drive research and technology in line with climate goals, while technical ministries oversee sector-specific technology applications, especially in mitigation for energy, industry, agriculture, and waste management.

The gathered information pertinent to technological requirements focuses on addressing climate change by transitioning to cleaner, sustainable energy systems, improving energy efficiency, and encouraging the adoption of renewable energy. Mitigation in the energy sector, encompassing power plants and transportation, as well as in the industry sector (IPPU), necessitates a broader spectrum of technology transfer and development compared to other sectors. Other sectors, including agriculture and waste management, require significant focus on technological advancements to meet NDC targets. The majority of technological requirements in IPPU sectors are classified as being in the expansion stage rather than the initiation of new technology. Sectoral consultations have identified technology development and transfer needs across all NDC sectors for the period 2025-2030.

Some technology is also derived from international support. An official letter from line ministries that received specific technology is included in the list of technology support received. Most types of technologies are currently in the implementation phase, including solar ice makers, photovoltaic systems, and cold storage solutions.

Capacity Building

Capacity building on climate change has been conducted by all ministries and related stakeholders. The majority of capacity building support is integrated in financial support. Technical directorates at ministries and agencies receive this type of support in the form of state budget allocation, blended finance, and grants/loans. However, gathering data and information

about capacity building's areas, progress, lessons learned, and experiences is still difficult due to unavoidable gaps and overlaps in capacity building initiatives.

Currently there is no specific institution at the national level that is dedicated for capacity building related to climate change. However, ministries and agencies have Capacity Building and Human Resource Development Units (e.g. *Badan Pengembangan Sumber Daya Manusia* – BPSDM) whose primarily focus is to provide capacity building at the individual level, which is essential for enhancing the skills and knowledge of government officials (ASN) who handle climate change issues.

Indonesia's ENDC categorized capacity building instruments into General and Technical. The first instrument (General Instrument) focuses on creating a broad-based foundation by incorporating climate change into the national system of education, training, and capacity building. while the second instrument (Technical Instrument) focuses on developing targeted capacity building program for institutions and individuals directly involved in climate change mitigation and adaptation efforts with two section, institutional level and individual level.

Data analysis, based on data collection which focus on public funds and government-led activities, reveals the majority of capacity building support received in Indonesia is focused on policy design and development/General Instruments (57%), reflecting the primary function of ministries and agencies. Support is mostly directed at adaptation (51%), followed by mitigation (28%), and cross-cutting areas (21%). Capacity-building needs is identified based on recent National Medium-Term Development Plan (RPJMN), BUR3 of Indonesia, and sectoral consultation. It suggests that needs relevant to adaptation are knowledge on the state of the art of climate data analysis and climate service, policy making and technical knowledge to implement adaptation strategies in respective sectors e.g. agriculture, health, ecosystem and landscape resilience and loss and damage. Meanwhile, needs relevant to technical knowledge in mitigation are energy planning, GHG Inventory, and institutional strengthening.

1.7. Information on Flexibility

Indonesia has not fully fulfilled the reporting requirements as mandated by Decision 18/CMA.1and Decision.5/CMA.3 and has implemented specific areas of flexibility. The flexibilities implemented in GHG Inventory encompass completeness, types of greenhouse gases, time series, and Quality Assurance and Quality Control (QA/QC). There are currently 31 emission categories that are not estimated (NE), suggesting potential incompleteness. The NE is designated solely for sources considered insignificant, in accordance with the mandate. Currently, there is insufficient data to determine the actual insignificance of these categories. The criteria for flexibility regarding insignificant sources pertain to those contributing less than 0.1% to the total national GHG emissions (without LULUCF) or 1,000 kt CO_2 equivalent, whichever is lower. Additionally, the total emissions from these insignificant categories must be less than 0.2% of the national total GHG emissions (without LULUCF). The exclusion of HFCs, PFCs, SF6, and NF3 is a notable aspect of gas types and their flexibility. The flexibility applied to time series does not reflect the emissions data from 1990. The current inventory offers only an estimation of emissions from 2000 to 2022. The flexibility applied in the QA/QC process lacks a detailed methodology for conducting QA/QC for the GHG Inventory in

accordance with the 2006 IPCC guidelines (IPCC, 2006). The current inventory solely offers information regarding quality assurance.

Monitoring the advancement of mitigation policies and measures involves the use of certain reporting flexibilities that exclude information on (i) the economic and social impacts of response measures, (ii) costs, non-GHG benefits, and interactions among policies and measures, (iii) mitigation co-benefits associated with adaptation actions, and (iv) the incorporation of non-GHG indicators to assess certain progress.

Key information regarding the financial, technology transfer, and capacity building support required and received under Articles 9, 10, and 11 of the Paris Agreement remains incomplete. Currently, data and information of supports is primarily from government-managed systems, which does not include data and information on supports received by private sectors and other institutions of non-government. A mechanism for reporting and recording direct support for climate change initiatives from international entities to the private sectors and other institutions of non-government has yet to be developed.

Lastly, all elements recommended for reporting in relation to adaptation, as per Decision 18/CMA.1 and Decision 5/CMA 3, are incorporated to the fullest extent possible.

1.8. Improvement of Reporting Overtime

Indonesia's plan of improvement for reducing flexibility areas in climate reporting encompass several critical areas of focus:

1. GHG Inventory: Enhance data completeness, ensure time series consistency, enhance QA/QC processes, and develop country-specific emission factors for key sectors.
2. Mitigation: Evaluate the economic and social impacts, implementation costs, and co-benefits associated with prioritized mitigation measures and adaptation actions.
3. Adaptation: Strengthen resilience and reduce vulnerabilities by leveraging tools like SIDIK, InaRisk, and managing datasets on meteorology/climate and its related data, alongside plans to improve data collection, financing, and stakeholder coordination.
4. Finance, Technology and Capacity Building (FTC): Establish reporting mechanism to address data gaps in financial support reporting detailing the usage and impact of received support.
5. Transparency in Climate Action: Strengthen data collection, standardize MRV systems, and improve regional capacity, Implement advanced monitoring technology, foster collaboration, and include biodiversity and social indicators. Formulate roadmaps aligned with policy and allocate resources for training ministry teams to improve MRV expertise and ensure consistent reporting.

CHAPTER I
NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENT

1.1 National Circumstances

1.1.1 Geographic Profile

Indonesia occupies a remarkably strategic position, situated between the vast Indian and Pacific Oceans, and linking the continents of Asia and Australia. Spanning from approximately 6° 04' 30'' North to 11° 00' 36'' South latitude and 94° 58' 21'' to 141° 01' 10'' East longitude along the equator, Indonesia is uniquely positioned at the equatorial line providing it with a tropical climate and diverse ecosystems. As the largest archipelagic nation globally, Indonesia comprises 38 provinces spread across islands that stretch along the equator. The country boasts the world's second-longest coastline, extending 95,181 kilometers, and its marine waters cover 5.8 million square kilometers, constituting about 71% of its total area (http://kkp/go.id). Figure 1.1 depicts the map of Indonesia.

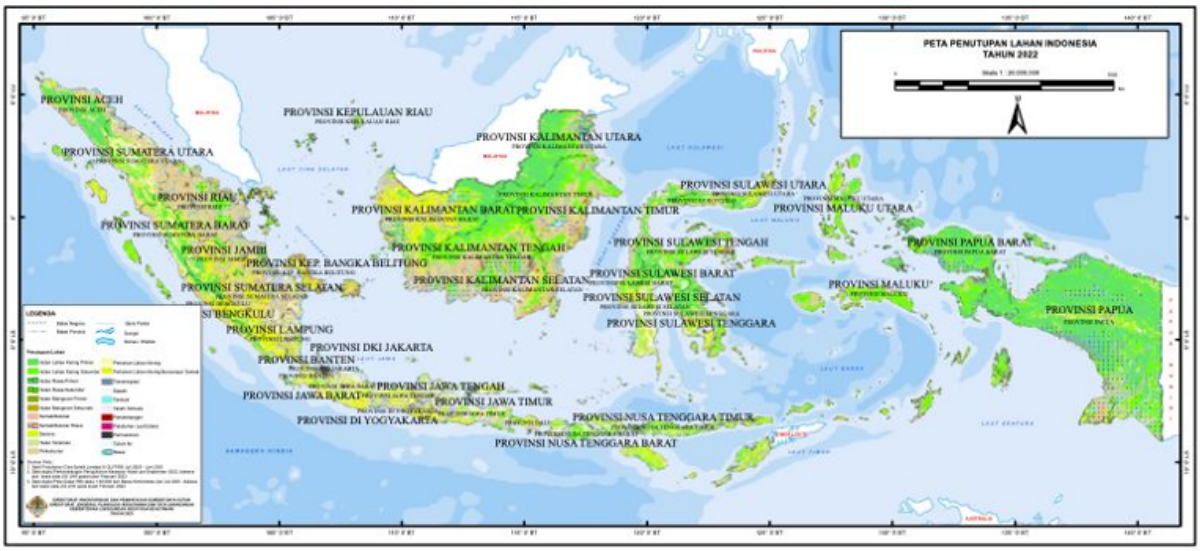


Figure 1- 1 Map of Indonesian land cover 2022 (source: MoEF, 2020)

Indonesia exhibits considerable geological diversity influenced by its distinct geology and tectonic activity. Situated between two oceans and bridging two continents, the Indonesian archipelago is positioned amidst three major Earth plates: the Eurasian Plate, the Pacific Plate, and the Indian-Australian Plate in Papua. This geographical setting features a tectonic environment characterized by the subduction of oceanic crust beneath continental crust, which typically results in the formation of various stratovolcanoes. The varied natural environments of Indonesia have shaped numerous landforms and terrains, while also presenting hazards including severe earthquakes, coastal tsunamis, volcanic eruptions impacting adjacent regions, recurrent ground movements, landslides, and flash floods.

1.1.2 CLIMATE PROFILE

Indonesia experiences a tropical climate due to its location along the equator. The climate is shaped by the consistent warm waters covering 81% of the nation's territory, leading to average temperatures of approximately 28°C along the coast, 26°C inland, and about 23°C in elevated mountainous areas. Seasonal temperature variations are relatively minor. Indonesia's climate is characterized by three primary rainfall patterns: monsoonal, equatorial, and local (Aldrian and Susanto 2003). In monsoonal regions, the rainy season occurs from October to March, whereas the dry season extends from April to September. The equatorial rainfall pattern exhibits maximum precipitation in April and October. In certain regions, the local rainfall pattern exhibits a reversal of the monsoonal cycle, with the rainy season spanning from April to September and the dry season from October to March. Peak rainfall in the local pattern generally occurs in in June and July (Figure 1.2)[1].

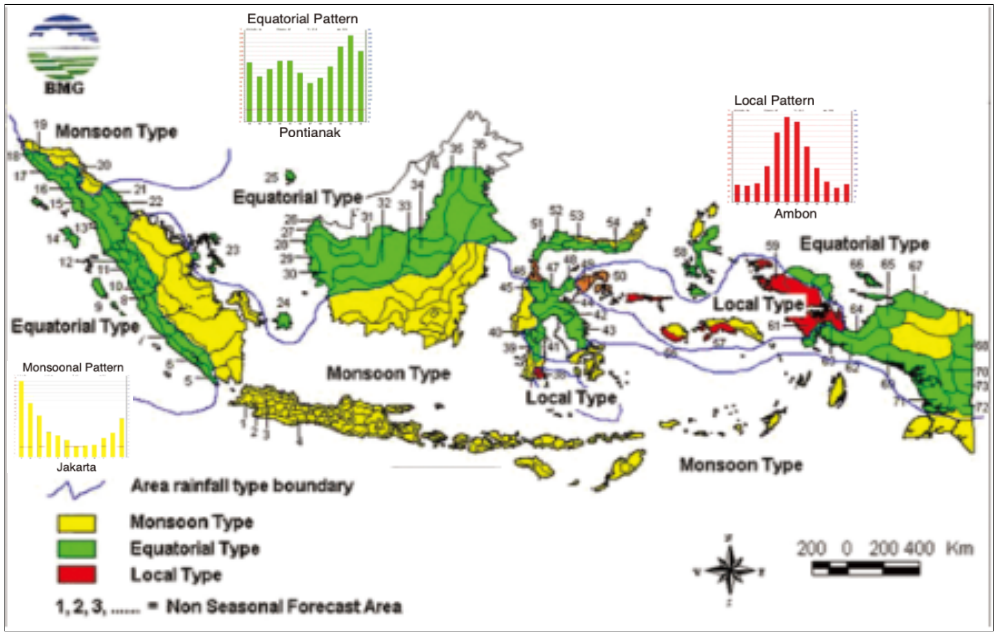


Figure 1- 2 Pattern of rainfall in the regions of Indonesia (BMKG)

In Indonesia, annual rainfall varies between 1800 and 6000 mm (Figure 1.3). The mean annual rainfall in the western region of Sumatera, the majority of Kalimantan, the western and central regions of Java, parts of Sulawesi, and most of Papua Island ranges from 3000 to 4000 mm per year. The eastern region of Java and Kalimantan experience annual rainfall amounts ranging from 1000 to 2500 mm. The lowest range of annual rainfall, below 2500 mm, is predominantly observed in both West and East Nusa Tenggara. The mountainous region of Papua typically experiences the highest annual rainfall, which can reach up to 6000 mm.

[1] https://iklim.bmkg.go.id/bmkgadmin/storage/brosur/LEAFLETINDO.pdf

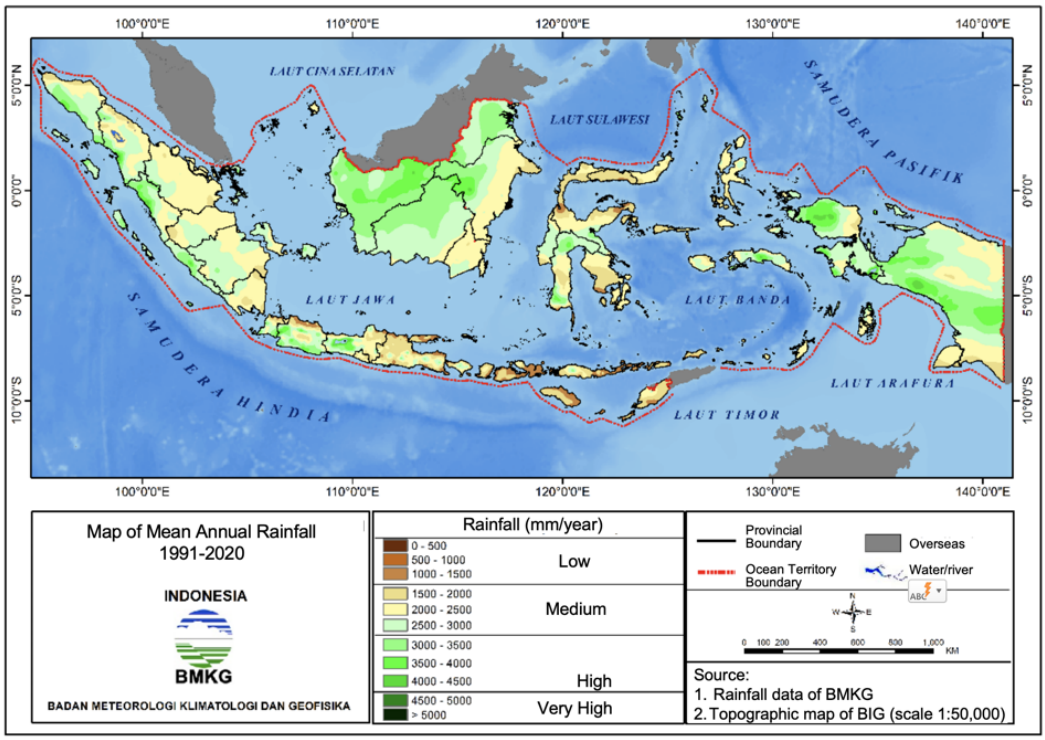


Figure 1- 3 Mean annual rainfall (1991 – 2020) in the regions of Indonesia (BMKG, 2021)

The climate of Indonesia is influenced by its tropical location and the ocean-atmosphere interactions. Indonesia, located between the Indian and Pacific Oceans, exhibits considerable climate variability influenced by phenomena such as the El Niño-Southern Oscillation (ENSO) in the Pacific and the Indian Ocean Dipole (IOD). El Niño, characterized as a warm phase of the ENSO, is associated with a decrease in rainfall in Indonesia. Conversely, La Niña, the cold phase of ENSO, results in above-normal rainfall in the region. The effects are intensified when El Niño aligns with a positive IOD, leading to a further decrease in rainfall, or when La Niña coincides with a negative IOD, resulting in increased rainfall (Nur'utami and Hidayat 2016). Studies indicate that a 1°C variation in sea surface temperature anomaly in the NIÑO-3.4 region can impact rainfall by more than 20 mm/month (Boer and Faqih 2004). Factors influencing climate variability in Indonesia include the Tropical Cyclones, the Monsoon, and the Madden-Julian Oscillation (MJO).

1.1.3 Demographic Profile

As of 2024, Indonesia's population stands at 281.604 million, with 24.0% aged under 15 years old, 64.7% between 15 and 60 years old (productive age), and 11.3% aged 60 years old and older[2]. The growth rate has decreased from 1.60 % per year during the periods 2000-2010 to 1.25% from 2010-2020. The average population density is 141 inhabitants per km², with a range from a minimum of 25.8 inhabitants per km² in Maluku and Papua Islands to a maximum of 3.606.5 inhabitants per km² in Java Island (BPS 2021). Life expectancy has increased rapidly over the last two decades. At present, the life expectancy for women is 73.33 years, while for men it is 69.44 years. The proportion of the elderly within the total population is rising due to a decline in the mortality rate (Ariteja 2017).

The rising proportion of individuals in the productive age group (15 to 64 years old) relative to those in the unproductive age category suggests a decline in the population dependency ratio.

[2] https://www.bps.go.id/id

Over the past 20 years, the population dependency ratio has decreased from 50.5% to 47.3%. This leads to a decrease in the economic burden on the working-age population that supports individuals in unproductive age groups. The evolving age structure may serve as a catalyst for enhancing economic growth and social welfare. The demographic bonus presents a "window of opportunity", critical for Indonesia's economic situation (Achmad et al. 2024).

1.1.4 Economic Profile

Over the 2015 – 2023 period, and 2023, a structural shift from agriculture to other sectors of the economy has occurred, evident in the GDP share of each sector (Table 1.1). the primary contributors to the country's GDP include Manufacturing at 18.67%, followed by Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles at 12.94%, Agriculture, Forestry, and Fisheries at 12.53%, and Construction at 9.92%. All four sectors accounted for 54.06% of Indonesia's economy.

Table 1- 1 Share of GDP by sector, 2015─2023 (in %)

No.	Sector	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	Agriculture, Forestry and Fishery	13.49	13.47	13.16	12.81	12.71	13.70	13.28	12.4	12.53
2	Mining and Quarrying	7.65	7.18	7.58	8.08	7.26	6.44	8.97	12.22	10.52
3	Manufacturing	20.99	20.51	20.16	19.86	19.71	19.88	19.24	18.34	18.67
4	Electricity and Gas	1.13	1.15	1.19	1.19	1.17	1.16	1.12	1.04	1.04
5	Water Supply, Sewerage, Waste Mngt & Remediation Activities	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06
6	Construction	10.21	10.38	10.38	10.53	10.75	10.71	10.44	9.77	9.92
7	Wholesale and Retail Trade; Repair of Motor Vehicles & Motorcycles	13.30	13.18	13.02	13.02	13.01	12.93	12.96	12.85	12.94
8	Transportation and Storage	5.02	5.20	5.41	5.38	5,57	4.47	4.24	5.02	5.89
9	Accommodation and Food Service Activities	2.96	2.93	2.85	2.78	2.78	2.55	2.43	2.41	2.52
10	Information and Communication	3.52	3.62	3.78	3.77	3.96	4.51	4.41	4.15	4.23
11	Financial and Insurance Activities	4.03	4.19	4.20	4.15	4.24	4.51	4.34	4.13	4.16
12	Real Estate Activities	2.84	2.82	2.81	2.73	2.78	2.94	2.76	2.49	2.42
13	Business Activities	1.65	1.71	1.75	1.80	1.92	1.91	1.77	1.74	1.83
14	Public Administration and Defense; Compulsory Social Security	3.90	3.87	3.67	3.65	3.61	3.76	3.46	3.09	2.95
15	Education	3.36	3.37	3.29	23.25	3.30	3.56	3.28	2.89	2.79
16	Human Health and Social Work Activities	1.07	1.07	1.07	1.06	1.10	1.30	1.34	1.21	1.21
17	Other Service	1.65	1.70	1.76	1.81	1.95	1.96	1.84	1.81	1.94
Gross value added at basic price		96.85	96.42	96.15	95.94	95.89	96.36	95.95	95.62	95.62
Taxes less subsidies on products		3.15	3.58	3.85	4.06	4.11	3.64	4.05	4.38	4.38
Gross domestic products		100	100	100	100	100	100	100	100	100

Source: BPS (2024, www.bps.go.id)

The GDP has experienced significant growth over the past decade. In 2023, Indonesia's GDP reached IDR 12,301 trillion (at constant 2010 prices), significantly exceeding the 2016 figure of IDR 9,435 trillion. From 2016 to 2019, the average annual GDP growth was approximately 5.04%. In 2020, this figure declined to -2.07%, while GDP per capita rose to 56.9 million, compared to IDR 48.0 million in 2016 (Table 1.2). The pandemic COVID-19 triggered a significant decline in GDP growth in 2020. The COVID-19 pandemic has significantly disrupted economic activity in Indonesia. It affected not only health but also the economy and society. Several sectors have experienced notable declines, including land-based industries such as agriculture, forestry, and fisheries, as well as trade and transportation, specifically

transportation and warehousing, and accommodation services related to food and drink. Individuals unable to work experience a decline in income and diminished purchasing power. Simultaneously, the industrial sector faced a significant decline in sales, necessitating layoffs or dismissals as companies could not meet payroll obligations.

Table 1- 2 Development of Indonesian GDP and exchange rate

	2015	2016	2017	2018	2019	2020	2021	2022	2023
GDP in trillion IDR (current price)*	11,526	12,407	13,589	14,837	15,834	15,434	16,977	19,588	20,892
GDP/cap in million IDR (current price)	45.1	48.0	51.89	56.0	59.1	56.9	62.3	71.0	75.0
GDP (constant price 2010), in trillion IDR*	8,983	9,435	9,913	10,426	10,949	10,722	11,120	11,710	12,301
GDP/cap in million IDR (constant price 2010)	35.2	36.5	38.9	39.5	41.9	58.7	40.780	42.471	44.139
GDP growth (%)*	4.9	5.0	5.1	5.17	5.02	-2.07	5.03	5.01	5.05
Exchange rate, (000 IDR/USD)**	13.759	13.436	13.548	14.481	13.901	14.105	14.282	14.278	15.592

Source: *BPS (www.bps.go.id), **Bank Indonesia (www.bi.go.id).

Domestic consumption and investment were the primary drivers of growth on the demand side, while the services sector was the key contributor on the supply side. The economy's significant reliance on resource extraction, raw material exports, and portfolio inflows to address current account deficits renders it susceptible to shocks and price volatility. Traditional growth sources, including dependence on a substantial pool of low-cost labor for competitiveness, may prove unreliable amid a global landscape characterized by heightened protectionism, evolving global value chains, and swift technological advancements.

Approximately 85% of Indonesia's exports were directed toward Asian countries. The composition of exports has undergone alterations. The export-import of the non-oil and gas industry was USD 129,739.5 million at the end of 2010, rising to USD 154,997.4 million by 2020 (BPS 2021). The liberalization of capital markets and the opening of national economies have resulted in increased capital movements across countries. During the period from 2018 to 2020, direct investments originating from Indonesia surpassed those entering the country. In 2020, investments from Indonesia amounted to IDR 413,535.5 billion, surpassing the totals of the two preceding years (BPS 2021).

Indonesia represents the largest economy within ASEAN (BPS 2021). Since 2014, the Indonesian government has advanced initiatives to establish Indonesia as a manufacturing hub in South-East Asia. In 2018, the Making Indonesia 4.0 roadmap was launched to enhance industrial competitiveness through the integration of key innovations such as artificial intelligence, robotics, and sensor technology. The roadmap emphasizes enhancing the capacity of five manufacturing sectors: food and beverages, automotive, electronics, chemicals, and textiles and garments (BPS 2021).

1.2 Institutional Arrangement

In order to implement Article 13 of the Paris Agreement, as mandated by Presidential Regulation No. 98 year 2021, Indonesia enacted Ministerial of Environment and Forestry Regulation No. 12 year 2024 regarding National Determined Contribution Article 91 – 99 on MRV and Article 100 – 111 on National Registry System of Climate Change (SRN-PPI; Figure 1.4) that consist of the following functions:

a. collects data on adaptation, mitigation and domestic and international resources

b. acknowledges any contribution for climate change adaptation and mitigation actions and resources
c. provides data and information for public on climate change adaptation and mitigation actions and resources and their achievement to achieve the targets
d. avoids double counting
e. MRV for mitigation, adaptation and carbon pricing

SRN-PPI is developed under policy on "One GHG Emission and Climate Resilience Data" in which the system has interlinkages and interoperability with other relevant information systems in ministries/agencies (e.g. SIDIK, APPLE GATRIK etc). SRN-PPI is implemented by responsible organization/actors at action level (ministries/agencies, sub-national, private sector, community), responsible organizations at join actions (ministries/agencies, sub-national, private sector, community, operator of SRN-PPI at DG-CC of MoEF and public as users. Information that is registered and also provided by SRN-PPI are related to actions which cover adaptation, mitigation, GHG Inventory, carbon pricing, join adaptation and mitigation actions, REDD+, resources and others and related to supports which cover funding sources, technology transfer and development, capacity building and technical assistance/experts.

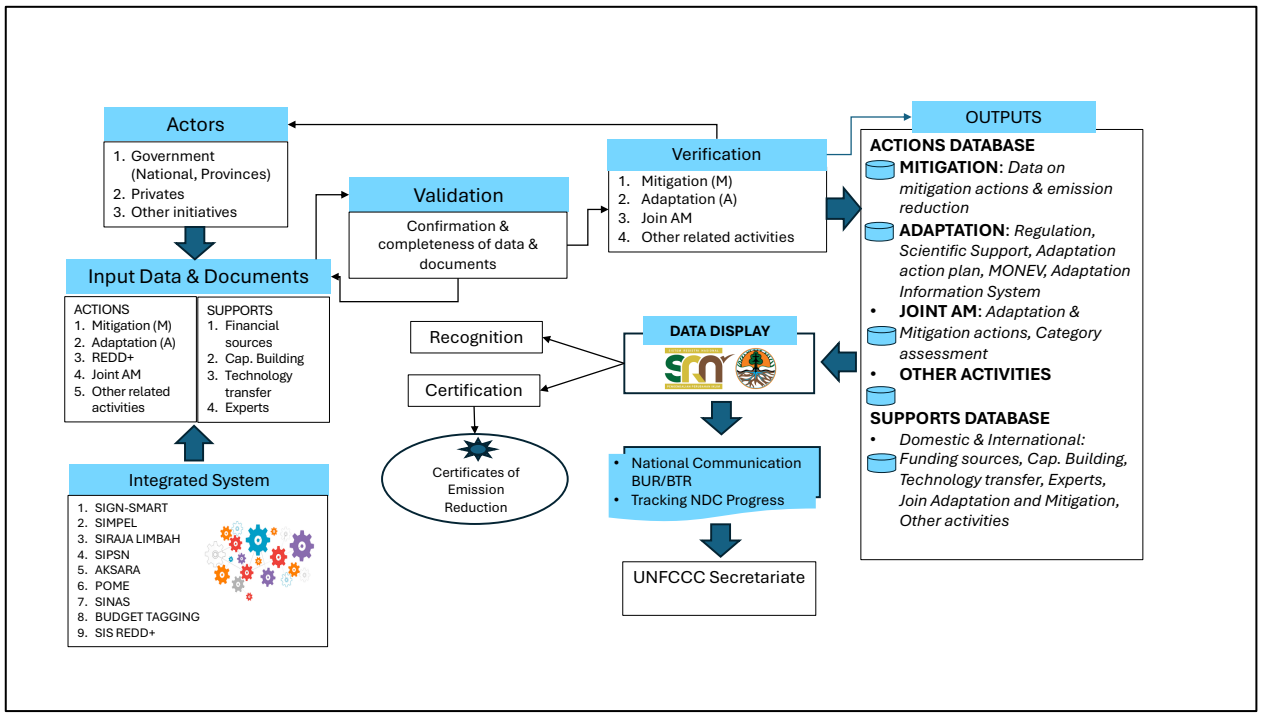


Figure 1- 4 Mechanism of National Registry System on Climate Change (SRN-PPI)

Responsible organization/actor may register electronically through SRN-PPI website at menlhk.go.id by following the steps outlined and illustrated in Figure 1:

a. Registration involves inputting data, consisting of name, email address, address and phone number.
b. SRN-PPI will grant access to the responsible organization/actor through the provision of a user name and password.

c. By 1(one) week after the access to the SRN-PPI has been granted, responsible organization/actor must input the general data of the activities to be registered, which includes title, current status, type, general objectives and specific objectives
d. Access to SRN-PPI will become invalid after one week without any input on general data.
e. The responsible institution/actor must provide technical data, consists of Planning Report and Implementation Report. The Planning Report comprises of proposed mitigation actions, methodology used, potential reduction in GHG emission, and a monitoring plan.
f. SRN-PPI will validate the conformity and completeness of the technical data in Planning Report that has been input by responsible organization/actor.
g. If the Planning Report is validated, responsible organization/actor must to submit Implementation Report.
h. SRN-PPI will validate the conformity and completeness of the technical data in the Implementation Report submitted by responsible organization/actor.
i. If the data is not conformed and incomplete, it will be returned to the responsible organization/actor for enhancement or additional data within one week.
j. If additional data or improved data is not received by the System within one week, the username and password will become invalid, and responsible organization/actor will lose access to the SRN-PPI
k. All validation of the Planning Report and Implementation Report by SRN-PPI will be completed in 1 (one) month.
l. The Planning Report and Implementation Report will undergo verification in SRN-PPI by the MoEF through a process of review and clarification
m. If the data cannot be verified, it will be returned to the responsible institution/actor for reprocessing.
n. The verified data will be entered into actions database or support database for subsequent display on SRN-PPI website for the following purposes:
    a. Government recognition of verified actions or supports.
    b. Certification for emission reduction (*Sertifikat Pengurangan Emisi GRK Indonesia*, SPEI)
    c. Information for the communication of National Communication/BTR to the UNFCCC Secretariat
    d. Tracking the progress of NDC

CHAPTER II
INFORMATION NECESSARY TO TRACK PROGRESS MADE IN IMPLEMENTING AND ACHIEVING THE NDC

2.1 National circumstances and Institutional Arrangements

2.1.1 Sectoral Condition

2.1.1.1 Energy

This sub-section presents sectoral energy conditions, including an overall view of primary energy supply and final energy consumption (by fuel type and by consuming sub-sector) and electric power sub-sector. Figure 2.1 shows the development of Indonesia's primary energy supply from 2000 to 2022. During this period, Indonesia's energy supply was dominated by fossil fuels (coal, oil, and natural gas) while the contribution of renewable energy (hydropower, geothermal, biomass and biofuels) is still low, i.e.16 % in 2022. The country's energy supplies mostly are from domestic resources, except oil product and crude oil that are supplied from import. During 2000-2022, the Total Primary Energy Supply (TPES) grew at an average rate of 3% per year from 146 million ton oil equivalent in 2000 to 268 million toe in 2022. The TPES growth declined in 2020 - 2021 due to Covid-19 pandemic, where there were some restricted activities during this period. After Covid-19, primary energy returned to the level of 2022.

As shown in Figure 2.1, fossil energy still dominates primary energy supply. In 2022 its share in primary energy supply was 84%. The remaining 16% was accounted for renewable energy. Although Indonesia is endowed with abundant renewable energy resource, its utilization still faces many constraints i.e. the geographical mismatch between the location of the energy resource and the location of energy demand centers. In addition, in some cases, technology investment costs of renewable energy are still higher than that of fossil energy systems. These constraints become challenges for the government in developing policies or regulations which will enable and promote the utilization of renewable energy.

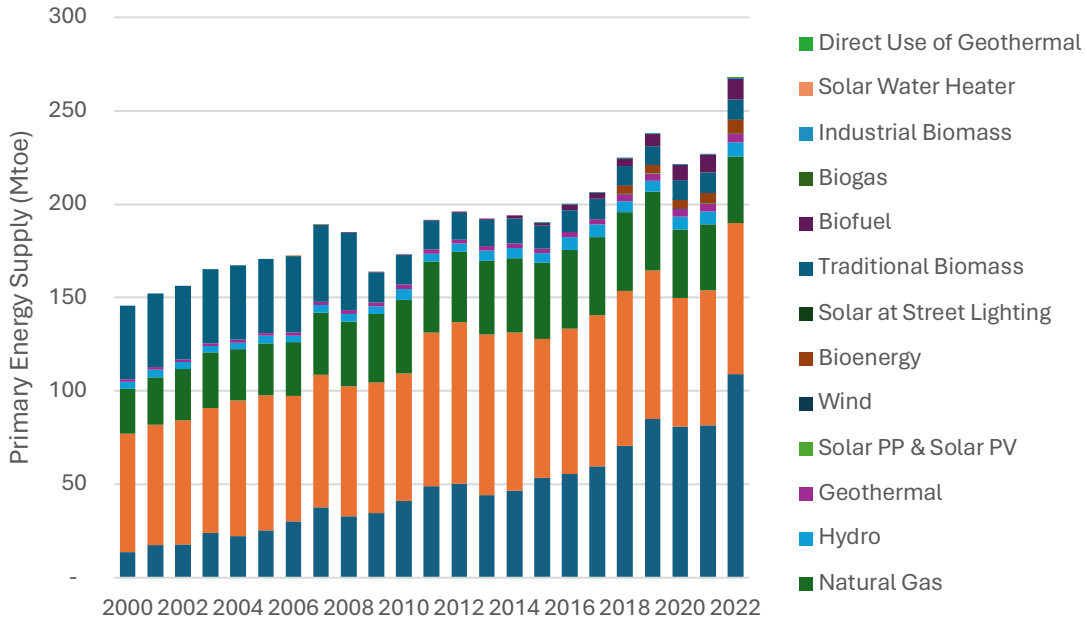


Figure 2- 1 Primary energy supply (Source: MEMR 2012&2022)

Primary energy supply is used to meet domestic energy demand. Part of the primary energy is used for export. Figure 2.2 presents the development of Indonesia's final energy consumption by type of consuming sub-sector in the period of 2000-2022. As indicated in this Figure, according to the type of consuming sub-sector, the final energy consumption is grouped into 5 categories: transportation, industry, residential, commercial and others (aggregate of agriculture, construction, mining and unrecorded activities). In the period of 2000-2022, the final energy consumption grew at an average rate (CAGR) of 2.2% per year from 108 million TOE in 2000 to 173 million TOE in 2022. As depicted in Figure 2.2, the major energy consumers in Indonesia are the transportation and industrial sub-sectors.

By type of consuming sub-sector, between 2000-2022 there was a shift in the proportion of energy consumption. In 2000, the share of consumption was dominated by residential sub-sector (40%) followed by industry sub-sector (34%) and transportation sub-sector (19%). Since 2013, the share of transportation sub-sector has exceeded the share of industry and residential sub-sectors, while in 2022, the share of industry (45%) exceeded the share of transportation (36%) and residential subsectors (14%). The remainders of the consumption were shared, in decreasing order, by residential, commerce and other sub-sectors.

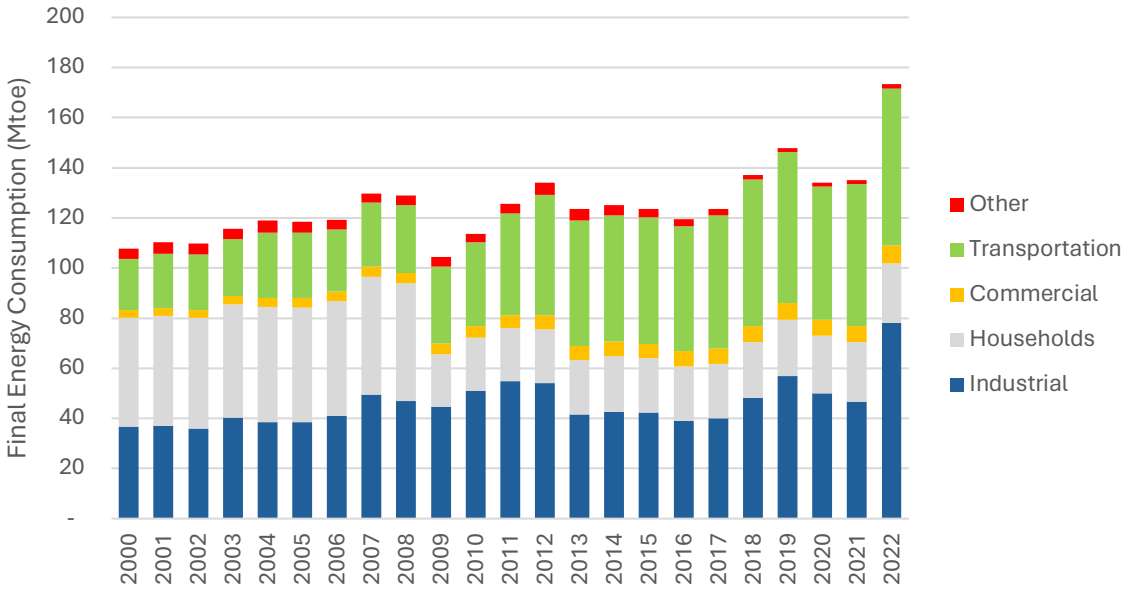


Figure 2- 2 Development of final energy consumption by sub-sector (Source: MEMR 2012&2023)

By type of fuels, the final energy consumption comprises of fossils (oil fuels, coal, coal briquette, natural gas, LPG), renewable energy (biomass, biofuel and biogas) and electricity (generated from fossil energy and renewable energy). The development of final energy consumption by type of fuels for 2000-2022 is shown in Figure 2.3. As shown in the figure, oil fuels dominated the final energy consumption, particularly in transportation and industry sub-sectors. Between 2000-2022 there are some notable changes in the proportion of final energy consumption. The share of electricity increased from 6% in 2000 to 15% in 2022. This increase is the result of improved access to electricity, indicated by electrification ratio, that has reached around 99.63% in 2022 (Statistics of Electricity, DGE MEMR).

The share of LPG increased from merely 1% in 2000 became to 6% in 2022, due to the implementation of kerosene-to-LPG conversion program, launched in 2007. The share of biofuel in total final energy was 5% in 2022, where in 2000 it had not been implemented. The government program to promote production and use of biofuel, especially biodiesel, started in 2007. Coal share in final energy increased from 5% (2000) to 25% (2022). This growth is attributed to the increased use of coal in industry such as steel and cement in construction which are rely on coal to scale production cost-effectively, and high global demand for exports from coal-dependent industries. In the case of natural gas, although in terms of absolute value the consumption is relatively constant around 13 million toe, in terms of share, it decreased from 11% in 2000 to 6% in 2022.

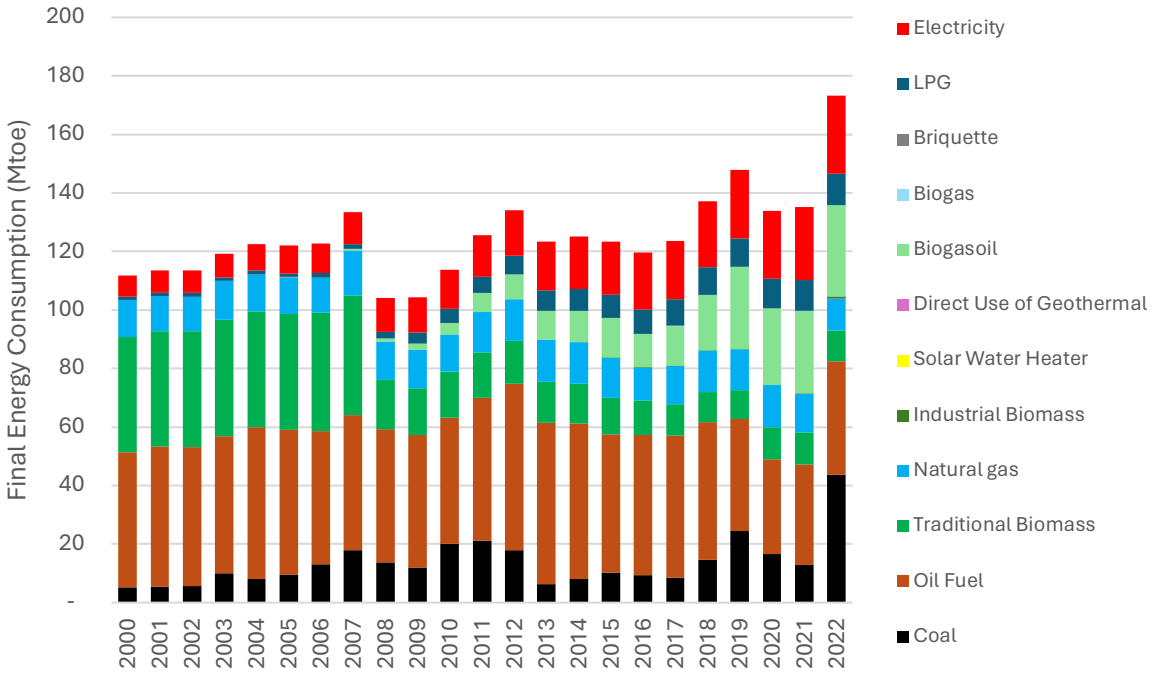


Figure 2- 3 Final energy consumption by fuel type (Source: MEMR, 2012 & 2023)

In supply side, power generation in 2000-2022 grew at an average rate of 6.1% per year. The development of power generation by energy source (power mix) for 2000-2022 is shown in Figure 2.4. By type of energy sources, the power generations were mainly supplied by fossil energy (coal, oil, natural gas). In 2000, power generation was dominated by coal-fired power plant 37%, natural gas 35%, and oil fuels 14%. In this year, fossil-based power generation accounted for 86% of total generation, while the remaining 14% was accounted by hydropower 11% and geothermal 3%. In 2022, the contribution of fossil-based power generation slightly decreased to 80%, where the proportion of the generation had changed to coal 62%, natural gas 17%, oil fuels 2%. The remaining 20% was shared by hydro 8%, biomass 6%, and geothermal 5%.

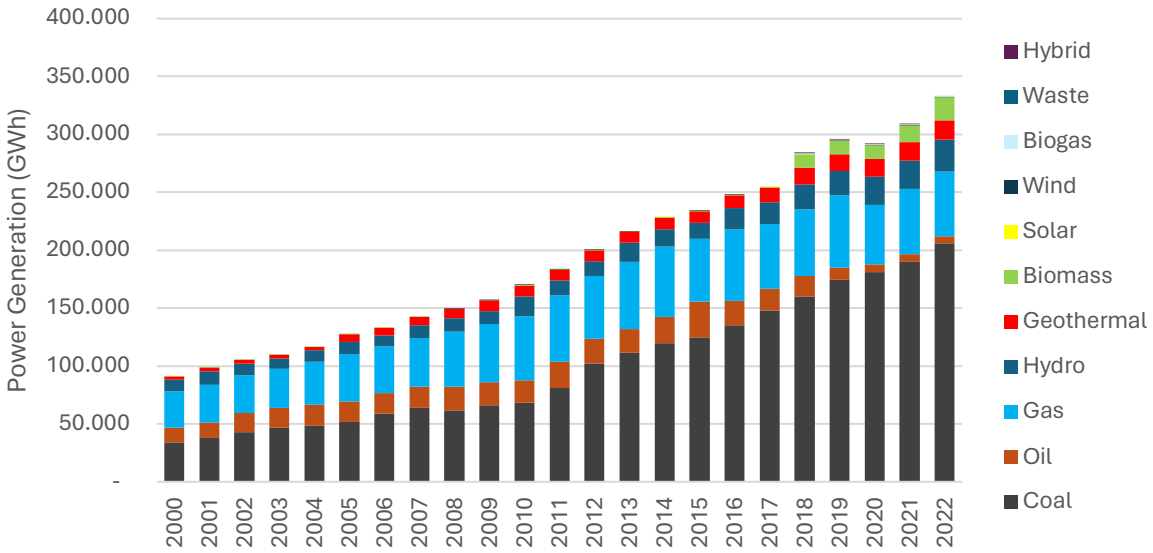


Figure 2- 4 Power generated by fuel (Source: MEMR, 2012 & 2023)

In demand side, the consumption of electricity is represented as electricity sales by consumer groups i.e., residential, industry, commercial, government, social and street lighting. The development of electricity consumption for 2000-2022 is shown in Figure 2.5. During this period, the electricity consumption grew at a rate of 5.8% per year from 79 TWh in 2000 to 274 TWh in 2022. The main electricity consumers were residential, industry and commercial, which in aggregate accounted for 95% of total electricity sales in 2000. In 2022, the three consumer groups decreased to 93% of total sales, in line with the increase of other consumer group consumptions.

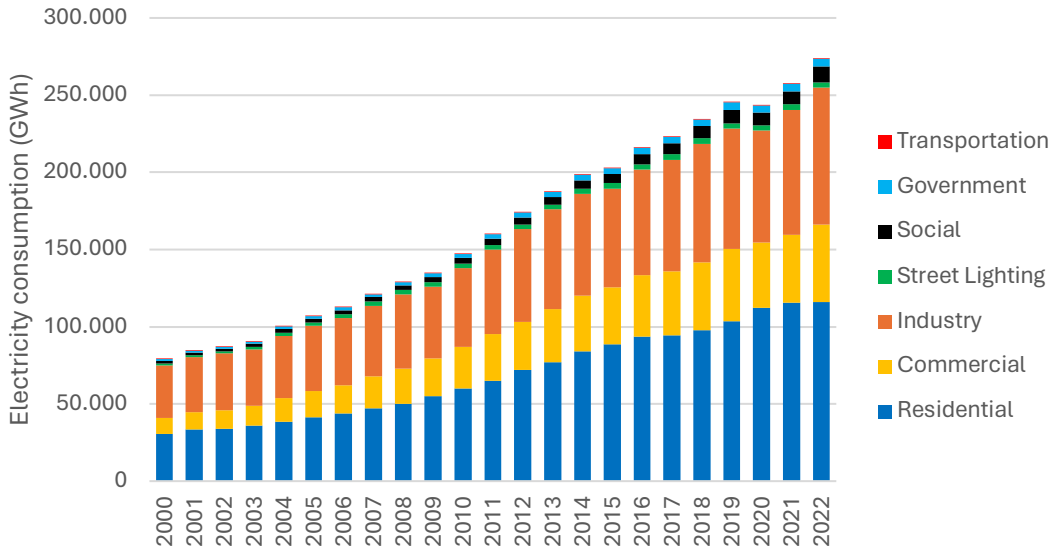


Figure 2- 5 Electricity consumption by customer (Source: MEMR, 2012 & 2023)

In terms of installed capacity, the development of power plants 2000-2022, is presented in Figure 2.6. The total installed capacity in this period grew at an average rate of 3.8% per year. However, as can be seen in Figure 2.6 there in an anomaly of install capacity data. If the growth calculated from 2001, the capacity growth is 6.2%, in line with growth of electricity generation. As indicated by the figure, the installed capacity of the power plants has been dominated by steam PP which is mostly coal-fired. Notable development in power plant is the entrance of significant biomass power plant capacity in 2015 (1671 MW) that has reached 2925 MW in 2022.

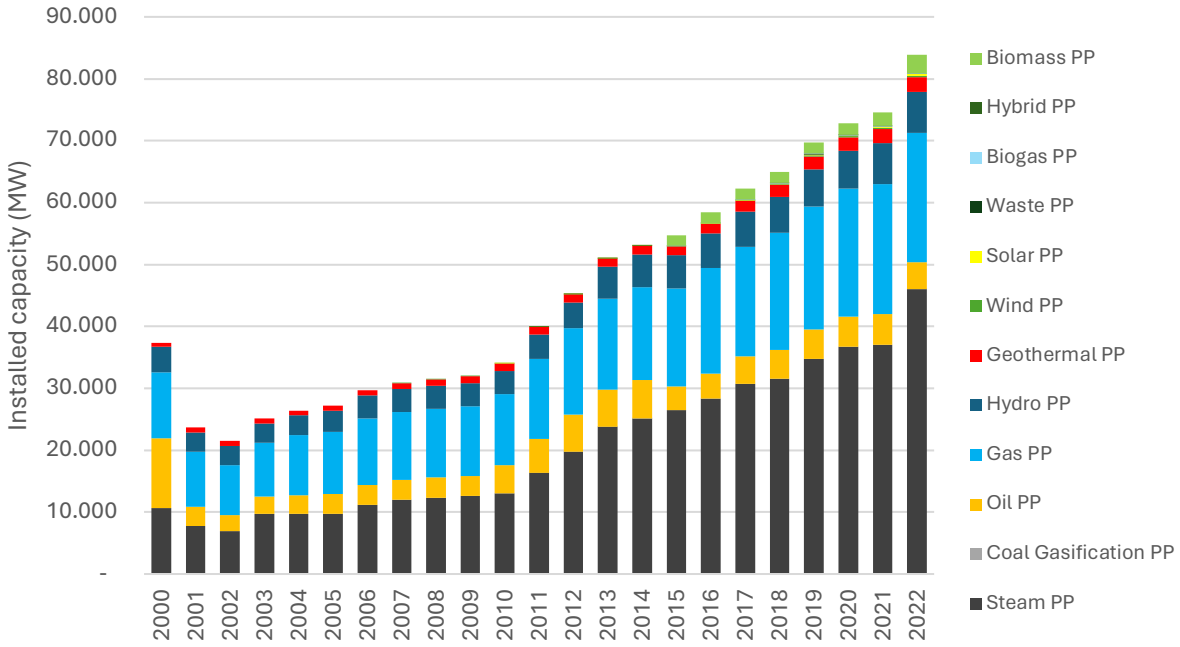


Figure 2- 6 Installed capacity of power plant by fuel. (Source: MEMR, 2012 & 2023)

Transportation

Transportation system comprises of land for road and railway, water-borne/sea transportation, and aviation. As an archipelagic country, water-borne/sea transportation and aviation are critical for ensuring connectivity, particularly among islands. The development of transportation sub-sector is driven mainly by population growth and economic developments. For road transportation, the length of road was increased from 537,837 kilometers in 2016 to 546,725 kilometers in 2022. Administratively, the road is categorized as state, provincial, and city/regency roads. Based on current data from BPS 2023, the length of state road reached 47,817 kilometers, while provincial road reached 54,633 kilometers, and city/regency road reached 444,276 kilometers. The improvement of railway transportation facilities such as high-speed train has increased commuting distance (transport demand). Energy consumption of road transportation is estimated based on length of road, transportation demand (passengers-km and ton freight-km) per year, specific energy consumption by type of road transport, and transportation mode share. Regarding the mode share, motor vehicle was the largest road transport mode in Indonesia, which accounted for 125 million in 2022. Other road transport includes passenger car, bus, and freight truck with the number of passenger car reached 17 million, bus 243 thousand, and freight truck 5.5 million (2022).

In railway transportation, rail networks are under centralized authority of one of Indonesia State-Owned Enterprise (BUMN). Promotion of public transportation and shifting modes of transportation mode to railway are several mitigation measures in Indonesia's climate policy. As for the number of train passengers, departing in January 2021 is not much different from the other two modes (public bus and private cars), which have also experienced a decline. During January 2021, the number of railway passenger reached 11.9 million people, reduced 11.95% compared to December 2020. Similarly, due to the pandemic, the number of goods transported by trains has also decreased by 8.61% to 4.0 million tons in January 2021 (BPS 2020d).

In aviation, there are airport as operators of supporting facilities and airline companies that operate the aircraft (BPS 2020b). Indonesia has a network of 264 domestic airports, of which 27 are also international airports. Domestic aviation has increased, in part due to a reduction in the real cost of airfares. Furthermore, international aviation and shipping are critical due to Indonesia geographical setting as archipelagic country and the importance of primary industry import-exports of time-sensitive goods (horticultural products and medical supplies), and tourism to the economy. Based on BPS (2021), the number of domestic arrivals passengers was 36.1 million people, and the number international arrival was 3.56 million people. With regard to sea transportation, 90 commercial ports and 165 non-commercial ports (BPS 2020c). The number of domestic sea transport passengers departing in January 2021 was recorded at 1.3 million people, down by 4.05% compared to December 2020. As with the number of passengers, the number of goods transported has also decreased by 5.20%, to 25.7 million tons.

In addition, international aviation and shipping have important role in transporting of primary industry import-exports of time-sensitive goods (horticultural products and medical supplies), and also to support tourism activities.

2.1.1.2 Industrial Process and Product Use (IPPU)

Industry sector has been playing an important role in Indonesian economy. Since the past decades, this sector has been contributing around 39% - 44% of the country's GDP. The important industry includes manufacturing, mining, and quarrying, which together have contributed to around 28.23% of Indonesia's GDP in 2022 (BPS, 2024).

The Ministry of Industry (MoI) considered eight priority industries as GHG emissions intensives. Among those industries, cement, basic chemicals (ammonia fertilizer, nitric acid, other petrochemicals), iron and steel making, and metal smelters (nickel, gold, aluminum, and bauxite) are considered as the main sources of IPPU and energy's GHG emissions. These priority industries are expected to grow as planned in the RIPIN (MoI, 2015). RIPIN states that there are 8 types of energy intensive that have to be included in the national GHG emissions mitigations from industry sector. During 2015 to 2035, the growth rate of the national manufacturing industry (exclude oil and gas) is estimated about 10.5%. However, the growth rate of specific industry is not available. Therefore, the projection of industry capacity or product use and the associated GHG emissions are carried out using the trend of current production capacity of those industries and also relevant issues (national or regional GDP and production target).

During 2020-2022, the overall annual growth of industry sector increased from -2.07% (2020) to 5.31% (2022). Among non-oil and gas industries, the sub-sectors that still have high annual growth in 2022 were Non-Metallic Mineral Industry (14.8%), Fabricated Metal Products Industry (11.37%), Machinery and Equipment Industry (10.67%), Leather, Leather Products, and Footwear Industry (9.36%) and Textile and Apparel Industry (9.34%). The breakdown of annual growth of the gross output of Non-Oil & Gas Industries during 2017- 2019 is listed in Table 2.1.

Table 2- 1 The annual growth of non-oil & gas industry 2020 – 2022 (in percent) (source: BPS 2024)

No.	Non-Oil & Gas Industry	2020	2021	2022*
1.	Food & Beverages Industry	1.58	2.54	4.90
2.	Tobacco Products Industry	-5.78	-1.32	-2.34
3.	Textile and Apparel Industry	-8.88	-4.08	9.34
4.	Leather, Leather Products, and Footwear Industry	-8.76	7.75	9.36
5.	Wood, Wood & Cork Products, and Bamboo & Rattan Plaiting Products Industry	-2.16	-3.71	0.59
6.	Paper and Paper Products Industry; Printing and Reproduction of Recorded Media	0.22	-2.89	3.73
7.	Chemical, Pharmaceuticals, and Traditional Medicine Industry	9.39	9.61	0.69
8.	Rubber, Rubber Products, and Plastics Industry	-5.61	1.08	-4.10
9.	Non-Metallic Mineral Industry	-9.13	0.89	-2.00
10.	Basic Metals Industry	5.87	11.50	14.80
11.	Fabricated Metal Products Industry; Computer, Electronic and Optical Products Industry; and Electrical Equipment Industry	-5.46	-1.62	6.71
12.	Machinery and Equipment Industry	-10.17	11.43	11.37
13.	Transport Equipment Industry	-19.86	17.82	10.67
14.	Furniture Industry	-3.36	8.16	-1.99
15.	Other Industry; Repair and Installation of Machinery and Equipment	-0.88	-1.64	6.08
National GDP		**-2.07**	**3.70**	**5.31**

Note: *preliminary figures

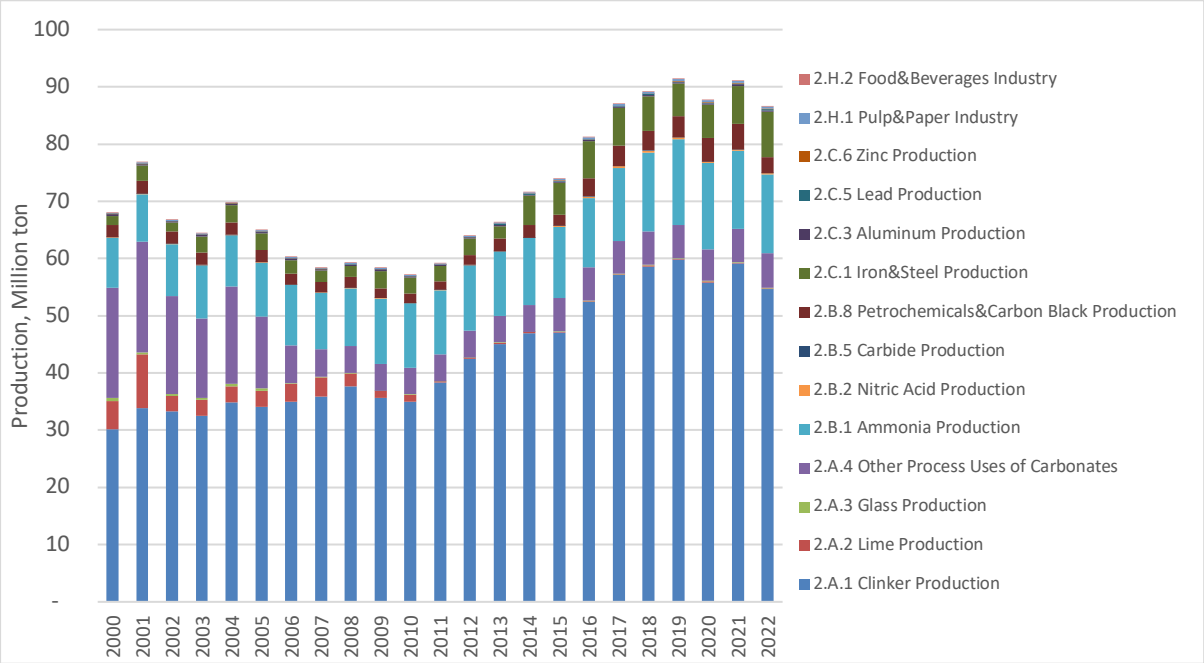


Figure 2- 7. Production capacity of industry (2000-2022)

As an overview, cement industries grew relatively high at the rate of 6.2% per year from 43.09 Mton (2010) to 73.9 Mton (2019), while the production capacity has decreased significantly for about -3.6% to 71.2 Mton in 2020 and estimated to be 70.4 Mton in 2021 during COVID-

19 pandemic (Figure 2.7). Almost all regions experienced a decline, Sumatra minus 4.1 percent, Java minus 13.6 percent, Kalimantan minus 10.8 percent, Sulawesi minus 11.8 percent, Bali-Nusa Tenggara minus 13.7 percent. Only Papua has experienced a growth of 9.6 percent. However, cement industry still recorded a very good export sales in 2020, namely with a total volume of 9.2 million tons successfully delivered to several main destination countries for Indonesian cement products, such as Australia, Bangladesh, Sri Lanka, Timor Leste and China. The growth of clinker and cement exports from Indonesia in 2020 reached 41.7 percent, where most of the exports were in the form of clinker products and a small portion of cement (source: https://asi.or.id/asi-at-glance/). Based on current consolidated data by cement industries and the association (ASI), this industry is estimated to grow around 2.0% (low economic scenario), and 3.0% (high economic scenario).

In 2023, ammonia production in Indonesia stood at 5.13 million metric tons. The production of ammonia experienced minimal fluctuations between 2013 and 2019, maintaining a consistent value of 5.0 million metric tons. There was a significant decline in 2020, where production dropped by 16.25% to 4.19 million metric tons. However, production rebounded in 2021 with an increase of 21.17%. Growth continued moderately, with a 0.57% increase in 2022 and 0.55% increase in 2023. The compound annual growth rate (CAGR) over the last five years averages at 0.52%.

Looking forward, the forecast predicts a steady increase in ammonia production, with a CAGR of 0.44% from 2024 to 2028, leading to a total growth of 2.23% over these five years. By 2028, production is expected to reach 5.28 million metric tons. Future trends to watch for include potential impacts of global trade dynamics, advancements in production technology, and shifts in domestic demand for ammonia. Environmental regulations and sustainability goals may also play a significant role in shaping production capabilities.

The Indonesia nitric acid market has experienced substantial growth and is anticipated to expand further. This growth is largely driven by rising demand in sectors such as fertilizer production, chemical manufacturing, and other key industries, alongside government initiatives that support industrial development. According to 6Wresearch, the nitric acid market size in Indonesia is projected to grow at a CAGR of over 4% between 2024 and 2030.

Several factors are contributing to this growth. The increasing need for nitrogen-based fertilizers is a primary driver, as nitric acid is a key component in their production. Additionally, expansion in the mining and chemical industries boosts demand, as nitric acid is used in ore processing and various chemical processes. The automotive sector also contributes due to nitric acid's role in producing synthetic rubbers and plastics, while construction and infrastructure development increase the demand for explosives, where nitric acid is a vital ingredient.

On iron and steel industry, The Indonesian Iron & Steel Industry Association (IISIA) forecasts a 5.2% increase in national steel consumption, reaching 18.3 million tons in 2024. This growth is expected to be driven by rising demand across sectors such as property, government infrastructure projects, and the automotive industry. The automotive sector anticipated to contribute significantly to domestic steel consumption, with new car sales projected to reach 1.1 million units in 2024, up from 1.05 million units in the previous year, according to GAIKINDO (Association of Indonesia's Automotive Industry) data. The IISIA reports that this

consumption growth is consistent with an upward trend observed from 2020 to 2023. In 2023, national steel consumption rose to 17.4 million tons, up from 16.6 million tons in 2022. Additionally, BPS-Statistics Indonesia data shows that steel products have been Indonesia's third-largest export commodity from 2020 to 2022, underscoring the sector's economic importance. In addition, the property sector, forecasted to grow by 3-5% this year, further supports steel demand, spurred by government policies such as value-added tax incentives for property purchases. These incentives aim to stimulate the property market, creating additional opportunities for growth in the steel industry.

2.1.1.3 Agriculture Sector

Located within the strategic equatorial line, Indonesia geographical condition indicates its importance as the main site for agricultural development. At least, the use of agricultural land consists of two main categories, namely rice fields (irrigated field and non-irrigated field) and non-rice field (dry field garden, shifting cultivation and temporarily unused land). Development of agricultural land area for the 2015-2022 period is shown in Table 2.2. In the 2015-2019 period, the area of paddy field experienced fluctuation. The increase in area occurred in 2016 and 2019, while the decrease in area occurred in 2017 and 2018. However, in the 2015-2019 period, the accumulative area of paddy has decreased by 628,959 hectares. This means that the average annual decline in paddy field area is 125,792 hectares.

Table 2- 2 Land area by utilization in Indonesia, 2015 – 2022 (ha)

No	Land type	Year							
		2015	**2016**	**2017**	**2018[1]**	**2019[2]**	**2020**	**2021**	**2022**
1	Paddy Field	8,092,907	8,187,734	8,164,045	7,105,145	7,463,948	7.463.948	7.463.948	7.463.948
2	Irrigated Paddy field	4,755,054	4,782,642	4,745,809	4,151,742	4,361,401	4,361,401	4,361,401	4,361,401
3	Non-Irrigated Paddy field	3,337,853	3,405,092	3,418,236	2,953,403	3,102,547	3,102,547	3,102,547	3,102,547
4	Non-Paddy Field (Non-Wetland)	29,392,324	28,555,790	29,121,269	27,730,369	29,353,138	29,353,138	29,353,138	29,353,138
5	Dry Field/Garden	11,861,676	11,539,826	11,704,769	11,696,845	12,393,092	12,393,092	12,393,092	12,393,092
6	Shifting Cultivation	5,190,378	5,074,223	5,248,488	5,256,324	5,188,658	5,188,658	5,188,658	5,188,658
7	Temporarily Unused Land	12,340,270	11,941,741	12,168,012	10,777,200	11,771,388	11,771,388	11,771,388	11,771,388

Source: BPS (2015 – 2017) and Minister of ATR/BPN;BPS (2015 – 2019) for non-paddy field). Note: [1)] The number is based on the minister decree of ATR/BPN-RI No. 399/Kep-23.3/X/2018. [2)] The number is based on the Decree of the Minister of ATR / Head of BPN No.686 / SK-PG.03.03 /XII/2019 dated 17 December 2019. After 2017, area of irrigated and non-irrigated are not available, they are estimated using average of the area proportion of 2015-2017.

This is risky considering that the government is promoting food security, especially for the commodity of rice, corn and soybeans. Similarly, within the same period, the area of dry field/garden has fluctuated annually. The increase in area occurred in 2017 and 2019, while a decrease in area was observed in 2016 and in 2018. Nevertheless, during the 2015-2019 period, in aggregate the dry field/garden area increased by 531,416 hectares. This means that during the last five years, the average annual increase in the area of dry field/garden was 106,283 hectares. During the 2015-2019 period, in aggregate the dry field/garden area increased by 531,416 hectares.

Furthermore, the area of temporarily unused land in 2019 will reach nearly 12 million hectares, indicating that there are still many agricultural lands that have not been used optimally. In other words, optimization of temporarily unused land is an opportunity as well as a challenge in agriculture sector. The use of land area from 2019-2022 was the same, since there is no new decree from the government. The use of land area during this period was still using the Decree of the Minister of ATR / Head of BPN No.686 / SK-PG.03.03 /XII/2019 dated 17 December 2019. Since the annual decline in paddy field is quite high during 2015-2019, in the year 2020, the government has a new decree for the protected paddy field land area, which stated that certain paddy field areas are not allowed to be change into other land use.

The paddy field harvested area was significantly decrease during 2018-2019 (Table 2.3), slightly decrease during 2019-2021, but shown an increase between 2021-2022. This decrease in annual harvested area, brought a decrease in paddy production during 2018-2021 and slightly increase in 2021-2022. This annual decreased was caused by several things, during 2018-2019 the land-use change in paddy field was still high, with the rate of 100,000 hectares annually; commodities conversion from paddy to other commodities; the production of superior variety seeds continues to decline; and the extreme climate events like El Niño and La Niña.

Table 2- 3 Harvested area and production of paddy field

No	Commodities	2015	2016	2017	2018	2019	2020	2021	2022
1	Harvested area (000 ha)	14,117	15,045	16,752	11,378	10,678	10,657	10,412	10,453
2	Production (000 ton GKG)	71,766	75,310	81,382	59,201	54,604	54,649	54,415	54,749

Sources: BPS and Ministry of Agriculture

Apart from the paddy field, agriculture commodities in Indonesia also include estate crops. Some of the most planted crops are oil palm, rubber, coconut, cocoa and coffee. The growth of the five estate crops for the past five years is presented in Table 2.4. Between 2016 – 2022, coffee shows a steady growth, while cocoa and coconut tend to decline by year. Rubber showed a slight increase while the growth of oil palm plantation has increased significantly since 2016, but the increased has slowing down from 2018 (Areas of Estate Crops in Indonesia, 2017-2022).

Table 2- 4 Planted area of five estate crops (000 hectare)

No	Area	2015	2016[a]	2017[b]	2018[b]	2019[c]	2020[c]	2021[d]	2022[d]
1	Oil palm	11,260.3	11,233.4	12,383.1	14,327.1	14,456.6	14,858.3	14,621.7	14,985.7
2	Rubber	3,621.1	3,644.8	3,659.1	3,671.3	3,675.9	3,681.3	3,776.5	3,826.5
3	Coconut	3,585.6	3,653,7	3,473.2	3,475.5	3,401.9	3,396.8	3,355.5	3,342.8
4	Cocoa	1,709.3	1,720.8	1,653.1	1,678.3	1,560.7	1,528.4	1,460.4	1,442.1
5	Coffee	1,229.8	1,246.7	1,238.5	1,241.5	1,245.2	1,242.8	1,279.6	1,285.8

Source: BPS [a]2018, [b]2019, [c]2021; [d]2023d)

The slowing rate of oil palm plantation growth was due to the issuance of Presidential Instruction (INPRES) Number 8 Year 2018 concerning Moratorium and Evaluation of Oil Palm Plantation Licensing and Increasing Productivity of Oil Palm Plantations. The objective of the Moratorium is so that existing permits can be utilized according to their designation to avoid abandoned land (temporary unused land-see Table 2.2). Abandoned land became the focus of the government because it was seen as unproductive, hence did not provide any added value

for the welfare of the people. The five-year moratorium stated the postponing of the issuance of forest release forms during the moratorium's implementation, which is three years since the INPRES was first issued. This postponement also applies to ongoing forest release applications that have been submitted, but not yet completed or has been identified as being in production forest areas. It also applies to ongoing forest release applications that have obtained principle approval, in which the area boundary has not changed and is in productive forest areas. The government will also review all oil palm plantation permits that have been issued, by conducting assessment of the fulfillment of the permits' holders obligations, which include the allocation of 20 percent of total plantation to plasma and development of High Conservation Value Forest (HCVF) areas. The government will ensure the fulfillment of oil palm fruit supplies to the industry through land productivity improvement efforts, instead of land expansion.

To enhance the economic benefits of oil palm plantation and reduce any potential damaging ecological impacts, the Indonesian government establish the Indonesian Sustainable Palm Oil (ISPO), which is a certification system, which aims to create a more sustainable Indonesian palm oil industry and to support the Indonesian President's commitment to reduce greenhouse gas emission by ensuring the implementation of regulations regarding oil palm plantation. Currently, ISPO is mandatory for companies and voluntary for smallholders. Once they are certified, they are able to meet the global demands for sustainable palm oil products and get a priority privilege to sell their Fresh Fruit Bunch (FFB) to ISPO certified companies. They also gained knowledge on good agriculture practices, which will help improve the productivity and quality of their crops. This is expected to increase their overall revenue, and at the end help to reduce deforestation and environmental damage from the expansion of plantation and unsustainable practices.

Other than cash crops and estate crops, husbandry is also important for Indonesia. The livestock population generally shows a steady increased in the period 2016-2020 (Table 2.5). It shows that poultry, especially broilers, are the main contributors to livestock population, followed by goats, beef cattle and sheep. Droughts can result in reduced pasture production and lower livestock performance.

Table 2- 5 Livestock population in Indonesia, 2015 – 2022

No	Population	Year							
		2015	2016	2017	2018	2019	2020	2021	2022
I	**Large Livestock (000 heads)**								
1	Beef Cattle	15,420	15,997	16,429	16,433	16,930	17,489	17,977	17,609
2	Dairy Cow	519	534	540	582	565	568	582	507
3	Buffalo	1,347	1,355	1,322	894	1,134	1,179	1,143	1,088
4	Horse	430	424	409	378	375	392	382	367
II	**Small Livestock**								
1	Goat	17,025	15,717	18,208	18,306	18,463	19,096	18,904	18,563
2	Sheep	19,013	17,862	17,142	17,611	17,834	17,769	15,636	14,063
3	Swine	7,808	7,904	8,261	8,254	8,521	9,070	7,178	6,749
III	**Poultries**								
1	Free-range Chicken	285,304	294,333	299,701	300,978	301,761	308,477	306,392	308,600
2	Layer	155,007	161,364	258,844	261,933	263,918	281,108	386,126	379,280
3	Broiler	1,528,329	1,632,801	2,922,636	3,137,707	3,169,805	2,970,494	2,889,208	3,114,028
4	Ducks	45,321	47,424	57,557	*59,551*	*57,229*	*56,570*	56,570	56,728

Source: Ministry of Agriculture (2022, 2023) & BPS (www.bps.go.id)

2.1.1.4 Forest, land and other land uses

Indonesia recognizes two statuses for its land territory, forest and non-forest areas (also known as Other Land Uses or *Area Penggunaan Lain – APL*). In 2021, Indonesia had about 118.366 million hectares of forest areas and 69.314 million hectares of non-forest area (MoEF, 2023). The forest areas are classified into five categories based on their functions, i.e. conservation forest (HK, 18.2%), protection forest (HL, 24.6%), limited production forest (HPT, 22.3%), production forest (HP, 24.3%), and convertible production forest (HPK, 10.6%). Conservation forests are designated for conservation efforts, including wildlife sanctuary, nature reserve, conservation area, and hunting parks (Act No. 5/1990). Protection forests serve to support ecosystems, maintain hydrological systems, prevent floods, control erosion, combat seawater intrusion, and preserve soil fertility. Production forests are intended for timber and non-timber production, while convertible production forests (HPK) are allocated for non-forest activities such as agriculture and settlements and can be transformed into non-forest areas (APL: Area Penggunaan Lain)

Clearing and converting HK and HL areas to other uses is prohibited. In contrast, clearing is permitted in HP and HPT areas, particularly in unproductive forests, for timber plantation purposes. HPK areas, however, are designated for activities such as agriculture, transmigration, plantations, and settlements, and thus allow for forest clearing. On the other hand, poor management of forests also leads to degradation. Over half of the remaining forests were at various degrees of degradation. Lightly to moderately degraded forests can recover with proper management, eventually achieving a climax forest state. The significant reduction in forest cover and unsustainable land management practices in non-forest areas have led to severe land degradation. As a result, crucial forest functions such as water retention, erosion control, nutrient cycling, microclimate regulation, and carbon sequestration have been critically impaired. The changes of land covers in forest and non-forest areas (APL) from 2017-2021 is presented in Table 2.6.

Table 2- 6 Extend of land cover in Indonesia from 2014-2022

Area	Land cover	2014	2015	2016	2017	2018	2019	2020	2021	2022
Forest Area (x1000 ha)	Forest	84,313	83,215	83,246	82,441	82,236	82,598	83,615	83,041	83,354
	Timber Plantation	3,824	3,411	4,483	3,409	3,386	4,302	4,798	4,809	4,939
	Non-Forest	32,634	33,937	32,696	34,540	34,764	33,382	31,849	30,516	29,902
Non-Forest Area (APL) (x1000 ha)	Forest	6,659	7,144	6,603	6,849	6,681	6,407	6,497	6,937	7,131
	Timber Plantation	971	1,258	941	1,251	1,223	808	652	549	545
	Non-Forest	59,351	58,787	59,784	59,262	59,462	60,256	60,342	61,828	61,716

Source : BPS (https://www.bps.go.id)

During the past two decades, Indonesia has experienced an increase in deforestation rate from 1990-1996 then it sharply decreases (Figure 2.8). Drivers of deforestation include conversion of forest areas for the use of other sectors such as expansions of agriculture plantations, mining activities, road infrastructure and transmigration. Among the major five agriculture plantation, namely oil palm, rubber, coffee, cocoa and coconut, oil palm shows the widest area and the

highest growth. Drivers of forest degradation include unsustainable forest management, illegal logging, disruption and occupation of illegal land in forest areas and forest fires.

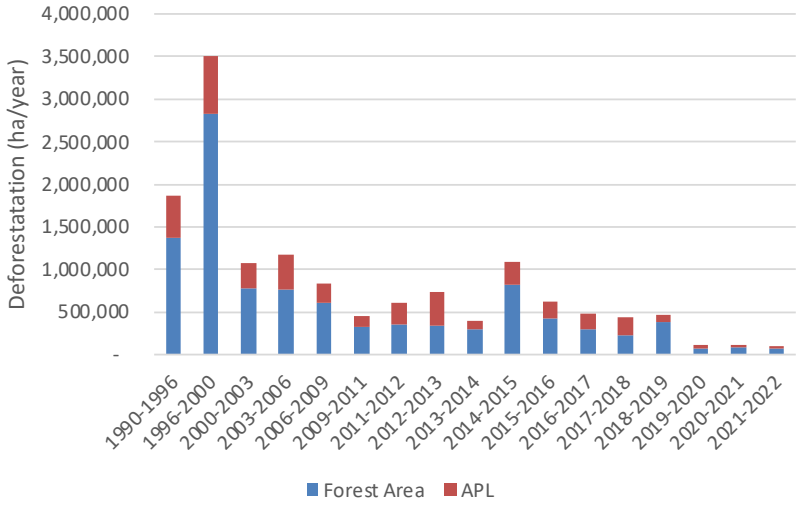


Figure 2- 8 Indonesia deforestation rate (1990-2022) (Source: MoEF 2022)

In addressing the causes of deforestation and forest degradation, Indonesia has issued and implemented five priority policies namely (i) combating illegal logging and forest fire (e.g. Act No. 18/2023), (ii) restructuring the forestry sector industries including enhancing plantation development (e.g. Minister Environment and Forestry Regulation No. 62/2019), (iii) rehabilitation and conservation of forest (e.g. Government Regulation No. 71/2014, No. 39/2016; Presidential Regulation 57/2016), (iv) promoting sustainable forest area (e.g. Government Regulation 6/2007; Minister Environment and Forestry Regulation 12/2015), and (v) strengthening of local economies (e.g. Minister Environment and Forestry Regulation No. 83/2016). In addition, Indonesia has imposed a moratorium on the issuance of new concessions in primary forests and peatlands since 2011, provided land for communities, resolved land use conflicts, and monitored environmental permits and law enforcement. In the effort to improve the weak state of open access forest areas and their management, the Government of Indonesia (GoI), among others, has established Forest Management Units in each province, as the smallest forest area management units at site level.

Apart from being a vast tropical forest area, Indonesia is also the largest tropical peatland with a total of around 13.43 million hectares (Anda et al 2021). Peatland has a multifunctionality including water function, niche for specific wildlife, and even production of agricultural and forest commodities. However, Indonesia peatland is also prone to fire due to the natural condition of peat as well as forest clearance. Almost every year forest and peatland fires cause disasters that damaged the environment, health, disrupt the economy, and worsen relations between countries due to haze generated from forest and peatland fires. The extend of land and forest fires increased significantly during extreme drought years which normally associated with the occurrence of El Niño (Figure 2.9).

On January 6, 2016, through President Regulation No.1/2016 Peatland Restoration Agency (BRG) was established to accelerate the recovery of hydrological and vegetation of degraded peatland that caused by forest and peat fires. In 2022, the mandate of this agency has been

expanded to include mangrove and through President Regulation No.120/2022 the name of this agency became Peatland and Mangrove Restoration Agency (BRGM).

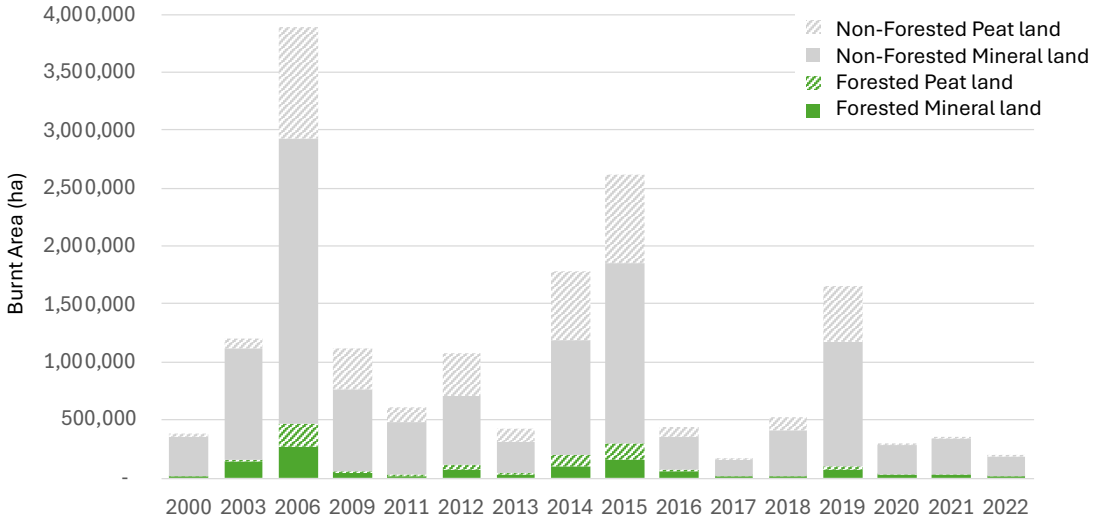


Figure 2- 9 Land and forest fire in Indonesia (2000-2022). Year 2006, 2015, and 2019 were El Nino years (Source: MoEF 2023)

2.1.1.5 Waste Sector

One of the biggest environmental problems in Indonesia is waste management. Indonesia generates large quantities of Municipal Solid Waste (MSW), with estimates reaching over 67 million tons annually. Rapid population growth, urbanization, and increased consumption contribute to this surge, overwhelming existing waste management infrastructure. Many areas, especially in rural regions, lack proper waste collection services. It is estimated that about half of Indonesia's waste ends up in open dumps or rivers, contributing to significant pollution. Mismanagement of waste disposal sites further worsens this issue, leading to public health risks and environmental degradation. While Indonesia has a low recycling rate, with most waste still ending up in landfills or illegal dumping sites. The infrastructure for recycling, composting, and converting waste-to-energy is limited, and informal recycling sectors handle a large portion of recycling without proper health or environmental standards. Improperly managed waste contributes to air and water pollution. Open burning, often used for waste disposal, releases hazardous pollutants, including dioxins and particulates, impacting air quality and public health.

Waste can be classified into: MSW; Domestic Wastewater (DWW); Industrial Wastewater (IWW) and Industrial Solid Waste (ISW); and other waste, including, toxic and hazardous waste which include electronic waste and infectious waste. In terms of GHG emissions reporting, the main sources of GHG emissions only include MSW, DWW, IWW, and ISW. Toxic and Hazardous waste are not emitting GHG, meanwhile infectious (clinical) waste has not been calculated and reported due to limited data and information, especially information on type of treatment. GHG emissions are calculated with the assumption in which the increased amount of waste that must be processed in each processing unit is influenced by a number of parameters, including economics, policies, regulations, lifestyles, processing plans, and waste reduction at source.

Municipal Solid Waste Management

Act No. 18 of 2008 on MSW Management requires the national and local governments, with support from communities and the private sector, to ensure the implementation of effective and environmentally friendly MSW management in line with the Law's objectives. To support this mandate, the government enacted Presidential Regulation No. 97 of 2017, which outlines the National Policy and Strategy (JAKSTRANAS) on Household Waste and Similar Waste (from non-residential areas) management. The MSW management plans for reducing the waste generation are set under JAKSTRANAS and JAKSTRADA, where the MSW generation is targeted to be reduced by 30% in 2025 through source reduction through collaboration among ministries/agencies, local governments, the private sector, and communities.

The regulation also mandates that local governments develop policies, strategies, and waste management plans that emphasize the 3Rs (Reduce, Reuse, Recycle) at the source and prioritize efficient, integrated processing at Final Disposal Sites (TPAs). These strategies are formalized in regional policy documents known as JAKSTRADA. To encourage multi-stakeholder participation, the Ministry of Environment and Forestry, through the Directorate General of Waste, Wastewater, and Hazardous Waste Management (PSLB3), has developed various support tools. These include policy guidance, reliable data management, and the National Waste Management Information System (SIPSN), which provides an accessible platform for tracking and managing waste data.

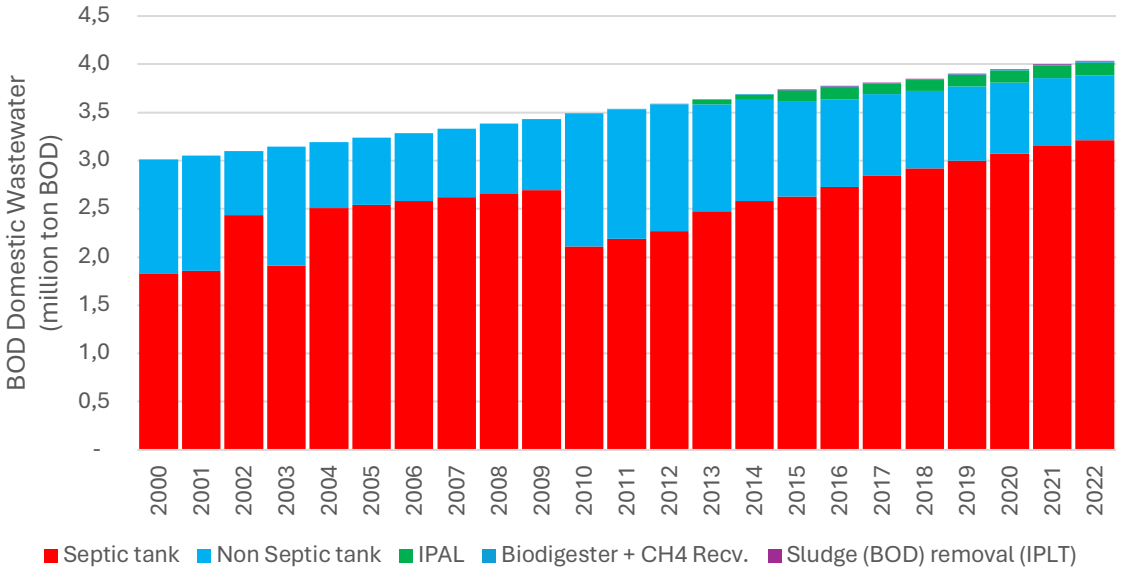
Currently, most MSW in Indonesia is transported to landfills or Solid Waste Disposal Sites (SWDS) after initial reduction at the source, composting, recycling, and recovery efforts. MSW stream is identified through several ways: (i) treatment at SWDS (include landfilling with gas capture and utilization); (ii) Reduction at the source through the implementation of 3R (Reduce, Reuse, Recycle), waste bank, composting (windrow, Mechanical Biological Treatment /MBT), and waste-to-energy (include anaerobic digestion at biogas facility) or material utilization to reduce waste volume before disposal; (iii) open burning and incineration, and (iv) others (untreated or unidentified). Although discouraged due to environmental impact, open burning of waste is still practiced in some areas where waste disposal infrastructure is limited.

In addition to aforementioned regulation and policies, the Presidential Decree No. 35/2018 was released to encourage the use of MSW for electricity generation (PLTSa) and the use of MSW for RDF (refuse-derived fuels). This regulation not only regulates the waste management through waste-to-energy but also supports the achieving of GHG emission reduction from the waste sector.

Domestic Wastewater Treatment

Increased population growth has an impact on increasing the amount of domestic wastewater. Disposal of domestic wastewater that is not well managed and careless defecation can cause serious pollution, while traditional septic system technology is one source of GHG emissions (especially methane). Domestic wastewater management in the form of black water and gray water has been regulated in the Minister of PUPR Regulation No. 4 of 2017 concerning the Implementation of the Domestic Waste Water Management System (SPALD).

The values of TOW of domestic wastewater are presented in Figure 2.10. It shows that more people are able to access toilet equipped with septic tank in line with the government program for the improvement of sanitation and health. It is also expected that beyond 2030, the use of septic tank reduced by increasing the use of centralized system that mostly aerobic.



(Notes: estimated from population (BPS), IPCC default of BOD, and degree of utilization for each type of treatment)

Figure 2- 10 Value of TOW in Domestic WWT 2000-2022

Industrial Waste Treatment

The development of industrialization in Indonesia comes with inseparable consequence, i.e. the increasing of industrial waste both in solid and liquid form. Indonesia has a policy related to the management of solid and liquid waste in PP Number 22 of 2021 and its derivative regulations governing the obligation to manage waste for individual or business entity producing solid and liquid waste. Industrial wastewater treatment is the main source of GHG emissions from the waste sector. The GHG emissions are generated from wastewater and solid waste treatment and/or handling units of various industries, particularly food and beverage, agro-industries, alcohol refining, petroleum refineries, oleochemical, plastic resins, CPO based biofuels and others.

The load capacity of industrial WWT and solid waste is estimated with assumptions that the load will continue to increase in line with the increasing of production capacity of agro-industry, food and beverage industry, and pulp paper industry. These industries are considered as priority industries, which has priority to continuously developed and expected to grow such as planned in National Development Plan of Manufacturing Industry (RIPIN - *Rencana Induk Pembangunan Industri Nasional*) during 2015 to 2035. In the RIPIN, it stated that those industries are to be included for the GHG mitigation plans.

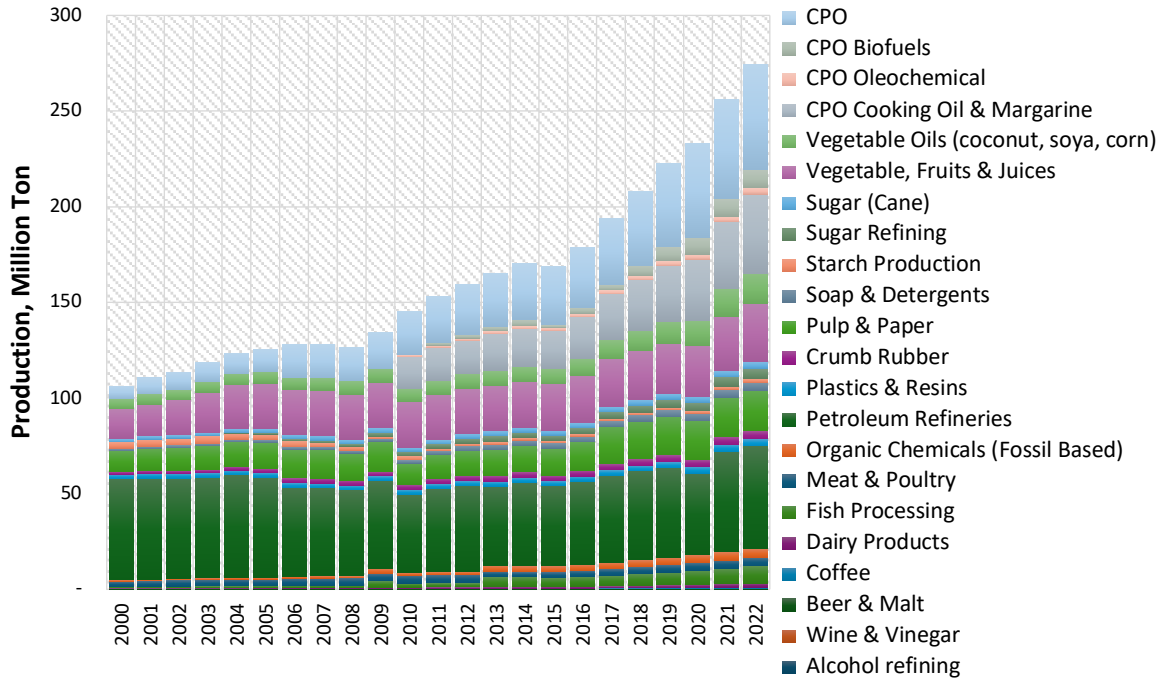


Figure 2- 11 Industrial production 2000-2022.

Notes: estimated from various sources (BPS, GAPKI, APKI, HEESI MEMR, statistics of farming and animal health, statistics of plantation Directorate General of Plantation, and Index Mundi) as well as extrapolated

A number of industrial solid waste, including sludge, contain organic content that has the potential to emit GHG emissions especially since they are treated in anaerobic system. Reporting system developed by Ministry of Environment and Forestry has been able to collect industrial solid waste and sludge data, i.e. WWTP (wastewater treatment plant) sludge of pulp & paper industry, de-inking paper sludge, petrochemical oil residue, sludge of petrochemicals oil, sludge of textile WWTP, sludge of residual oil. Some sludges are categorized as hazardous waste in Indonesia, however not all hazardous waste treatment emitting GHG.

2.1.2 Institutional Arrangement

2.1.2.1 Planning, Implementation, Monitoring and Evaluation

The MoEF, as the National Focal Point for the UNFCCC in Indonesia, plays a central role in coordinating climate change mitigation activities across sectors. Business process for mitigation of climate change at national level is defined in the Presidential Regulation No. 98 year 2021, as depicted in Figure 2.12.

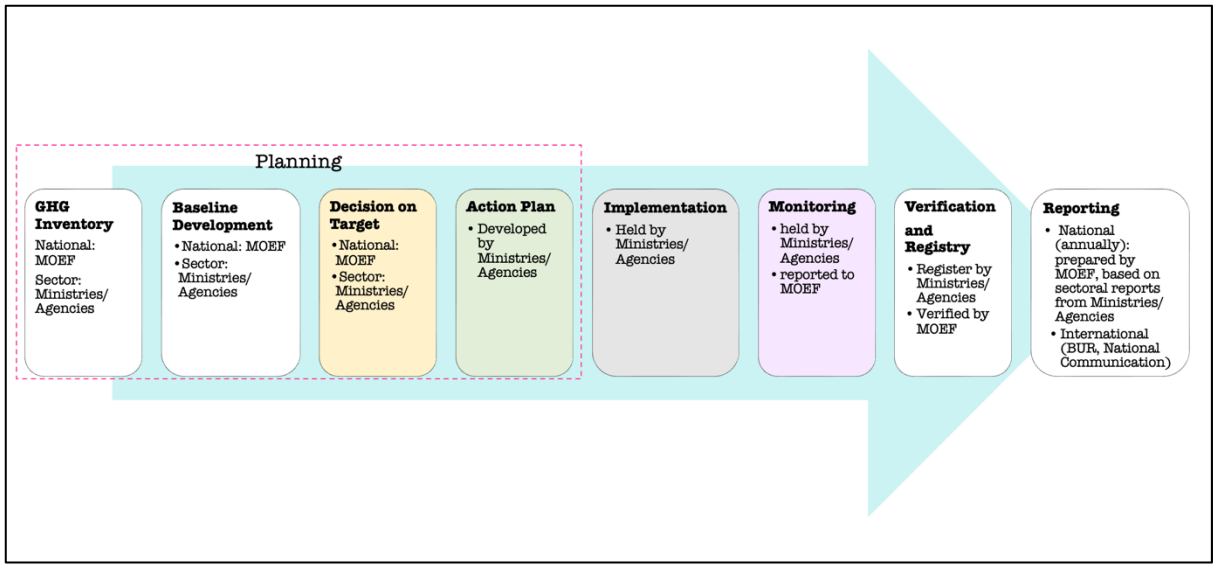


Figure 2- 12 Business Process of Mitigation of Climate Change

In the planning stage, the MoEF establishes national GHG baselines and targets. Working with other ministries, MoEF develops sector-specific baselines and targets for energy, transportation, forestry, agriculture, industry, and waste (Figure 2.16). Each ministry then creates a mitigation action plan aligned with national targets, detailing strategies, policies, and programs to reduce emissions.

During implementation, ministries execute these plans through on-ground initiatives. Dedicated units within each ministry manage the full cycle of mitigation activities—planning, implementation, monitoring, and reporting—while coordinating with MoEF to ensure data accuracy and adherence to national standards (Table 2.9). The results of these actions are registered in the National Registry System (SRN-PPI), managed by MoEF, serving as a centralized repository for verification, transparency, and accountability.

MoEF oversees the verification process to ensure sectoral consistency and prepares the annual National GHG Inventory Report, consolidating emissions data nationwide. It also publishes the Verified GHG Emission Reduction Report, highlighting verified reductions by sector. MoEF leads the submission of Indonesia's climate reports, including the Biennial Update Report (BUR), National Communication (NATCOM), and Biennial Transparency Report (BTR), to the UNFCCC Secretariat.

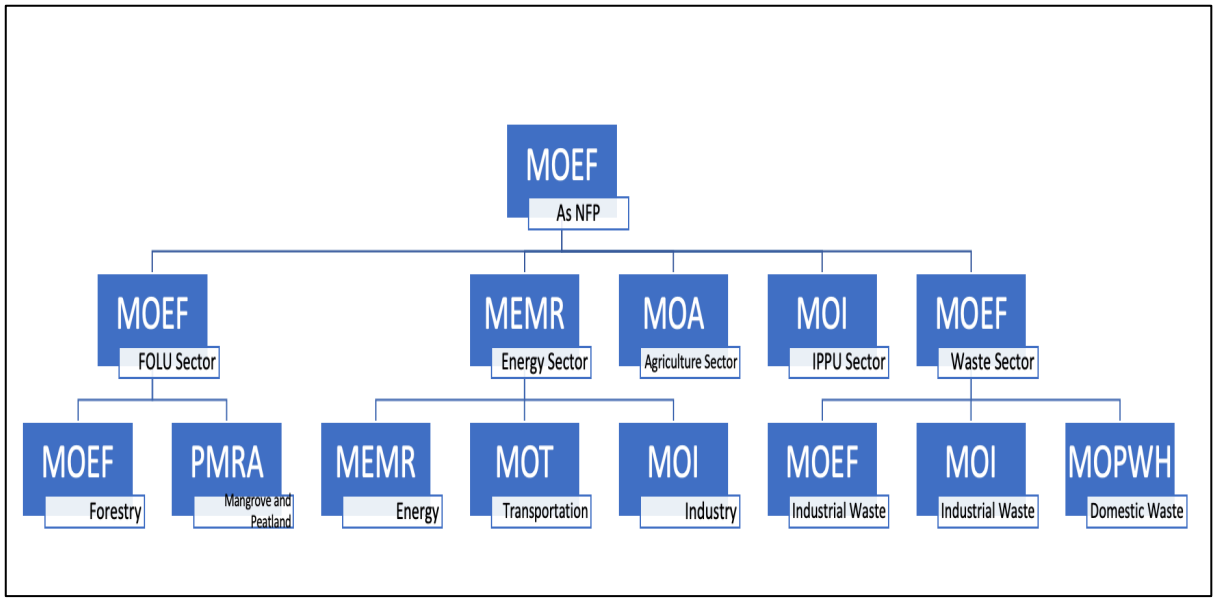


Figure 2- 13 Institutional Arrangement of Planning, Implementation, Monitoring, Registry, Verification and Reporting of Mitigation

Table 2- 7 Ministries/agencies responsible for planning, implementation, monitoring, registry, verification and reporting of mitigation

Sector	Responsible Units in the Ministries/Agencies	Related Units in the Ministries/Agencies
Energy	Coordinator: Directorate of Energy Conservation, Ministry of Energy and Mineral Resources	Related Directorates in: Directorate General of New, Renewable Energy and Energy Conservation, Directorate General of Oil and Gas Directorate General Electricity Directorate General of Mineral and Coal
	Coordinator: Center for Sustainable Transportation Management, Ministry of Transportation	Related Bureaus and Directorates in: Secretariat General Directorate General for Land Transportation Directorate General for Sea Transportation Directorate General for Air Transportation Directorate General for Railways
	Coordinator: Center for Green Industry, Ministry of Industry	Related Directorates in: Directorate General of Agro-Industry Directorate General of Chemical, Pharmacy and Textile Directorate General of Steel, Machinery, Transportation and Electronics Center of Standardization of Policy for Industrial Services
IPPU	Coordinator: Center for Green Industry, Ministry of Industry	Related Directorates in: Directorate General of Agro-Industry Directorate General of Chemical, Pharmacy and Textile Directorate General of Steel, Machinery, Transportation and Electronics Center of Standardization of Policy for Industrial Services
Agriculture	Coordinator: Bureau of Agricultural Planning, Ministry of Agriculture	Related Directorates in: Directorate General of Food Crops Directorate General of Horticulture Directorate General of Livestock and Animal Health Directorate General of Estate Crops Directorate General of Agriculture Infrastructure and facilities

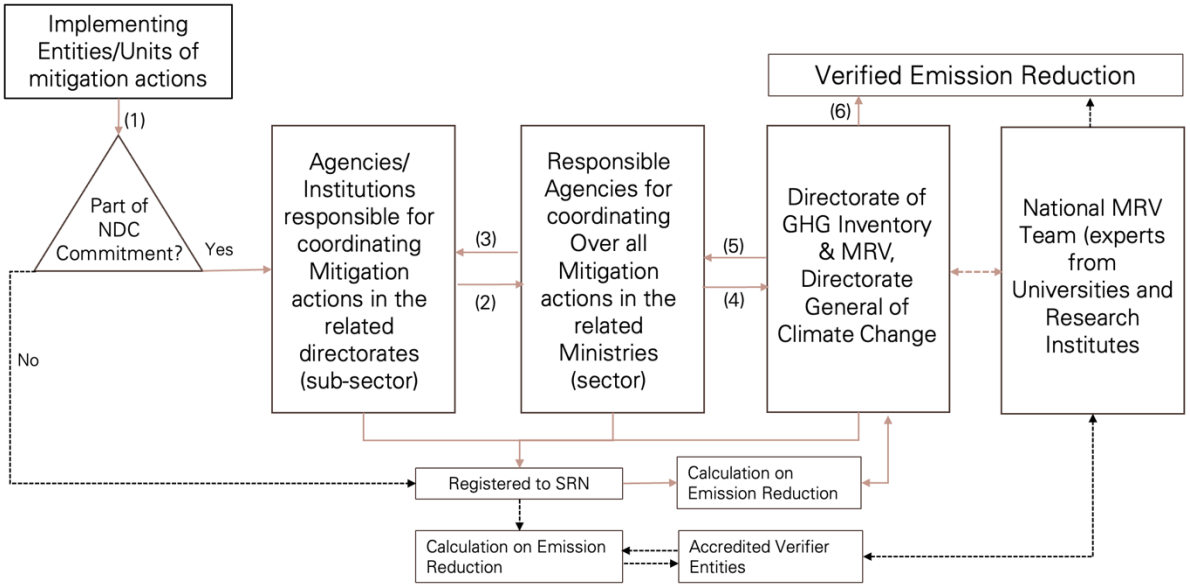
FOLU	Coordinator: Directorate of Climate Change Mitigation, Ministry of Environment and Forestry	Related Directorates in: Directorate General for Forest Planning and Environmental Governance Directorate General of Watershed Management and Forest Rehabilitation Directorate General for Sustainable Forest Management Directorate General for Natural Resources and Ecosystem Conservation Directorate General for Social Forestry and Environmental Partnership, Directorate General for Law Enforcement of Environment and Forestry
	Peat and Mangrove Restoration Agency (PMRA)	Related Working Groups
Waste	Directorate Mitigation, Ministry of Environment and Forestry	Related Directorates in: Directorate General of Pollution Control and Environmental Damage Directorate General of Management of Domestic Solid Waste, Toxic and Hazardous Waste and Substances
	Directorate of Sanitation Ministry of Public Works and Housing	Directorate of Sanitation, General for Human Settlements
	Coordinator: Center for Green Industry, Ministry of Industry	Related Directorates in: Directorate General of Agro-Industry Directorate General of Chemical, Pharmacy and Textile Directorate General of Steel, Machinery, Transportation and Electronics Center of Standardization of Policy for Industrial Services

2.1.2.2 Institutional Arrangement for Tracking the Mitigation Progress

Indonesia's institutional arrangement for tracking the progress of NDC involves multiple government bodies, each with defined roles to ensure Indonesia's climate commitments are achieved through consistent monitoring, verification, and reporting. The Directorate General of Climate Change (DGCC) within MoEF is responsible for overall coordination and oversight of NDC tracking and reporting. It consolidates data from various ministries and sectors to provide an integrated assessment of national progress toward NDC targets. Under the DGCC, Directorate for GHGI & MRV is tasked with setting the guidelines, methodologies, and standards for monitoring GHG emissions and reductions across sectors. It works with other ministries to standardize the reporting process and ensures that all submissions adhere to Indonesia's MRV system. Each relevant ministry is responsible for implementing and tracking climate actions within its domain as shown in Figure 2.16 and Table 2.9). Independent verification teams within MoEF (National MRV Team) verified the GHG emission reduction achievement data submitted by each sector, ensuring accuracy and consistency. These bodies perform quality assurance checks.

The data flow for tracking NDC progress involves multiple steps. Each sectoral ministry collect and submits data on relevant climate actions through the SRN-PPI. The private sector and other stakeholders also report their contributions directly to the SRN-PPI. Sectoral ministries calculate emissions reductions following the methodologies established by the GHGI & MRV Directorate. MoEF conducts a multi-level verification process, where both internal teams and independent bodies check the accuracy and completeness of the submitted data. MoEF compiles the verified data into a national annual report that reflects Indonesia's overall progress toward NDC targets to public at national level. This report is submitted to the UNFCCC as

part of the country's international obligations. Description of institutional process for tracking the progress of climate change mitigation is presented in Figure 2.14.



***Step 1**. Entities (private/business /sectoral units) that commit to implement mitigation activities as part of NDC commitment reported the activities to the responsible agencies coordinating the mitigation activities in the related sub-sector (directorates), while the ones who are not committed registered their activities directly to the SRN-PPI. **Step 2** Persons in charge in the responsible agency of the related sub-sector calculate the emission reduction using the manual worksheet agreed by the Directorate GHGI & MRV (all worksheets are equipped with a methodology for calculating GHG emission reductions). Results of the calculation are submitted to the responsible agency coordinating overall mitigation actions in the related ministry (sector) for verification (Quality Assurance) and sent back to the sub-sector if needed (**Step 3**) for clarification. **Step 4** the sector submitted the result of the calculation to Directorate GHGI & MRV for further processing along with the calculation worksheet. Directorate GHGI and MRV and MRV TEAM conducted further verification (internal discussions to map data considered unclear and incomplete). **Step 5**, directorate GHGI & MPV, invites the directorates to discuss the achievements in reducing GHG emissions and proposals for improvements in the next submission based on findings of the MRV Team. **Step 6**, the MRV team refine the calculation whenever needed following the findings and the Directorate GHGI and MRV issue report of verified emission reduction.*

Figure 2- 14 Institutional process for tracking the progress

2.2 Description of Indonesia's Nationally Determined Contribution

2.2.1 Background

Indonesia submitted its Intended NDC to the Secretariat of the UNFCCC prior to COP 21. During the COP 21, Parties adopted Decision 1/CP.21 on the Adoption of the Paris Agreement in which ratified by the Government of Indonesia through Act No. 16 year 2016. As mandated by Decision 1/CP.21 paragraph 22, Parties to communicate their First Nationally Determined Contribution no later than when the Party submits its respective instrument of ratification, acceptance, approval or accession of the Paris Agreement. To provide the information necessary for clarity, transparency and understanding in accordance with decision 1/CP.21, Indonesia submitted its First NDC prior to COP 22 in 2016.

Indonesia's First NDC reflected progress beyond previous commitments in the INDC in terms of: (a) the national BAU scenario used – the NDC's BAU was slightly lower than the INDC's

BAU (from 2.881 Gt CO_2e in the INDC to 2.869 Gt CO_2e in 2010 in the First NDC), and (b) sectoral BAU clarity and emission reduction targets, as well as the assumptions used in projecting and allocating BAU targets. The First NDC set ambitious mitigation targets for the forestry and land use sectors as well as the energy sector, accounting for approximately 97% of the total national commitment (GoI, 2016)[3].
In 2021, Indonesia submitted Updated NDC, reflecting progress beyond the previous NDC. Continuing this commitment, in 2022, Indonesia revisited and strengthened its NDC as mandated by Decision 1/CMA 3 (GoI, 2021)[4]. The Enhanced NDC (ENDC) was submitted to the UNFCCC Secretariat on September 23, 2022 with increased emission reduction targets from 29% in the First NDC and Updated NDC to 31.89% unconditionally (CM1 or with measures) and from 41% to 43.20% conditionally (CM2 or with additional measures) from its BAU emission (without measures) by 2030 (GoI, 2022)[5].

In the BAU baseline scenario, greenhouse gas emissions from all sectors will continue to increase, except the forestry sector, and in 2030 the emission level will reach 2.869 Gt CO2e. In the BAU, the energy and waste sectors are projected to have the largest emissions growth rates. In 2030, the emission level from these two sectors will reach almost 3 times the emission level in 2010. For the agricultural and industrial sectors, the rate of increase in emissions is relatively low, while for the forestry sector the rate of emissions has decreased slightly (Table 2.10). With measures (CM1), the growth of the emission is lowering and by 2030 the level of emission reaches 1.953 Gt CO_2e and with additional measures the level of emission reaches 1.632 Gt CO_2e (Table 2.10).

Table 2- 8 Projection of emission of the BAU and the emission reduction target of CM1 and CM2 by sectors in ENDC

Sector	GHG Emission Level 2010* (Mt CO_2e)	GHG Emission Level 2030			GHG Emission Reduction				Annual Average Growth BAU (2010-2030)	Average Growth 2000-2012
		Mt CO_2e			Mt CO_2e		% of Total BAU			
		BAU	CM1	CM2	CM1	CM2	CM1	CM2		
1. Energy	453	1,669	1,311	1,223	358	446	12.5%	15.5%	6.7%	4.50%
2. Waste	88	296	256	253	40	44	1.4%	1.5%	6.3%	4.00%
3. IPPU	36	69.6	63	61	7	9	0.2%	0.3%	3.4%	0.10%
4. Agriculture	111	120	110	108	10	12	0.3%	0.4%	0.4%	1.30%
5. Forestry and Other Land Uses (FOLU)	647	714	214	-15	500	729	17.4%	25.4%	0.5%	2.70%
TOTAL	**1,334**	**2,869**	**1,953**	**1,632**	**915**	**1,240**	**31.89%**	**43.20%**	**3.9%**	**3.20%**

2.2.2 Description of the Enhanced Nationally Determined Contribution

Following the Decision 18/CMA.1, Parties shall use the 100-year time-horizon GWP values from the IPCC Fifth Assessment Report, while in the development of ENDC, the metrics used

[3] https://unfccc.int/sites/default/files/NDC/2022-06/First%20NDC%20Indonesia_submitted%20to%20UNFCCC%20Set_November%20%202016.pdf
[4] https://unfccc.int/sites/default/files/NDC/2022-06/Updated%20NDC%20Indonesia%202021%20-%20corrected%20version.pdf
[5] https://unfccc.int/sites/default/files/NDC/2022-09/23.09.2022_Enhanced%20NDC%20Indonesia.pdf

refers to the IPCC Second Assessment Report. In this regard, the ENDC emission projection is adjusted following the Decision. In addition, for forest and other land use sector, the adjustment was not only made due to change of the metrics, but also due to change in activity data and emission factors (see section 2.2.4). The result of the adjustment of the ENDC emission projection is presented in Table 2.9. It is shown that after the adjustment, the emission reduction targets are lower than the submitted ENDC.

Table 2- 9 Adjustment of projection of emission of the BAU and the emission reduction target of CM1 and CM2 by sectors in ENDC

Sector	GHG Emission Level 2010* (MTon CO_2e)	HG Emission Level 2030			GHG Emission Reduction				Annual Average Growth BAU (2010-2030)	Average Growth 2000-2012
		MTon CO_2e			MTon CO_2e		% of Total BAU			
		BAU	CM1	CM2	CM1	CM2	CM1	CM2		
1. Energy	430	1,620	1,262	1,174	358	446	13.69%	17.05%	4.9%	5.6%
2. Waste	89	360	311	307	50	54	1.91%	2.06%	0.2%	0.3%
3. IPPU	36	69.5	62.5	60.9	7	9	0.27%	0.33%	0.5%	0.5%
4. Agriculture	124	134	122	122	12	12	0.46%	0.44%	0.2%	0.3%
5. Forestry and Other Land Uses (FOLU)	388	431	72	-25	360	456	13.74%	17.45%	14.7%	22.0%
TOTAL	**1,067**	**2,616**	**1,829**	**1,640**	**787**	**976**	**30.07%**	**37.33%**	**20.6%**	**28.6%**

To increase the clarity, transparency and understandable of the ENDC as mandated by Dec.18/CMA.1, Table 2.10 provides the description of the ENDC.

Table 2- 10 Description of the Enhanced Nationally Determined Contribution

Objective(s) and description, including objective types, as applicable:	Emission reduction relative to BAU baseline. With measures (CM1), the level of emission in 2030 will be 30.62 % below the BAU, and with additional measures, it will be 38.71% below the BAU.
Methodology for emission projection	Model for estimating emission projection under different scenarios are the following (see Annex 2.1 description of modeling framework): • Dashboard of Agriculture, Forestry, and Other Land Uses (AFOLU) for land-based sector; • AIM-ExSS (Extended Snapshot) for projecting energy demand (electricity) by the user side, AIM-Enduse for solving linear optimization equations for the technological selection; • Dashboard of Cement Industry for IPPU sector (Ministry of Industry); • *First Order Decay*-FOD (IPCC-2006) for waste sector.

Objective(s) and description, including objective types, as applicable:	Emission reduction relative to BAU baseline. With measures (CM1), the level of emission in 2030 will be 30.62 % below the BAU, and with additional measures, it will be 38.71% below the BAU.
Target year(s) or period(s), and whether single-year or multi-year targets, as appropriate:	To reach the 2030 emission reduction target, the implementation of measures is targeted to reduce emission to certain level below the BAU emissions from 2011-2030.
Reference point(s), level(s), baseline(s), base year(s) or starting point(s), and their respective value(s), as applicable:	Base year: GHG Emission Level 2010 of 1,029 Mt CO_2e.
	BAU scenario for 2030: net emissions balance of 2,554 Mt CO_2e.
Time frame(s) and/or periods for implementation, as applicable	2011 – 2030.
Scope and coverage, including, as applicable, sectors, categories, activities, sources and sinks, reservoirs and gases, as applicable:	- The objectives include all sectors of the inventory: energy, IPPU, agriculture, FOLU, and waste. - Scope of gases are Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O). - For FOLU the pools being included are living biomass, and soil carbon for peatland.
Intention to use cooperative approaches involving the use of ITMOs under Article 6 toward NDCs under Article 4 of the Paris Agreement, as appropriate:	Indonesia plans to use cooperative approaches to increase its emission reduction ambitions under conditional target (CM2). Policies and regulations are still being developed.
Any update or clarification of previously reported information, as applicable:	The projection of emission of ENDC is adjusted following the change in metrics (GWP) from IPCC AR2 to IPCC AR5 and also the change in activity data and emission factors specific for the FOLU sector.

2.2.3 Intention to use cooperative approaches involving the use of ITMOs under Article 6 toward NDCs under Article 4 of the Paris Agreement

Indonesia perceives cooperative approaches under Article 6 of the Paris Agreement as one among viable ways to mobilize finance from international sources to support its NDC target achievement. Indonesia also intends to pursue voluntary cooperation involving the use of internationally transferred mitigation outcomes (ITMOs) in the NDC implementation, to enable for higher ambition in mitigation and adaptation actions as well as to promote sustainable development and environmental integrity.

Presidential Regulation No. 98/2021 concerning the Implementation of Carbon Pricing to achieve the NDC target and control over greenhouse gas emissions in the national development serves as a legal framework to implement NDC toward low carbon and climate resilience. It also prescribes carbon pricing, including arrangements for carbon trading, carbon levies and

result-based payments, and SRN-PPI. The Presidential Regulation No. 98/2021 provides guidance on NDC implementation and allows mobilization of finance from both domestic and international sources, including the use of Article 6 of the Paris Agreement to support NDC target achievement. The MoEF Regulation No. 21/2022 further guides the implementation of carbon pricing in Indonesia. This Regulation takes into account the guidance under Article 6 where the use of ITMOs toward NDCs shall ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to avoid double counting, consistent with CMA guidance. The regulation also indicates any cooperation under Article 6 which involve carbon credit transfer overseas shall be authorized by participating Parties and subject to corresponding adjustment.

Furthermore, the implementation of the Presidential Regulation No. 98/2021 and its corresponding MoEF Regulation No. 21/2022 are equipped with National Carbon Registry within the SRN-PPI. The SRN-PPI is connected to the Indonesia's Carbon Exchange under Indonesia Stock Exchange (*Bursa Efek Indonesia/BEI*). Compulsory registration of mitigation actions and results to the SRN-PPI is the means for avoiding double counting of mitigation achievement and safeguarding carbon transfer beyond national boundary.

Mitigation actions implemented through carbon market mechanisms must register the mitigation action plans into the SRN-PPI. The implementing entity (project proponent) must develop the Mitigation Action Design Document (DRAM) containing baseline emission information developed using standards and methodologies approved by the Government, UNFCCC or National Standarization Agency, mitigation action plans, emission reduction target, and monitoring methodology. The DRAM will be validated by the accredited entity.

The result of the emission reduction from the implementation of the mitigation action is reported and will be verified by the accredited entity. The issuance of the emission reduction certifcate (SPE) will be based on the report of verification reviewed by the National MRV Team (Figure 2.15). The SPE can be traded through carbon exchange or to individual buyers. The emission reduction from the carbon-market traded domestically will be reported as part of achievement of NDC target (Figure 2.15).

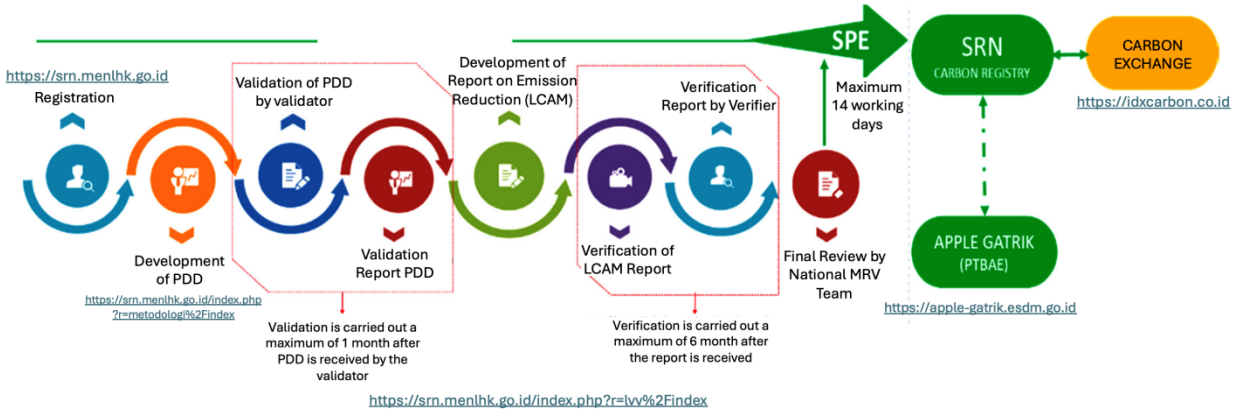


Figure 2- 15 Process the registration of the mitigation actions for obtaining Emission Reduction Certificate (SPE) for carbon trading (MoEF)

2.2.4 Update or Clarification of Previously Reported Information

ENDC used GWP on a 100-year timescale in accordance with the IPCC's 2nd Assessment Report. Following the COP decision, it is mandatory to use GWP from AR5 IPCC's. The change of this GWP affect the emission reduction target defined in the ENDC. In addition, there were also changes in methodology for estimating GHG emissions from IPPU in cement industries under ENDC and this BTR1, i.e. (i) activity data in the ENDC used cementitious base (WBCSD) while the BTR1 used clinker production (domestic and export) base (IPCC2006) and (ii) emission factor (EF) of ENDC used EF per cementitous while BTR1 used EF that was determined by CaO content in clinker and carbonates content in CaCO3 (IPCC2006, Tier 2). In addition, the calculation of the baseline, reduction target CM1 and CM2, and achievement verification by KLHK for ENDC also used cementitius based.

For the FOLU sector, the projection of emission is also adjusted following the revision of activity data of peatland and emission factors of the secondary forest and perennial crops as well as those of peat decompositions used in the development of the GHG Inventory (Table 2.11). For the waste sector, there is updated database of national MSW management (SIPSN) which is improved in data reporting of MSW to SWDS (based on real data). Previous report still referred to JAKSTRANAS that still using assumptions (Table 2.12). In addition, there is necessity to adjust the level of activity (industrial production), which is based on that is calculated in inventory. These are to allow for the calculation of achievement of reducing emission from mitigation by referencing to GHG Inventory.

Table 2- 11 Activity data and emission factors used for calculation of emission projection in ENDC of the previous and current report for FOLU sector

Elements Change	Previous Report	Current Report
Area of peatland (million ha)	14.5	13.4
EFs for peat decomposition (drained peat)	IPCC defaults	CS EF (Novita et al. 2020)
EF for primary forest (Gw, t dm/ha/yr)	0	0.7
EF for secondary forest (Gw, t dm/ha/yr)	2.15	3.40
EF Perennial crops (Gw, t dm/ha/yr)	2.69	5.04
EF of restored peat (tCO2/ha/year)	0	32.42
Timber Plantation (Gw, t dm/ha/y)	13.33	9.60
Carbon stock (t dm/ha)	90	117.6

Table 2- 12 Activity data used for calculation of emission projection in ENDC of the previous and current report for waste sector

Elements Change	Previous Report	Current Report
AD of MSW goes to landfill (million ton) from JAKSTRANAS to SIPSN	BAU 2015 = 47 2020 = 50 2022 = 51	BAU 2015 = 17 2020 = 26 2022 = 27

JAKSTRANAS is reported as data of assumed MSW generation and treated MSW (real data 2015-2020 and extrapolated data 2000-2014) SIPSN data available for 2019-2023, while 2000-2018 extrapolation from SIPSN data	CM1 2015 = 46,5 2020 = 47 2022 = 43	CM1 2015 = 17 2020 = 22 2022 = 23 (time series data is presented in NID)
AD of industrial production (in industrial waste sub sector). The level of activity (industrial production) must be at the same level with that is calculated in inventory. Thus, projection up to 2030 is based on this adjustment.	Production level from 22 types of industry 2020 = 229 million ton 2022 = 246 million ton	Production level from 22 types of industry 2020 = 233 million ton 2022 = 277 million ton (time series data is presented in NID and sub chapter sectoral condition)

Notes: SIPSN is National Waste Management Information System, JAKSTRANAS is national policy and strategy for household waste management

2.3 Progress in Implementation and Achievement of NDC

To evaluate the level of achievement of the targets set by the NDC and the need to review and/or modify related activities, a number of quantitative indicators have been established. These indicators are summarized in the CRT (Annex II Decision 5/CMA.3) which presents information related to the selected indicators for monitoring the NDC. These tables illustrate the mitigation indicators, showing their relationship to the NDC, along with their values and baselines, their values in the current inventory, and projections up to 2030.

Overall, Indonesian has achieved its unconditional and conditional emission reduction target (CM1 & CM2) in the last three years (2020-2022). And the period 2011-2019, level of national emission (all sectors) in most of the years is still above the unconditional target (Table 2.13 & Figure 2.16). This is mainly due to the level of emission from FOLU or LULUCF were relatively high which offset the achievement of other sectors. Without including LULUCF, the level of emissions is already below the conditional emission level for the last 10 years (2014-2022; Table 2.14 & Figure 2.17). Achievement of emission reduction by sector is described in the following sections.

Table 2- 13 Projection of adjusted baseline, CM1 and CM2 of ENDC emission and GHGI with LULUCF from 2010-2022

Scenario	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Million tonnes CO2e													
BAU	1,066.88	1,280.98	1,311.60	1,342.57	1,376.15	1,404.48	1,466.65	1,534.94	1,599.50	1,661.17	1,719.88	1,754.21	1,827.44
CM1	1,066.88	1,087.71	1,105.03	1,122.90	1,143.34	1,158.58	1,198.48	1,247.41	1,290.60	1,330.80	1,367.72	1,376.75	1,426.28
CM2	1,066.88	1,008.13	1,015.81	1,023.95	1,034.38	1,039.74	1,069.77	1,108.25	1,141.49	1,171.74	1,198.65	1,184.72	1,241.93
GHGI (with LULUCF)*	1,033.80	1,142.30	1,313.54	1,147.15	1,553.72	1,870.55	1,540.10	1,355.61	1,180.55	1,490.77	1,203.37	1,195.08	1,296.32

Note: *Emission from LULUCF does not include emissions from categories which are not covered in the ENDC, i.e. emission of non-CO_2 from drained peat, CO_2 emission from living biomass for GL, WL, OL and ST as in ENDC no emission/removal in these categories.

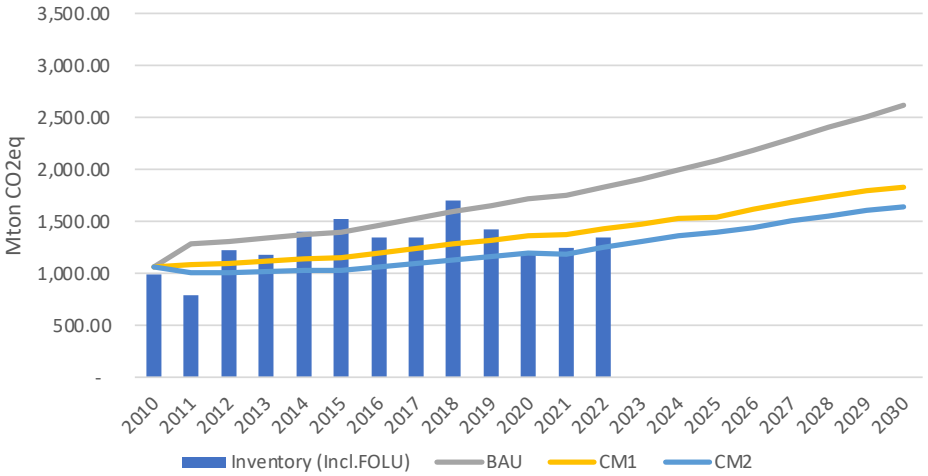


Figure 2- 16 Comparison between GHG Inventory and emission projections of ENDC with LULUCF (2010-2022)

Table 2- 14 Projection of adjusted ENDC emission and GHGI without LULUCF from 2010-2022

Scenario	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Million tonnes CO2e													
BAU	678.03	708.43	743.64	779.35	817.85	851.29	918.77	988.06	1,057.17	1,123.61	1,187.31	1,268.71	1,346.54
CM1	678.03	705.14	737.22	769.84	805.10	835.24	890.10	946.81	1,003.18	1,056.62	1,106.82	1,179.07	1,241.11
CM2	678.03	704.93	736.88	769.32	804.15	834.02	888.67	945.34	1,001.60	1,054.94	1,105.02	1,177.13	1,238.30
GHGI (without LULUCF)	683.25	754.48	791.88	767.58	794.60	825.54	818.62	872.17	911.97	969.03	917.79	957.86	1,070.54

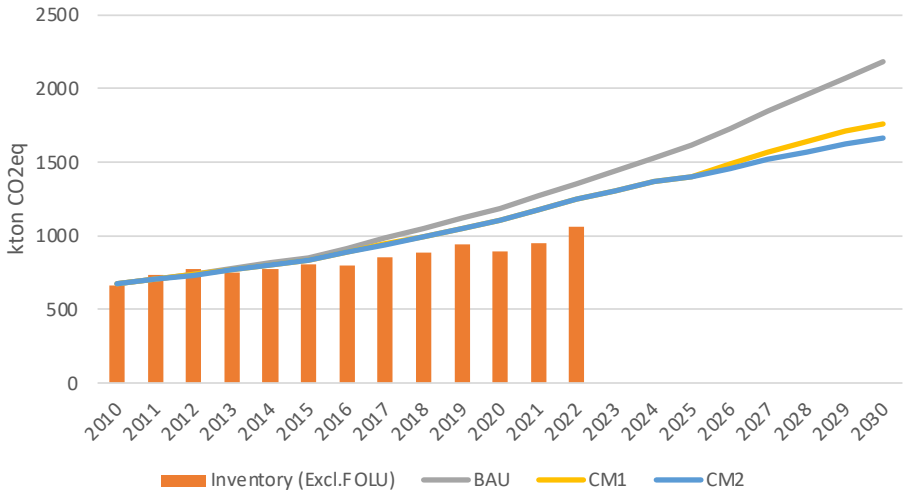


Figure 2- 17 Comparison between GHGI and emission projections of ENDC without LULUCF (2010-2022)

2.3.1 ENERGY SECTOR

Mitigation in energy sector has focused on renewable energy, energy efficiency, low-carbon energy, and clean technology in power plants. The achievement of mitigation actions is expressed in terms of GHG emission reduction resulted from implementing the actions. Emission reduction in a given year is the difference between projected GHG emission level

under baseline scenario and actual emission level as calculated in GHG Inventory for the same year. The emission levels of baseline scenario and that of inventory results for 2010-2022 are shown in Figure 2.18.

As can be seen in the figure, the inventory emission levels are mostly lower than that of the baseline, indicating that the mitigation activities have resulted emission reduction. By comparing the inventory emission and the baseline emissions level, the reduction in GHG emission was found to be, in kton CO2eq, 231,317 (2020), 285,559 (2021) and 241,934 (2022). The lower emission levels in 2020-2021 are not solely due to mitigation actions but also caused by lower energy consumption due to COVID-19 pandemic. The GHG emissions reduction calculated by comparing GHGI and baseline emissions of ENDC are usually much higher compared to the monitoring report (MRV) from KLHK due to GHGI cannot represent the achievement of mitigation actions implementation.

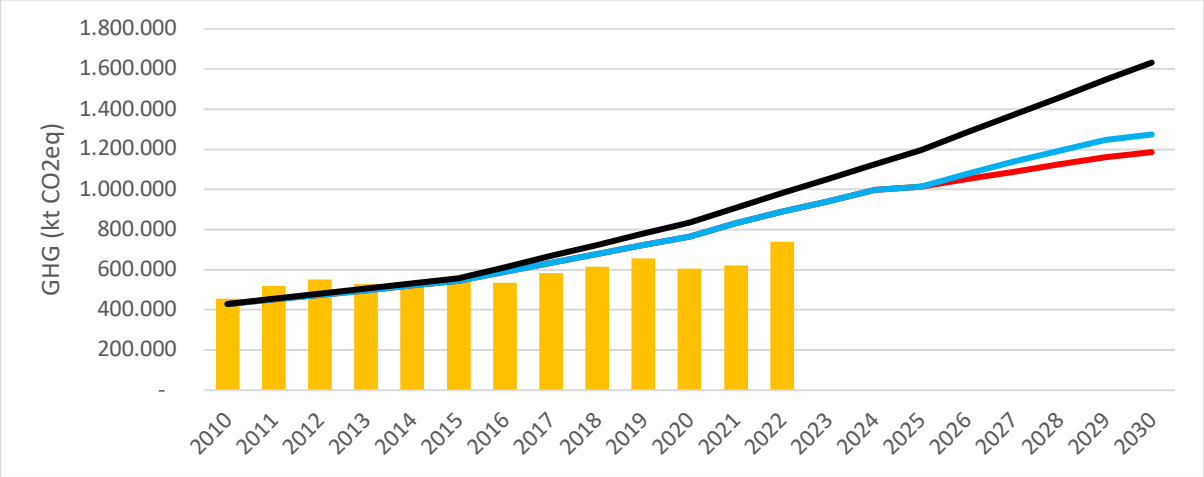


Figure 2- 18 Emission levels of energy sector for baseline scenario and actual inventory

A monitoring report from Minister of Energy and Mineral Resources (MEMR) verified by MoEF showed that emissions reduction under CM1 during 2020 - 2022 are 75,507.4 kt CO_2e in 2020, 91,482.6 kt CO_2e in 2021, and 123,219 kt CO_2e in 2022, which have surpassed the CM1 target of energy sector of ENDC, i.e. 70,150 kt CO_2e in 2020, 77,990 kt CO_2e in 2021, and 91,870 kt CO_2e in 2022. It should be noted that the achieved emission reduction from energy sector cannot only estimated by comparing emissions level of GHGI and baseline emissions of ENDC.

2.3.2 IPPU Sector

Referring to the Indonesia Enhanced NDC (ENDC), the targets of the GHG emissions reduction under unconditional ENDC (CM1) and conditional ENDC (CM2) scenarios for the IPPU sector are 0,12% (CM1) and 0,16% (CM2) respectively, below the baseline emissions level in the 2030. The impacts of the implementation of mitigation actions have resulted in the reduction of emissions level (compared below to the baseline emissions). This is indicated by the gap between baseline emission and inventory emission level at the corresponding year as shown in Figure 2.19.

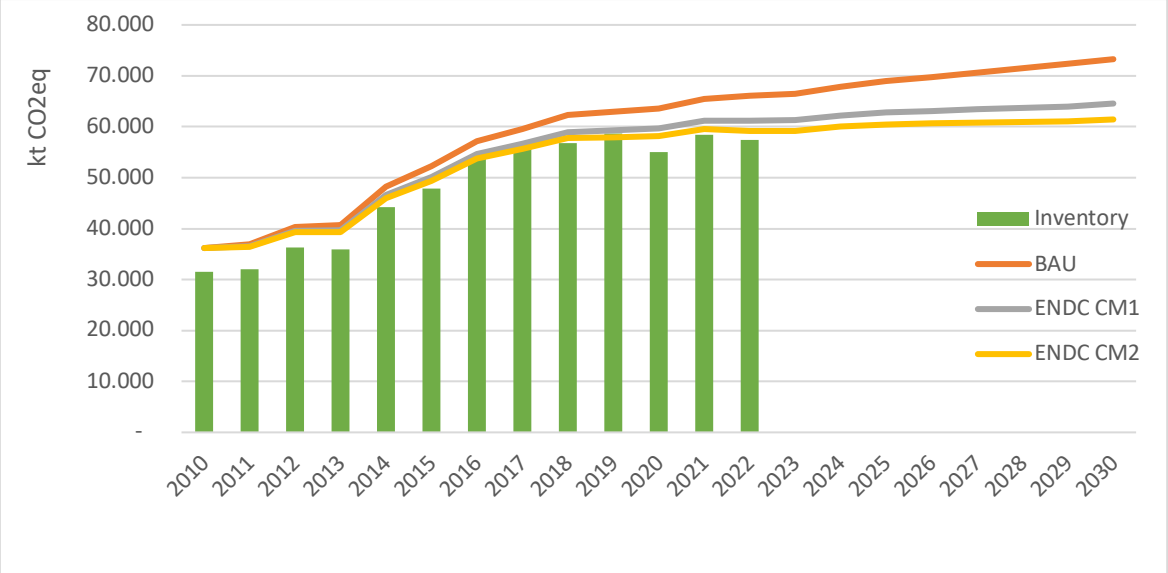


Figure 2- 19 GHG emissions of the IPPU sector and the corresponding baseline emissions

Since this sub-section reports the achievement of emissions reductions from mitigations implemented during 2020-2022 that were mostly carried out using domestic resources, therefore, the target of unconditional ENDC (CM1) was used for assessing the success of mitigation achievement. The IPPU sector aims to mitigate emissions of CO2 from cement, ammonia, and iron/steel production; PFCs from aluminum; and N2O from nitric acid, achieving reductions of 8,649 kt CO_2e in 2020, 7,087 kt CO_2e in 2021, and 8,713 kt CO_2e in 2022 if it is estimated by comparing and baseline emissions projection of ENDC (using GWP 5th AR).

The monitoring report from MoI verified by KLHK showed that emissions reduction under CM1 during 2020-2022 from cement industries and ammonia production accounted for 2,731 kt CO2e in 2020, 2,786 kt CO2e in 2021, and 4,613 kt CO2e in 2022. This reduction have exceeded the unconditional target (CM1) of IPPU sector i.e. 3,483 kt CO2e in 2020, 3,762 kt CO2e in 2021, and 4,314 kt CO2e in 2022, which both of the verified achievement and target was calculated using GWP 2nd AR.

In cement industries, comparison of the industry's baseline emission level and GHG emission inventory in the same year, shows that there is a significant reduction in the GHG emissions level. By implementing blended cement technology, the cement industries have met the requirements of the Green Industry Standard, which is efficiency in the use of energy and feedstock. The results of the GHG emission estimates indicate that the emission reduction from 2020 until 2022 were 2,099 kt CO_2e in 2020, 2,232 kt CO_2e in 2021, and 2,547 kt CO_2e in 2022. It is important to note that the 2030 GHG emission reduction target for blended cement was 2,750 kt CO_2e (CM1) and 3,250 kt CO_2e (CM2).

In ammonia fertilizer industries, the comparison of the IPPU baseline emissions level and IPPU emission inventory in the same year shows that there is a potential for significant emission reduction. The IPPU emissions from ammonia plants have been reduced by increasing the efficiency of ammonia plant and implementing advanced technology with greater efficiency in the use of natural gas for some of the new plants. It shows that most of the ammonia fertilizer

industries have met one of the requirements of the Green Industry Standard, which is the efficient use of natural gas for energy and feedstock. The reductions for three consecutive years, starting in 2020 were 3,416 kt CO_2e, 3,640 kt CO_2e, and 3,708 kt CO_2e, which exceeded the ENDC target in 2020-2022 was 1,384 kt CO_2e in 2020, 1,530 kt CO_2e in 2021, and 1,767 kt CO_2e in 2022. It should be noted that the target of the IPPU emissions reduction in the ammonia fertilizer industry in 2030 is 3,950 kt CO_2e (CM1) and 4,650 kt CO_2e (CM2)..

2.3.3 Agriculture, Forest and Other Land Uses

2.3.3.1 Agriculture Sector

Emission level of agriculture sector from the inventory from 2010-2022 compared to projection of emission of ENDC under the BAU scenario was lower in most of the years, but in 2021 and 2022 the emission increased closed to the baseline (Figure 2.20). This suggests that the agriculture sector is off target**,** particularly in year 2021 and 2022. Nevertheless, cumulatively emission reduction from 2011-2022 is below the baseline, which reach about 51 Mton CO2e.

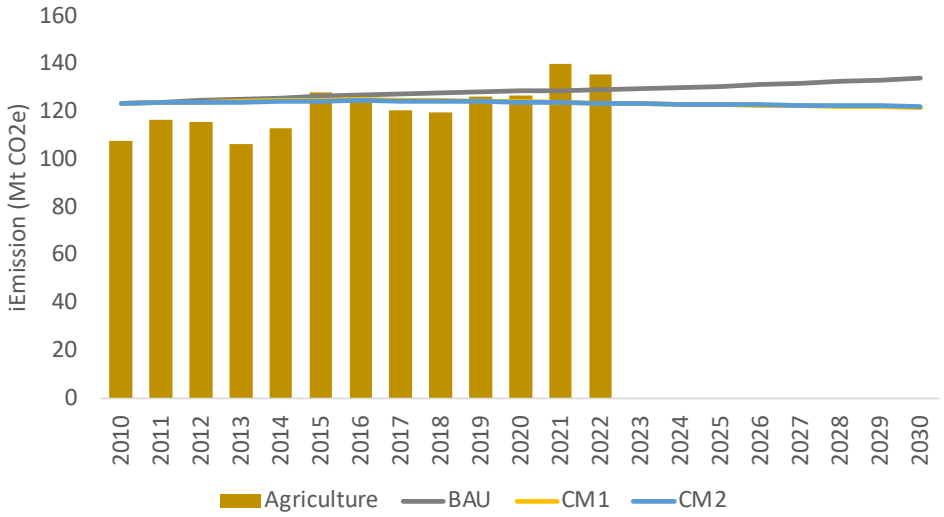


Figure 2- 20 GHG emissions of the Agriculture sector and the corresponding baseline emissions

2.3.3.2 Forest and Other Land Uses

Referring to the Indonesia Enhanced NDC (ENDC), mitigation actions implemented to meet the emission reduction target of the FOLU sectors are avoiding deforestation and forest degradation by addressing the drivers, increasing the implementation of sustainable forest management focused on reduced-impact logging and enrichment planting through silviculture intensive (SILIN) and acceleration the establishment of timber plantation and agriculture plantation in degraded land/forest, increasing rate of land rehabilitation and improvement of peatland management. In addition, efforts to increase crop productivity and planting intensity in meeting food demand (intensification) which lead to reducing pressure on forest for agriculture expansion are prioritized. The efforts have brought the emission from this sector fall below the baseline, but not yet achieved the target (Figure 2.21).

Nevertheless, some key mitigation actions have been successfully implemented and meet or exceed the target as described in Table 2.15. The achievement can be reflected using non-GHG indicators for that specific measures. Efforts to address the drivers of deforestation and to continue the implementation of moratorium policies for stopping the issuance of new permits

on primary forest an peatland for private investments causing forest extraction or opening forest since 2011, have effectively reduce the deforestation (Figure 2.22). It shows that the cumulative deforestation in the period 2013-2022 is lower than the CM1 target. Nevertheless, the rate of forest degradation exceeded the BAU rate. Forest degradation in this regard defined as change of primary forest to secondary forest due to logging. Evaluation of this achievement was based on satellite assessment.

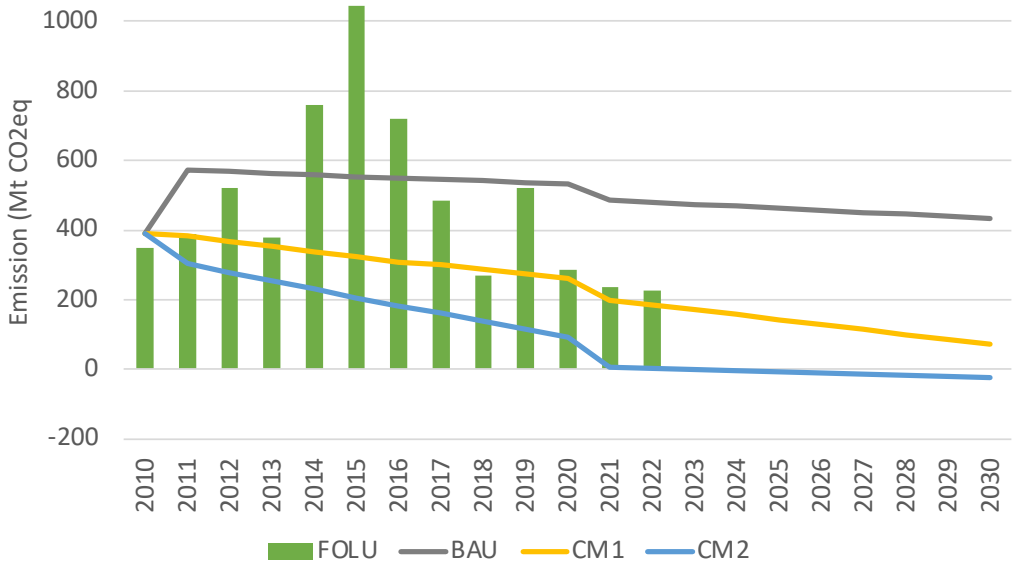


Figure 2- 21. GHG emissions of the FOLU sector and the corresponding baseline emissions

Table 2- 15 Summary of the achievement of NDC target in FOLU sector

Mitigation Activities	Achievement
Avoid deforestation*	On track (Slightly higher than CM1)
Avoid forest degradation*	Off target (Slightly lower than BAU)
SFM (implementation of RIL-C and SILIN)**	Over target
Establishment of timber plantation*	Off target (Lower than BAU)
Land rehabilitation without rotation*	Off target (Lower than BAU)
Land rehabilitation with rotation*	Off target (Lower than BAU)
Peat restoration*	On track (Slightly higher than CM1 but less than CM2)
Peat water management***	Over target (More than CM2)

Note: *Based on satelite; ** Based on APHI (2019); *** Based on Performance Report from BRGM & PPKL (2023).

Furthermore, based on report from the Indonesian Forest Bussiness Association (APHI; 2019), implementation of SFM already exceeded the ENDC target (Figure 2.23). Similarly based on report from the Directorate General of Sustainable Forest Management, cumulative area of timber plantation that have been established in the period 2011-2021 has also exceeded the target. Nevertheless, based satelite assessment, the establishment of new timber plantation in this period is still below the target. The rate of establishment of timber plantation slowed down after 2018 (Figure 2.23).

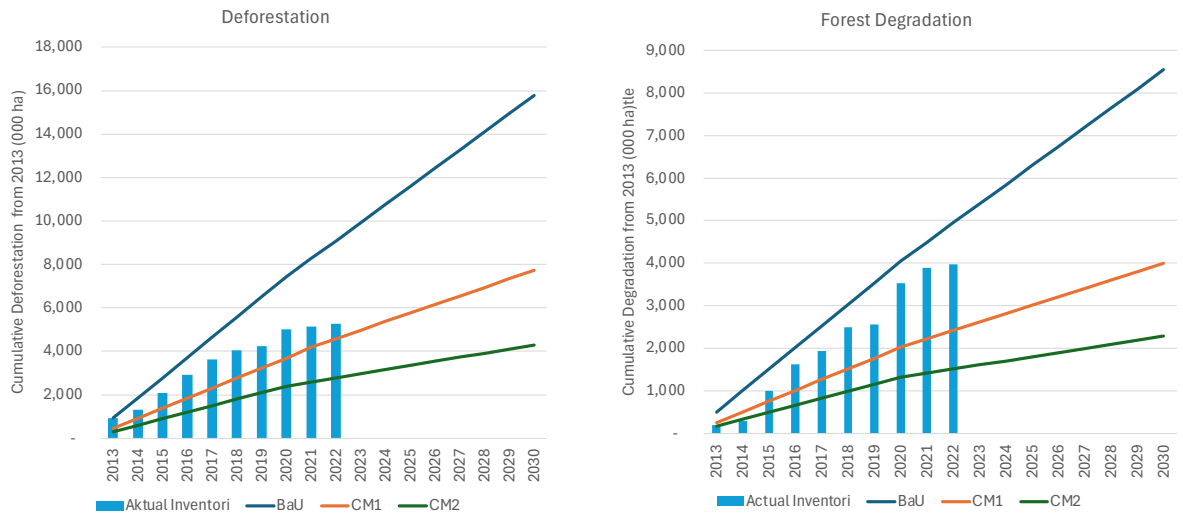


Figure 2- 22 Cumulative deforestation (left) and forest degradation (right) in the period 2013-2022 relative to ENDC baseline and target

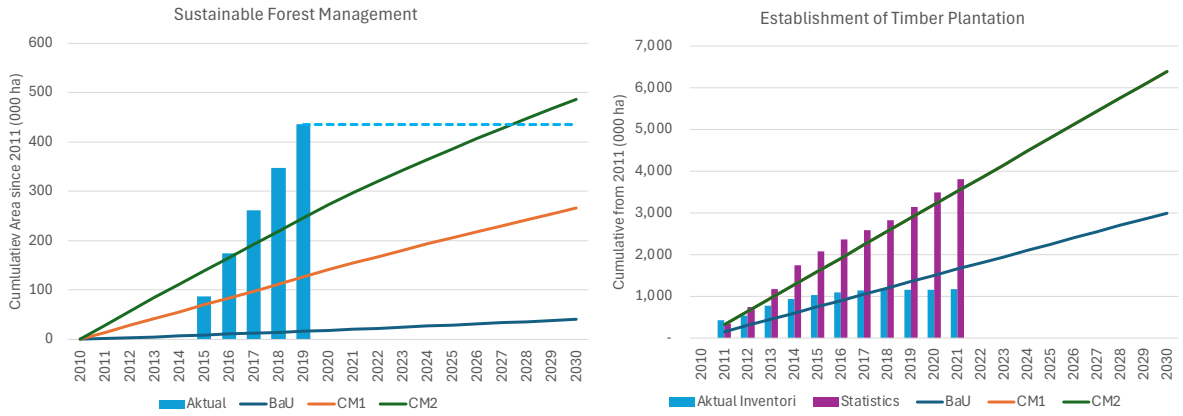


Figure 2- 23 Cumulative area that implemented SFM (left) and establishment of timber plantation (right) in the period 2011-2019 relative to ENDC baseline and target

From satellite assessment, degraded land being rehabilitated using MPTs (Multi-purpose Tree Species) without rotation in the period 2011-2021 has meet the target (Figure 2.24). This effort needs to be continued to keep on track. Based on statistical report, land that have been rehabilitated without rotation (rehabilitation of degraded land in forest area) is much higher than that monitored by the satellite. Similarly, the land rehabilitation with rotation monitored using satellite is also much lower than that from statistical report (Figure 2.24). The data used for measuring the impact of the implementation of these actions on emission is not the statistical data but satellite data.

The areas subjected to rehabilitation without rotation from the satellite is detected from the change of non-forested lands (shrubs, grassland, unproductive land) to secondary forest. The approach for detecting area of degraded peatland that have been restored is like rehabilitation without rotation, i.e. from the change of non-forested lands (shrubs, grassland, unproductive land) in the peatland to secondary forest. The data suggests that cumulative area of degraded peatland that have restored in the period of 2011-2020 has reach the target (Table 2.25). However, evaluation of progress on the implementation of improved water management in

peatland by concessions is solely based on report from the concessions which verified by the Directorat of Peat Ecosystem Destrcution Control (DPKEG, 2018, 2020, 2023). The result of verification indicated that more than 70% of concessions operate in the peatland has implement improved water management which is already exceeded the target.

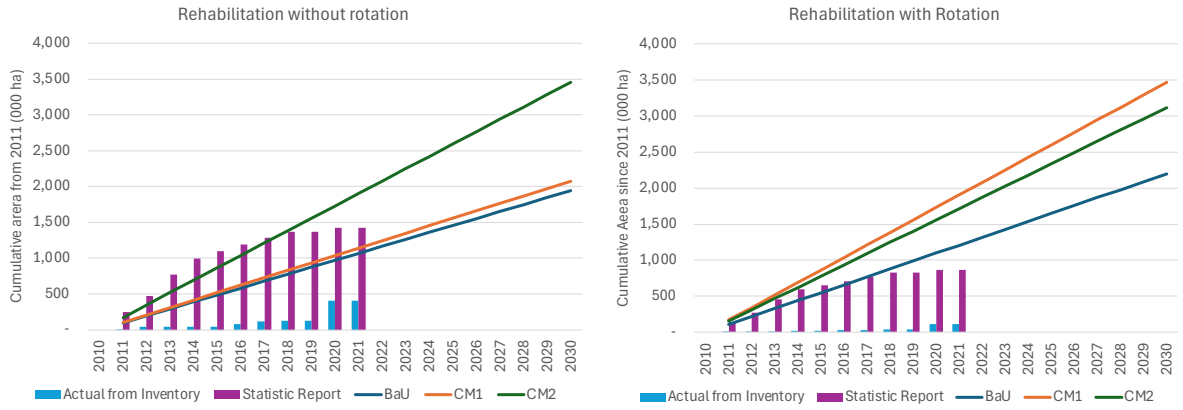


Figure 2- 24 Cumulative area of degraded land rehabilitated without rotation (left) and with rotation (right) in the period 2011-2019 relative to ENDC baseline and target

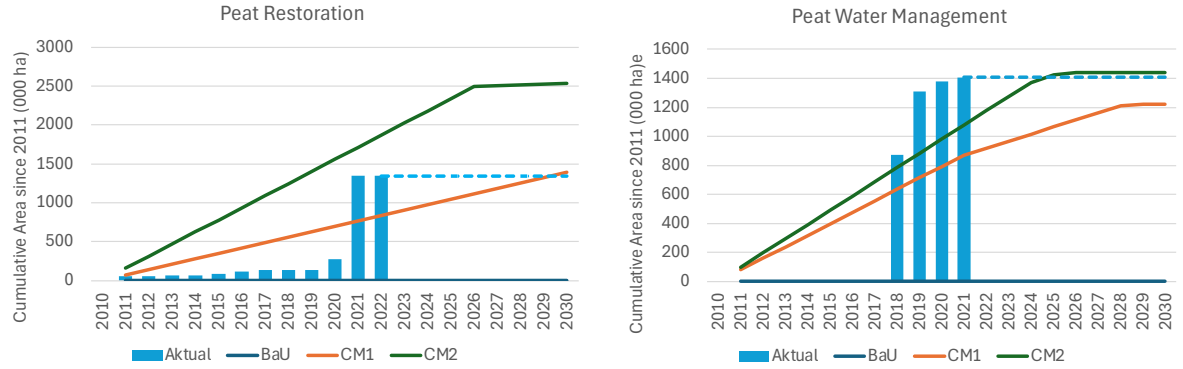


Figure 2- 25 Cumulative area of degraded peatland being restored (left) and that of concessions implement improve water management in peat land (right) in the period 2011-2019 relative to ENDC baseline and target

The emission from the inventory for the LULUCF sector shown in Figure 2.21 included the impact of SFM and improved peat water management by adding the emission reduction resulted from the implementation of the action. This approach is adopted as the estimation of the emission from LULUCF used AD monitored by the satelite data, while AD for SFM and improve water management obtained from the concessions' reports (Table 2.16).

Table 2- 16 Concessions area implemented SFM and improved peat water management since 2010

Action	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Area (ha)												
Peat WM	0	0	0	0	0	0	0	0	943,902	1,249,217	1,490,041	1,503,223	1,503,223
SFM	0	0	0	0	0	87,200	174,200	261,200	348,200	436,000	436,000	436,000	436,000

Implementation of RIL by concessions was reported increased the forest growth between 2-4 times forest growth of conventional logging (Campanello et al. 2009; Schwartz et al. 2012;

West et al. 2014). Similarly, implementation of intensive silviculture (SILIN) also increased the forest growth between 4 fold of the selective logging (Unenor et al. 2015; Soekotjo, 2009; Widiyatno et al. 2014; Bischoff et al. 2005). Referring to the findings, it is assumed that the growth of logged over forest (secondary forest) in the concessions implements the SFM increased from 3.4 to 5.7 tdm/ha.year. Furthermore, following the regulation concessions operate in the peatland should implement improved water management aiming at maintaining height of increasing water table from 70 cm to 40 cm from the surface. Based on verification report from Directorate of Peat Ecosystem Destruction Control, on average the water table can be increased only up to 53 cm. There is an increase of water table by about 17 cm from the baseline. With this increase, the reduction of CO_2 emission from peat decomposition will be 16.83 tCO2/ha/yr[6]. 17/10 * 9.9 tCO_2/ha/year. With this assumption, the emission of the GHG Inventory from FOLU are adjusted accordingly by reducing the emission of the FOLU with the estimated emission reduction from these two activities. The estimated emission reduction is presented in Table 2.17.

Table 2- 17 Estimated emission reduction from the implementation of SFM and improved peat water management

Action	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
	Area (ha)												
Peat WM	0	0	0	0	0	0	0	0	15,885,863	21,024,323	25,077,385	25,299,249	25,299,249
SFM	0	0	0	0	0	345,632	690,471	1,035,310	1,380,149	1,728,159	1,728,159	1,728,159	1,728,159

2.3.4 WASTE SECTOR

Mitigation reduction targets of waste sector in the ENDC for unconditional scenario (CM1) is 49,972 kt CO_2eq in 2030. The GHG emissions reduction is calculated based on the differences between baseline and inventory of GHG emissions for the same year. The baseline and inventory cover GHG emissions from municipal solid waste (MSW) treatment, domestic waste water treatment, and industrial waste treatment. Recalculation of the baseline and the inventory had been made for the year 2010 until 2022, in which the MSW activity data has changed from the previous NGHGI that used MSW data from JAKSTRANAS to the updated NGHGI that used SIPSN data and the GWP changed from the 2AR reference to the 5AR report.

The ENDC target (using GWP AR2) under CM1 (unconditional) for the waste sector are 1,560 kt CO2e (2020), 2,135 kt CO2e (2021), 3,043 kt CO2e (2022). The verified GHG emissions reductions (by KLHK) achieved from national mitigation actions in waste sector during 2020 - 2022 (calculated using GWP in 2AR) are 1,359.6 kt CO2e, 1,692.1 kt CO_2eq and 1,694.7 kt CO_2e. It can be seen that mitigation actions in 2020 and 2021 had exceeded the CM1 target. However, if the GHG emissions reduction is estimated by comparing the base line emissions and inventory, the emission reduction in 2022 had achieved 31,596 kt CO_2eq (using GWP AR5). The estimation is calculated based on the base line emission in 2022 which was about 170,459 kt CO_2eq and the GHG Inventory in the same year which was 138,862 kt CO_2eq.

There is a significant difference in the results of calculating the reduction achievements of mitigation actions from the approaches using verification mitigation action (project basis) with

[6] Every 10 cm increase in water table, the CO2 emission from peat decomposition will decrease 9.9 tCO2/ha/yr (Novita et al., 2021: https://doi.org/10.3390/f12070832)

those using baseline and inventory comparisons. The main differences are mainly due to differences in GWP used in GHG emission calculations and the existence of emission reductions from activities not covered by the ENDC mitigation target (CM1) such as the avoidance of CH4 emission formation due to the utilization of empty fruit bunches (EFB) that are usually dumped at the factory site by various consumers through market mechanisms. The GHG emissions reduction potential from the utilization of EFB is estimated to be 28,394 kt CO_2eq. The GHG emissions inventory, baseline, emission reduction and ENDC target are shown in Figure 2.26.

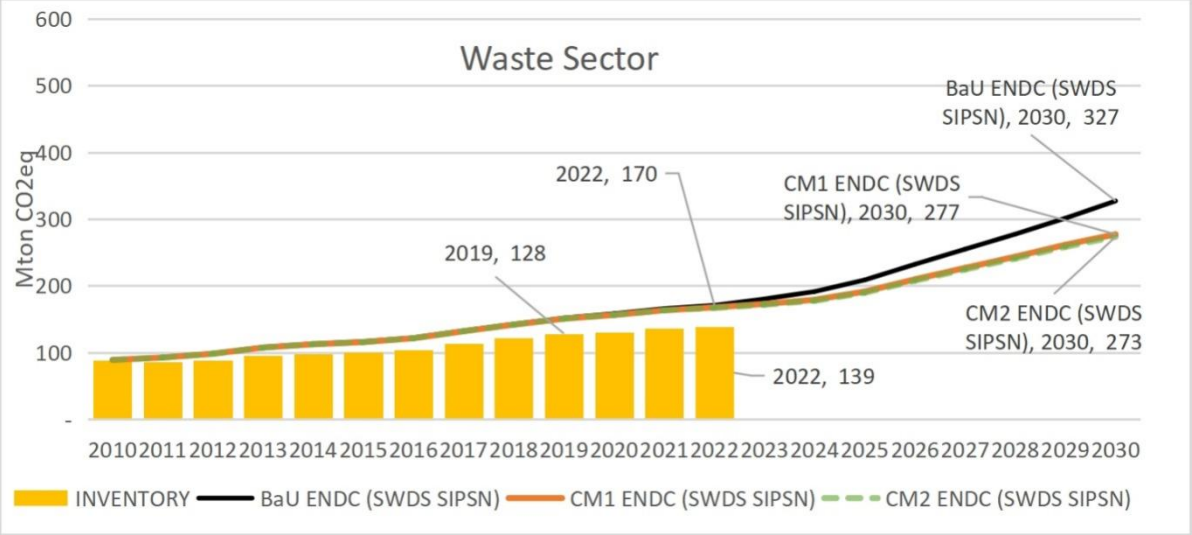


Figure 2- 26 Baseline vs inventory of waste sector 2010-2022

2.4 Mitigation Policies and Measures, Action and Plans

2.4.1 Energy

2.4.1.1 Mitigation Policies

Mitigation policies and regulations in energy sector have been enacted to promote the use of renewable energy in power, transport and industry sub-sector and energy efficiency measures. Those policies and regulations are summarized in Table 2.18.

Table 2- 18 Policies and regulations for the implementation of energy sector mitigation activities

Mitigation Actions	Policy Instruments	Description
Application of new renewable energy in buildings	MEMR Regulation No.49/2018 concerning Solar Power Generation Systems	Regulate the business of implementing solar power plants, including on a small scale
	MEMR Regulation Number 16 of 2019 Article 14 (second amendment to Minister of Energy and Mineral Resources Regulation Number 49 of 2018)	Regulate the implementation of rooftop solar PV for industrial consumers and other commercial buildings
	Minister of Energy and Mineral Resources Regulation No.12/2018 concerning the revision of Minister	Regulate the provision of solar lights to communities without access to electricity

Mitigation Actions	Policy Instruments	Description
	of Energy and Mineral Resources Regulation No. 33/2017 concerning the Implementation of Physical Activities of New Energy Utilization and Renewable Energy and Energy Conservation	
Application of new renewable energy in the transportation sub-sector	MEMR Regulation No.24/2021 concerning the Provision and Utilization of Biodiesel Fuel in the Financing Framework by the Palm Oil Plantation Fund Management Agency (BPDPKS)	Regulate the provision and utilization of biodiesel through palm oil BPDP (*Badan Pengelola Dana Perkebunan Kelapa Sawit*) funds
	Presidential Decree No. 66/2018 on the second revision of Presidential Decree No.61/2015 concerning the Collection and Utilization of the Fund Management Agency Perkebunan Kelapa Sawit	Regulate the collection and utilization of funds in the palm oil BPDP, including for the development of biofuels
	MEMR Regulation No. 12/2015 concerning the Supply, Utilization, and Trading of Biofuel as another fuel	Regulate the minimum mandatory to use biofuels mixed oil fuels and the administration of biofuels
Application of new renewable energy in the electricity generation sub-sector	MEMR Regulation No. 4 of 2020 concerning Utilization of Renewable Energy Sources for Electricity Supply	Regulate the mechanism for purchasing electricity from renewable energy power plants to accelerate renewable energy
Increasing the application of new, renewable energy and energy conservation	Presidential Regulation No.22/2017 concerning the National Energy General Plan	Determination of an energy mix plan including a portion of new renewable energy of 23% in 2025 and 31% in 2050
	Government regulation No. 33 of 2023 concerning energy conservation	Regulate the implementation of energy conservation; convenience, incentives and disincentives; guidance and supervision related to energy conservation
	MEMR Regulation No.12 /2018 concerning the revision of Minister of Energy and Mineral Resources Regulation No. 39/2017 concerning the Implementation of Physical Activities for the	Regulate the implementation of the use of new renewable energy and energy conservation, including purchasing electricity based on new renewable energy

Mitigation Actions	Policy Instruments	Description
	Utilization of New, Renewable Energy and Energy Conservation	
Implementation of energy efficiency	MEMR Regulation No.14/2021 concerning Minimum Energy Performance Standards for Energy Utilization Equipment	Revoke MEMR Regulation No.18 of 2014 concerning energy-saving labeling for lamps and MEMR Resources No.57 of 2017 concerning minimum energy performance standards for air conditioners

2.4.1.2 Mitigation Actions Plan

The level of GHG emissions in the mitigation scenarios (CM1, CM2) is achieved through mitigation actions in the energy sector which include the use of renewable energy, energy efficiency measures, use of low-carbon fuels, and clean energy generation. These mitigation actions are implemented in the energy sub-sectors, namely the energy production sub-sector (generation), and the energy user sub-sector (transportation, residential and commercial, and industry).

The drivers of GHG emissions growth are population growth and economic activities and fuel and technology choice. The population and economic growth assumption in mitigation scenario is the same as those assumed in the baseline scenario.

The mitigation activities include; (i) substitution of fossil fuels by using renewable energy in power generation, transport, and industrial sectors, (ii) increase energy efficiency measures in energy supply and energy use, referring to the government's target, which is that by 2025 the energy efficiency of the industrial sub-sector can reach 6%, household 5%, transportation 5% and commercial 1%, (iii) using lower carbon energy (conversion of kerosene to LPG), urban gas networks, use of natural gas (BBG) in urban public transport and fuel switching in transport, (iv) increasing the use of more efficient coal generation technology (clean coal technology) and low-carbon generation (PLTG/PLTGU).

Related to mitigation, there is additional mitigation activities conducted in energy sector compare to 3rd BUR due to excluding post mining reclamation and counting-out gas fuel/CNG commitment in public transport. The additional activities cover increased mitigation from transportation sub-sector i.e., biodiesel (B35), biogasoline (E5), transportation management and vehicles rejuvenation, EV implementation, and mode shift (electrical train, BRT, freight train, passenger train, LRT, MRT, high-speed train). The adjusted reduction target is presented in the following figure.

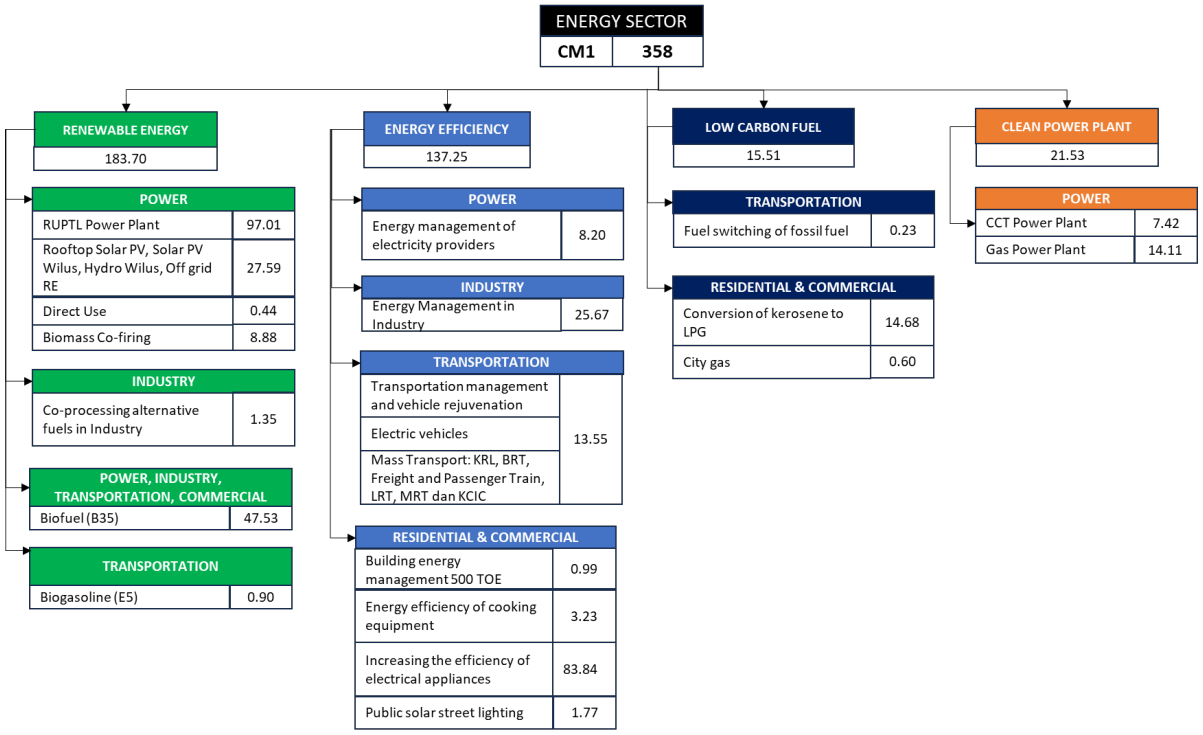


Figure 2- 26 Reduction target (Mton CO2eq) in 2030 by mitigation type in energy sector under CM1

Mitigation action types in energy sector consist of:

a) Renewables energy
b) Energy efficiency
c) Low-carbon energy
d) Clean technology in power plant

Each type of mitigation action is implemented in each sub-sector of energy as elaborated in the following sub-chapters.

2.4.1.2.1 Energi Production

2.4.1.2.1.1 Power

The power generation sub-sector is one of the main emitters in the energy sector. Emissions from the power generation come from the use of fossil fuels, i.e. coal, oil fuels and natural gas. Mitigation actions in the power sub-sector includes: increasing the use of renewable energy i.e. geothermal (PLTP), hydro (PLTA & PLTM), solar (PLTS), wind (PLTB), bioenergy (biomass, biogas, bio-waste and biofuel). Mitigation actions in power sector is summarized in Table 2.19.

Table 2- 19 Mitigation actions at power plants

Description	Units	CM1		
		2020	2025	2030
CCT coal power plant	MW	7,320	12,794	16,114
PLT Gas (PLTG/GU)	MW	5,636	10,168	11,373
Energy management in power plants	ktoe	-	1.23	2.46
RUPTL renewable energy development plan	MW	373	10,642	20,923
PLTS Atap. PLTS Wilus. PLTA Wilus. PLT EBT Off-grid	MW	57	6,306	15,483

Description	Units	CM1		
		2020	2025	2030
Direct utilization of biomass and biogas in off-grid plants	ktoe	1.26	24.42	48.80
Co-firing biomass	Million Tons	-	10.2	8.9

2.4.1.2.1.2 Biofuel

In an effort to mitigate GHG emissions from transportation, industry, power plants, and commercial activities in Indonesia, fossil fuels will be substituted with domestically produced biofuel (BBN). The biofuel development plan is shown in Table 2.20.

Table 2- 20 Biofuel Development Plan

Biofuel Production (million kL)	2020	2025	2030
TOTAL	8.4	11.6	17.9

2.4.1.2.2 Resident and Commercial

Mitigation actions in the residential and commercial sub-sectors are mainly energy efficiency measures in the demand side. both through the use of energy-efficient appliances and the development of more efficient energy systems. To increase equipment efficiency and measure energy use, what will be done is issuing minimum energy performance standards (SKEM), providing energy-saving labeling and building codes. With efficiency standards, the equipment on the market and used by the public is efficient equipment. The implementation of building codes will ensure that new buildings constructed are energy efficient.

Efficiency standards that have been published include those for energy-efficient lighting, air conditioning, and refrigerators. The building codes that have been published are for office and commercial buildings in Jakarta. The issuance of building codes will continue for other big cities such as Bandung, Surabaya and Medan. Efforts to increase efficiency for the household sub-sector are also carried out through the use of more efficient electrical equipment (Table 2.22). In addition, there are mitigation actions through fuel substitution from high-carbon to lower-carbon fuels (kerosene-to-LPG or natural gas). The use of kerosene in households in several regions of eastern Indonesia will be replaced by LPG. The gas network (Jargas) will also reduce the use of kerosene and LPG in households. The substitution of LPG by natural gas channeled through the gas network is not only intended to reduce GHG emissions but primarily to reduce the burden of LPG imports.

2.4.1.2.3 Industrial

Referring to Table 2.22, mitigation actions in the industrial sub-sector include energy efficiency improvements on the demand side such as the development of more efficient energy systems, such as waste heat recovery and utilization and cogeneration systems (electricity and thermal).

In addition, there is the use of renewable energy through co-processing alternative fuels, such as biomass waste (palm kernel shell, cashew, paper, wood, castor fruit) in the cement industry, CPO industry, and other industries.

Table 2- 21 Mitigation actions in the residential and commercial sub-sectors

Description	Unit	CM1		
		2020	2025	2030
Building energy management	ktoe	-	54.09	106.73
Increased efficiency of electrical equipment	GWh	386	11,118	17,660
Energy-Efficient Street Lights	ktoe	-	191.52	191.52
Efficient cooking equipment	Million Units	-	10.17	18.17
Kerosene-to-LPG Conversion	Million Tons	7.14	8.03	8.03
Gas Network (JARGAS)	Million households	0.21	1.20	1.85

Table 2- 22 Mitigation actions in the industry

Description	Unit	CM1		
		2020	2025	2030
Energy management in Industry	ktoe	766.09	3,650.61	7,299.77
Co-processing alternative fuels in Industry*	PJ	2.06	4.47	10.57

2.4.1.2.4 Transportation

GHG emissions from the transport sub-sector are derived from (i) fossil fuel combustion, namely fuel oil (BBM) and fuel gas (BBG) and (ii) electricity (indirect emission). The GHGs generated from fossil fuel combustion are mainly CO_2 gas and a small amount of CH_4 and N_2O gas. The type of GHG produced from burning fossil fuels is mainly CO_2 gas and a small amount of CH_4 and N_2O gas. The type of GHG produced from the use of electricity in electric trains (KRL) and mass rapid transit (MRT), produces indirect GHG emissions that occur in power plants.

Mitigation actions in transportation sub-sector consist of 2 major groups, namely (i) improvement of transport system efficiency (equipment and development of mass transport modes) (ii) substitution of fossil fuels by renewable fuels and low-carbon fuels.

Increased efficiency of transportation system by improvement of transport system efficiency includes:

- Increasing the provision and utilization of public transportation facilities, namely bus rapid transit (BRT), electric rail trains (KRL), MRT, light rapid transit (LRT), and passenger trains (KA);
- Increasing the efficiency of transportation equipment through vehicle rejuvenation,
- Encouraging the use of electric motorized vehicles, namely electric-fueled trains (KBL) and LCEVs (provided the electricity used is low or zero carbon electricity);

- Encouraging the use of energy-efficient vehicles, namely LCGC (Low-Cost Green Car);
- Increasing the efficiency of city road transportation management by implementing odd-even vehicle plate number regulations;
- Using of traffic technology for smooth traffic on national roads (Area Traffic Control System/ ATCS);
- Improvement of railway traffic using double track railway;
- Increased use of railway for freight transport (moving from trucks to trains);
- Building Aids for Shipping Navigation (SBNP);
- Increased use of low-emission fuels, by using fuels with higher octane number (RON 88, compressed natural gas);
- Increasing use of biofuel (biodiesel and biogasoline) to replace petroleum fuels.

Mitigation activity targets of the transport sub-sector is summarized in Table 2.23.

Table 2- 23 Mitigation actions in transportation

Description	Unit	CM1		
		2020	2025	2030
Target number of KRL passengers	Passenger/day		428,571	1,500,000
Target BRT passengers	Passenger/day		428,571	1,500,000
Freight Train				
Passenger Trains				
LRT				
MRT				
KCIC				
Electric vehicles	Million units	-	0.37	2.20
Electric motor bike	Million units	-	11.79	13.00
Fuel Switching BBM (RON 92)	Million kL	4.06	5.77	5.77
Fuel Switching BBM (RON 98)	Million kL	0.35	0.32	0.32
Fuel Switching BBM (RON 90)	Million kL	18.14	29.68	29.68
Natural Gas Public Transport	MMSCFD	24.7	28.6	28.6
BBN*	Million kL	8.4	11.6	17.9
Biogasoline E5	Million kL			

Note: Some of mitigation actions of the ENDC for transportation has changed and replaced which include CNG for transportation is replaced with use of biogasoline E5, use of biodiesel B35, use of electric vehicles and modal shift)

2.4.2 IPPU

2.4.2.1 Mitigation Policies

To support and facilitate mitigation actions in industries, the MoI has issued policy instruments to encourage increased use of alternative energy and material, and to enhance energy efficiency measures that could reduce GHG emissions from the energy and IPPU sectors. Table 2.24 presents IPPU policy instruments related mitigation actions in the industry sector.

Table 2- 24 Policy instruments for supporting mitigation actions in IPPU sector in industries

Mitigation Measures	Policy Instruments	Description/remarks
Development of Green Industry in Cement Manufacturing	Ministerial Regulation No. 512/M-IND/Kep/12/2015 concerning Green Industry Standards for Portland Cement	Describes the definition, the requirement criteria of green industries (i.e energy efficiency measures and low-carbon alternative fuel and raw materials (AFR) that reduce GHG emissions), verification method, and general requirements for integrated cement industry
Development of Green Industry in Fertilizer Manufacturing	Ministerial Regulation No. 148/M-IND/Kep/3/2016 concerning Green Industry Standard for the Manufacture of Single Artificial Fertilizer Macro Primary Nutrient Industry	Describes the definition, requirement criteria for green industries (i.e., energy efficiency measures that reduce GHG emissions), verification method, and general requirements for fertilizer industry, especially the Single Artificial Fertilizer Macro Primary Nutrient Industry
Development of Green Industry in Fertilizer Industry	Ministerial Regulation No. 27/2018 concerning Standardization of Green Industry for Urea, SP-36, and Ammonium Sulfate Fertilizers	Describes criteria for green industry, verification method, and general prerequisites for fertilizer industry
Development of Green Industries in Indonesia	Ministerial Regulation No. 51/2015 concerning the Guidelines for the Development of Green Industry Standards	The guideline is anticipated for the preparation of Green Industry Standard applicable to different industries. The guideline contains provisions regarding requirement criteria of green industry including definition of standards for raw materials, energy, auxiliary materials, waste management, and corporate management for green industry
Development of Green Industries in Integrated Pulp Paper Industry	Ministerial Regulation No. 514/M-IND/Kep/12/2015 concerning Green Industry Standards for Pulp and Integrated Pulp Paper	The standard describes the definition, requirement criteria of green industries (energy efficiency measures, raw material and water savings, low-carbon alternative fuels, recycle materials utilizations, and cleaner production measures) that reduce GHG emissions, verification method, and general requirements for pulp and integrated pulp paper industries

2.4.2.2 Mitigation Action Plans of IPPU Sector

Referring to the Enhanced Nationally Determined Contribution (ENDC) document, the target for reducing GHG emissions in the unconditional (CM1) and conditional (CM2) scenarios for the IPPU sector is 7 million tons of CO_2e and 9 million tons of CO_2e respectively below the baseline emission level in 2030. The impact of implementing mitigation actions has resulted in a decrease in emission levels (compared to baseline emissions). Mitigation steps to achieve the ENDC (CM1) target include (a) increasing the use of alternative materials for cement mixtures, where the use of alternative materials will replace some of the clinker, thereby reducing the clinker to cement ratio from 81% in 2010 to 70% in 2030, (b) increasing the efficiency of ammonia production plants to reduce the use of natural gas as a raw material.

The GHG emission reduction target for the IPPU sector is determined based on potential mitigation actions to reduce emissions of CO_2, N_2O, dan PFCs (CF_4/C_2F_6) gases from the production process in the cement, ammonia, nitric acid, steel, and aluminum industries. The emission reduction target does not include GHG emissions from the use of products and production processes in other categories of industries (IPCC 2006), such as the electronics industry, emissions from fluorinated substitutes for ODS.

These mitigation actions can be grouped as follows (Table 2.25):

a) Unconditional targets are achieved through major mitigation actions implemented in the cement and ammonia industries;
b) Conditional targets are achieved through potential mitigation actions implemented by increasing mitigation implementation in the cement and ammonia industries in CM1 plus mitigation actions in the nitric acid, steel and aluminium industries.

Table 2- 25 Mitigation actions in IPPU sector

Mitigation Actions	BAU	CM1 (*Unconditional*)	CM2 (*Conditional*)
Main Mitigation Actions			
Reduction of CO_2 emissions from cement production	There are no climate change mitigation actions and policies or regulations that lead to reducing GHG emission levels	Mitigation of 'blended cement' (in some cement production) by adding additives or alternative raw materials to reduce the 'clinker to cement ratio' from 81% in 2010 to 70% in 2030 to achieve the CM1 target	Increased mitigation action of 'blended cement' (most or all cement production) with the additional of additives or alternative raw materials to reduce the clinker to cement ratio from 81% in 2010 to 65% in 2030 to achieve the CM2 target (after the CM1 target is achieved)
Reduction of CO_2 emissions from ammonia production		Improvement of ammonia plant technology with more efficient technology	Improvement of ammonia plant technology with more efficient technology in the use of fossil fuels (for raw materials and fuel) and CO_2

Mitigation Actions	BAU	CM1 (*Unconditional*)	CM2 (*Conditional*)
			recovery after the CM1 target is achieved
Other Potential Mitigation Actions			
Reduction of CO_2 emissions from iron and steel industry	There are no climate change mitigation actions and policies or regulations that lead to reducing GHG emission levels	Replacement of more efficient smelter technology (energy and raw materials) and utilization of scrap as a substitute for raw materials. The emission reduction target is estimated from data on new technology that is being/planned to be installed and the amount of scrap currently utilized nationally	Increasing the replacement of more efficient smelter technology (energy and raw materials) and the use of scrap as a substitute for raw materials. The GHG emission reduction target is estimated from data on the number of new technologies that have the potential to be installed and scrap that has the potential to be used by the industry nationally. The CM2 target is determined after the CM1 target is achieved
Reduction of PFC emissions from the aluminum industry		Incorporating part of the GHG emission reduction achievements (PFCs and CO_2) from CDM activities at the Aluminum Smelter at PT Inalum which ended in 2017 to achieve the CM1 target	Entering higher achievement of GHG emission reduction (PFCs and CO_2) from CDM activities at the Aluminum Smelter which has ended in 2017 To achieve the CM2 target. The CM2 target is determined after the CM1 target is achieved
Reduction of N_2O emissions from the nitric acid industry		Technology improvement by installing secondary catalyst for N_2O emission destruction in nitric acid production process. CM1 target is determined by considering nitric acid industry that installs secondary catalyst for N_2O emission destruction	Technology improvement by installing secondary catalyst for N_2O emission destruction in nitric acid production process. CM1 target is determined by considering nitric acid industry that installs secondary catalyst for N_2O emission destruction

Notes: ENDC document lists 5 industries distinctively; in this table, 3 industries are aggregated under other potential mitigation actions

2.4.2.2.1 Cement Industries

Mitigation measures for achieving the ENDC (CM1) target include increase the use of alternative materials for blended cement, in which the use of alternative materials will replace some of the clinker to reduce the clinker to cement ratio from 81% in 2010 to 70% in 2030 (for 50% of the total cement productions). The 2030 GHG emission reduction target for blended cement was 2,750 kton CO_2 (CM1) and 3,250 kton CO_2 (CM2).

2.4.2.2.2 Mitigation in Ammonia (Fertilizer) Industries

Mitigation measures for achieving the ENDC (CM1) target include improve the efficiency of ammonia production plants to reduce the use of natural gas as a feedstock, as well as energy supply in ammonia plants and improving the efficiency of CO_2 recovery in the primary reformer of the fertilizer industry. The 2030 GHG emission reduction target for ammonia production was 3,950 kton CO_2 (CM1) and 4,650 kton CO_2 (CM2).

2.4.2.2.3 Mitigation in Other Industries

Other IPPU emissions reduction potentials include the main reduction potential resulting from the implementation of mitigations in the following industries, i.e. nitric acid production, iron and steel making, and aluminum smelter. In iron steel industry, mitigation measure for achieving the ENDC (CM1) target include replacement of more efficient smelter technology (energy and raw materials) and utilization of scrap as a substitute for raw materials. The emission reduction target is estimated from data on new technology that is being/planned to be installed and the amount of scrap currently utilized nationally. In aluminum industry, mitigation action includes technology improvement by installing secondary catalyst for N_2O emission destruction in nitric acid production process. CM1 target is determined by considering nitric acid industry that installs secondary catalyst for N_2O emission destruction.

2.4.3 Agriculture, Forest, and Other Land Uses

2.4.3.1 Mitigation Policies of AFOLU

The main strategies for reducing GHG emissions from the agriculture, land, and forestry sectors include: (i) Accelerating the adoption of low-carbon farming technologies in the agricultural sector, (ii) Optimizing spatial planning, utilizing unproductive land, and increasing productivity and planting intensity to reduce pressure on natural forests in meeting development needs and agricultural land expansion, (iii) Improving land and forest resource management systems by establishing Forest Management Units (KPH) in all forest areas, (iv) Increasing the adoption of sustainable forest management practices in production forests, (v) Accelerating the development of industrial and community forests and the use of plantation wood to meet timber demand, thereby reducing dependence on natural forests for timber, (vi) Conserving and enhancing carbon sinks through the restoration of production forest ecosystems, land rehabilitation, and a moratorium on new permits or concessions in peatland areas, and (vii) Improving peatland management systems. The policy framework for implementing mitigation actions in these sectors, which directly or indirectly result in GHG emissions reductions, is already in place. A number of key policies and regulations to support the implementation of climate change mitigation actions is presented in Table 2.26.

Table 2- 26 Policy instruments for supporting mitigation actions in AFOLU sector (additional to those listed in BUR2)

Measures	Policy Instrument	Description/Remarks
Reduced deforestation and forest degradation	Presidential Instruction No. 6/2017 and No.5/2019 concerning new permits moratorium and governance improvement	Regulate the moratorium/suspension of new licenses and the improvement of primary forest governance and peatlands.

	Minister of Environment and Forestry Regulation No. 17/2017 concerning protection of primary forest and peatland under concession area of timber plantation	Regulates to conserve the primary forest and peat ecosystem with essential function (no logging allowed) which located under the work area of private timber plantation.
	Minister of Environment and Forestry Regulation No. 83/2016 concerning granting forest access to community through social forestry	Policy on forest management system employed by the community to improve their livelihoods and life quality as well as developing the forest potentials.
Sustainable Forest Management	Minister of Environment and Forestry Regulation No. 30/2016 concerning the Performance Evaluation of Forest Management	Policy that mandates all forest concession holders to obtain forest sustainable management certification, to ensure they apply sustainable management practices.
	Directorate General of sustainable production forest management (PHPL) Regulation No.9/2018 concerning Reduce Impact Logging (RIL) Technique	Policy that mandates forest concession holders applying RIL technique to increase timber logging efficiency and minimize ecological impact from the logging activity.
Carbon sink enhancement	Minister of Environment and Forestry Regulation No. 62/2019 concerning the arrangement of private timber plantation area to optimize the production function	Policy that allows planting of no- timber commodities (e.g., food crops, bioenergy, and agroforestry) for unproductive land or silviculture technique of clear cutting with enhanced regeneration (THPB) for natural forests in the concession area of private timber plantation.
	Government Regulation N.46/2017 concerning Economic instrument for environment	Innovative policy to grant incentive (e.g., loosen administrative process, awards, public announcement regarding the private's positive performance, etc.) to timber plantation concession holder who implement business activity that positively improve the environment (e.g., increased planting rate according to the work plan).
	Minister of Environment and Forestry Regulation No. 39/2016 concerning the Revision to the Ministerial Regulation No. 9/2013 regarding Guidance and Support/Incentive on Forest and Land Rehabilitation	Policy that provides supports and incentives for the rehabilitation of degraded lands and forests and optimizing the use of unproductive lands through the planting of multi-purpose tree species (MPTS) under an agroforestry system.
Peat ecosystem management	Minister of Environment and Forestry Regulation No. 15/2017 concerning peatland water level monitoring	Policy that mandates all peat land managers to maintain the peatland water level not more than 40 cm.
	Presidential Regulation No. 57/2016 concerning the Revision to the Presidential Regulation No. 71/2014	A more rigid policy regulate the use of peat lands. This policy also mandates the governments at all levels to develop integrated peatland protection and management actions and to restore/rehabilitate the degraded peatlands.
Enhancement of Land, Forest, and Peat Fire Management	Presidential Instruction No. 11/2015 concerning Land and Forest Fire Management	Policy that mandates all level of governments to develop land and forest fire management system at their jurisdictions and implement sanctions for business players who do not implement fire

		management within the area under their jurisdictions.
	Minister of Agriculture Regulation No. 5/2018 concerning Land Clearance and Management for Plantation Without Burning	Policy that mandates all estate crop concession holders to maintain environmental sustainability and not using fire for land clearing and land management.

2.4.3.2 Mitigation Action Plan of AFOLU

Referring to the main strategies for reducing emissions in the agriculture, land, and forestry sectors previously outlined, the forms of mitigation activities conducted in these sectors include:

- Application of low-emission technologies in rice cultivation and other food crops and plantations.
- Application of emission-reduction technologies in the livestock sector, specifically reducing emissions from enteric fermentation by improving feed quality through feed ration adjustments, feed fermentation, increasing concentrate, and more. Additionally, managing livestock waste by converting it into biogas/energy and composting.
- Reducing emissions from deforestation and forest degradation, through the prevention or reduction of changes in forested areas, whether planned or unplanned, from forested to non-forested conditions.
- Sustainable Forest Management, reducing emissions by managing forests sustainably with innovative, low-environmental-impact techniques, such as Reduced-Impact Logging (RIL), as well as other sustainable forest management techniques that reduce the damage caused by timber harvesting activities.
- Increasing carbon stocks, by enhancing both above-ground and below-ground carbon reserves through land rehabilitation, natural regeneration, enrichment planting, and establishing forest plantations on low-carbon land.
- Forest conservation, ensuring the protection of forests with high conservation value (HCV) and high carbon stock (HCS).
- Peatland management, reducing emissions by rewetting drained peatlands, increasing above-ground carbon stocks through revegetation, and preventing fires.

2.4.3.2.1 Agriculture

The mitigation action plans in the agriculture sector to meet the emission reduction target consists of several activities. These include the increased implementation of several low-emission cultivation technologies in the rice paddy, livestock sub-sectors, and the use of non-CO_2 emission control technologies for soil. Low-emission cultivation technologies to be applied in rice cultivation include the use of low methane-emission rice varieties, the implementation of water-saving irrigation systems, and the application of organic fertilizers to reduce the use of nitrogen fertilizers. The use of organic fertilizers can reduce the use of urea fertilizer in accordance with the nitrogen content in the organic fertilizer. In the livestock sub-sector, the technologies improving feed quality by providing feed supplements and managing cattle manure for biogas production. The mitigation action plans targeted to be implemented from 2020-2030 is presented in Table 2.27.

Table 2- 27 Target area for implementation of mitigation actions in agriculture sector

Mitigation actions	Scenario	Cumulative from 2011										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Use of low methane-emission rice varieties (000 ha)	BAU	-	-	-	-	-	-	-	-	-	-	-
	CM1	453	498	543	588	633	678	723	767	812	857	902
	CM2	470	517	563	610	656	702	748	794	840	886	932
Implementation of water use efficient technology in rice paddy (000 ha)	BAU	166	207	248	290	331	372	414	455	496	538	579
	CM1	1,024	1,178	1,332	1,487	1,642	1,797	1,954	2,110	2,267	2,425	2,583
	CM2	1,393	1,589	1,785	1,982	2,179	2,377	2,576	2,775	2,974	3,175	3,376
Application of organic fertilizers (000 tons)	BAU	1.669	2.076	2.313	2.498	2.677	2.850	3.018	3.180	3.336	3.487	3.631
	CM1	1.940	2.254	2.558	2.782	3.003	3.221	3.437	3.651	3.863	4.072	4.279
	CM2	2.917	3.314	3.627	3.935	4.240	4.541	4.838	5.131	5.421	5.707	5.989
Implementation of biogas (manure for biogas; 000 heads)	BAU	0	0	0	0	0	0	0	0	0	0	0
	CM1	78	86	95	103	112	121	129	138	147	157	166
	CM2	117	129	142	155	168	181	194	208	221	235	249
Feed supplement for ruminant (000 heads)	BAU	0	0	0	0	0	0	0	0	0	0	0
	CM1	3.339	3.688	4.038	4.392	4.748	5.107	5.468	5.832	6.199	6.569	6.942
	CM2	3.884	4.289	4.697	5.108	5.522	5.940	6.360	6.784	7.211	7.641	8.075

2.4.3.2.2 Forest and Other Land Uses (FOLU)

Mitigation action plans in the forestry sector is carried out through increased efforts to control the drivers of deforestation and forest degradation, the implementation of sustainable forest management systems, the expansion of plantation forest development, land rehabilitation, and the improvement of peatland and mangrove management systems. Efforts to control the drivers of deforestation and forest degradation aim to reduce the rates of deforestation and degradation. In the BAU scenario, deforestation from 2013 to 2030 is projected to reach over 15.8 million hectares, with degradation affecting 8.5 million hectares. Efforts to control the drivers of deforestation in the CM1 and CM2 scenarios are targeted to reduce deforestation by 52% and 74%, respectively, and forest degradation by 53% and 73%, respectively (Table 2.28).

Table 2- 28 The cumulative area of deforestation and degradation permitted during the 2013-2030 period to achieve the emission reduction targets in the forestry sector

Actions	Scenario	Cumulative from 2013*										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Deforestation (000 ha)	BAU	7.432	8.263	9.095	9.927	10.760	11.594	12.428	13.262	14.098	14.934	15.771
	CM1	3.692	4.154	4.515	4.876	5.239	5.600	5.962	6.325	6.688	7.051	7.414
	CM2	2.400	2.575	2.750	2.925	3.100	3.275	3.450	3.625	3.800	3.975	4.150
Forest Degradation (000 ha)	BAU	4.043	4.493	4.943	5.393	5.843	6.293	6.744	7.194	7.644	8.095	8.545
	CM1	2.021	2.219	2.416	2.614	2.812	3.009	3.207	3.405	3.602	3.800	3.997
	CM2	1.320	1.417	1.512	1.609	1.705	1.802	1.897	1.994	2.090	2.187	2.282

Furthermore, the intensity of mitigation actions related to increasing carbon stocks, specifically through the development of plantation forests, is targeted to increase by 113% from the BAU scenario in both the CM1 and CM2 scenarios. Meanwhile, land rehabilitation activities are targeted to increase by 34% (CM1) and 59% (CM2) from BAU. For sustainable forest management (implementation of RIL and enrichment activities such as SILIN), the target is to increase by 5 times (CM1) to 11 times (CM2) compared to BAU. Specifically, for peat restoration activities, the practice is not implemented in the BAU scenario, while in the mitigation scenarios CM1 and CM2, it is targeted to be implemented over 1.4 million and 2.5 million hectares, respectively. Similarly, for improving peat water management systems, this

practice is not conducted in the BAU scenario, and in the CM1 and CM2 scenarios, it is targeted to be implemented over 1.2 million and 1.4 million hectares, respectively (Table 2.29).

Table 2- 29 The intensity of mitigation action implementation in the baseline scenario (BAU) and mitigation scenarios (CM1 and CM2).

Mitigation actions	Scenario	Cumulative from 2011										
		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Sustainable Forest Management (000 ha)	BAU	19	21	23	25	27	29	31	34	36	38	41
	CM1	141	155	168	180	193	206	218	231	243	255	267
	CM2	273	297	320	343	365	386	407	428	448	467	486
Rehabilitation without rotation (000 ha)	BAU	972	1.069	1.166	1.263	1.361	1.458	1.555	1.652	1.749	1.846	1.944
	CM1	1.038	1.142	1.246	1.350	1.454	1.557	1.661	1.765	1.869	1.973	2.076
	CM2	1.730	1.903	2.076	2.250	2.423	2.596	2.769	2.942	3.115	3.288	3.461
Rehabilitation with rotation (000 ha)	BAU	1.098	1.208	1.318	1.428	1.537	1.647	1.757	1.867	1.977	2.086	2.196
	CM1	1.730	1.903	2.076	2.250	2.423	2.596	2.769	2.942	3.115	3.288	3.461
	CM2	1.557	1.713	1.869	2.025	2.180	2.336	2.492	2.648	2.803	2.959	3.115
Establishment of timber plantation (000 ha)	BAU	1.500	1.650	1.800	1.950	2.100	2.250	2.400	2.550	2.700	2.850	3.000
	CM1	3.200	3.520	3.840	4.160	4.480	4.800	5.120	5.440	5.760	6.080	6.400
	CM2	3.200	3.520	3.840	4.160	4.480	4.800	5.120	5.440	5.760	6.080	6.400
Peat restoration (000 ha)	BAU	0	0	0	0	0	0	0	0	0	0	0
	CM1	698	768	837	907	977	1.047	1.117	1.186	1.256	1.326	1.396
	CM2	1.559	1.716	1.871	2.027	2.182	2.338	2.493	2.503	2.513	2.523	2.533
Peat water management (000 ha)	BAU	0	0	0	0	0	0	0	0	0	0	0
	CM1	792	868	917	967	1.016	1.065	1.114	1.163	1.212	1.221	1.221
	CM2	981	1.079	1.177	1.275	1.373	1.426	1.440	1.440	1.440	1.440	1.440

2.4.4 WASTE

2.4.4.1 Mitigation Policies

For the waste sector, the government has issued at least three new policy instruments since 2017 to support the implementation of climate change mitigation actions. The three main policy instruments can be seen in Table 2.30.

Table 2- 30 Policies and regulations related to mitigation actions in the waste sector

Mitigation Action	Policy Instrument	Description
Implementation of 3R (reduce, reuse, recycle), composting and final processing that is good and environmentally friendly	Act 18/2008 about waste management	Regulating waste management in a good and environmentally conscious manner at the central and regional levels as well as partnerships with waste management business entities
Waste management policy at the national level	Presidential Regulation (Perpres) No. 97/2017 about national policy and strategy (JAKSTRANAS) for household waste management	Guidelines for developing clean energy from waste through processing household waste and household-like waste JAKSTRANAS includes strategies, programs, and targets for reducing household waste and household-like waste at the national level

Mitigation Action	Policy Instrument	Description
Waste management policies at the sub-national level	Minister Environment and Forestry (Permen LHK) No. P.10/MENLHK/SETJEN/PLB. 0/4/2018 Regarding the Guidelines for Developing Policies and Strategies for the Management of Household Waste and Similar Waste.	JAKSTRADA is a policy direction and strategy for reducing household waste and household-like waste at the provincial and district/city levels
Converting waste to energy	Perpres No. 35/2018 Regarding the Acceleration of the Development of Waste-to-Energy Processing Facilities Based on Environmentally Friendly Technology	Provisions regarding the acceleration of clean technology development in waste-based power plants at the provincial and district/city levels
Reporting System to support National MSW Database	PERMEN LHK No. 6/2022 regarding SIPSN (National Waste Management Information System)	National Waste Management Information System is a network system that manages data sourced from several basic data that are integrated into a collection of Waste Management information. In order to implement waste management by the government and local governments, and encouraging community participation in waste management, it is necessary to build a waste management information system that is connected as a single information system network

2.4.4.2 Mitigation Actions Plan

Mitigation strategies for reducing GHG emissions from the waste sector are implemented through reduction, avoidance, destruction, and utilization of GHG emissions generated during the treatment of MSW, DWW, ISW, IWW. The GHG emission level in the mitigation scenarios are achieved through mitigation actions in waste treatment as follows:

- Domestic solid waste: utilization of LFG recovery for electricity generation or heat/steam, utilization of organic waste for compost production, paper recycling through the 3R program and Waste Bank, and utilization of waste as fuel in PLTSa and/or RDF / solid recovered fuel (SRF), as well as other utilization (processing) of waste that does not produce emissions (such as: animal feed, BSF maggots, etc.).
- Domestic liquid waste: separation of sludge from septic tanks, construction of centralized wastewater treatment plants with aerobic systems, and construction of communal wastewater treatment plants with biodigester systems equipped with the utilization of methane gas as fuel (energy).
- Industrial solid waste (including industrial wastewater treatment plant sludge): utilization as fuel, raw materials, and compost; to achieve unconditional targets, mitigation is

implemented in the paper pulp industry in the form of utilization of wastewater treatment sludge as raw materials, fuel (incineration), and compost with the target of reducing GHG emissions; Industrial liquid waste: processing with a biodigester equipped with methane recovery and utilization for power generation and heat/steam supply.

Table 2- 31 Mitigation target of waste sector in 2030

Mitigation Action by Sub-Sector	**BAU**	**2030 CM1**
Domestic Solid Waste	**Level: 45.22 Mton CO_2eq**	**Level: 30.53 Mton CO_2eq Reduction: 14.68 Mton CO_2eq**
1. LFG recovery and utilization	No LFG Recovery	The implementation of Landfill Gas (LFG) recovery which is supported with the rehabilitation of an open dumping TPA into a sanitary landfill and equipped with methane gas utilization.
2. Waste utilization by composting and 3R (paper).	No additional activities or enforcement on composting and 3R	Treatment of waste by composting and 3R paper
3. PLTSa/RDF (Refuse-Derived Fuel) implementation Note: PLTSa = *Pembangkit Listrik Tenaga Sampah*	No effort on waste-to-energy	Utilization of waste by converting to energy through RDF/SRF (in industry) or as renewable energy source in PLTSa;
4. Utilization of waste to switch from landfill disposal to zero landfill disposal in 2060	No direction on zero landfill disposal	Utilization of waste is enhanced with additional waste-to-energy or MSW recovery & utilization facilities
Domestic Liquid Waste		**No Reduction Target**
Management and treatment of domestic liquid waste.	No mitigation actions.	Centralized / Integrated IPAL (city /communal/region scale) operated using aerobic system IPLT to treat sludge removal from septic system Biodigester and utilization of biogas
Industrial Waste		**Reduction: 34.89 Mton CO_2e**
Management and treatment of industrial waste.	No mitigation actions.	Utilization of WWTP sludge and industrial solid waste through composting, reuse as raw material, use as energy, etc
		Wastewater treatment in palm oil, pulp & paper, fruits/vegetables & juices processing, and other industries: to implement methane capture & utilization (biogas).

Notes: ENDC document addressed reduction in 2030 for each mitigation action; in this table the 2030 reduction targets are aggregated in each sub-sector considering change in activity data (domestic solid waste) and mitigation progress (some actions can be delay in implementation and substituted by other).

2.4.4.2.1 Domestic Solid Waste

Efforts to reduce GHG emissions in the domestic solid waste (garbage) sub-sector include increasing the capacity of LFG recovery infrastructure at the final processing site (TPA) and adding facilities that reduce the amount of waste that has the potential to emit GHG if dumped at the TPA, through among others: (i) implementing 3R (reduce, reuse, recycle) by recycling paper through the operationalization of waste bank activities, (ii) utilizing (organic) waste into compost to continue activities that have been realized in the base year (2010), and (iii) utilizing refuse-derived fuel (RDF) or SRF which is used as fuel in industry and power plants (PLTSa).

In the mitigation scenario, it appears that there is an increase in the amount of waste handled through composting and paper recycling and still requires additional facilities for processing (utilizing) other zero-emission waste, LFG recovery, and waste-to-energy (PLTSa/RDF/SRF) to achieve the ENDC target. RDF/PLTSa will start to be implemented in 2020 and will continue to grow significantly.

2.4.4.2.2 Domestic Liquid Waste

Mitigation actions in the domestic liquid waste sub-sector include the use of technologies that have an impact on reducing GHG emissions that contribute to total national GHG emissions, namely methane gas (CH_4). Methane gas emission mitigation technologies include: IPLT facilities to process sludge taken from septic tanks, centralized IPAL with aerobic systems, and communal IPAL with biodigester systems equipped with methane gas utilization. In the domestic liquid waste sub-sector, N_2O emissions are indirect emissions that are much lower than methane emissions. In the ENDC, there is no binding target for the domestic liquid waste sub-sector. However, since 2020, the implementation of domestic liquid waste GHG mitigation technology has been identified.

2.4.4.2.3 Industrial Liquid and Solid Waste

GHG emission mitigation actions from industrial wastewater processing can be carried out by recovering and utilizing methane gas produced by industrial wastewater treatment plants with the biodigester concept. It should be noted that sludge recovery from wastewater treatment plants can reduce methane production. However, sludge recovery from industrial wastewater treatment plants is often considered common practice and is therefore not included in the ENDC commitment. However, the utilization of industrial wastewater treatment plant sludge will be counted as a mitigation activity in the solid waste sub-sector (industry).

Types of industries whose solid waste handling emitting significant GHG emissions are the pulp and paper industry, palm oil industry, and food and beverage industry; thus they need to implement mitigation actions. Industries that are estimated to have the potential to carry out GHG emission mitigation actions from their solid waste are the pulp and paper industry. GHG emissions from the pulp industry are generated from the handling of WWTP sludge by landfilling, while GHG emissions from the paper industry come from the handling of WWT sludge in sludge holding ponds; therefore GHG mitigation from this sub-sector would come from activity that minimize waste generation (such as utilization) and implement technology with lower emission factor. Emission mitigation actions for handling solid waste from the pulp and paper industry include: (i) Utilization of IPAL sludge as raw material, (ii) Utilization of IPAL sludge as fuel, and (iii) Utilization of IPAL sludge as compost.

2.5 Summary of GHG Emission and Removals

2.5.1 Summary of GHG Emission and Removals in 2022

Total emissions in 2022 were 1,383,854.81 kt CO2e. Emissions, without LULUCF, totaled 1,071,542.18 kt CO2e (Table 2-32). LULUCF accounted for 22.6% of total national emissions, which is less than the energy sector's contribution of 68.9%. The waste sector ranked third,

contributing approximately 10.0%, followed by the agriculture sector at 9.7%, and IPPU at 4.2%. Carbon dioxide (CO_2) constituted approximately 77.8% of total greenhouse gas emissions, followed by methane (CH_4) at 18.1%, nitrous oxide (N_2O) at 4.1%, and perfluorocarbons (PFCs) at 0.004%.

In energy sector, fuel combustion is responsible for the majority of emissions (96.84%), with three primary sources—energy industries, manufacturing industries and construction, and transport—contributing to 92.11% of these emissions. Mineral and metal industries are the main contributors in the IPPU sector, accounting for roughly 74.56% of total emissions within this sector. Enteric fermentation, rice cultivation, and agricultural soil contribute approximately 83.88% of emissions within the agriculture sector. In LULUCF sector, cropland is the primary source of emissions, releasing almost twice the carbon that forests sequester. The main sources of cropland emissions include peat decomposition and peat fires. In the waste sector, wastewater treatment and discharge represent the largest share of emissions at 80.9%, followed by emissions from solid waste disposal, specifically domestic solid waste.

Table 2- 32 Summary of GHG emissions and removals in 2022

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/ removals	CH_4	N_2O	HFCs	PFCs	Unspeci-fied mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_X	Total GHG emissions/ removals
	kt CO_2e												
Total national emissions and removals (with LULUCF)	**1,075,194.99**	**250,509.94**	**57,093.96**	**FX**	**55.61**	**FX**	**FX**	**FX**	**30.60**	**876.22**	**IE,NA, NE,NO**	**IE,NA, NE,NO**	**1,382,854.50**
Total national emissions and removals (without LULUCF)	**777,299.21**	**241,455.69**	**51,732.42**	**FX**	**55.61**	**FX**	**FX**	**FX**	**3.74**	**63.08**	**IE,NA, NE,NO**	**IE,NA, NE,NO**	**1,070,542.93**
1. Energy	**712,371.82**	**21,813.50**	**4,568.07**						**NE,NO**	**NE,NO**	**NE,NO**	**NE,NO**	**738,753.39**
1.A. Fuel combustion	707,721.11	3,163.12	4,560.51						NE	NE	NE	NE	715,444.74
1.A.1. Energy industries	314,393.28	111.07	1,090.08						NE	NE	NE	NE	315,594.43
1.A.2. Manufacturing industries and construction	204,612.78	807.54	1,103.20						NE	NE	NE	NE	206,523.52
1.A.3. Transport	154,955.56	1,255.10	2,128.74						NE	NE	NE	NE	158,339.40
1.A.4. Other sectors	33,759.49	989.40	238.50						NE	NE	NE	NE	34,987.39
1.A.5. Not-specified	NE,NO	NE,NO	NE,NO						NE	NE	NE	NE	NE
1.B. Fugitive emissions from fuels	4,650.71	18,650.38	7.56						NE,NO	NE,NO	NE,NO	NE,NO	23,308.65
1.B.1. Solid fuels	NE,NO	4,243.97	NE						NE,NO	NE,NO	NE,NO	NE,NO	4,243.97
1.B.2. Oil and natural gas and other emissions from energy production	4,650.71	14,406.42	7.56						NE	NE	NE	NE	19,064.69
1.C. CO_2 Transport and storage	NE,NO												NE,NO
2. Industrial processes and product use	**56,337.73**	**102.84**	**865.45**	**FX**	**55.61**	**FX**	**FX**	**FX**	**NE**	**NE**	**NE**	**NE**	**57,361.63**
2.A. Mineral industry	31,480.03	NO	NO						NO	NO	NO	NO	31,480.03
2.B. Chemical industry	9,366.80	102.84	865.45	NO	NO	NO	NO	NO	NO	NO	NO	NO	10,335.09
2.C. Metal industry	10,981.37	NO	NO	NO	55.61	NO	NO	NO	NO	NO	NO	NO	11,036.98

2.D. Non-energy products from fuels and solvent use	4,358.07	NO	NO						NO	NO	NO	NO	4,358.07
2.E. Electronic industry			NO	NO	NO	NO	NO	NO					NO
2.F. Product uses as substitutes for ODS				FX	FX	FX	FX	FX					FX
2.G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.H. Other	151.46	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	151.46
3. Agriculture	**6,206.43**	**86,197.38**	**43,162.03**						**3.74**	**63.08**	**IE,NA, NE,NO**	**NE,NO**	**135,565.84**
3.A. Enteric fermentation		36,720.88											36,720.88
3.B. Manure management		2,530.56	12,962.28								IE,NE		15,492.83
3.C. Rice cultivation		46,841.59									NE		46,841.59
3.D. Agricultural soils		NA	30,146.09						NA	NA	NA		30,146.09
3.E. Prescribed burning of savannas		103.38	52.81						3.70	61.68	NE	NE	156.19
3.F. Field burning of agricultural residues		0.98	0.85						0.04	1.40	NE	NE	1.83
3.G. Liming	2,159.22												2,159.22
3.H. Urea application	4,047.21												4,047.21
3.I. Other carbon-containing fertilizers	NE												NE
3.J. Other	NO	NO	NO						NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	**297,895.78**	**9,054.25**	**5,361.54**						**26.86**	**813.13**	**NA,NE**	**NA**	**312,311.57**
4.A. Forest land	-266,741.53	2,371.39	5,018.35						3.12	202.99	**NE**		-259,351.80
4.B. Cropland	412,258.89	5,585.53	156.45						10.65	392.02	NE		418,000.87
4.C. Grassland	86,099.06	1,077.74	186.74						13.09	218.12	NE		87,363.54
4.D. Wetlands	1.66	19.60	NA,NE						NE	NE	NE		21.26
4.E. Settlements	1,994.71	NE	NA,NE						NE	NE	NE		1,994.71
4.F. Other land	64,283.00	NE,NO	NE,NO						NE	NE	NE		64,283.00
4.G. Harvested wood products	NE,NO												NE,NO

4.H. Other	NO	NO	NA,NO						NA,NE	NA,NE	NA,NE	NA	NA,NO
5. Waste	**2,383.23**	**133,341.96**	**3,136.87**						**NA**	**NA**	**NA**	**NA**	**138,862.07**
5.A. Solid waste disposal		**21,724.54**							**NA**	**NA**	**NA**		21,724.54
5.B. Biological treatment of solid waste		2.09	34.06						**NA**	**NA**	**NA**		36.15
5.C. Incineration and open burning of waste	**2,381.81**	**21,724.54**							**NA**	**NA**	**NA**	NA	4,635.09
5.D. Wastewater treatment and discharge		2.09	34.06						**NA**	**NA**	**NA**		112,292.62
5.E. Other	1.43	2,019.29	233.99						**NA**	**NA**	**NA**	NA	173.68
6. Other *(please specify)*	**NE**	109,423.80	2,868.82	**FX**	**NE**	**FX**	**FX**	**FX**	**NE**	**NE**	**NE**		**FX,NE**
Other sources of emissions/removals	NE	172.25	NO	FX	NE	FX	FX	FX	NE	NE	NE		FX,NE
Memo items:													
1.D.1. International bunkers	NE,NO	NE,NO	NE,NO						NE	NE	NE	NE	NE,NO
1.D.1.a. Aviation	NE	NE	NE						NE	NE	NE	NE	NE
1.D.1.b. Navigation	NE,NO	NE,NO	NE,NO						NE	NE	NE	NE	NE,NO
1.D.2. Multilateral operations	NE	NE	NE						NE	NE	NE	NE	NE
1.D.3. CO_2 emissions from biomass	73,181.06												73,181.06
1.D.4. CO_2 captured	NE												NE
5.F.1. Long-term storage of C in waste disposal sites	113,680.44												113,680.44
Indirect N_2O			NE										NE
Indirect CO_2	NE												NE

2.5.2 EMISSION TREND

Between 2000 and 2022, total emissions rose by approximately 62%. Among the sectors, the highest increase is in energy (142%), and followed by waste (134%), IPPU (44%), and agriculture (26%). Emission from LULUCF decreased by 9% (Table 2.33). Energy sector experienced the most significant rise in emissions within energy industries. In IPPU sector, emissions from metal industries and from non-energy products from fuels and solvent use in 2022 exceeded those in 2000 by more than fourfold. In agriculture sector, the most significant increase in emissions is attributed to prescribed burning of savanna, followed by rice cultivation and enteric fermentation. In waste sector, during this period, emissions from the primary source (wastewater treatment and discharge) more than doubled.

Table 2- 33 Trend of GHG emission and removal between 2000 and 2022 by categories

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2022	Change from reference Year to latest reported year
	kt CO_2e		%
Total (net emissions) [4]	**854,503.31**	**1,382,854.50**	62%
1. Energy	**305,290.56**	**738,753.39**	142%
1.A. Fuel combustion	266,118.58	715,444.74	169%
1.A.1. Energy industries	84,020.68	315,594.43	276%
1.A.2. Manufacturing industries and construction	72,601.71	206,523.52	184%
1.A.3. Transport	58,851.22	158,339.40	169%
1.A.4. Other sectors	50,644.96	34,987.39	-31%
1.A.5. Other	NE,NO	NE,NO	NE,NO
1.B. Fugitive emissions from fuels	39,171.98	23,308.65	-40%
1.B.1. Solid fuels	578.11	4,243.97	634%
1.B.2. Oil and natural gas and other emissions from energy production	38,593.87	19,064.69	-51%
1.C. CO_2 Transport and storage	NO	NO	NO
2. Industrial processes and product use	**39,804.94**	**57,361.63**	44%
2.A. Mineral industry	28,523.25	31,480.03	10%
2.B. Chemical industry	8,210.49	10,335.09	26%
2.C. Metal industry	2,147.62	11,036.98	414%
2.D. Non-energy products from fuels and solvent use	831.33	4,358.07	424%
2.E. Electronic industry	FX,NA,NE,NO	FX,NA,NE,NO	FX,NA,NE,NO
2.F. Product uses as substitutes for ODS	FX,NE,NO	FX,NE,NO	FX,NE,NO
2.G. Other product manufacture and use	FX,NE,NO	FX,NE,NO	FX,NE,NO
2.H. Other	92.25	151.46	64%
3. Agriculture	**107,188.93**	**135,565.84**	26%
3.A. Enteric fermentation	25,480.92	36,720.88	44%
3.B. Manure management	9,800.10	15,492.83	58%

3.C. Rice cultivation	46,243.01	46,841.59	1%
3.D. Agricultural soils	21,121.63	30,146.09	43%
3.E. Prescribed burning of savannas	313.61	156.19	-50%
3.F. Field burning of agricultural residues	2.69	1.83	-32%
3.G. Liming	791.63	2,159.22	173%
3.H. Urea application	3,435.33	4,047.21	18%
3.I. Other carbon-containing fertilizers	NE	NE	NE
3.J. Other	NO	NO	NO
4. Land use, land-use change and forestry [4]	**342,991.31**	**312,311.57**	-9%
4.A. Forest land	-208,730.59	-259,351.80	24%
4.B. Cropland	422,929.37	418,000.87	-1%
4.C. Grassland	112,547.16	87,363.54	-22%
4.D. Wetlands	0.94	21.26	2156%
4.E. Settlements	746.07	1,994.71	167%
4.F. Other land	15,498.35	64,283.00	315%
4.G. Harvested wood products	NE,NO	NE,NO	NE,NO
4.H. Other	NA,NO	NA,NO	NA,NO
5. Waste	**59,227.57**	**138,862.07**	134%
5.A. Solid waste disposal	11,555.21	21,724.54	88%
5.B. Biological treatment of solid waste	0.04	36.15	82389%
5.C. Incineration and open burning of waste	3,443.47	4,635.09	35%
5.D. Wastewater treatment and discharge	42,676.48	112,292.62	163%
5.E. Other	1,552.36	173.68	-89%
6. Other *(as specified in summary 1)*	**FX,NE**	**FX,NE**	**FX,NE**
Memo items: [5]			
1.D.1. International bunkers	NE,NO	NE,NO	NE,NO
1.D.1.a. Aviation	NE	NE	NE
1.D.1.b. Navigation	NE,NO	NE,NO	NE,NO
1.D.2. Multilateral operations	NE	NE	NE
1.D.3. CO_2 emissions from biomass	172,746.82	73,181.06	-58%
1.D.4. CO_2 captured	NE	NE	NE
5.F.1. Long-term storage of C in waste disposal sites	28,966.17	113,680.44	292%
Indirect N_2O	NE	NE	NE
Indirect CO_2 [6]	NE	NE	NE
Total CO_2 equivalent emissions without LULUCF	511,512.00	1,070,542.93	109%
Total CO_2 equivalent emissions with LULUCF	854,503.31	1,382,854.50	62%
Total CO_2 equivalent emissions, including indirect CO_2, without LULUCF	511,512.00	1,070,542.93	109%
Total CO_2 equivalent emissions, including indirect CO_2, with LULUCF	854,503.31	1,382,854.50	62%

2.6 PROJECTION OF GHG EMISSION AND REMOVALS

Emission under without measures (BAU) with LULUCF is projected to reach 2,598 million tCO2e, while with measures (unconditional) and additional measures (conditional) scenarios will reach 1,809 Mt CO_2e and 1,618 Mt CO_2e respectively (Figure 2.30, Table 2.34). Without LULUCF, the projected emission without measures (BAU), while with measures (unconditional) and additional measures (conditional) are 2,166 Mt CO_2e, 1,737 Mt CO_2e, and 1,643 Mt CO_2e respectively.

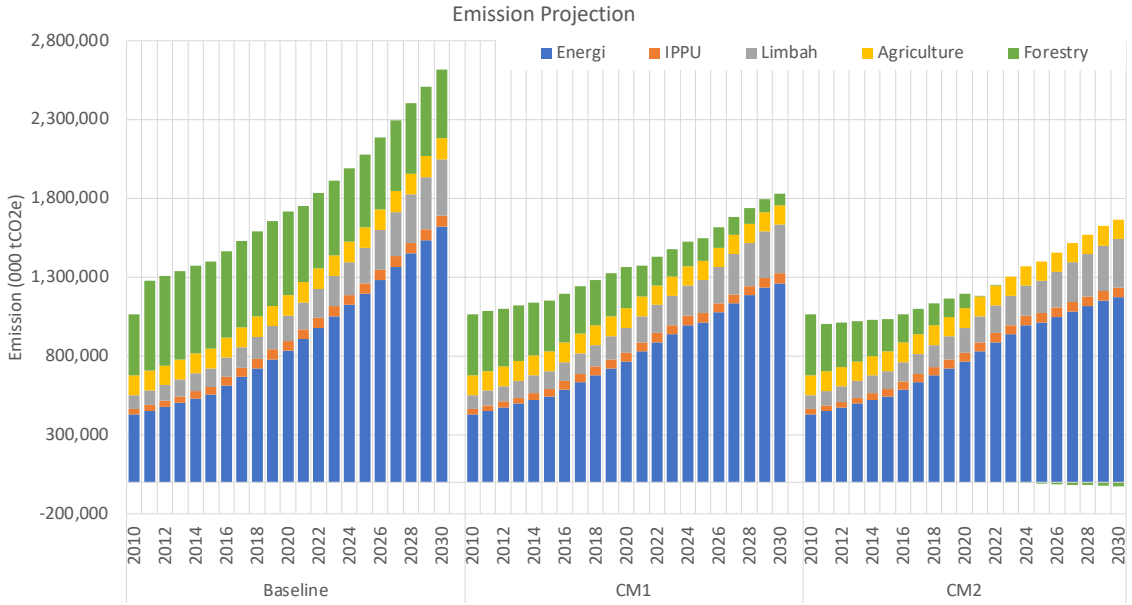


Figure 2- 27 Adjusted projection of emission of ENDC

Table 2- 34 Adjusted projection of emission of ENDC

Scenario	Sector	2010	2015	2020	2025	2030
			kt CO_2e			
BAU (Without Measures)	Energy	429,521.23	556,253.54	836,683.48	1,196,692.83	1,631,835.23
	IPPU	36,188.43	52,206.34	63,623.20	68,947.65	73,268.71
	Waste	88,614.84	116,199.86	157,942.68	208,637.45	327,066.62
	Agriculture	123,704.46	126,634.50	129,060.73	130,855.91	134,076.09
	FOLU	388,847.22	553,188.32	532,573.66	462,955.73	432,041.70
	Total	1,066,876.19	1,404,482.56	1,719,883.75	2,068,089.57	2,598,288.35
CM1 (With Measures)	Energy	429,521.23	544,688.49	766,533.48	1,014,482.83	1,273,815.23
	IPPU	36,188.43	50,126.61	59,696.83	62,763.26	64,566.26
	Waste	88,614.83	115,441.68	156,104.88	191,236.67	277,094.56
	Agriculture	123,704.46	124,979.36	124,485.72	122,976.09	121,985.67
	FOLU	388,847.22	323,345.20	260,898.81	142,926.77	72,517.62
	Total	1,066,876.18	1,158,581.34	1,367,719.71	1,534,385.62	1,809,979.34
CM2 (With Additional Measures)	Energy	429,521.23	544,688.49	766,533.48	1,014,482.83	1,185,815.23
	IPPU	36,188.43	49,325.00	58,183.27	60,454.46	61,439.20
	Waste	88,614.83	115,441.68	156,104.88	189,413.04	273,295.46

Scenario	Sector	2010	2015	2020	2025	2030
	Agriculture	123,704.46	124,564.91	124,194.97	123,195.90	122,460.29
	FOLU	388,847.22	205,721.88	93,637.48	-8,097.80	-24,401.36
	Total	1,066,876.18	1,039,741.96	1,198,654.08	1,379,448.44	1,618,608.83

Indonesia employed a set of models to develop its emission pathways through a two-stage analysis process. The emission pathway under different scenarios using two separate models, i.e. AFOLU which uses AFOLU Dashboard (a spreadsheet model) and energy model which uses AIM-Enduse and AIM-ExSS (Extended Snapshot). Economic and population growth were identified as the main drivers influencing changes in food and energy demand. The AIM-ExSS model is used to estimate rational projections of energy demand (electricity) by the user side (industrial, commercial, residential, and transportation). Based on the service demand projected by AIM-ExSS, the AIM-Enduse model used for for solving linear optimization equations for the technological selection (can be used to the process unit level) with an optimization framework which minimizes the total system cost subject to various constraints, e.g., the potential of renewable energy, capability and availability of energy supplies, technology penetration, emissions targets, etc. The model is a recursive dynamic model that simulates energy flow with an economic and engineering approach from the base year to the target year. The output of the AIM-Enduse model can be interpreted in the form of a pivot diagram as in an energy mix, installed technology mix, energy cost system, and emission pathways.

The Backcasting Approach is used to design an energy system that is suitable to meet future energy needs where the Indonesian people are targeted to have a high economic level like today's developed countries and a modern lifestyle but have a high level of awareness of the impact of energy use activities on environmental damage. climate change, scarcity of natural resources, and various other environmental impacts (Figure 2.31).

The AFOLU Dashboard, depicted in Figure 2.31, is designed to analyze future land demands and uses under various development scenarios, estimating greenhouse gas emissions resulting from land-use changes within these scenarios. The model simulates the change in land uses based on the change in development activities for meeting the demand of people for settlements, food and wood and animal for feed as well as government target for producing agriculture commodities for exports. As the population increases, the demand for settlement, food, wood and feed also increases which will drive the change in land uses. The food consumption pattern changes with GDP as well as the level of food loss and waste. The capacity of land for producing the commodity depends upon crop/plant productivities and cropping intensity/land-use efficiency. The changes of land use in the future therefore depends on the change in assumption on a combination of drivers, including population and GDP growth, livestock/animal population growth, crops productivity, cropping intensity, feed and food consumption level and production target for some key strategic commodities. The change in land use and land management will trigger the greenhouse gas emission and removal. The level of the emission and the removal can be controlled by mitigation technologies.

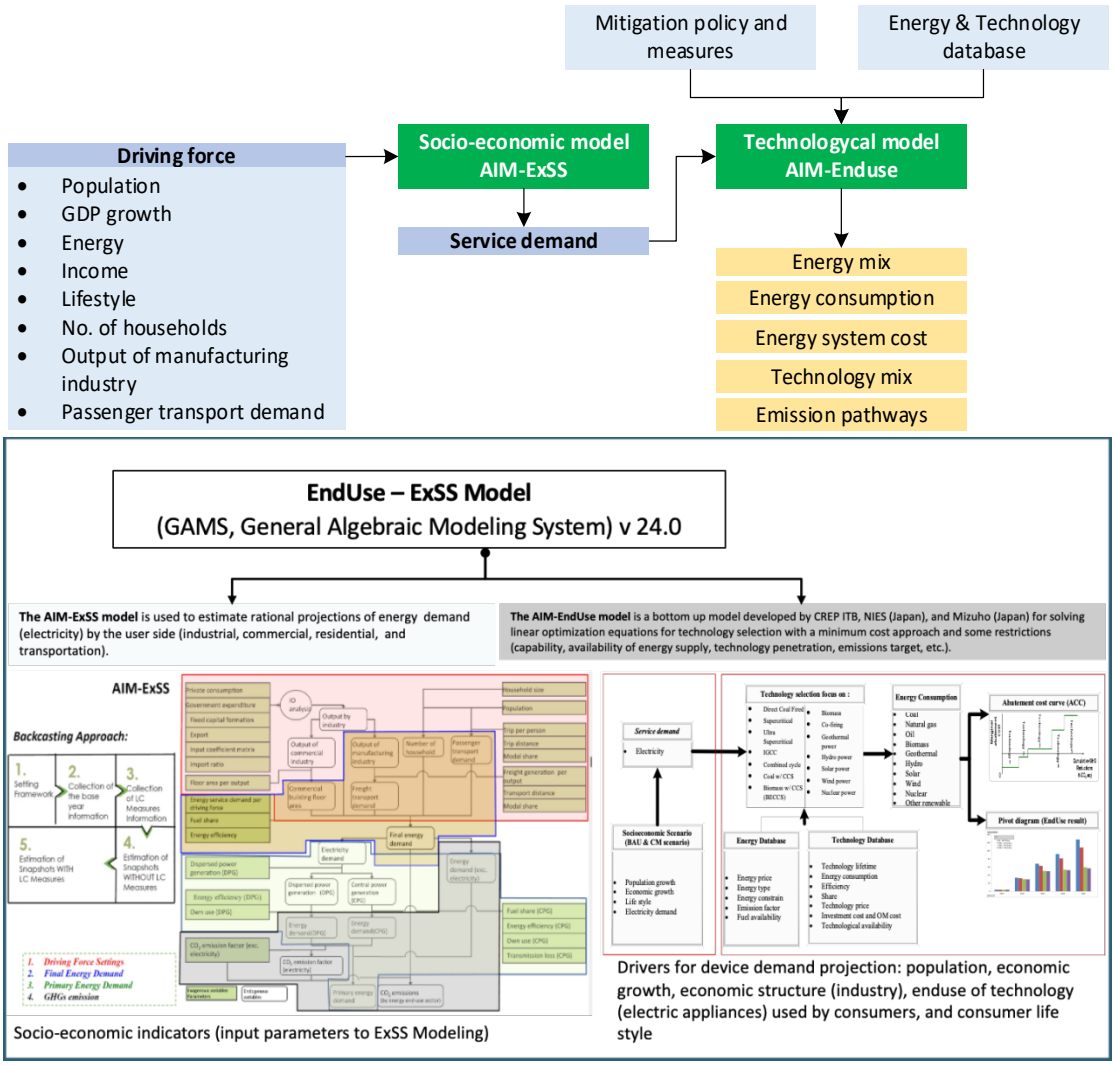


Figure 2- 28 Back casting approach using energy model: AIM-ExSS and AIM-Enduse

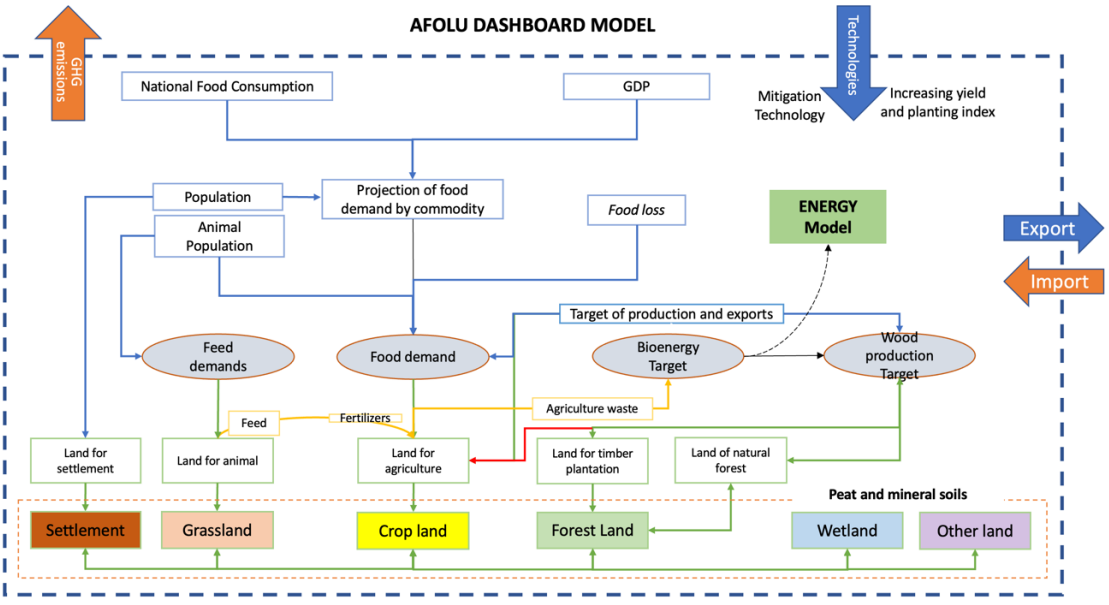


Figure 2- 29 Structure of the AFOLU Dashboard

CHAPTER III
INFORMATION RELATED TO CLIMATE CHANGE IMPACTS AND ADAPTATION

3.1 National Circumstances, Institutional Arrangements and Legal Frameworks

3.1.1 Relevant National Circumstances For Adaptation Measures

The Indonesian archipelago is at the confluence of two continents and two oceans, positioned at the intersection of three major tectonic plates: the Eurasian Plate, the Indo-Australian Plate, and the Pacific Plate (Sihombing, 2014). This geographical location confers intricate and varied biogeophysical attributes to the region. Indonesia exhibits a tropical climate, defined by two primary seasons: the wet season and the dry season (BMKG, 2022). According to BMKG (2022), the mean annual temperature ranges from 21 to 31°C, while annual precipitation shows significant variation, with levels below 1,000 mm in East Nusa Tenggara and exceeding 4,500 mm in Papua (KLHK, 2022a). This variability highlights the distinctive climatic conditions that are prevalent in each geographical region.

Indonesia, as an archipelagic nation, exhibits diverse topography comprising mountainous regions, lowlands, and coastal areas. The terrestrial landscape comprises various soil types, including alluvial, andosol, and latosol (KESDM, 2019), and is influenced by temperature variations and alterations in precipitation patterns (KEMENTAN, 2023a). Indonesia possesses extensive coastal and marine territories, featuring over 81,000 km of coastline (Adyasari et al., 2021; KLHK, 2017a). This expanse supports 3.44 million hectares of mangrove forests (KLHK, 2017b) and 2.5 million hectares of coral reefs (KKP, 2017). The estimated land area exceeds 191 million hectares, with tropical forests covering more than 120 million hectares (KLHK, 2021a). Indonesian forests are vital for the production of forestry commodities and are crucial for carbon sequestration and biodiversity conservation. Approximately 80 percent of Indonesia's land area demonstrates significant biodiversity (KLHK, 2020a), with conservation forest areas, including Nature Reserve Areas / *Kawasan Suaka Alam* (KSA) and Nature Conservation Areas / *Kawasan Pelestarian Alam* (KPA), covering 22.1 million hectares (KLHK, 2020a). The availability of water resources is significantly influenced by the terrestrial water bodies, which include more than 5,700 river systems (USAID, 2023) and 5,807 lakes (KLHK, 2022a).

Indonesia is a populous nation with a population of 277.8 million (BPS, 2024), projected to rise to 308.37 million by 2035 (BPS, 2023a). Over 58.6% of the population resides in urban areas, with forecasts suggesting a rise to 72.9% by 2045 (BPS, 2020). Rapid urbanization can exacerbate the vulnerability of urban populations to flooding events, extreme heat, and potable water scarcity. Alongside population growth, Indonesia's economic conditions, as reflected by Gross Domestic Product, Human Development Index, and per capita income, are illustrated in Figure 3-1.

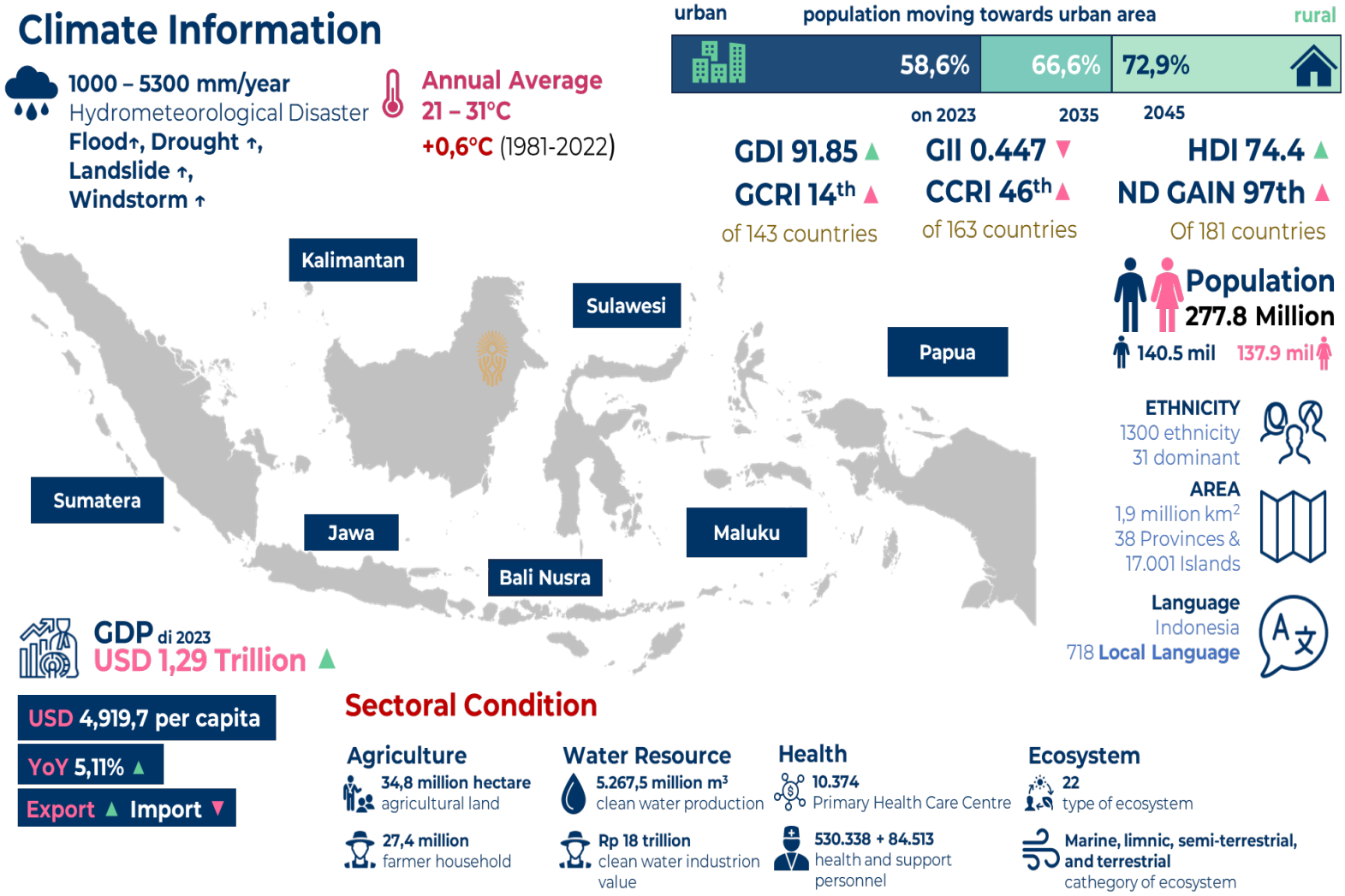


Figure 3- 1 Climate, demographic, social, economic conditions, and priority sectors potentially impacted by climate change in Indonesia
Source: compiled from various source

The extensive geographical area with diverse bio geophysical conditions and a growing population, necessitates the development of sustainable infrastructure to meet various needs, such as the provision of water resources, electricity, roads, and telecommunications. Global climate change affects the frequency and intensity of extreme weather events (KLHK, 2020b) and has significant implications for food availability (BKP, 2020), water resources (PUPR, 2020a), health (KEMENKES, 2021), and ecosystem functions and services (KLHK, 2020b) in Indonesia. Indonesia ranks 97th in terms of vulnerability and 99th in readiness to address climate change (ND-Gain, 2024). Despite improvements in environmental quality, evidenced by the 2023 Environmental Quality Index (IKLH) of 72.54 (KLHK, 2023), additional measures are necessary to strengthen ecosystems and landscapes. These challenges arising from the impacts of global climate change necessitate climate change adaptation efforts.

Indonesia's commitment to climate change adaptation is reflected in the First NDC document (KLHK, 2016), revised in the Updated NDC (MoEF, 2021), and enhanced the ambition in the document of ENDC (MoEF, 2022a), and articulated in the Adaptation Communication (ADCOM) document (MoEF, 2022b). These commitments demonstrate the necessity of climate change adaptation to enhance national climate resilience. Climate change adaptation focuses on climate-sensitive priority areas, namely: food, water resources, energy, health, ecosystems, and disaster management. This First Biennial Transparency Report (BTR1) highlights priority areas including agriculture as part of the food sector, water resources, health, and ecosystems. Agriculture was selected to represent the food sector in this BTR1, considering the complexity of the food sector and the directive for a more detailed examination of adaptation processes in this priority area. The Energy sector is excluded from the BTR1 report, as it primarily focuses on Climate Change Mitigation. The disaster management sector is closely associated with the loss and damage framework in Indonesia. This BTR1 report includes information on the review of the initiation of Loss and Damage Framework in the country.

3.1.1.1 Food

Indonesia's total agricultural land amounts to 36.8 million hectares, with 7.5 million hectares (20%) cultivated and 11.8 million hectares (14%) remaining unused (ATR/BPN, 2019). Rice fields are predominantly located on Java Island, representing 46% of the total. Approximately 67,000 extension workers support 21.8 million farmer households in the agricultural sector. The narrow agricultural sector (including Food Crops, Horticulture, Plantations, and Animal Husbandry) employs 38.14 million individuals, comprising 23.04 million (60.41%) male farmers and 15.10 million (39.59%) female farmers. The largest proportion of the workforce in this sector falls within the productive age range of 25-59 years, comprising 24.5 million people (67.46%). A significant number of men are employed in the food crops, horticulture, and plantation sub-sectors, totaling 18.6 million people (BPS, 2022a). The nearly 40% participation of women highlights the significant role of female farmers in management and cultivation, as they are frequently engaged throughout the entire production chain, from upstream to downstream.

The provinces of West Java, Central Java, and East Java are the primary rice producers in Indonesia, accounting for 52% of total rice production and 49% of maize production. In 2022, the cattle population totaled 18.5 million, with East Java housing the largest concentration at 4.94 million. The overall livestock population has declined since 2021; however, the poultry population has risen by 6.15%. Provinces including DKI Jakarta, West Java, and East Java

exhibit a deficit in beef and buffalo meat while demonstrating a surplus in chicken meat (BPS, 2022b). Plantations account for 3.99% of the GDP within the agricultural sector, while food crops contribute 2.6%. East Java Province accounts for the largest GDP contributions in the agricultural sector at 13% and in animal husbandry at 23% (BPS, 2022b; KEMENTAN, 2022a).

3.1.1.2 Water Resources

Indonesia has modalities related to water resource adaptation measures. Indonesia comprises 5,700 rivers organized into 128 river basins, which include 5 transnational river basins, 31 inter-provincial river basins, 28 national strategic river basins, 52 inter-regency/city river basins, and 12 river basins located within regencies or cities. Furthermore, there are 840 lakes covering a cumulative area of 7,103 square kilometers, among which 15 are classified as national priority lakes (PUPR, 2021). There are 421 Groundwater Basins (GB), comprising 4 transnational GB, 35 inter-provincial GB, 176 inter-regency/city GB, and 206 GB located within regencies/cities. According to the Groundwater Atlas Map (KESDM, 2020), the groundwater potential is approximately 520 billion m^3/year, of which about 30%, or roughly 155 billion m^3/year, is available for utilization.

Regarding water resource infrastructure, there are 215 dams (PUPR, 2020b) in operation, with projections indicating an increase to 229 by 2024. Indonesia faces a significant challenge related to climate change concerning the availability and demand for water resources, with clean water production recorded at 5,300 billion cubic meters in 2022 (BPS, 2023b). Irrigation represents the largest water demand, particularly in Java (57,972 billion cubic meters annually) and Sumatra (41,195 billion cubic meters annually), alongside the livestock and fisheries sectors in Sumatra (4,840 billion cubic meters annually). The total water availability reaches 690,000 billion cubic meters annually; however, its distribution is uneven. Approximately 70% of water sources are located in Kalimantan and Papua, Water availability in Java and Bali is critical, with water utilization in Java at 98.92% of total available resources, and in Bali-Nusa Tenggara surpassing carrying capacity at 111.35% (KLHK, 2021b).

3.1.1.3 Health

In 2022, the healthcare sector in Indonesia has achieved significant development, particularly in infrastructure and services, exemplified by the presence of 10,374 Primary Health Care Centers/Pusat Kesehatan Masyarakat (Puskesmas) functioning as primary healthcare facilities for the public (KEMENKES, 2023a). The distribution of Puskesmas in specific regions, such as Papua Island, is inadequate, as evidenced by the absence of these facilities in several sub-districts. In 2022, 56.1% of Puskesmas had healthcare personnel who met the standard requirements. However, this distribution is uneven, with Papua and West Papua attaining only 16.4% and 7.6%, respectively (KEMENKES, 2023a). Initiatives aimed at equalizing the distribution of healthcare personnel emphasize the provision of incentives for service in underdeveloped, frontier, and outermost regions. Health worker professionalism development and continuous training programs for healthcare workers have been implemented to enhance service quality and adaptability, though their implementations are inconsistent. Ministry of Health (MoH) / *Kementerian Kesehatan* (Kemenkes) documented 4,550 pharmaceutical and medical device production facilities in Indonesia. The majority of production and distribution facilities are concentrated in Java and Sumatra, comprising 94.2% of production facilities and 76.1% of distribution facilities.

Despite Indonesia's healthcare expenditure of IDR 569.4 trillion in 2022, access to healthcare services in remote areas continues to pose significant challenges. Indonesia, covering an area

of 1.9 million km², encounters logistical challenges in healthcare delivery, especially in remote island regions. Furthermore, 52.89% of villages are located in flat regions, which heighten the risk of flooding and the transmission of diseases. The humid tropical climate increases the likelihood of pathogen proliferation. The distribution of healthcare facilities is uneven, with access ranging from 5.3% to 31.3% in villages. The health data collection system has been established in Indonesia, from the regional to the national level. Data collection at the regional level is carried out by healthcare service institutions and health offices, involving health surveillance personnel in the reporting of disease cases. This mechanism is not currently operating at optimal efficiency.

3.1.1.4 Ecosystem

There are 22 types of natural ecosystems which are divided into four classifications: marine, limnic, semi-terrestrial, and terrestrial ecosystems (Bappenas, 2015). The terrestrial forest covers an area of 120.47 million hectares, with Papua comprising 32% of this total. Indonesian forests are essential for forestry commodity production, biodiversity conservation, and carbon storage, especially within peat swamp ecosystems that encompass 24.67 million hectares and terrestrial conservation areas that cover 22.1 million hectares (MoEF, 2024). Freshwater ecosystems, including rivers and lakes, serve essential functions as water resources, renewable energy sources, and mechanisms for flood control. Indonesia has 2,397 rivers that span a total length of 84,678 km and contains 5,807 lakes. Mangrove regions in Indonesia span 3.44 million hectares, accounting for roughly 20-25% of global mangrove ecosystems. Indonesia is located in the Coral Triangle Area, covering an area of 2.5 million hectares, constitutes a habitat for 76% of the global coral reefs. The maritime sector supports the livelihoods of 2.4 million fishermen in capture fisheries and 266,600 individuals engaged in aquaculture and fish farming (BPS, 2023c).

3.1.2 Regulatory Framework and Institutional Governance

The governance of climate change in Indonesia is established through a policy and regulatory framework that facilitates adaptation efforts. Multi-stakeholder participation mechanisms in adaptation implementation are governed by Presidential Regulation No. 98 of 2021 (President Republik Indonesia, 2021a) and Minister of Environment and Forestry Regulation No. 33/2016 (Permen LHK, 2016). The development of the National Registry System/Sistem Registri Nasional (SRN) (srn.menlhk.go.id) serves as a transparency platform aimed at enhancing the reporting and monitoring of adaptation actions in Indonesia. Encouraging parties to engage and contribute effectively to climate change adaptation efforts is essential.

Perpres No. 98 of 2021 highlights the significance of stakeholder participation in the implementation of climate change adaptation measures across various levels, from national to local. The Ministry of Environment and Forestry (MoEF) / *Kementerian Lingkungan Hidup dan Kehutanan* (KLHK) serves as the National Focal Point for Climate Change in Indonesia, coordinating actions related to climate change adaptation at the national level. MoEF plays a significant role in the protection and restoration of ecosystems, alongside enhancing community capacity in environmental management. Ministry of Development Planning / *Kementerian Perencanaan Pembangunan Nasional* (Bappenas) is responsible for facilitating the incorporation of adaptation measures into development planning, aligning with the execution of Sustainable Development Goals (SDGs), specifically SDG 13 concerning climate action (Bappenas, 2024).

Multiple ministries and institutions are engaged in efforts to adapt to climate change. The Ministry of Finance (MoF) / *Kementerian Keuangan* (Kemenkeu) is responsible for planning and allocating the budget to facilitate adaptation actions. The Ministry of Home Affairs / *Kementerian Dalam Negeri* (Kemendagri) is responsible for regulating minimum service standards / *Standar Pelayanan Minimal* (SPM) and coordinating local governments in the implementation of adaptation strategies. Other ministries, specifically the Ministry of Agriculture (MoA)/*Kementerian Pertanian* (Kementan), the Ministry of Energy and Mineral Resources / *Kementerian Energi dan Sumber Daya Mineral* (Kemen ESDM), and the MoH, play roles and contribute to mitigating the impacts of climate change in accordance with their designated duties, functions, and service areas (Figure 3-2).

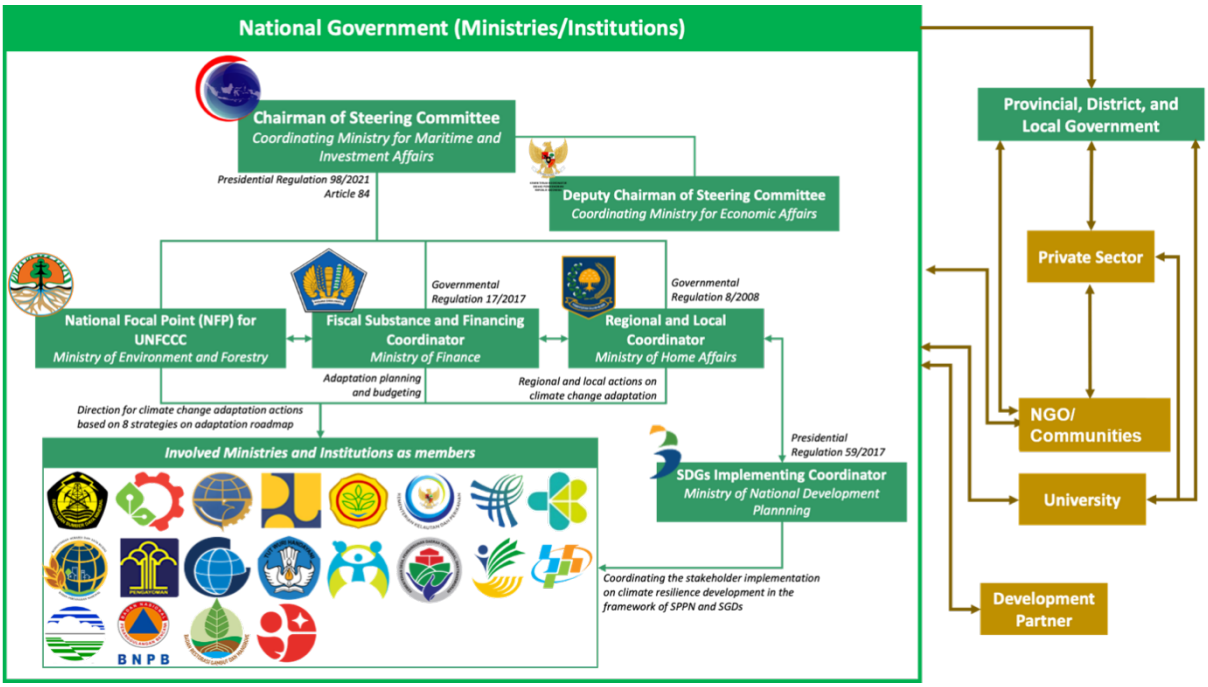


Figure 3- 2 Institutional Governance on Climate Change Adaptation in Indonesia

Local governments/Pemerintah Daerah (Pemda) play a crucial role in implementing adaptation actions by developing climate adaptation policies at the local level. This includes formulating sub-national adaptation plans and facilitating community efforts to enhance adaptive capacity. Private sector entities, civil society organizations, academic institutions, and development partners are urged to assist in the implementation of adaptation initiatives. The involvement of the non-party stakeholders is crucial for facilitating the execution of climate change adaptation measures at the local level. The private sector is anticipated to play a significant role in executing adaptation initiatives designed for community development activities, which are integral to social responsibility and the preservation of natural resources and the environment. Civil society plays a crucial role in advocacy, capacity building, and the implementation of adaptation actions, thereby enhancing public participation in tackling climate change challenges (KLHK, 2020b). The regulatory framework and institutional governance in Indonesia aim to foster collaboration among diverse stakeholders, promoting synergy between national government entities (Party Stakeholders) and Non-Party Stakeholders (NPS). The party stakeholders are crucial in fostering enabling conditions via policies, regulations, and

technical guidelines aimed at resource mobilization, technology transfer, and capacity development. The NPS plays a significant role in the implementation of adaptation actions, especially at the local level. The implementation of these actions encourages NPS, particularly the private sector, to facilitate or mobilize funding sources for local level adaptation actions conducted by community groups. The support of the regulatory framework and institutional governance for implementing climate change adaptation actions is tailored to the priority areas, namely: food, water resources, energy, health, ecosystems, and disaster management. This BTR1 report elucidates the regulatory and institutional framework for key areas, specifically agriculture, water resources, health, and ecosystems.

3.1.2.1 Food

MoA established a Climate Change Impact Team in the agricultural sector, as outlined in Minister of Agriculture Regulation No. 530.1/Kpts/OT.050/M/8/2020 regarding the Climate Change Impact Team in this sector. Adaptation activities are distributed among various technical directorates based on their specific responsibilities and functions. MoA consolidates all adaptation activities, conducts tagging, and submits reports to Bappenas via the AKSARA application.

MoA has established regulations concerning climate change adaptation, which are classified into four categories: food security, protection, funding, and institutional governance. Minister of Agriculture Regulation (Permentan) related to food security includes Act No. 18/2012, which establishes a national food system aimed at ensuring food safety, quality, and diversification for all Indonesians; Act No. 22/2019 concerning Sustainable Agricultural Cultivation Systems; and Minister of Village, Disadvantaged Regions and Transmigration Regulation/*Peraturan Kementerian Desa, Pembangunan Daerah Tertinggal dan Transmigrasi* (Kemendes PDTT) No. 7/2021, which governs the prioritized use of village funds to enhance both plant-based and animal-based food security at the village level. This text addresses the management and utilization of funding within the agricultural sector, specifically referencing the Permentan No. 37/2019, which outlines guidelines for the implementation of the Agricultural Social Assistance Program. Act No. 41/2009 emphasizes the protection of sustainable food agricultural land, stipulating that such land must not be converted and should continue to be utilized for food production. Additionally, Permentan No. 39/2018 introduces an early warning system and strategies for addressing the impacts of climate change within the agricultural sector. Regulations on institutional governance, exemplified by Permentan No. 47/2016 serve as a reference for the preparation of extension work plans across different administrative levels.

3.1.2.2 Water Resources

The regulatory framework governing water resource management in Indonesia reflects the provisions of the 1945 Constitution (UUD 45), specifically Article 33, which asserts that the management of natural resources is intended to benefit the populace. Numerous developments in laws (UU) and Government Regulations (PP) have occurred in previous periods concerning the regulation of water resource management. Act No. 17/2019 on water resources establishes fundamental principles for water management, encompassing area-based management, community involvement, and the safeguarding of water resources. This law is underpinned by four Government Regulations: the Irrigation PP, the Drinking Water Supply System (SPAM) PP, the Water Source PP, and the Water Resource Management PP. The applicable policy for irrigation is PP 20/2006, which governs the planning, utilization, and oversight of water

resources to ensure sustainable management. PP 122/2015 addresses the Drinking Water Supply System, while PP 121/2015 pertains to Water Resources Utilization. PP 43/2008 governs hydrogeological boundaries, stipulates requirements for groundwater management plans and permits, and addresses data management related to groundwater. The management of river basins is governed by PP 37/2012, which outlines the processes of planning, implementation, monitoring, evaluation, and supervision from upstream to downstream. This policy document indicates that DAS management is conducted in accordance with spatial planning and water resources management frameworks as stipulated by relevant laws and regulations. PP 22/2021 addresses water quality regulation by establishing guidelines for environmental approval, as well as the protection and management of water quality. It also encompasses the management of hazardous and toxic waste, alongside non-hazardous waste, in relation to water resources.

The implementation is further detailed in the Ministerial Regulations (Permen), in addition to government regulations. Permen PUPR 12/2021 establishes technical guidelines pertaining to water quality and its application for agricultural and industrial purposes. Permen ESDM 7/2020 governs water utilization within the mining industry. Permen 4/2021 establishes Guidelines for the Implementation of The Acceleration Program Aimed at Enhancing Irrigation Water Use. Permen PUPR 37/PRT/M/2015 governs the authorization for the utilization of water and/or water resources.

3.1.2.3 Health

MoH plays a vital role in monitoring and addressing the impacts of climate change on public health, having identified 24 diseases that necessitate surveillance due to their potential to trigger extraordinary events. Climate change influences several diseases, including Dengue Fever, Malaria, Diarrhea, and Pneumonia. MoH integrates adaptation efforts via national health programs and disease control initiatives. MoH Regulations delineate health adaptation strategies for climate change. These strategies encompass the management of vector-borne, water-borne, and air-borne diseases, alongside the development of climate-resilient health systems (KEMENKES, 2012; KEMENKES, 2020; KEMENKES, 2022). The MoH Regulation No. 532 of 2019 establishes the Technical Team for Adaptation to the Impacts of Climate Change in the Health Sector. This regulation mandates the formation of a technical team comprising all units within the MoH to enhance health adaptation initiatives (APIK). The MoH Regulation No. 21/2020 pertains to the Strategic Plan of the MoH, focusing on the prevention of infectious disease spread linked to climate change, in accordance with the National Action Plan for Climate Change Adaptation in the health sector.

3.1.2.4 Ecosystem

In the context of climate change adaptation and ecosystem resilience in Indonesia, numerous regulations highlight the significant role of terrestrial, coastal, marine, and freshwater ecosystems in confronting the challenges associated with climate change. Act (UU) No. 41/1999 governs the sustainable management of terrestrial forest ecosystems by delineating forest functions, whereas Government Regulation (PP) No. 6/2007 enhances the integrated management of these ecosystems. Peatland ecosystems are governed by the MoEF Regulation (Permen LHK) No. P.60/2019, which mandates their management as carbon sinks and regulators of the water cycle. Act No. 1 of 2014 and Act No. 32/2014 govern the management of coastal and marine resources, focusing on conservation, community welfare, and the rehabilitation of priority coastal areas. Presidential Regulation (Perpres) No. 60/2021

safeguards priority lakes in freshwater ecosystems from pollution, while Government Regulation (PP) No. 38/2011 governs the utilization and rehabilitation of rivers to preserve their ecological functions as water resource providers.

Ecosystem management is conducted by institutions including the MoEF, the Ministry of Public Works and Housing/*Kementerian Pekerjaan Umum dan Perumahan Rakyat* (Kemen PUPR), and the Ministry of Maritime Affairs and Fisheries/*Kementerian Kelautan dan Perikanan* (KKP). The Peatland and Mangrove Restoration Agency/*Badan Restorasi Gambut dan Mangrove* (BRGM) is mandated by Presidential Regulation No. 1 of 2020 to plan, implement, and monitor the restoration of peatland and mangrove ecosystems. Concurrently, the National Disaster Management Authority/*Badan Nasional Penanggulangan Bencana* (BNPB) is responsible for coordinating adaptation efforts related to disaster mitigation impacting these ecosystems (Presidential Regulation No. 1 of 2020; Act No. 24 of 2007). The current regulatory framework seeks to sustainably protect and manage biodiversity while enhancing ecosystem resilience against climate change impacts (KLHK, 2020b).

3.2 Impacts, Risks and Vulnerabilities

3.2.1 Current and Future Climate Trends and Hazards

Over the observation period from 1981 to 2023 in Indonesia, 2016 emerged as the warmest year, exhibiting an anomaly of 0.6°C (Figure 3-3a). In 2023, the temperature anomaly reached 0.5°C, making it the second warmest year recorded. Indonesia's average annual air temperature has risen at a rate of 0.6°C per 30 years, according to data analysis from 116 stations covering the period from 1981 to 2023 (Figure 3-3b) (BMKG, 2024). Certain observation station locations in Banten, East Java, West Kalimantan, East Kalimantan, Central Sulawesi, and Maluku exhibit a temperature increase rate exceeding 1°C per 30 years. Observation points in regions including the Riau Islands, North Sumatra, South Sumatra, Central Java, Central Kalimantan, North Kalimantan, South Kalimantan, North Sulawesi, Maluku, and West Papua indicate a temperature increase rate of 0.8 to 1°C per 30 years. The remaining values fall within the range of 0.2 to 0.8°C over a period of 30 years. The national maximum temperature in Indonesia exhibits a positive trend, rising by 0.5°C per30 years from 1981 to 2023. The national rate of change in Indonesia from 1981 to 2023 showed a notable increase in minimum temperature, averaging 1.1°C per 30 years.

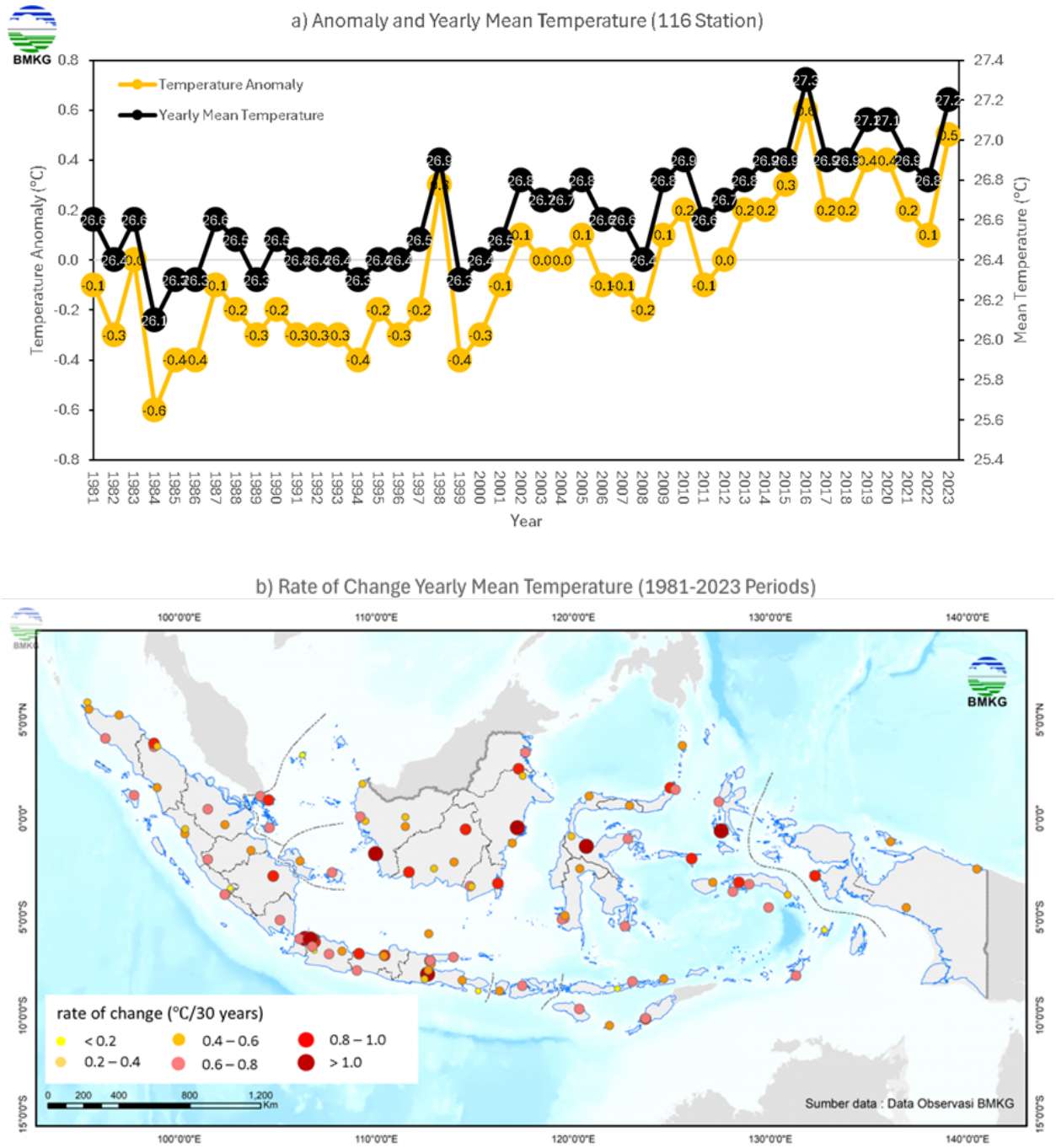


Figure 3- 3 Rate of change in air in the period 1981-2023, a) anomalies and annual average temperatures from 116 observation stations and b) mean temperature (Tmean). (source: https://www.bmkg.go.id/iklim/?p=analisis-laju-perubahan-suhu-udara)

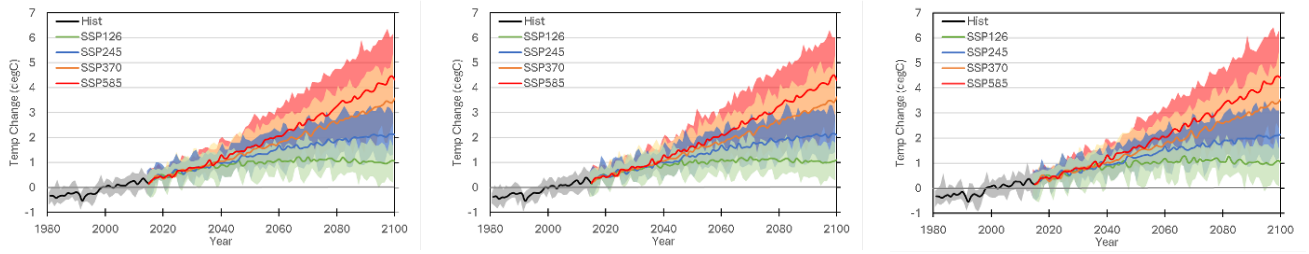
This trend is anticipated to persist in the future. Projections for air temperature in 2040 and 2050 indicate an increase in maximum temperatures of 0.98°C and 1.2°C, respectively, alongside a rise in minimum temperatures of 1.0°C during the same timeframe (IPCC, 2022). Projections for 2040 indicate a temperature increase of 0.98°C, and 1.2°C for 2050, thereby heightening the probability of extreme temperatures (Seneviratne et al., 2021). Projections indicate a minimum temperature increase of 1.5°C by 2040 and 1.8°C by 2050 (IPCC, 2022). The latest climate scenarios from the Shared Socio-economic Pathways (SSP) reported by the IPCC (2023) indicate that temperature projections exhibit a consistent trend, with the most

extreme scenario predicting temperature increases of approximately ± 4°C by the century's end (Figure 3-4). The output from the Global Climate Model (GCM) derived from the Climate Model Intercomparison Project phase 6 (CMIP6) database, utilizing 10 climate models adjusted with historical observation grid data, indicates a significant upward trend in air temperature conditions by the end of the century. The projected increases in average air temperature, maximum air temperature, and minimum air temperature are 4.3°C, 4.4°C, and 4.2°C, respectively, under the highest climate scenario (SSP5-8.5). In the SSP2-4.5 scenario, identified as the middle scenario, average air temperature, maximum air temperature, and minimum air temperature are projected to increase by up to 2.1°C, 2.1°C, and 2.2°C, respectively (Figure 3-4 a, b, and c). Spatially, the projection of the increase in average air temperature shows relatively similar conditions for all regions of Indonesia. The range of temperature increases between provinces in Indonesia is also relatively the same (Figure 3-4d).

a) Trend of projected mean temperatures (Tmean)

b) Trend of projected minimum temperatures (Tmin)

c) Trend of projected maximum temperatures (Tmax)



d) Map of projected mean temperatures (Tmean) for period of 2080-2099 for Indonesia area

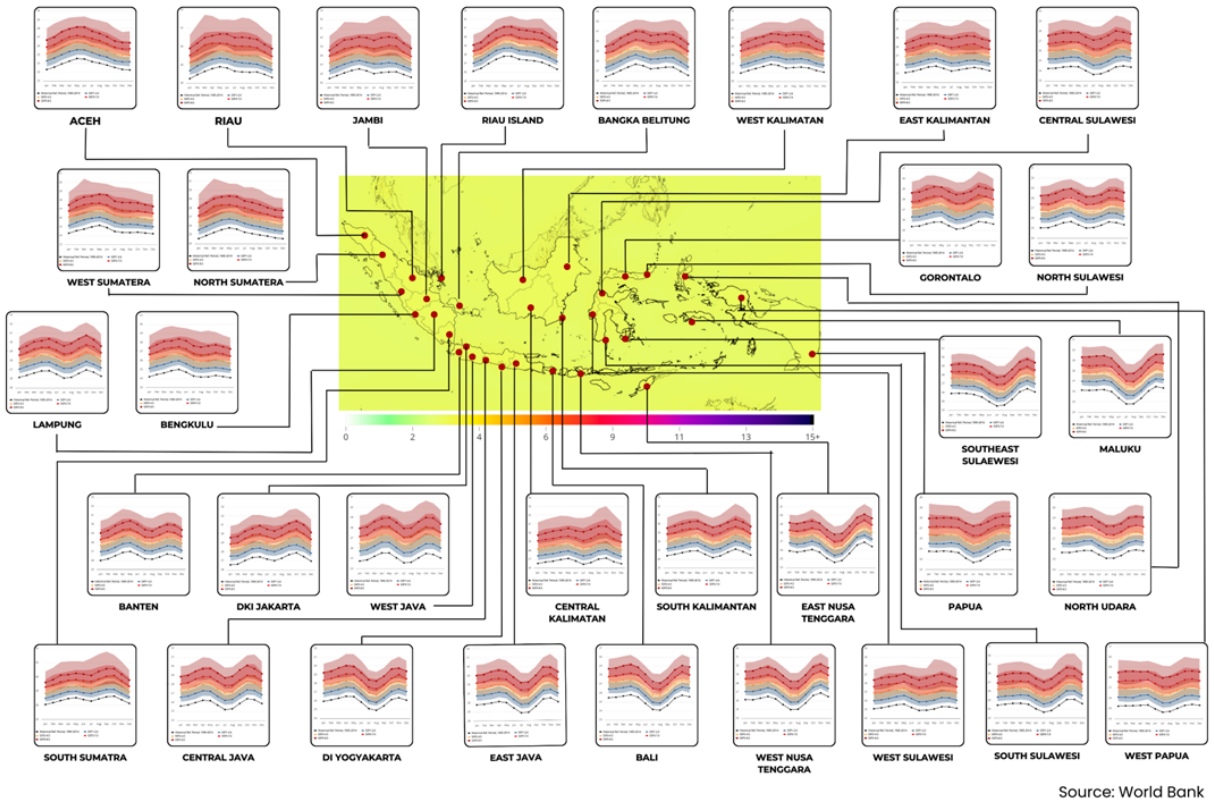


Figure 3- 4 Projections of air temperature in Indonesia based on CMIP6 multi-model GCM under SSP scenarios for the period 1981-2100: a) trend projection of mean air temperature (Tmean), b) trend projection of minimum air temperature (Tmin), c)

trend projection of maximum air temperature (Tmean) in Indonesia, and d) map of projected increase in average air temperature in Indonesia for the period 2080-2099 (relative to the period 1995-2014) in the SSP2-4.5 scenario, along with the average climatology graph for each province in all SSP scenarios.

The analysis of annual rainfall indicates that the majority of regions in Indonesia are experiencing increased precipitation, with some areas showing an increase of 200 to 300 mm over the past 30 years or more. Conversely, certain regions, including Central Java and East Java, have witnessed a reduction in rainfall exceeding 300 mm (Figure 3-5). The rise in maximum daily rainfall across most regions indicates a positive trend. In the past thirty years, there has been a notable variation in the number of rainy days in Indonesia. The western regions of Indonesia experienced a decrease in rainy days, whereas the Central to Eastern regions have seen an increase of over six days (BMKG, 2022). The rise in high rainfall days in Indonesia serves as a significant indicator of the escalating risk of hydrometeorological disasters, particularly since the period from February to April typically experiences a reduction in rainy days (IPCC, 2022).

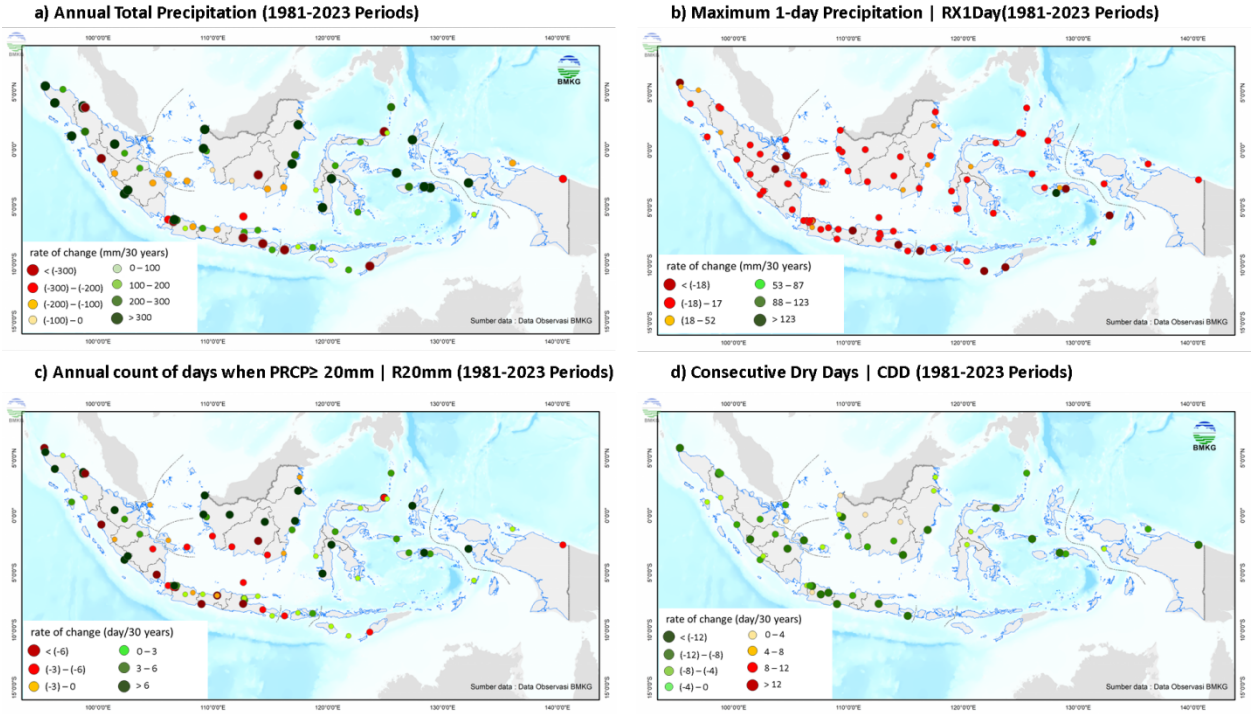
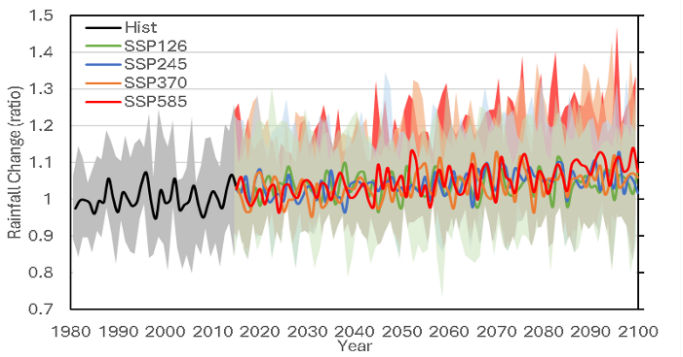


Figure 3- 5 Rate of change in a) annual total rainfall, b) annual maximum daily rainfall (Rx1day), c) number of days with rainfall >20 mm/day (R20mm), and d) mkg consecutive dry days (CDD) for the period 1981-2023 (Source: https://www.bmkg.go.id/iklim/?p=analisis-laju-perubahan-curah-hujan)

Projections indicate an increase in total daily rainfall of 0.8% by 2040 and 2.8% by 2100, relative to the 1981-2010 baseline. Additionally, forecasts suggest a 4% rise in daily rainfall by 2040 and 11.7% increase by 2100, particularly during the peak rainy season (IPCC, 2022). Projections suggest a 4% increase in daily rainfall by 2040 and 11.7% increase by 2100, which may influence the occurrence of extreme events such as floods and landslides (IPCC, 2022). Additionally, a study conducted for Indonesian 3rd National Communication (NC3) in 2017 utilizing RCP scenarios indicates that rainfall in Indonesia is expected to rise in mainland regions during the rainy season, whereas a decline is anticipated during the dry season (MoEF, 2017). The increase in rainfall may reach 20% relative to historical conditions, whereas the decrease can attain 40%. The Sumatra and Kalimantan regions are likely to experience increased rainfall during the rainy season, whereas the Java region is expected to see a decrease

in rainfall during the dry season. The latest SSP scenarios utilizing a multi-model ensemble indicate that regional average rainfall in Indonesia is expected to exhibit a diverse pattern of change, with a general tendency for increase by 2100 (Figure 3-6a). Rainfall increases under the SSP5-8.5 scenario are comparatively greater than those observed in other scenarios.

a) Trend of projected rainfall for Indonesia



b) Map of projected rainfall for period of 2040-2059

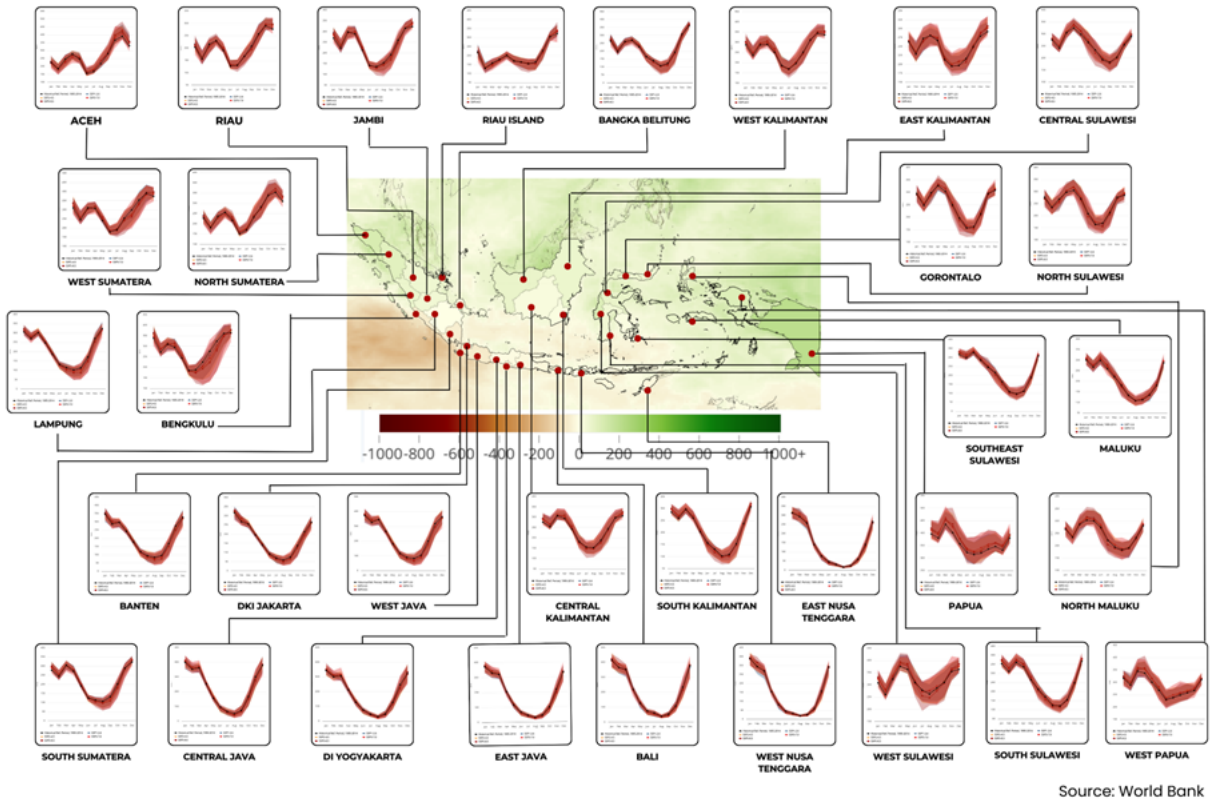


Figure 3- 6 a) Projected rainfall trends in Indonesia for the period 1981-2100 and b) Map of projected rainfall changes in Indonesia for the period 2040-2059 (relative to the period 1995-2014) in the SSP2-4.5 scenario, along with the average climatology graph for each province in all SSP scenarios.

Spatially, rainfall tends to increase in the eastern terrestrial region of Indonesia, especially in Papua. Meanwhile, a decrease in the percentage of rainfall is projected to occur in the western part of Indonesia, especially in the Indian Ocean waters off the west coast of Sumatra (Figure 3-6b). The percentage change in rainfall in Indonesia varies according to the type of rainfall pattern. Regions with a monsoonal rainfall pattern show a relatively small percentage change.

However, rainfall in the rainy season has relatively increased, while in the dry season it tends to decrease. The highest percentage change in rainfall is in regions with equatorial and local rainfall patterns. In this region, the percentage decrease in rainfall during the dry season is higher than the percentage increase in rainfall during the rainy season. Both conditions can be indicators for determining adaptation options, especially in relation to anticipating climate-related hazards.

At the local level, climate change exerts varying influences on different locations, particularly regarding its effects on rainfall patterns. Rainfall in NTB (West Nusa Tenggara) is projected to increase by 5% during December-February and decrease by up to 10% in March-May (McGregor et al. 2016). In West Kalimantan, rainfall is projected to decrease by up to 7.5% during the dry season in May-June and increase by up to 10% during the rainy season in February-April. In regions exhibiting an equatorial rainfall pattern, such as West Kalimantan, climate projections indicate a potential decrease in rainfall during the second peak of the rainy season, which occurs around November (Jadmiko et al. 2017).

The upward trend in annual rainfall in Indonesia indicates a rise in maximum daily rainfall, with increases ranging from 10 to over 20 mm across most regions. Between 1981 and 2023, Indonesia observed a maximum daily rainfall (Rx1day) rate of change with a peak increase of 158 mm per 30 years and a minimal decrease of 53 mm per 30 years. Between 1981 and 2023, the national rate of change in the number of days with rainfall exceeding 20mm/day (R20mm) in Indonesia recorded a maximum increase of 39 days per 30 years and a minimum decrease of 13 days per 30 years. The rate of change in CDD in Indonesia from 1981 to 2023 exhibited a maximum increase of 4 days per 30 years and a minimum decrease of 286 days per 30 years. Future extreme climate conditions are changing as a result of climate change. In the Indonesian NC3 report, from the downscaling of projections using regional climate models, several extreme climate indices based on rainfall data have undergone significant changes (Faqih et al. 2016). For the RX1DAY index, it is generally projected to increase by up to 30% compared to baseline conditions. The increase occurred in the mainland areas, while in the sea area around the west coast of Sumatra, it experienced a decrease. However, changes in the RX1DAY index are not always the same in each projection time period. The RX5DAY index shows a change pattern that tends to be similar to the RX1DAY index. However, in some inland locations such as on the island of Java, there is a tendency that in the future the RX5DAY index value will decrease by up to 20% compared to the baseline period. Other climate indices that have changed are R20MM, which generally tends to decrease by up to 40%, the CWD index, which also tends to decrease by up to 25%, especially in the mainland areas of Java Island, and the CDD index, which tends to increase in the future in almost all regions of Indonesia.

Studies on extreme climate utilizing CORDEX data reveal a change pattern consistent with earlier research findings. The CDD index typically rises by as much as 50%, particularly during the peak of the dry season (June to August) and the onset of the rainy season (September to November). The RX1DAY index is anticipated to rise in the majority of regions across Indonesia. The regions exhibiting the most significant increase are Kalimantan and Papua, suggesting a potential for increased wetness in the future. The R50MM index is anticipated to decline in the majority of regions in Sumatra and Java, whereas it is expected to rise in Kalimantan and Papua (Supari et al. 2020). Alterations in extreme climate conditions will influence the likelihood of climate-related disasters in the future. Future projections indicate an increase in the probability of drought events in Indonesia (World Bank and ADB 2021). Projections indicate that El Niño events are expected to increase in both frequency and intensity

as a result of rising global temperatures (King et al. 2016). The probability of forest and land fires escalates during drought conditions. The likelihood of forest and land fires is expected to rise in correlation with the increasing frequency of drought events (Jadmiko et al. 2017).

The occurrence of extreme events, including heatwaves, intense rainfall, extended dry periods, and tropical cyclones, is on the rise. The intensity of extreme events is rising, evidenced by the increase in maximum wind speeds of tropical cyclones. Climate hazards are becoming more frequent, characterized by a rise in extreme weather events, including floods, droughts, landslides, and forest and land fires (Figure 3-7). Evidence indicates that numerous regions in Indonesia are susceptible to different forms of hydrometeorological disasters. The rising temperatures, alterations in rainfall patterns, sea level rise, and the heightened frequency and intensity of extreme events serve as significant indicators of climate change impacts in Indonesia. Figure 3-8 presents the trends and projections related to climate change in Indonesia.

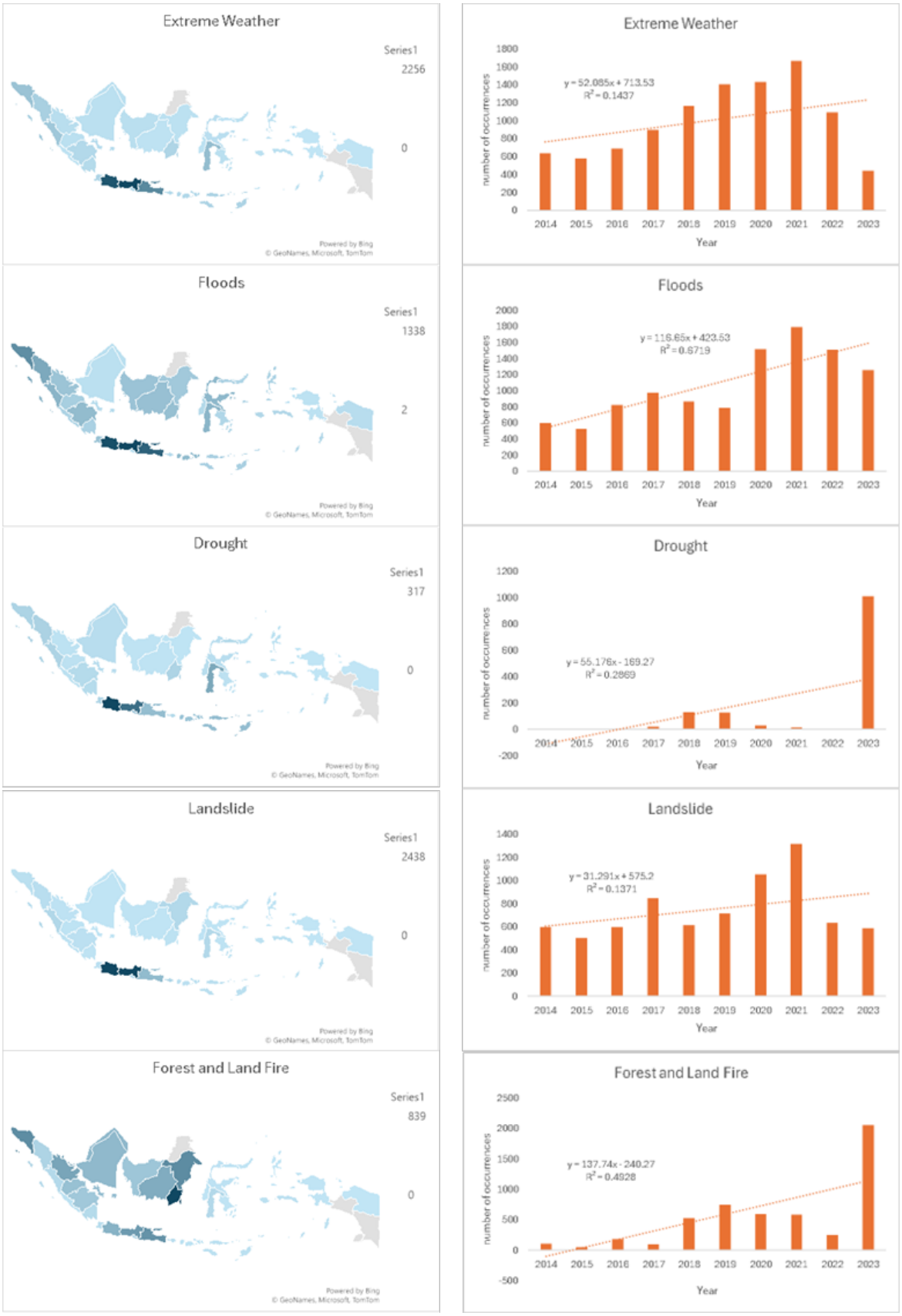
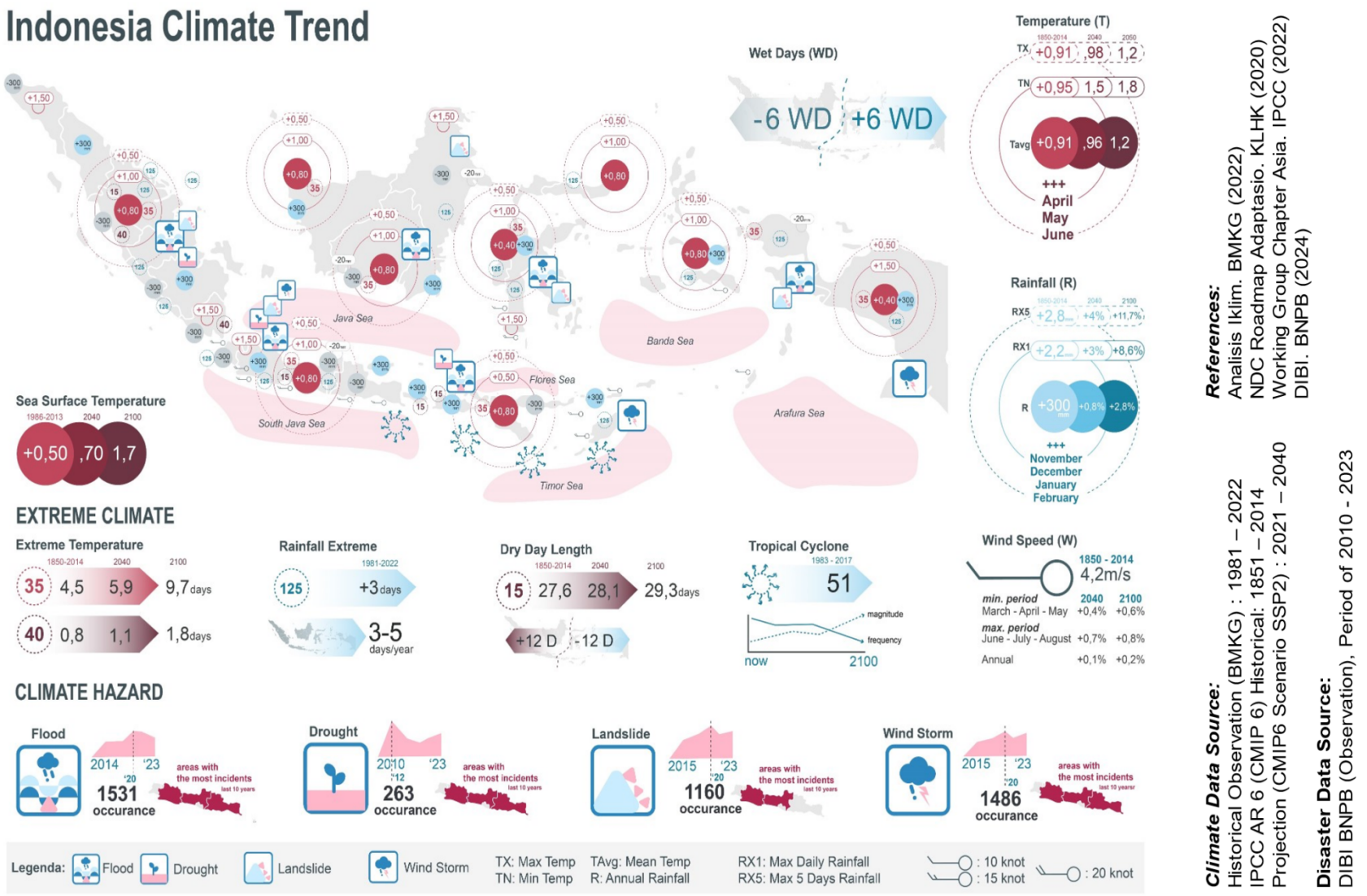


Figure 3- 7 Historical Climate Hazard Trends. The data is processed from the Indonesian Disaster Information Data (bnpb.go.id). Data regarding forest and land fires and droughts may include information not captured on this website



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Analisis Iklim. BMKG (2022)
NDC Roadmap Adaptasio. KLHK (2020)
Working Group Chapter Asia. IPCC (2022)
DIBI. BNPB (2024)

Climate Data Source:
Historical Observation (BMKG) : 1981 – 2022
IPCC AR 6 (CMIP 6) Historical: 1851 – 2014
Projection (CMIP6 Scenario SSP2) : 2021 – 2040

Disaster Data Source:
DIBI BNPB (Observation), Period of 2010 - 2023

Figure 3- 8 Trends and projections of climate change in Indonesia

3.2.2 Observed And Potential Climate Change Impacts

Climate change is projected to affect crop productivity, decrease water availability, heighten the risk of disease outbreaks, and lead to biodiversity loss, which are critical concerns for Indonesia (KLHK, 2022b). The NDC Adaptation Roadmap document indicates that Indonesia has conducted an assessment of the anticipated economic impacts of climate change at the national level for the projection period of 2021-2050, using a baseline from 1991-2020. The potential losses attributed to climate change impacts are estimated to be approximately -2.87% of GDP (KLHK, 2020b). This impact estimate corroborates the Asian Development Bank (ADB) report, which anticipates that climate change could affect Indonesia's national GDP by as much as 3.5% by 2100 (ADB & WB, 2021). The impacts of climate change in Indonesia are identified from various documents and mapped onto priority areas reported in the BTR1 (Figure 3-9).

3.2.2.1 Food

Climate change has led to a decline in Indonesia Food Security Index from 2018 to 2022 (KEMENTAN, 2022a). Extreme weather events, including floods, droughts, and outbreaks of pests and diseases, have significantly disrupted agricultural production. Between 1981 and 2020, rice production experienced an average annual decline of 1.37% (Apriyana et al., 2016; Ruminta, 2018). Sea level rise has adversely affected rice production in coastal regions (Sembiring et al., 2020). Current agricultural technology sustains rice productivity at 5 tons per hectare, while rice and maize productivity outside Java is lower due to inconsistent technology application (Ruslan, 2021). The decline has impacted the GDP of the agricultural sector and the national GDP (KLHK, 2020a). The production of fruits, vegetables, and legumes, alongside rice, has decreased because of alterations in temperature and rainfall patterns (Semba et al., 2022; van Leeuwen and Darriet, 2016; Yeli, 2019), leading to economic repercussions in horticulture totaling Rp 134,821 billion (KEMENTAN, 2018). The cultivation of plantation crops, including cocoa, coffee, and oil palm, faces a potential decline, which may lead to a reduction in national GDP by 3.94% (KEMENTAN, 2022b). Climate change adversely affects aquaculture and livestock, resulting in reduced fish and milk production, with projections indicating a potential decline in livestock meat production by up to 20% by 2050 (KEMENTAN, 2022c; Tuwaidan, 2022).

3.2.2.2 Water Resources

The Strategic Plan (Renstra) concerning water resources, published by the Kemen PUPR (PUPR, 2020b), indicates that the persistent effects of climate change have resulted in numerous disasters with extensive consequences, a trend that is on the rise, including floods, landslides, droughts, storms, and land fires. The NDC Adaptation Roadmap (2020) indicates that climate variability can impact the sustainability of water resources by increasing the risks of floods and droughts.

Climate change has resulted in a 20-30% increase in rainfall during the rainy season and a 10-20% decrease during the dry season (BMKG, 2020). The rise in temperature has similarly affected evapotranspiration, leading to reduced water availability (BMKG, 2020). Climate change-induced alterations in temperature and precipitation disrupt the land water balance, leading to heightened water demand, particularly in agriculture, and impacting water availability in both quantity and quality (PUPR, 2020). Alterations in precipitation patterns affect water quality. Water quality is projected to decline by 50% by the year 2030 (KLHK 2022). Changes in rainfall patterns are estimated to reduce the supply of irrigation water by

19% during dry years, with no significant changes observed in wet years (PUPR, 2020a). The varying availability of raw water resources across different islands exacerbates this issue, particularly in Java, which has the largest population in Indonesia and the lowest availability of these resources. In Java and Nusa Tenggara, water production is projected to decline in availability consistently from 2020 to 2034 and from 2030 to 2045. In 2022, the average reduction in raw water availability was 439.21 m^3 per capita per year in Java and 1,098.08 m^3 per capita per year in Nusa Tenggara (PUPR, 2020a).

3.2.2.3 Health

Climate change elevates the risk of infectious diseases, including Acute Respiratory Infections (ARI)/pneumonia, dengue fever, malaria, and diarrhea, particularly during rainy and dry seasons (KEMENKES, 2021). Extreme temperatures and rainfall can elevate the incidence of ARI/Pneumonia, resulting in estimated health sector losses of 0.10% of national GDP, and potentially up to 1.8% in the event of large-scale disasters (KLHK, 2020a). The projected decline in national GDP associated with basic needs, including food, energy, health, and water, is estimated to range from -0.66% to -3.45% by 2030 (KLHK, 2020a).

In 2022, there were 143,266 reported cases of dengue fever (DBD) and 1,237 fatalities attributed to the disease. The incidence rises during each wet period following an El Niño event. Papua Province exhibited the highest malaria endemicity, recording an Annual Parasite Index (API) of 156.59 per 1,000 population. In contrast, 78% of provinces have attained an API of less than 1 per 1,000 population. Pneumonia case detection was highest in the provinces of West Papua, DKI Jakarta, and Bali, exceeding 70%. In 2022, the national pneumonia detection rate was 38.8%. In 2022, the leading climate-influenced diseases resulting in mortality among children under 5 years old were pneumonia (12.5%), diarrhea (5.8%), and dengue fever (4.4%) (KEMENKES 2023a). Alongside these four climate-influenced diseases, other health issues emerge as concomitant disorders during flood, drought, and storm events.

3.2.2.4 Ecosystem

Climate change impacts forests and other land ecosystems, freshwater ecosystems, and coastal and marine environments. Forest degradation leads to hydrometeorological disasters, including floods and landslides (KLHK, 2020a). Land-use change reduces global ecosystem services, with significant potential losses observed in both terrestrial and marine biomes (KLHK, 2020a). Indonesia's coral reefs and mangroves are threatened by deforestation, which accounts for 6% of the forest losses (Murdiyarso, 2015). Between 1980 and 2000, Indonesia lost more than a third of its mangroves—at a faster rate than tropical forests and coral reefs (Campbell and Brown, 2015). At least one million species worldwide are at risk of extinction due to alterations in land and marine functions, pollution, overexploitation, invasive alien species, and climate change (Bappenas, 2015). Global climate change is expected to affect migratory wildlife in Indonesia. Projections indicate a decrease in habitat distribution and increased migration distances between 2050 and 2100 (Condro et al., 2022). Significant species, including the Javan Hawk-eagle, *Nisaetus bartelsi* (Syartinilia et al., 2024), and the Bornean orangutan, *Pongo pygmaeus* (Condro et al., 2019), may be vulnerable to reduced distribution and habitat extent.

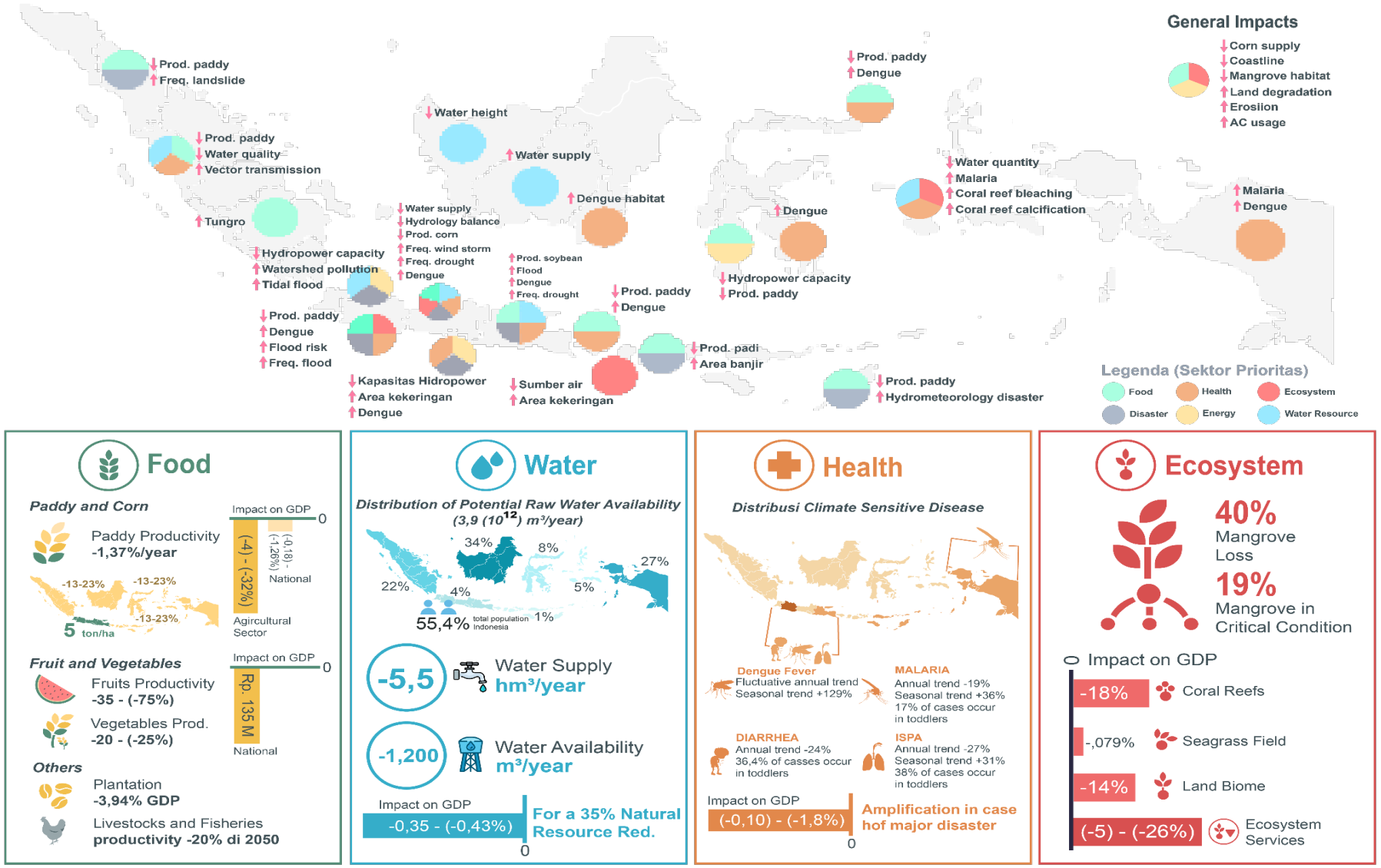


Figure 3- 9 Climate change impacts on priority sector

3.2.3 Approaches, Methods, Uncertainties, And Challenges

The methods, uncertainties, and challenges associated with evaluating the impacts of climate change and adaptation in Indonesia illustrate the intricate interplay of geographical, social, and economic factors. A multi-sectoral approach is utilized to evaluate the impacts of climate change, along with associated risks and vulnerabilities. This method is utilized in climate-sensitive priority sectors, including agriculture, water resources, health, and ecosystems. Assessments based on socio-economic factors are essential for comprehending the effects on the most vulnerable populations, particularly in coastal, rural, and remote regions. A participatory approach that engages local communities in decision-making is employed to guarantee adaptation actions that are both locally relevant and sustainable.

The evaluation of climate change effects in Indonesia depends on global and regional climate projection models, including CMIP6 and CORDEX-SEA, which offer data on anticipated alterations in temperature, precipitation, and extreme weather phenomena. These models facilitate the assessment of economic impacts and disaster risks, subsequently quantifying potential economic losses. Analyses frequently utilize historical data and future projections, incorporating climate data from local observation stations and satellites. Meteorological, Climatological, and Geophysical Agency / *Badan Meteorologi, Klimatologi, dan Geofisika* (BMKG) plays essential role in providing climate data. Furthermore, high spatial resolution projection data obtained through dynamic downscaling methods are employed to enhance the precision of risk assessments at the local level.

The high climate variability in Indonesia presents challenges of uncertainty, complicating long-term predictions. Variations in climate projection models, including the application of CMIP6 and diverse SSP scenarios, contribute additional uncertainty regarding the efficacy of adaptation strategies. The limitations of meteorological data, particularly in remote regions, pose challenges in comprehending the specific risks encountered by local communities. The restricted access to high-resolution data from recent scenarios, including the AR6 SSPs, constrains the capacity for conducting more comprehensive evaluations at national and local scales.

Significant challenges encompass socio-economic conditions that intensify community vulnerability, including poverty, gender inequality, and restricted access to resources. The economic sectors susceptible to climate change, such as agriculture and water resources, have multiplier effects on other sectors complicating the implementation of adaptation strategies. Complexity arises from the necessity to synchronize development requirements with adaptation initiatives. The effective implementation of climate change adaptation strategies is hindered by the challenge of cross-sectoral and intergovernmental coordination between national and local governments.

3.3 Adaptation Priority and Barriers

3.3.1 Climate Change Adaptation Priorities

In Indonesia, climate change adaptation focuses on addressing the impacts and risks associated with climate change, especially in designated priority areas. Adaptation action guidelines are customized to specific local contexts, informed by data on vulnerabilities, risks, and projections of climate change impacts. Guidelines for climate change adaptation in priority areas are outlined in several pertinent policy documents, including: Adaptation Communication (ADCOM) (MoEF, 2022b), Indonesia Long-Term Strategy on Low Carbon and Climate

Resilience (LTS-LCCR 2050) (MoEF, 2021c), Enhanced NDC (ENDC, 2022), and Climate-Resilient Development (Bappenas, 2021a).

The primary objective of adaptation in Indonesia is to enhance climate resilience, which encompasses three dimensions: economic resilience, social and livelihood resilience, and ecosystem and landscape resilience. The objective is accomplished by enhancing adaptive capacity to mitigate the risk of losses resulting from climate change impacts. Adaptation prioritization occurs through two approaches: regional and sectoral prioritization, as detailed in the ADCOM (MoEF, 2022b) and LTS-LCCR 2050 (MoEF, 2021c) documents. Regional prioritization is achieved by mapping areas according to risk factors associated with climate change impacts and the conditions of regional vulnerability. Sectoral prioritization addresses areas significantly impacted by climate change, namely: food, water, energy, health, ecosystems, and disaster management (MoEF, 2022b). The implementation of climate change adaptation strategies is reinforced by operational regulations, specifically: PERMEN LHK No. 33/2016 concerning the formulation of climate change adaptation actions, PERMEN LHK No. P.7/2018 providing guidelines for vulnerability, risk, and climate change impact assessments, and PERMEN LHK No. 84/2016 on Climate Village Program / *Program Kampung Iklim* or *Program Komunitas Iklim* (ProKlim) that encourages communities and related parties to perform local actions on climate change mitigation and adaptation.

Climate change adaptation actions in Indonesia are incorporated into national development planning documents, specifically the National Medium-Term Development Plan / *Rencana Pembangunan Jangka Menengah Nasional* (RPJMN) and the National Action Plan for Disaster Risk Reduction / *Rencana Aksi Nasional Pengurangan Risiko Bencana* (RAN-PRB). The national priorities outlined in the 2020-2024 RPJMN encompass seven development agendas, including the objective of fostering a sustainable environment and improving resilience to disasters and climate change (Bappenas, 2020). This guarantees that adaptation actions enhance climate resilience while also yielding co-benefits in the reduction of greenhouse gas emissions (KLHK, 2021b). The coherence of priority sector adaptations outlined in the BTR1 Report—specifically food, water resources, health, and ecosystems—is elaborated upon below.

3.3.1.1 Food

Priorities for adaptation in the food sector focus on enhancing food commodity production, intensifying agricultural practices, and addressing food demand. This adaptation focus aligns with three Priority Programs outlined in the MoA's Strategic Plan (RENSTRA) 2020-2024: Priority Program no.3 seeks to enhance food consumption quality and security, alongside the availability of agricultural products, by employing sustainable production methods. Additionally, Priority Program no.6 promotes the industrialization of the agricultural sector, generates employment opportunities, and enhances investment (KEMENTAN, 2023b). The ministry aims to enhance the productivity and welfare of human resources in the agricultural sector by promoting sustainable productivity that adapts to climate change and by improving the governance of the national food system. Strengthening is implemented through Priority Program no.7, emphasizing vocational education, research, innovation, and the safeguarding of intellectual property rights to establish an innovation ecosystem that facilitates technology transfer and the development of innovative products (KEMENTAN, 2023b).

3.3.1.2 Water Resources

Adaptation priorities in the water resources sector focus on managing water supply and demand to enhance storage capacity, safeguard infrastructure against climate change effects, and

broaden water distribution networks. The prioritized actions for water resources adaptation align with the national programs outlined in the RPJMN IV 2020-2024, specifically programs 1, 2, and 5. Kemen PUPR aligns with these priorities by ensuring equitable management of water resources in Indonesia through the enhancement of basic service infrastructure, development of strategic areas, and rehabilitation of vegetative lands (Kemen PUPR, 2022). The primary actions encompass the development of irrigation networks and water collection systems, the implementation of weather modification technologies to mitigate droughts and floods, and the enhancement of integrated water resources management institutions within river basins. The priority actions are implemented via the National Strategy for Sustainable Groundwater and Raw Water Management and the National Strategy for Infrastructure Disaster Management, emphasizing the development of disaster resilient infrastructure, management of disaster-prone areas, and restoration of priority river basins (PUPR, 2020b). Water management involves the implementation of both non-structural and structural adaptation actions aimed at mitigating water-related risks associated with climate change, such as floods, coastal erosion, and water pollution.

3.3.1.3 Health

The priority of adaptation in the health sector aligns with National Priority (PN) 3 of the RPJMN IV 2020-2024, particularly within Development Priority (PP) 3, which focuses on enhancing health services to achieve universal health coverage, and PP 5, which aims to improve the well-being of children, women, and youth. These priorities are further outlined in the Ministry of Health's Strategic Plan (RENSTRA) to meet key national health targets, including maternal and child health, community nutrition, disease prevention and control, the Healthy Living Community Movement (Germas), and strengthening the health system through transformative health initiatives (Regulation by Minister of Health/PERMENKES: 3/2022). Efforts to reach these goals include strengthening nutrition programs, enhancing disease surveillance, mitigating the urban heat island effect, and improving residential environments ADCOM (MoEF, 2022b).

The prioritization of climate change adaptation in the health sector includes: (1) enhancing early detection of disease outbreaks, (2) improving of health information systems, (3) capacity building for government health agencies, (4) strengthening community capacity for disease outbreak prevention; (5) reinforcing health regulations; (6) ensuring sustainable health financing (Bappenas, 2021b). This approach also emphasizes the importance of ensuring access to clean water by addressing both quantity and quality. Key initiatives include constructing and maintaining clean water and sanitation infrastructure to mitigate water-borne diseases, conducting educational campaigns on hygiene and sanitation, and implementing safe drinking water treatment practices (KEMENKES, 2022).

3.3.1.4 Ecosystem

The adaptation priorities in the ecosystem sector are based on several national and sub-national policies that align with the Development Agenda in the National Medium-Term Development Planning (RPJMN) IV 2020-2024, articulated explicitly in the National Priority (PN) 6 is building the environment, increasing disaster resilience, and climate change. The priorities focus on managing airspace ecosystems, terrestrial ecosystems, freshwater, coastal areas, and marine environments. The adaptation efforts regarding the priorities carried out through ministries/agencies include the following: sustainable management and utilization of land and sea resources and ecosystems; protection and restoration of ecosystems; developing and

making effective management of conservation areas, including marine conservation areas; increasing public awareness and involvement in ecosystem protection in reducing the impacts of climate change; development of eco-climate zoning to regulate ecosystem services and functions; adopting Ecosystem-based Adaptation (EbA) (KLHK, 2019); and public participation in sustainable environmental management.

3.3.2 Challenges, Gaps and Barriers to Adaptation

The implementation of adaptation actions priority encounters numerous challenges, gaps, and obstacles. Institutional factors, financial constraints, and limited access to technology serve as obstacles to the implementation of adaptation strategies. The challenges encountered consist of the limited or varied capacities of local governments in planning and executing adaptation priorities, the necessity to enhance coordination among institutions, and the inconsistent comprehension of climate change impacts at the local level.

National level adaptation actions must be synchronized with the national development plan such as medium-term development plan to ensure alignment with local needs. Financial challenges are associated with the reliance on international donor funds for adaptation activities, raising concerns regarding program sustainability. Budgetary limitations frequently hinder the execution of adaptation programs, particularly in the adoption of advanced technologies and optimal practices. Funding gaps highlight the necessity for enhanced budget allocations and the attraction of private sector investment.

Additionally, significant challenges pertain to the comprehension, strategizing, and administration of climate change adaptation priorities. The variability of Indonesia's regional characteristics and the uncertainties inherent in climate impact assessments pose challenges in identifying suitable adaptation strategies and their execution. Moreover, restricted access to precise technology and data impedes effective planning. The identified limitations hinder the assessment of adaptation needs across various priority areas, necessitating sufficient technological and infrastructural support. Specific challenges in the priority areas are further explored and explained as follows.

3.3.2.1 Food

The food sector in Indonesia encounters multiple challenges that impede its economic potential, including the prevailing negative perception of agriculture as a low-status and undesirable occupation (KEMENTAN, 2023b). The agriculture workers are predominantly composed of older individuals, with only 9.08% aged 15-24 years. This demographic trend raises concerns regarding the regeneration of farmers and the potential for innovation (KEMENTAN, 2023b). The low level of education presents a challenge, as 59.3% of farmers have not completed primary education. Additionally, challenges in securing capital compel many farmers to depend on their own resources (National Socio-Economic Survey / *Survei Sosial Ekonomi Nasional*-SUSENAS, 2022). The transformation of agricultural land into residential or commercial properties poses a risk to productivity, evidenced by a 0.3% annual decline in agricultural land attributed to such conversions (BPS, 2023d). Agricultural production remains concentrated on the island of Java, posing risks to national food security (BPS, 2023d). Training programs, modernization, and land protection policies are essential to enhance food security and improve the appeal of the agricultural sector for the younger generation.

3.3.2.2 Water Resources

Challenges in adapting the water resources sector in Indonesia encompass several obstacles that impede the effectiveness of implemented programs. The management of agricultural water

resources presents a significant challenge, as many farmers and land managerscontinue to depend on conventional systems, thereby affecting the efficiency of water management in agriculture. Accurate and evenly distributed data is essential for effective water resources management. This includes the need for uniform approaches in analyzing the potential for water damage, particularly through guidelines addressing the impact of climate change on anticipated rainfall. The disparity in human resource capacity presents a challenge in identifying, planning, and managing the risks associated with climate change impacts on the water resources sector.

Adapting to climate change through structural and non-structural measures presents challenges in aligning with sub-national spatial planning, primarily due to discrepancies in their objectives. This presents challenges during on-the-ground implementation, resulting in certain programs being unable to be executed directly (PUPR, 2022; BNPB, 2022). Additionally, Weather Modification Technology (WMT) encounters challenges related to elevated operational costs and the necessity for robust cross-sectoral coordination (BMKG, 2023a).

3.3.2.3 Health

The limited resources, both in terms of budget and personnel, are the main constraints and challenges in the implementation of adaptation in the health sector (KEMENKES, 2023a). Certain regions encounter challenges in data reporting, resulting in delays and inconsistencies that hinder responses to public health emergencies (BPS, 2022c). In addition, limited technology and internet access hinder the effectiveness of the implementation of adaptation programs, including reporting through systems like the Early Warning and Response System (EWRS), the Vector Surveillance Information System (Silantor), and the Malaria Information System (SISMAL). The lack of health entomologists in numerous regions also presents a significant obstacle to the advancement of adaptation efforts. Geographical constraints in specific regions exacerbate the situation, leading to dependence on central resources and limited technical capacity for independent vector control, thereby hindering uniform adaptation implementation. On the other hand, the community's awareness and behavior concerning the impacts of climate change and potential solutions remain inconsistent, especially in the Lagging, Forefront, and Outermost regions, which is also a crucial factor.

3.3.2.4 Ecosystem

Common challenges include constraints related to funding, infrastructure, and the length of program implementation. The sustainability of programs is frequently suboptimal, attributed to inadequate monitoring and evaluation systems and insufficient stakeholder involvement in maintenance and post-implementation activities (KLHK, 2022b). Several additional challenges exist, including suboptimal coordination and collaboration among stakeholders, insufficient community understanding and participation, and conflicts of interest concerning resource management. These issues manifest in practices such as water sharing and the selection of plant species in conservation or restoration programs for specific ecosystems.

3.3.2.5 Climate Services

The availability of the latest detailed climate projection data is crucial for supporting vulnerability and risk assessment and mapping in Indonesia. High-quality climate data with detailed spatial and temporal resolution, encompassing both historical and projection periods, is essential, particularly at the local level. BMKG is responsible for managing climate data derived from observations and currently operates 186 observation stations across Indonesia (BMKG, 2023b) (Figure 3-10). Challenges persist in enhancing the quantity and distribution

of observation stations, particularly in mountainous and hilly regions susceptible to hydrometeorological disasters. The preparation of long-term climate projections by BMKG encounters limitations stemming from inadequate computing systems and insufficient human resources.

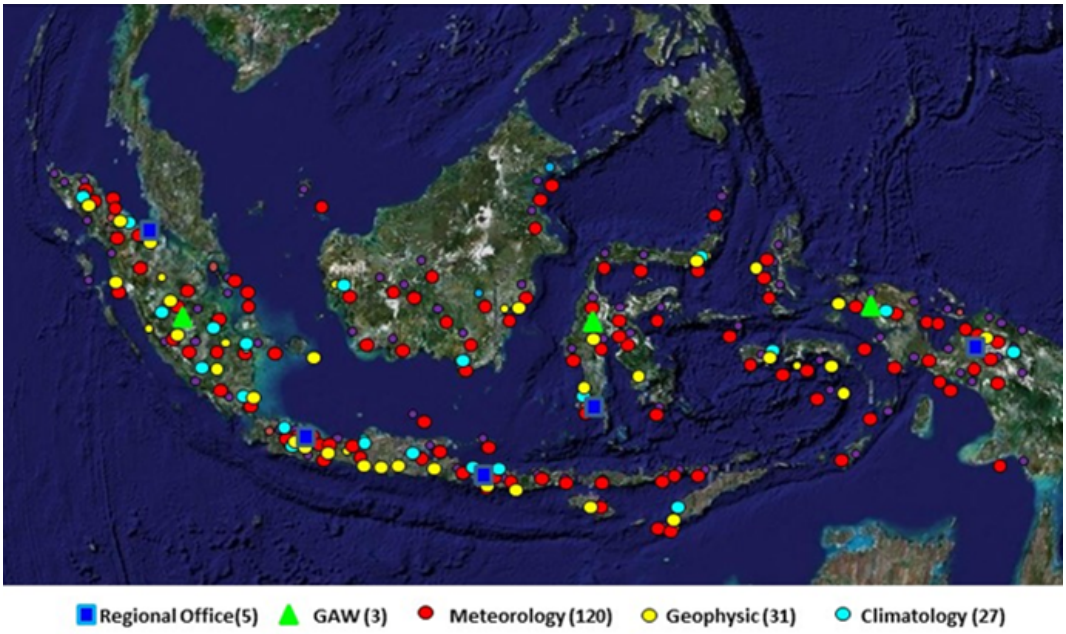


Figure 3- 10 Distribution of BMKG-owned MKG observation stations. (Source: BMKG, 2023)

3.4 Adaptation Strategies, Policies, Plans, Goals, and Actions To Integrate Adaptation Into National Policies and Strategies

3.4.1 Coherence of Adaptation Action Strategies with National Development

Climate change adaptation strategies are incorporated into the national development framework to improve economic, social, and livelihood resilience, along with ecosystem and landscape resilience to the impacts of climate change. The adaptation strategies outlined in the Climate Change Adaptation Roadmap document (KLHK, 2020b) comprise eight primary strategies. The initial step entails fortifying integrated multi-sectoral policy instruments and frameworks, encompassing data collection and coordination to improve the execution of adaptation strategies. The second step highlights the necessity of integrating adaptation into development planning via cross-sectoral financial mechanisms and investment. Furthermore, climate literacy is a critical aspect of the third strategy, as heightened awareness of climate change risks is essential for informing evidence-based adaptation measures (Figure 3-11).

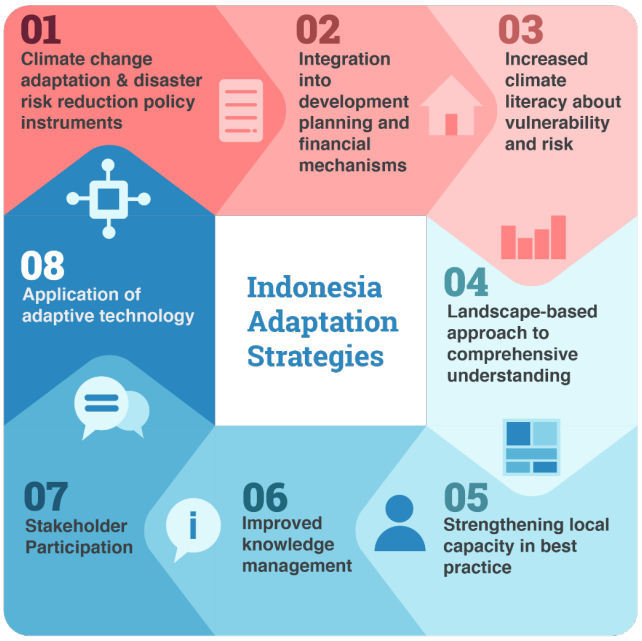


Figure 3- 11 Eight key climate change adaptation strategy groups

The fourth strategy employs a holistic landscape-based approach to enhance the understanding of the integration of spatial planning and land development, particularly in regions susceptible to climate change. The fifth step emphasizes the enhancement of local capacities through culturally and gender-informed best practices, while the sixth strategy highlights the significance of knowledge management in reinforcing adaptation coordination grounded in existing scientific data. The seventh strategy emphasizes enhanced stakeholder participation to promote multi-sectoral synergies in the execution of adaptation programs. The final step involves the application of adaptive technology, which seeks to ensure that the adaptation measures implemented are effective in risk reduction while also offering supplementary benefits for climate change mitigation.

The integration of adaptation strategies with development planning focuses on both long-term and medium-term objectives, exemplified by the RPJMN 2020-2024. This RPJMN prioritizes the enhancement of climate resilience and disaster resilience. The National Action Plan for Climate Change Adaptation / *Rancangan Aksi Nasional Adaptasi Perubahan Iklim* (RAN-API), initiated in 2014, which revised and transformed to Climate Resilient Development/Pembangunan Berketahanan Iklim (PBI) in 2021, functions to serve the efforts of climate change actions endorsed by the RPJMN 2020-2024. The integration of adaptation policies and development planning is evident at the sub-national level (i.e., Provincial or District) via the Sub-national Action Plan for Climate Change Adaptation/*Rencana Aksi Daerah Adaptasi Perubahan Iklim* (RAD-API), enabling provincial and local governments to formulate adaptation strategies that address the unique requirements of their regions. MoEF facilitated the sub-national government to develop the RAD-API. This facilitation assists the responses to the effects of climate change, ensuring the impacts and vulnerabilities are adequately addressed.

To enhance global resilience and reduce climate vulnerabilities, adaptation strategies aligned with the Global Goal on Adaptation (GGA) were established under the Paris Agreement. The

GGA provides a framework for evaluating adaptation progress by improving capacity and resilience. Indonesia supports this goal with tools like The Vulnerability Index Data Information System / *Sistem Informasi Data Indeks Kerentanan* (SIDIK), which assesses climate vulnerabilities, and platforms that are developed for managing information on climate change adaptation, related programs, tools, and actions initiated by MoEF and map disaster risks (InaRisk) by BNPB (Table 3-1). These data-driven systems aid in implementing Decision 7/CMA.3, fostering effective adaptation to climate impacts.

Table 3- 1 Mapping of existing modalities in Indonesia in accordance with global goal on adaptation commitments

No.	GGA Commitments (Based on Decision 7/CMA.3 of the Paris Agreement)	Available Modalities Aligned with GGA Commitment Guidance
1.	Establish impact, vulnerability, and risk assessments (by 2030)	SIDIK (KLHK): http://sidik.menlhk.go.id/ InaRisk (BNPB): https://inarisk.bnpb.go.id/ VAA → health risk: https://apikkemkes.id/home
2.	Multi-hazard early warning systems (by 2027)	Extreme Weather Early Warning: https://signature.bmkg.go.id/ Flood Early Warning: https://dashboardpencegahan.bnpb.go.id/ Dengue Early Warning (Jakarta): https://iklim.bmkg.go.id/id/dbdklim/
3.	Climate information services for risk reduction and systematic observation (by 2027)	BMKG: https://iklim.bmkg.go.id/id/
4.	Country-driven, gender-responsive, participatory, and transparent national adaptation plans (by 2030)	Annex 2 Enhanced NDC, Climate Resilient Development Policy (Bappenas, 2021a), APIK (KEMENKES, 2019), National Action Plan (in progress)
5.	Develop and operationalize monitoring, evaluation and learning systems (by 2030)	AKSARA (Monitoring and Evaluation of RPJMN achievements): https://pprk.bappenas.go.id/aksara/ National Registry System: https://srn.menlhk.go.id/

3.4.2 Priority Sector Adaptation Strategies

In Indonesia, the attainment of climate change adaptation objectives is facilitated by eight action-oriented strategies outlined in the NDC Adaptation Roadmap, which are systematically aligned with the priority sectors identified in BTR1: agriculture, water resources, health, and ecosystems. The Government of Indonesia seeks to fortify policies, improve capacities, and employ adaptive technologies to effectively tackle the challenges posed by climate change.

In the agriculture sector, identified actions align with the Priority Programs outlined in the Ministry of Agriculture's Strategic Plan (RENSTRA), including the development of agricultural financing schemes, improvement of water management systems, enhancing capacity building for extension workers and farmers, development of superior crop varieties, and improvement climate-adaptive agricultural information systems. The government is

promoting crop diversification, organic fertilizer usage, and the adoption of climate resilient irrigation technologies. Climate change adaptation seeks to improve resilience to climate impacts while also facilitating the reduction of greenhouse gas emissions, as outlined in the LTS-LCCR 2050 document (MoEF, 2021c). One example is implementing the Climate-Smart Agriculture (CSA) concept, an adaptation activity with mitigation co-benefits. For example, composting houses aim to reduce greenhouse gas emissions while enhancing soil carbon sequestration and increasing soil water holding capacity.

The water resources sector strategy aims to reduce consumption and enhance the efficiency of water management, aligning with the national adaptation strategy. Subsequent policies focus on enhancing water storage capacity by developing infrastructure, including dams and irrigation systems. This strategy employs a landscape-based approach that takes into account the specific regional conditions relevant to water resources management. The development of climate-adaptive infrastructure to respond to shifting rainfall patterns, alongside integrated water management initiatives, is anticipated to enhance national water security. Supportive actions involve the management of water resources (PSDA), the administration of water tariffs, and the formation of Technical Implementation Units (UPT), which include 12 River Basin Centers (BBWS) and 25 River Basin Offices (BWS) throughout Indonesia (PUPR, 2020a).

The health sector primarily focuses on the impacts of climate change, particularly the increasing prevalence of vector-borne tropical diseases. Enhancing the health surveillance system and optimizing health services to combat diseases like dengue fever and malaria are essential priorities in adaptation efforts. The government is actively enhancing public understanding of the impacts of climate change on health by involving multiple stakeholders in educational initiatives and fostering collaborations across sectors and programs. The adaptation of the health sector fosters the production of traditional and herbal medicines, thereby enhancing economic resilience and decreasing the carbon footprint, consistent with national policy on pharmaceutical and medical device development.

In the ecosystem sector, the EbA approach serves as the principal strategy for the protection and restoration of ecosystems impacted by climate change. The government has initiated efforts to restore forests and rehabilitate coastal regions to sustain ecosystem balance and safeguard biodiversity. This approach is essential for mitigating natural disasters, including floods and landslides, which are increasingly prevalent due to climate change. Indonesia is enhancing climate change adaptation across multiple development sectors through a cohesive approach, ensuring these measures support climate-friendly sustainable development.

The government is enhancing knowledge management related to climate change to support the implementation of adaptation strategies by developing a web-based portal initiated by MoEF (https://adaptasi.ppi.menlhk.go.id/), which is accessible to various stakeholders. This system was established to integrate climate data, disaster risks, and adaptation actions, thereby facilitating the monitoring and evaluation of implemented actions. The adaptation portal requires further development to facilitate local capacity building via training and mentoring, thereby supporting the implementation of adaptation actions across diverse regions. The utilization of adaptive technologies is a central focus in enhancing adaptation actions, especially within priority sectors. The government is advocating for the implementation of smart technologies that can reduce risks associated with climate change impacts and facilitate climate change mitigation efforts. Standardization and monitoring of adaptive technologies are conducted to ensure sustainability, particularly in response to the complexities of climate change impacts.

Stakeholder participation is essential for effectively implementing climate change adaptation strategies. The government is promoting the engagement of all stakeholders, including communities and the private sector, in the development and execution of adaptation strategies. The implementation of adaptation strategies, especially in priority areas, is anticipated to be more effective through collaboration. Collaboration among stakeholders, capacity building, and the implementation of adaptive technologies serve as fundamental components for attaining sustainable climate resilience.

3.4.3 Stakeholder Participation, Local Knowledge, and Gender Perspectives

The incorporation of scientific knowledge, gender perspectives, and traditional, indigenous, and local knowledge constitutes a crucial framework for climate change adaptation planning and implementation. Climatological and meteorological data (BMKG, 2023) are utilized to forecast and observe indicators of climatic trends and projections. This data underpins the analysis of impact, vulnerability, and risk associated with climate change effects. Climate modeling serves to project the impacts of climate change and identify the most vulnerable regions, facilitating targeted and suitable adaptation strategies (IPCC, 2021). Knowledge management pertaining to climate change adaptation is essential. The initiative for a knowledge-sharing portal, overseen by the MoEF as the National Focal Point for Climate Change, serves as an effective mechanism for managing and disseminating information on climate change adaptation (https://adaptasi.ppi.menlhk.go.id/). Effective knowledge management facilitates broad access to data and information regarding climate change adaptation, thereby enhancing the capacity of communities and relevant stakeholders.

The incorporation of gender perspectives in the development of adaptation policies is essential. The gender perspective seeks to analyze the differential impacts of climate change on men and women, while advocating for inclusive participation through the involvement of women in decision-making processes. Programs such as adaptation skills training and economic support for women have been established to address their needs in relation to climate change (UNDP, 2022). This confirms that effective adaptation strategies should account for gender differences to enhance inclusivity and responsiveness to the needs of the entire community.

Conversely, indigenous, traditional, and local knowledge play crucial roles in Indonesia's climate change adaptation strategies. The government has implemented traditional practices through community-based actions, known as Community-Based Climate Action (CBCA), which have demonstrated effectiveness in mitigating climate variability. This encompasses the management of natural resources in a sustainable manner and the incorporation of local knowledge regarding weather patterns and biodiversity into adaptation strategies. Communities have implemented various adaptation actions, both independently and through government-initiated programs, including Disaster Resilient Villages (Destana) and the Climate Village Program (ProKlim) (ADCOM, 2022). The actions demonstrate community involvement in tackling climate change challenges, emphasizing the integration of their knowledge in adaptation planning. This ensures that the implemented adaptation strategies are pertinent to the local context and incorporate local wisdom.

The Government of Indonesia encourage private sector to take part in climate change adaptation initiatives. While private-based actions frequently occur independently and may overlook climate change, certain initiatives demonstrate an understanding of the significance of adaptation. Challenges, including low investment returns and insufficient awareness of climate change risks, hinder private sector participation in adaptation projects (BKF, 2021).

Effective climate change adaptation requires collaboration among government entities, communities, and the private sector to establish a comprehensive supporting system.
At the local community level, the government acknowledges the significant role of the communities in the sustainable management and use of natural resources (KLHK, 2022b). The government's Social Forestry Program exemplifies the involvement of local communities in forest management, aligning with their traditional knowledge and cultural values. The agricultural zoning practice in Kasepuhan, Banten, exemplifies the prudent management of natural resources by indigenous communities (Prabowo dan Sudrajat, 2023). Challenges persist in engaging communities in adaptation actions. Effective narratives and communications are essential for disseminating knowledge regarding climate change and adaptation within communities, particularly in rural regions. The involvement of local communities in adaptation initiatives remains primarily confined to conservation programs, necessitating greater encouragement for their role as key contributors to adaptation efforts.

3.5 Progress on Implementation of Adaptation

3.5.1 Climate Change Adaptation Action Program

The framework for advancing climate change adaptation in Indonesia focuses on three primary areas: economic resilience, social and livelihood resilience, and ecosystem and landscape resilience. Each category is defined by a range of programs, strategies, and actions implemented in alignment with the eight adaptation strategies outlined in the preceding sub-section. The initial inclusion of adaptation action occurred in the First NDC in 2016, accompanied by general adaptation guidance. Following the updates in 2021 documented at the Updated NDC and in 2022 through the Enhanced NDC (ENDC), the adaptation strategies have been elaborated and intensified. The integration with the Paris Agreement and the engagement of stakeholders from diverse sectors, including local communities and the private sector that participations are encouraged and acknowledged by the ProKlim, has become increasingly apparent. This enhancement aligns with national documents, including the 2020-2024 RPJMN and Indonesia's 2045 Vision. These efforts demonstrate Indonesia's commitment to addressing climate change comprehensively and sustainably.
This BTR1 report necessitates an evaluation of several key elements, including the formulation of national policies and strategies, implementation of adaptation actions, engagement of stakeholders, and enhancement of capacity building. Monitoring progress is essential for tracking the implementation of adaptation in a transparent manner. Indonesia's dedication to climate change adaptation encompasses multiple programs designed to strengthen resilience across economic, social, and ecological dimensions, as reflected with the ENDC (MoEF, 2022a). To improve economic resilience, six main programs, ten strategies, and 25 activities must target food systems, ecosystems, water resources, and disaster management. The Disaster Resilient Village program, sustainable agriculture via agroforestry, and the People's Business Loan / Kredit Usaha Rakyat (KUR) contribute to the maintenance of food security (KEMENTAN, 2022b). Weather Modification Technology in the water sector contributes to the disaster risk reduction, particularly in coastal regions. Initiatives like the KUR for agricultural sector, facilitates access to financing for farmers to tackle climate-related challenges. Social resilience is enhanced through 6 key programs, 10 strategies, and 20 actions that address health and ecosystems. Programs like ProKlim and regional agricultural initiatives are essential for enhancing community resilience. Social resilience isfostered through

initiatives designed to enhance community quality of life, including the Slum-Free City (KOTAKU) program and Child-Friendly Schools, alongside the provision of essential infrastructure like clean water via PAMSIMAS.
The 2022 ENDC outlines ecosystem resilience targets comprising 5 key programs, 9 strategies, and 21 actions aimed at ecosystem management. Notably, social forestry is highlighted for its role in water conservation and adaptation within the energy sector. The program directives emphasize environmental preservation and restoration. Forest and land rehabilitation program aims to restore degraded forest ecosystems resulting from deforestation. The Peat Care Village program and the Indonesian Coastal School engage the community in the active protection of natural resources and the sustainability of ecosystems (Table 3-2).

Overall, the adaptation programs improve economic, social and livelihoods, as well as ecosystem and landscape resilience and promote central, regional, and local government collaboration. The programs address climate change's effects on food security, water management, disaster risk mitigation, and environmental protection for Indonesia's sustainable future. The national and sub-national governments, acted as policymakers, adaptation actors, facilitators, or funders, may collaborate and cooperate with non-government organizations, private sectors, and development partners, to undertake adaptation efforts. Funding allocation from the state budget (APBN), regional budgets (APBD), as well as international and national donor institutions also support the realization of adaptation programs, with the community as the implementers or actors in carrying out adaptation actions on the ground.

Table 3- 2 Summary of monitoring the achievement of action implementation based on ENDC

Adaptation Commitment	Key Program Directives, Strategies, and Actions *Source:* ENDC (MoEF, 2022a)	Achievements *Source*: ADCOM (MoEF, 2022b)	Actions Not Yet Planned
Economic Resilience	6 key programs, 10 strategies, 25 actions *Sectors: Food, Ecosystem, water, disaster management*	• Implemented / in progress: 20 actions • Planned: 1 action • Not yet planned: 4 actions	1. Identification and development of best practices in river basin management 2. Identification and development of best practices and local wisdom in the utilization of forest resources 3. Identification and development of best practices in land use and management. 4. Rehabilitation of degraded land with species suitable for energy
Social and Livelihood Resilience	6 key programs, 10 strategies, 20 actions *Disaster, Health, Ecosystem, Energy, Water*	• Implemented / in progress: 16 actions • Not yet planned: 4 actions	1. Capacity building for all stakeholders in responding to the Early Warning System (EWS) 2. Protection of historical and cultural sites 3. Integration of SIDIK into various related systems regarding vulnerability, risk, and impact 4. Integrating adaptation into infrastructure development and maintenance
Ecosystem and Landscape Resilience	5 key programs, 9 strategies, 21 actions *Sectors: Ecosystem, Disaster, Water, Energy*	• Implemented / in progress: 14 actions • Not yet planned: 7 actions	1. Identification and development of best practices in social forestry 2. Facilitation, supervision, and compliance with the principles of sustainability applied to each social forestry scheme 3. Application of EFT in social forestry 4. Restoration of degraded coastal areas as important ecosystems 5. Prevention and eradication of invasive alien species 6. Developing policy instruments and tools to assess vulnerability, risk, and climate impacts on national priority watersheds 7. Awareness campaigns on the importance of integrating vulnerability, risk, and climate impacts in urban planning and development

Source: Adaptation Communication - ADCOM (MoEF, 2022b) based on ENDC (MoEF, 2022a) directives

3.5.2 Implementation of Priority Sector Adaptation Actions

3.5.2.1 Food

The adaptation actions in the food sector focus on climate change adaptation for sustainable agriculture and plantations. These actions are identified through five strategic action directives coordinated by five implementing units within MoA (Figure 3-12). Climate-Smart Agriculture approaches are applied across various actions, such as the development of agricultural financing schemes, improvement of water management systems, enhancing capacity building for extension workers and farmers, development of superior crop varieties, and improvement climate-adaptive agricultural information systems.

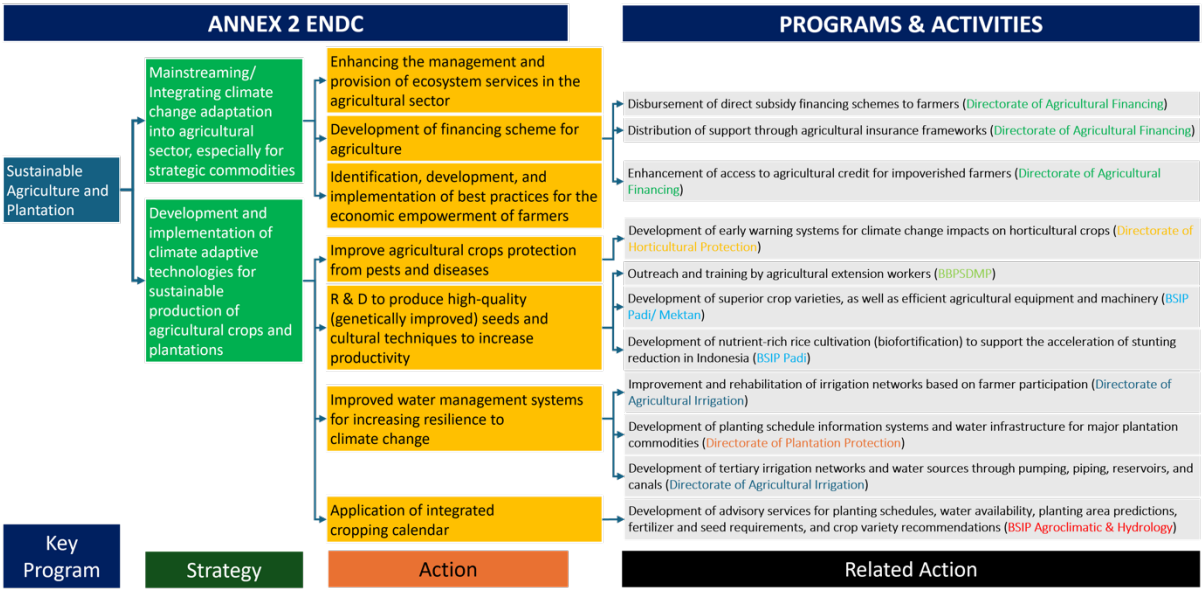


Figure 3- 12 Tracing the implementation of adaptation actions based on Annex 2 of the ENDC in agricultural sector

MoA offers Indonesian farmers financing schemes for; 1) KUR 2) Agricultural Equipment Business Loan / Kredit Usaha Alat Mesin Pertanian (KUA), and 3) Agricultural Insurance. KUR offers unsecured credit and interest subsidies to farmers/Farmer Groups/Joint Farmer Groups. KUA, a 500 million–2 billion IDR credit for Agricultural Machinery and Equipment Service Provider Units, was developed in 2022. KUA is used to buy agricultural machinery and equipment with a 10% down payment and collateral. Assigned banks/non-banks channel KUR and KUA. In 2022, 2,070 farming business operators have obtained access to financing through credit and funding facilitation programs. Insurance assignments to PT Jasindo include a total of 353,258.50 Ha of rice fields protected by Rice Farming Business Insurance/Asuransi Usaha Tani Padi (AUTP) and 67,436 heads of Cattle/Buffalo Farming Business Insurance/Asuransi Usaha Tani Sapi/Kerbau (AUTS/K). MoA subsidies 80% of AUTP premiums, 62.5% of AUTS/K, and farmers cover the remaining costs. The AUTP compensation is 6 million IDR and the AUTS/K compensation is 10 million.

To strengthen water resilience in the agricultural sector, the MoA has launched programs related to water management, including the rehabilitation of tertiary irrigation networks and the construction of *embungs* (small reservoirs). In 2022, several provinces restored 3,000 tertiary irrigation networks (RJIT), build 688 pumped irrigation, 150 piped irrigation, and 400

embungs. The Main Commodity Plantation Water Infrastructure and Crop Planning Information System (SIRAMI KEBUNKU) initiative is being developed. More precise data and information updates and public system dissemination are needed to support thewidespread and sustainable use of the SIRAMI KEBUNKU application.

To protect crops from the impact of climate change, the Early Warning System (EWS) for Horticultural Crop Management and Early Warning System (SIPANTARA) was introduced to monitor and predict natural disasters that may lead to crop damage. This application enables farmers to optimize planting schedules and protect crops from unfavorable weather conditions. This application has been deployed across Indonesia, serving as a valuable tool in tackling the challenges posed by climate uncertainty.

Research and development of New Superior Varieties/Varietas Unggul Baru (VUB) are essential for maintaining crop productivity, particularly in challenging climates. Since the 1960s, more than 300 new rice varieties have been developed to address climate change, including extreme weather conditions. This effort is vital to ensure agricultural productivity remains stable despite changing climate conditions.

To accelerate technology dissemination, MoA also conducts outreach through online webinars such as "Ngobrol Asyik" (Ngobras) and Mentan Sapa Petani dan Penyuluh (MSPP), along with technical guidance for extension workers and farmers throughout Indonesia. Support programs for extension workers include Operational Assistance for Extension Workers/Biaya Operasional Penyuluh (BOP) for transportation, mobile data package support for webinar participation, and field schools that enhance farmers' and extension workers' skills using fields as learning environments. A notable initiative, Genta Organik (Gerakan Tani Pro Organik), encourages farmers to independently produce and use organic fertilizers and natural pesticides. This program has been implemented in 1,020 farmer group field schools across 32 provinces, supported by the SIMURP (Strategic Irrigation Modernization and Urgent Rehabilitation) project, which aims to improve production, enhance knowledge in CSA, reduce crop failure risks, lower greenhouse gas emissions, and increase farmers' incomes in irrigated and swamp paddy fields.

Planting Calendar Information System/Sistem Informasi Kalender Tanam Terpadu (SI KATAM), later Adaptive Information System for Planting Planning/Sistem Informasi Adaptif untuk Perencanaan Tanam (SIAP TANAM), uses climate adaptation technology. This approach gives water, fertilizer, and production estimations for climate-adaptive planting planning. Farmers across Indonesia can now access this system for irrigated paddy fields, rainfed paddy fields, and swamp paddy fields. With regularly updated information, farmers can optimize their agricultural practices for both wet and dry seasons and reduce the risk of rice crop failure by forecasting rice production and distribution up to four months ahead.

An integrated planting calendar and water management and irrigation network improvements are part of this sustainable farming program. SIAP TANAM helps farmers grow at the proper time based on the latest climatic data to adapt to climate change-induced weather patterns. Overall, the agricultural climate change adaptation framework is designed to improve food security, farmer empowerment, and environmental sustainability.

3.5.2.2 Water Resources

In the realm of water resources, adaptation actions are implemented by multiple ministries and agencies (K/L). This program consists of 11 action directives executed in coordination with various K/L (Figure 3-13). Key programs in integrated watershed management encompass strategies aimed at enhancing cross-sectoral and regional synergies, incorporating climate

change adaptation, and fostering climate resilient ecosystem management. The initial strategy involves action directives that constitute a program aimed at implementing an integrated upstream and downstream approach for forest rehabilitation and restoration, alongside the protection of terrestrial water resources. This action program is derived from the key integrated watershed management program and is executed through various initiatives, including forest and land rehabilitation, as well as the provision of irrigation infrastructure and water collection for irrigation purposes. The activities are cross-cutting program conducted by various Ministries or Institution related to water resource management, i.e. Kemen PUPR and MoEF. The supporting information system, SIMDAS (http://sipdas.menlhk.go.id/), was developed by MoEF to facilitate the integrated watershed management program and has been conducted on an annual basis by MoEF . The subsequent action directive involves establishing a supportive environment through the development of relevant documents and the implementation of technology, such as weather modification operation (OMC) technology, in collaboration with various line Ministries. OMC is a cross- ministries/agencies initiative includes Kemen PUPR, BMKG, and BNPB. The second strategy involves action directives that focus on the development of ecosystem services in watershed management, the implementation of best practices, and the integration of watershed management into regional spatial planning. In the pursuit of managing a climate resilient watershed ecosystem, action focus on enhancing watershed management through the consideration of risk, vulnerability, and impact. Additionally, the development of instruments and policies is essential for assessing climate change risks, vulnerabilities, and impacts on the water resources sector.

On the other hand, initiatives to address land conversion employ two strategies: preventing the conversion of productive land for alternative uses and developing climate-adaptive technologies to enhance sustainable land management practices. The action directives involve comprehensive rehabilitation of degraded land and soil and water conservation, including the implementation of water injection technology and ProKlim activities, such as tree planting in water source areas. The program aimed at enhancing settlements focuses on delivering essential services and fostering climate resilient infrastructure. This is achieved by integrating adaptation into the development and maintenance of infrastructure, which includes directives for improving water resource management, particularly groundwater, and bolstering emergency disaster management initiatives. Finally, the program for the conservation and restoration of ecosystems, aimed at adapting to climate change impacts in the water resources sector, is underpinned by a strategy to enhance the integrated functionality of ecosystems. This includes action directives for the restoration of mangrove forests and degraded peatlands, complemented by ProKlim activities such as the planting and rehabilitation of mangroves in coastal areas and small islands, vegetation planting and canal dam construction, and capacity building for communities that maintain peatland rewetting infrastructure.

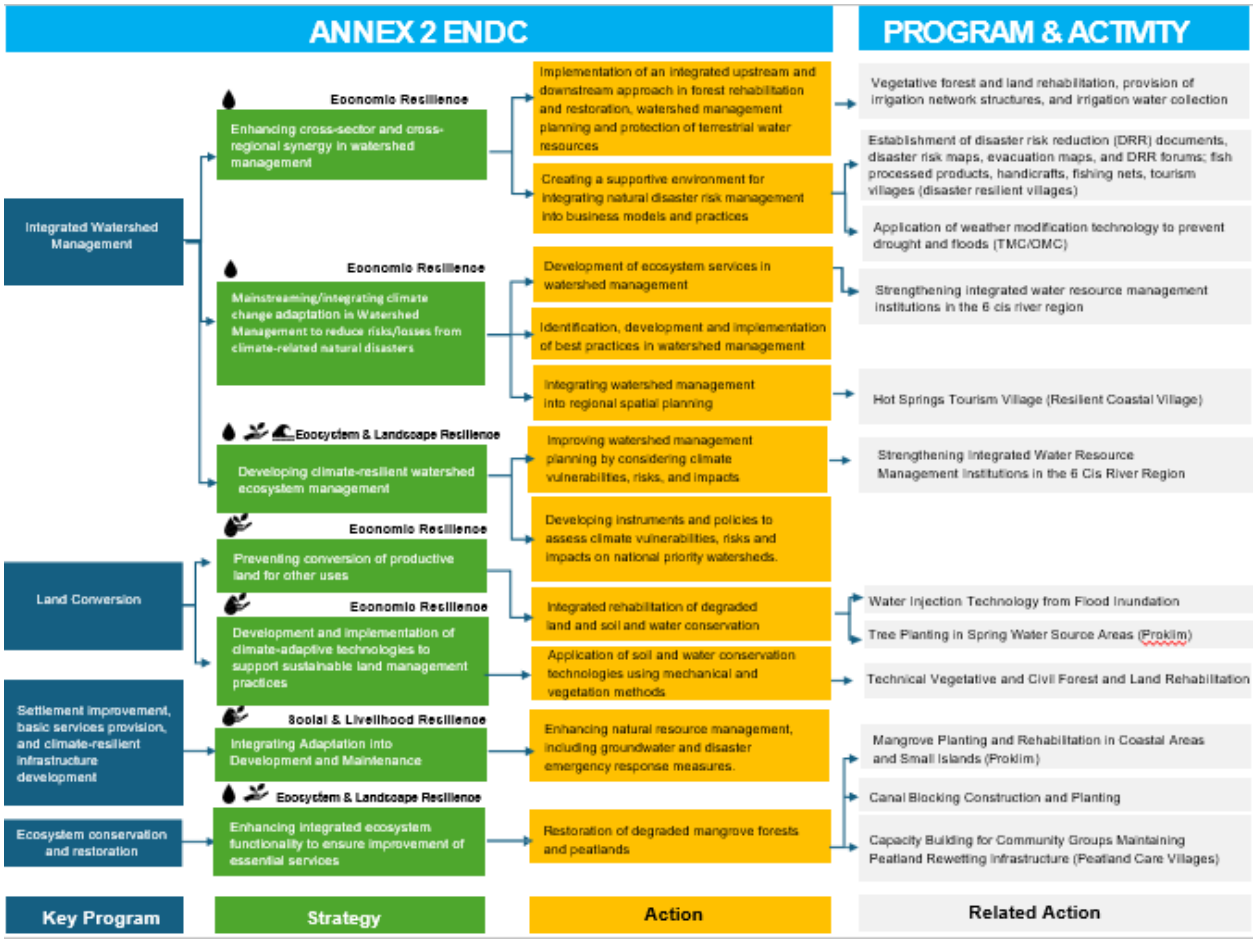


Figure 3- 13 Tracing the implementation of adaptation actions based on Annex 2 of the ENDC in water resources sector

The Resilient Coastal Village program by KKP has been implemented in 208 villages within the coastal sector, with the objective of enhancing resilience to climate risks, particularly regarding the provision of clean water. The Zero Delta Q program by Kemen PUPR, which emphasizes green infrastructure, is currently in the planning phase to facilitate effective collaboration among agencies, thereby enhancing infrastructure resilience. The water damage control program implemented by Kemen PUPR emphasizes infrastructure rehabilitation. The restoration of critical watersheds is prioritized, aiming to restore 108 critical watersheds across 150,000 hectares by 2024. These programs illustrate Indonesia's dedication to incorporating climate change adaptation across multiple sectors.

3.5.2.3 Health

The ADCOM document (MoEF, 2022b)indicates that in the health sector, initiatives to address climate change require collaboration across multiple sectors alongside the MoH. The programs entail cross-sectoral coordination addressing multiple health dimensions, including capacity building for services, health crisis management, and resilience to climate change. Nine programs have been implemented throughout Indonesia, with one program in endemic areas and seven prototype programs in pilot areas (Table 3-3).

Table 3- 3 Geographical coverage of the health sector adaptation program implementation

IMPLEMENTATION AREAS	CONFIRMED PROGRAMS
Nationwide	1. Daily Disease Outbreak Reporting System/DHIS (District Health Information System) 2. Disease surveillance and monitoring system to detect and respond to health threats quickly. 3. Malaria Information System (SISMAL) 4. Vector Surveillance Information System (Silantor) 5. Socialization of the use of simple technology to prevent mosquito larval development (e.g. larvitrap and ovitrap) 6. Percentage of pneumonia and diarrhea cases treated according to criteria 7. Accreditation of health service facilities. In 2022, 81.9% of hospitals were accredited (2022 Strategic Plan Target: 90%). 8. Technical guidance on Vector and Disease Carrier Prevention and Control Services 9. Evidence-based study on the readiness of data and information on the health impacts of climate change
Endemic/Disaster-Prone Areas	1. Strengthening the EDAT (Early Diagnosis and Prompt Treatment) approach for malaria in Papua and East Nusa Tenggara
Pilot Regions	1. Vector and disease carrier survey 2. Pilot project: Mass Malaria Drug Administration (MOMAL) (Keerom Regency, Papua) 3. Green Hospital (Halted during the COVID-19 pandemic) 4. Health Reserves (TCK), Emergency Medical Team (EMT) (implementation in each district/city in stages from 2022-2024) 5. Climate-Healthy Village (Desa Desi) 6. Healthy City 7. Utilization of seasonal disease calendars

The establishment of a Technical Team for Climate Change Adaptation in the health sector, as mandated by Minister of Health Decree No. 532 of 2019, supports the planning and implementation of adaptation actions. This team is responsible for planning, supporting implementation, monitoring and evaluating climate change adaptation efforts. The identified adaptation programs emphasize both the preparedness of health services and the mitigation of climate change's effects on health systems across different regions, including the resilience of infrastructure. In 2022, the MoH established a working group focused on climate change and environmental disaster adaptation. This team aims to enhance the significance of environmental health in addressing the challenges posed by climate change, particularly in regions susceptible to natural disasters and health crises associated with climate change. Figure 3-14 presents the strategies and action directives for addressing climate change within the health sector.

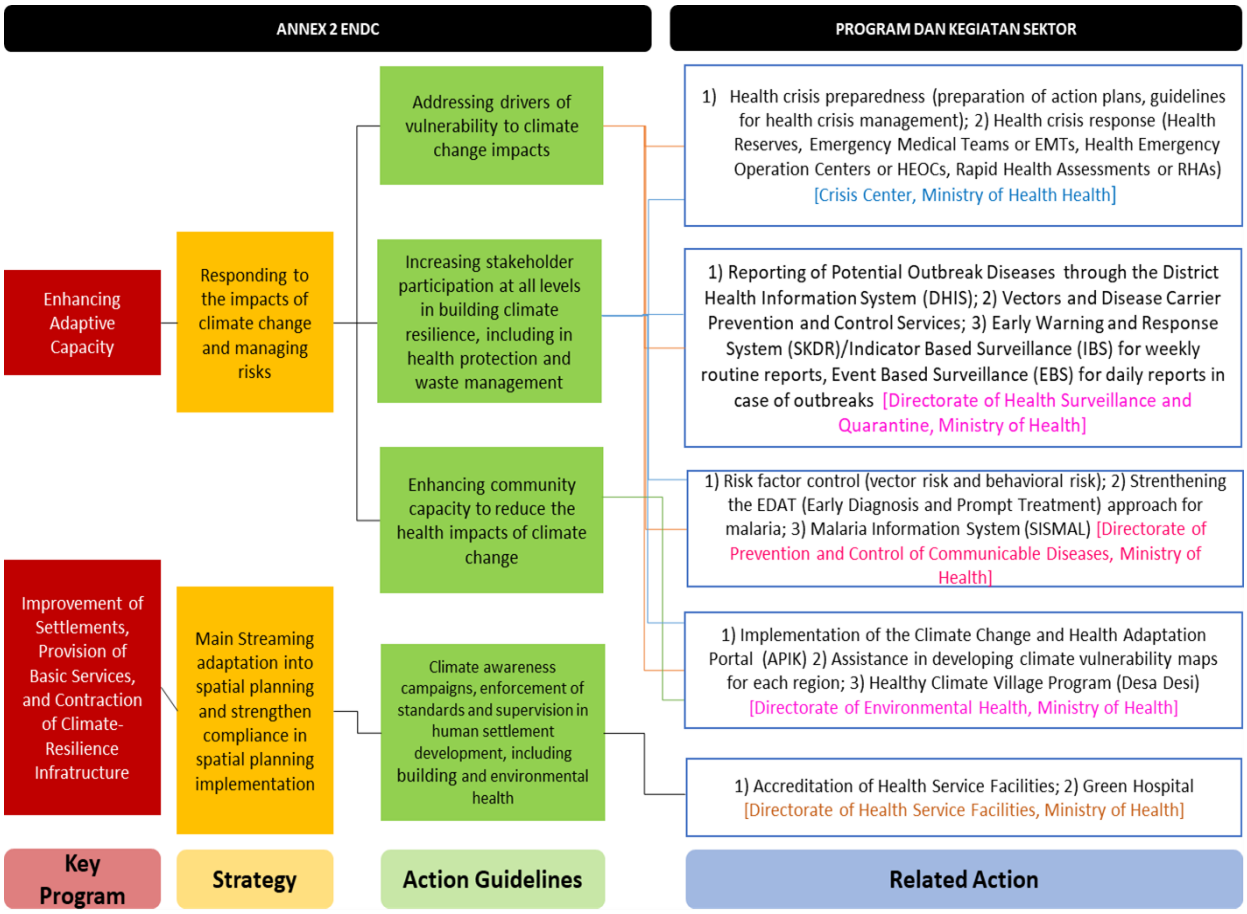


Figure 3- 14 Tracking the implementation of adaptation actions based on Annex 2 of the ENDC in the health sector

The implementation of these strategy and action guidelines is realized through various health programs and activities, such as strengthening the role of environmental health, identifying potential health threats in endemic areas, and enhancing the capacity of health services. Additionally, the programs also encompass initiatives aimed at managing diseases associated with climate change impacts and adapting healthcare facilities in disaster-prone areas. The Government of Indonesia prepares the health sector for the challenges posed by climate change by integrating adaptation strategies included in the Annex 2 ENDC. Cross-sectoral collaboration and the enhancement of adaptive capacity are the keys for sustaining national health resilience in the face of the escalating effects of climate change.

3.5.2.4 Ecosystem

The primary objective in the economic domain is to establish a supportive ecosystem that fosters resilience and facilitates the transition to a low-carbon economy. The programs implemented encompass the sustainable management of land and resources. MoEF conducts the provision of seedlings and nursery development, alongside forest and land rehabilitation actions. These efforts include vegetation planting and the implementation of basic civil engineering measures, such as the construction of retention dams, control dams, and gully plugs. In the period of 2018 to 2023, forest and land rehabilitation has been carried out over an area of 1.88 million hectares. Sustainable Forest Management is implemented to ensure

ecosystem sustainability and to promote the development of forest utilization businesses through the multi-business forestry model. It also involves the establishment of ecosystem service payment mechanisms in production forest management and the advancement of community-based forest management schemes. Up until 2022, the social forestry program has distributed access rights for forest area utilization to communities covering 5.31 million hectares, 1.1 million households, with 7,644 units of decree.

In the social and livelihood aspect, the programs emphasize enhancing community capacity to access natural resources, aiming to reduce socio-economic disparities in regions impacted by climate change. Multiple ministries and agencies have implemented programs for environmental education, conservation education, and resource management and disaster risk assistance. MoEF conducts environmental and conservation education, targeting communities and school-age children, particularly in and around protected areas.

The focus on ecosystem and landscape resilience are the conservation, restoration, and sustainable management of diverse ecosystems, particularly in preserving the sustainability of natural resources. The programs encompass the safeguarding of ecologically significant regions and the execution of policies that promote environmental sustainability. Mangrove rehabilitation programs are implemented by various ministries and agencies, such as BRGM, MoEF, and KKP. BRGM is conducting mangrove rehabilitation in nine priority provinces, while MoEF is executing mangrove planting in regions beyond BRGM's scope. The total area of mangrove ecosystems rehabilitated by MoEF from 2020 to 2022 amounted to 21,302 hectares. In 2020, MoEF rehabilitated 18,710 hectares of mangrove ecosystems. After the establishment of BRGM, the area rehabilitated by MoEF in 2021 and 2022 was 1,381 and 1,211 hectares. In 2021 and 2022, BRGM rehabilitated 34,911 and 3,638 hectares of mangroves, bringing the total area of mangrove ecosystems rehabilitated by BRGM over these two years to 38,549 hectares. The national mangrove map is regularly updated to reflect the development of mangrove cover. Mangrove rehabilitation offers supplementary advantages, including enhancing community capacity for livelihood diversification via the promotion of ecotourism, the development of mangrove-based products, and the practice of non-extractive cultivation. Besides mangroves, KKP also conducts rehabilitation of other essential coastal ecosystems, such as seagrass and coral reefs.

BRGM implements peatland restoration programs in seven priority provinces, supported by the MoEF, alongside the establishment of Community-based Peatland Conservation and Restoration (*Desa Mandiri Peduli Gambut*/DMPG) and the Peatland Hydrological Unit Management Forum (KHG). The total area of peatland ecosystems restored by BRGM from 2016 to 2023 is 1.8 million hectares, with a total of 170 DPMGs formed until 2022. Efforts to enhance the effectiveness of protected areas are implemented through the optimization of land-use patterns, specifically via a zoning system, and by engaging the community in area management. The efforts are conducted by two primary stakeholders: MoEF and KKP. From the Government of Indonesia's target to effectively manage 20 million hectares of marine protected areas by 2024 and establish a total of 32.5 million hectares by 2030, KKP has designated 117 marine protected areas, covering an area of 29.3 million hectares. Figure 3-15 and Figure 3-16 illustrate the tracking of actions or activities associated with the ENDC guidelines.

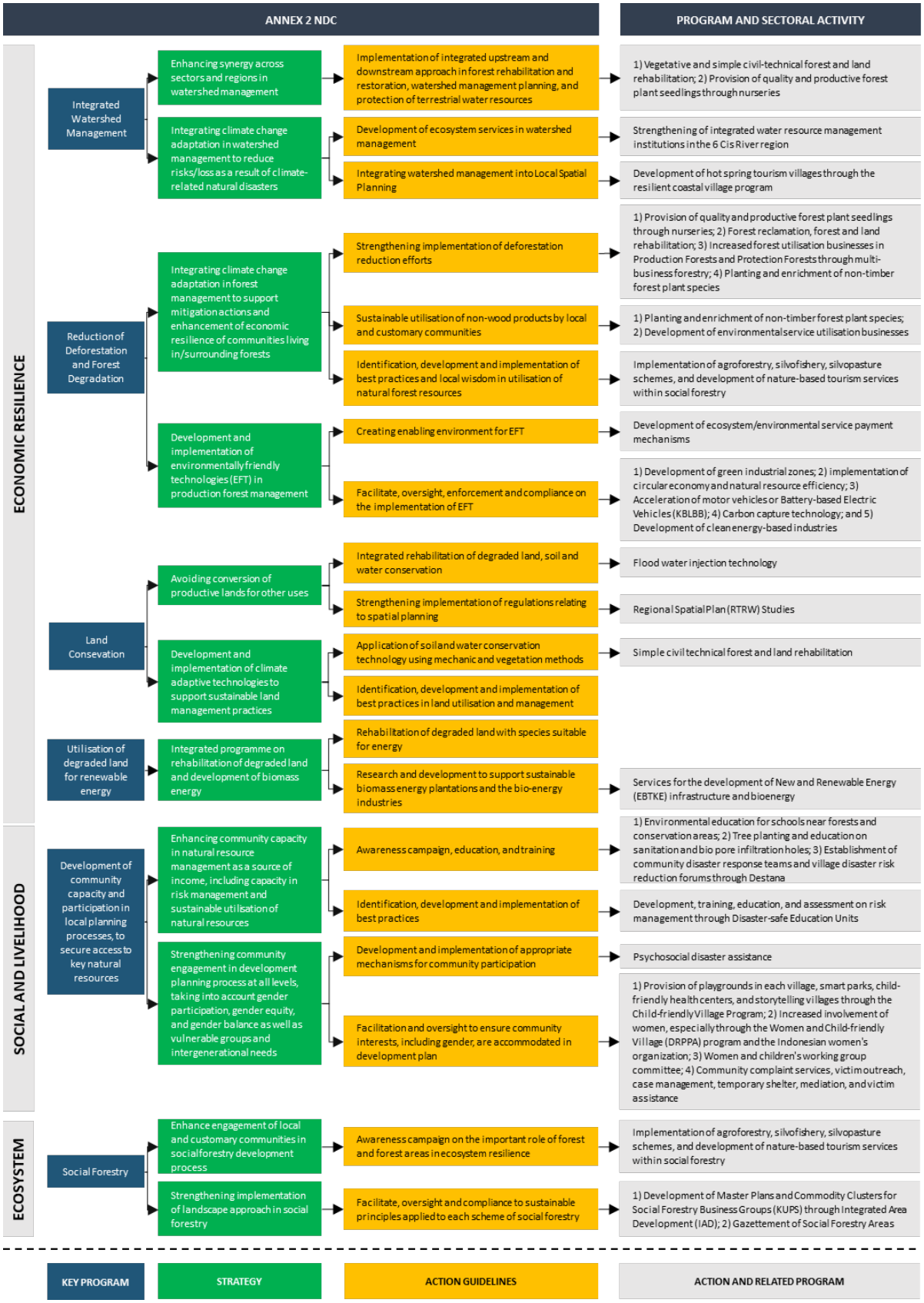


Figure 3- 15 Tracking the implementation of adaptation actions based on Annex 2 of the ENDC in the ecosystem aspect, focused on economic and social-livelihood resilience

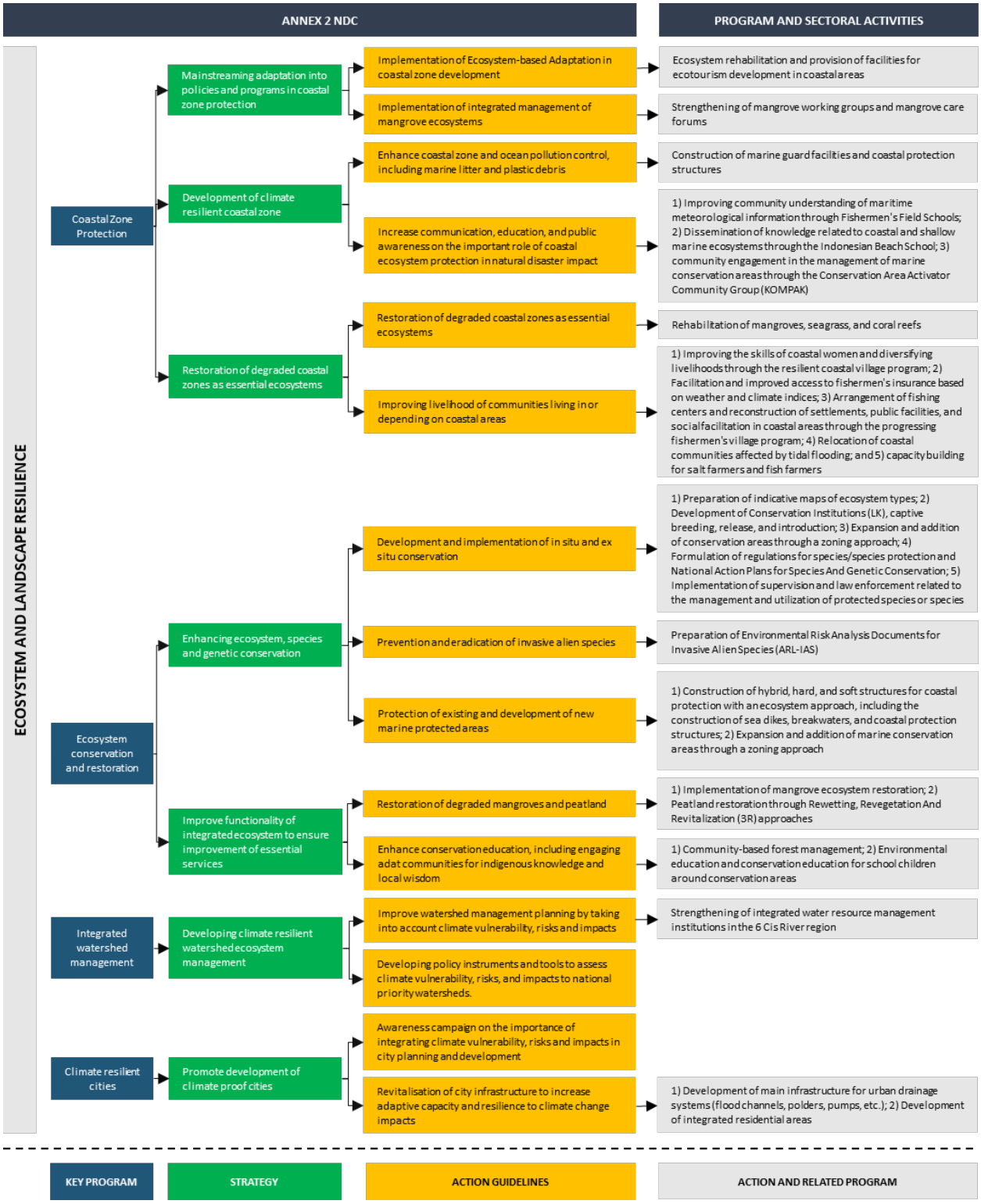


Figure 3- 16 Tracking the implementation of adaptation actions based on Annex 2 of the ENDC in the ecosystem aspect, focused on ecosystem and landscape resilience

3.5.2.5 Climate Services

Systematic observation of climate change is essential for supporting international climate agreements, including the UNFCCC and the Paris Agreement, and for formulating adaptation and mitigation strategies. The systematic observation system collects data using modern methods and technologies to ensure accuracy, consistency, and continuity over time and across

geographical locations. This system necessitates a network of observation stations to perform systematic observations and gather climate data utilizing advanced technologies to guarantee precision and continuity. This method encompasses a network of terrestrial and atmospheric stations, including weather stations, ocean buoys, and radiosondes; remote sensing observations via radar and satellites to monitor variables like atmospheric composition and surface temperature; and paleoclimate reconstruction for historical climate data. BMKG is responsible for government duties related to meteorology, climatology, and geophysics, as mandated by relevant laws and regulations. BMKG operates 186 stations, which include 5 Regional Offices, 3 GAW Stations, 120 Meteorology Stations, 31 Geophysics Stations, and 27 Climatology Stations. BMKG operates a total of 1,212 automated observation systems, which include 343 Automatic Weather Stations (AWS), 695 Automatic Rain Gauges (ARG), 105 Automatic Aerological Weather Stations (AAWS), 34 Automatic Surface Weather Stations (ASRS), 27 Integrated Climate and Weather Observation Stations (IKRO), and 8 SHIP systems. Additionally, there are 29 radiosonde observation locations and 44 weather radars in use. Figure 3-17 illustrates the distribution of different types of weather, climate, and air quality observation instruments across the provinces of Indonesia. Additionally, BMKG is responsible for the enhancement and upkeep of instruments to ensure the continuity of long-term systematic observations.

The Geospatial Information Agency/Badan Informasi Geospasial (BIG), the government institution tasked with managing geospatial information, has maintained a geospatial observation network until 2024. This network is essential for monitoring climate change impacts, including sea level rise and land subsidence, through the Geodetic Control Network (1,999 pillars), CORS Stations (474 stations), Tidal Network (292 stations), and Gravity Network. Additional information can be found on the BIG portal at https://srgi.big.go.id/map/jkg-active.

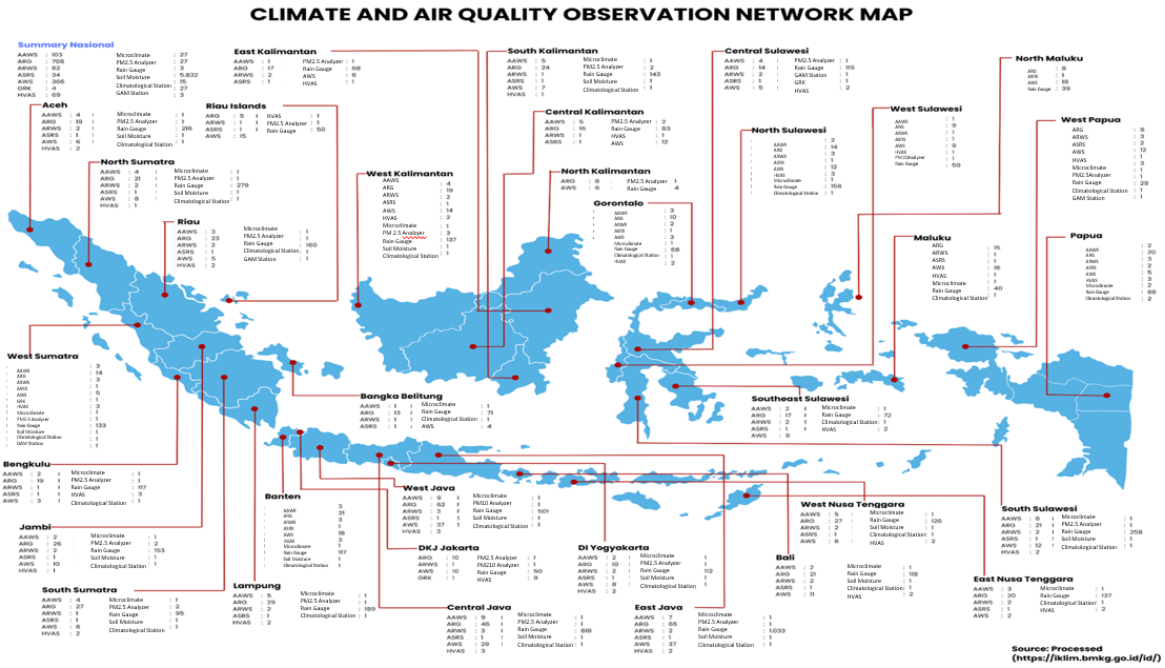


Figure 3- 17 Map of the climate and air quality observation network by province. The map is processed from data obtained from the BMKG website (Source: https://iklim.bmkg.go.id/id/)

The systematic observations conducted by BMKG facilitate public climate information services, encompassing archives of direct observation data and derived products. The data is accessible online via the BMKG portal and serves multiple functions, including historical climate research, seasonal climate forecasting, and the identification of Seasonal Zones (ZOM). Efforts to enhance the quality of observational data involve the provision of gridded rainfall and temperature data products to analyze climate conditions and their effects. BMKG has developed projection data through downscaling analysis in collaboration with CORDEX-SEA (25 km resolution, daily, RCP 4.5) and the Japan Meteorological Research Institute (5 km resolution, daily, RCP 8.5), with current data constrained to the CMIP5 scenario. BMKG publishes climate change analysis based on this data on its website (https://www.bmkg.go.id/iklim/?p=proyeksi-perubahan-curah-hujan) to facilitate adaptation and mitigation efforts. The downscaling simulation process for the CMIP6 scenario is currently in progress, with a target completion date of 2025, aimed at enhancing the data foundation for climate change decision-making in Indonesia.

Indonesia has established impact-based early warning services to mitigate extreme climate events and disasters, specifically the Meteorology EWS (MEWS; https://signature.bmkg.go.id/) and Climate EWS (https://cews.bmkg.go.id/home.php). The MEWS system detects extreme weather conditions that may lead to floods or tornadoes. The CEWS system offers long-term forecasts extending up to three months for drought, heavy rainfall, and potential ENSO, which is beneficial for the agricultural sector in managing planting schedules and crop selection.

3.5.3 Participation in Community Adaptation Actions

The implementation of climate change adaptation actions in Indonesia involves multiple stakeholders, ranging from the national government to local governments. The number of regions (Figure 3-18) that have developed adaptation action plans reflects the commitment of local governments to implementing adaptation in accordance with Presidential Regulation 98/2021 on the economic value of carbon, particularly in Articles 42 paragraphs 4-6 and Article 46 paragraph 2. Adaptation efforts are implemented by Ministries/Agencies, local governments, businesses, and communities. Adaptation action plans that are prepared based on vulnerability assessment can assist in the preparation of the Strategic Environmental Assessment / Kajian Lingkungan Hidup Strategis (KLHS). The KLHS is required for the development of Regional Medium-Term Development Plan / Rencana Pembangunan Jangka Menengah Daerah (RPJMD), the Regional Environmental Protection and Management Plan / Rencana Pengelolaan dan Perlindungan Lingkungan Hidup (RPPLH), and other development planning initiatives.

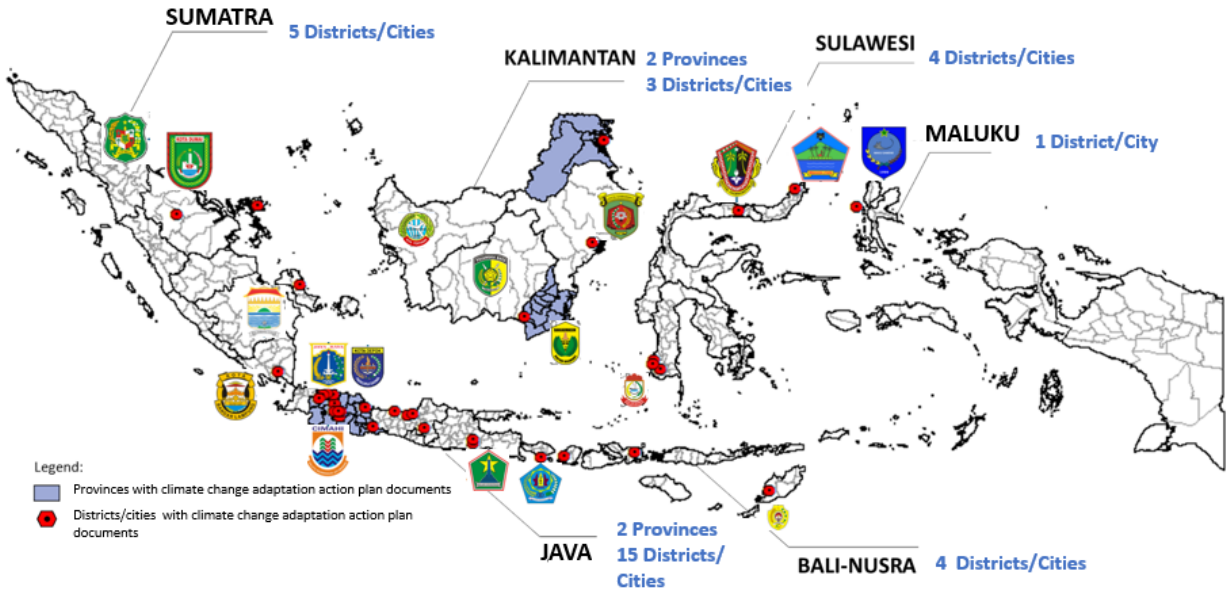


Figure 3- 18 Distribution of provinces and regencies/cities that have developed climate change adaptation action plan documents (Source: KLHK as of 2023)

By 2022, approximately 10% of provinces (4 out of 38) and less than 1% of regencies/cities (37 out of 514) have formulated Climate Change Adaptation Action Plan documents (Figure 3.5.6). Regions that have implemented these action plans via regulations include DKI Jakarta, Tanjungpinang City, Surakarta City, and Pekalongan City. The implementation of these regulations is anticipated to enhance the execution of adaptation actions by local government agencies via their respective Regional Work Plans / Rencana Kerja Pemerintah Daerah (RKPD). Various obstacles exist in the preparation of adaptation action plans, including the necessity to enhance local government awareness regarding the urgency of the action plan, constrained budgets, and the tendency for discussions to overlook climate change impacts. The understanding of Regional Apparatus Organizations / Organisasi Perangkat Daerah (OPD) concerning climate change risks requires alignment, and there are limitations in data availability and information, as well as challenges related to distance during the field validation process.

Additionally, adaptation actions necessitate the participation of multiple stakeholders, including representatives from non-governmental institutions (NPS). Indonesia's NDC commitment emphasizes the necessity of engaging multiple stakeholders in the execution of climate change initiatives, reflecting transparency and accountability in policymaking, as stipulated in Article 4, Line 13 of the Paris Agreement. Support from non-governmental institutions, including the private sector, business entities, local communities, NGOs, academics, and religious organizations, is essential for the development of inclusive regional policies. Approximately 75 institutions are engaged in climate change adaptation efforts across different regions in Indonesia (Figure 3-19). These institutions concentrate on food, ecosystem, and disaster management, engaging in capacity building for local governments and communities, alongside providing policy and funding assistance.

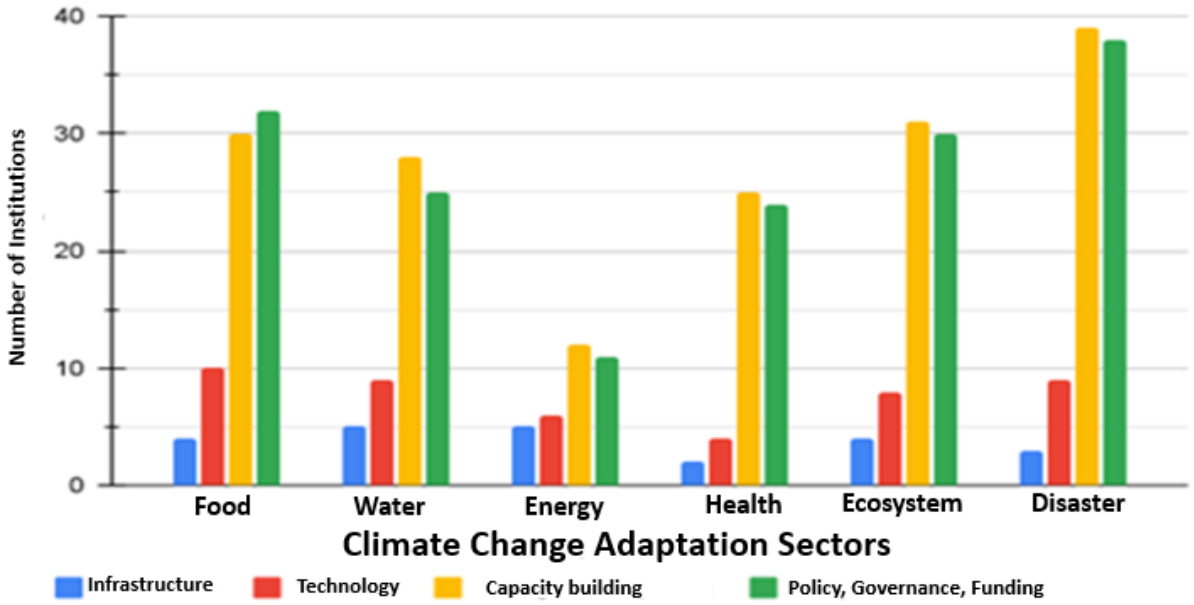


Figure 3- 19 Compilation of non-governmental organizations involved in the implementation of climate change adaptation in Indonesia (source: developed from Bappenas, 2021c)

Community participation is intentionally incorporated into community-based action programs within the national framework via the ProKlim initiative. This program promotes the engagement of diverse stakeholders and fosters collaboration among government entities, local communities, businesses, and other institutions to attain shared objectives in enhancing community resilience and mitigating greenhouse gas (GHG) emissions locally. ProKlim, initiated in 2012 and elevated to a national movement in 2015, was recognized as a CBCA in 2016, governed by the Minister of Environment and Forestry Regulation No. P.84 of 2016. As of 2022, ProKlim has been implemented in 4186 sites (Figure 3-20) and has evolved into the Climate Community Program (ProKlim). ProKlim aims to engage a broader audience and create opportunities for diverse communities to participate.

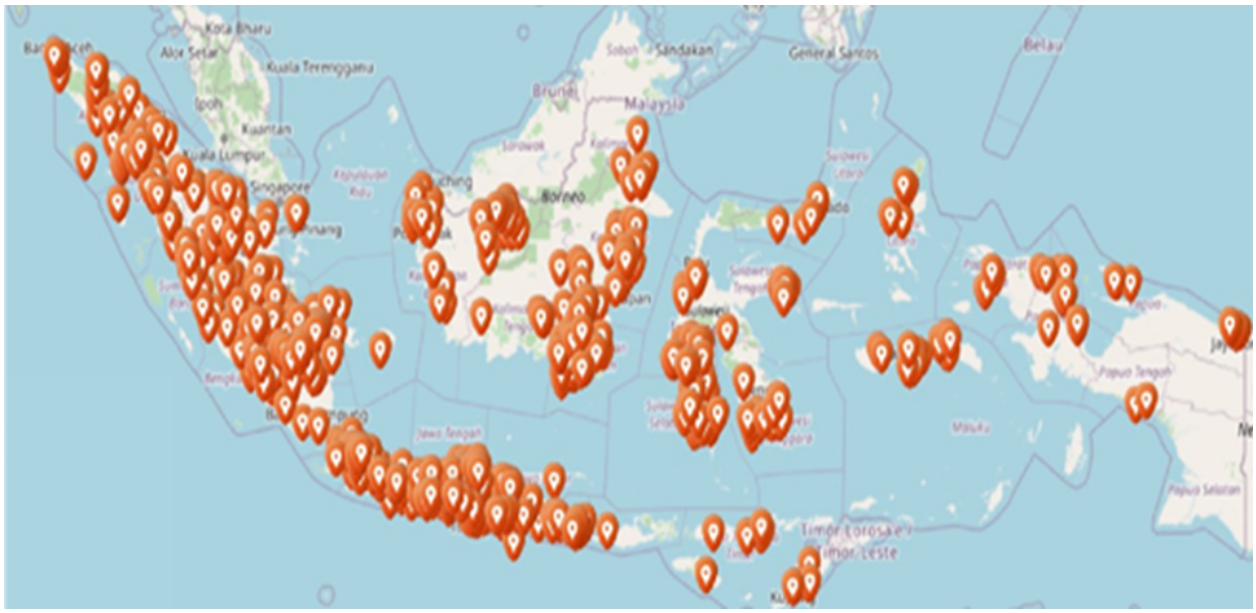


Figure 3- 20 Distribution of ProKlim action sites as of 2022 (Source: https://srn.menlhk.go.id/)

Ministries and line ministries have promoted programs and initiatives aimed at enhancing community resilience through climate change adaptation actions. Some of these initiatives include Resilient Village/Neighborhood (1116 villages, 2020)[7] by BNPB, Climate Caring Village by the Ministry of Villages, Climate-Healthy Village by the MoH (3 supervised pilot area, 2023)[8], and the Resilient Coastal Area program by the KKP. In addition, many actions are initiated directly by the community, leveraging local wisdom and knowledge.

The Government of Indonesia is actively engaging local communities in natural resource management via the social forestry scheme. This approach enables local communities to attain prosperity while safeguarding the environment, as evidenced by sustainable cultural practices and governance. The potential of Community-Managed Conservation Areas (AKKM), overseen by indigenous peoples and local communities across more than 4.2 million hectares, illustrates the role of communities in natural resource management. Sustainable natural resource management by indigenous communities contributes significantly to local economic development and environmental sustainability. The primary challenge in engaging the community in adaptation actions lies in the structural barriers that impede action. The communication of knowledge regarding climate change poses a challenge for stakeholders in effectively disseminating information to rural communities. The community's wealth and practices in managing natural resources are:

- The *leuweung* tradition in Kasepuhan, Banten Province, encompassing the zoning of agricultural land. The *leuweung garapan* (cultivated forest) serves traditional agricultural purposes, the *leuweung tutupan* (protected forest) is maintain as a source of clean water, food, and medicine, while the *leuweung cadangan* (reserved forest) is designated for the benefit of future generations. The zoning management is reinforced by the customary law practice known as *Tatali Paranti Karuhun*. Their *leuwit* system is capable of sustaining food stocks even during periods of famine.
- The Tana' Ulen tradition in Kalimantan encompasses protected primary forest areas characterized by high biodiversity, which are utilized by indigenous Dayak communities to sustain their livelihoods.
- The Sasi prohibition in Haruku Island, Central Maluku, imposes restrictions on entry, removal, or activities within designated areas for specified durations.
- The Awig-awig in Bali and Nusa Tenggara serve as regulations that dictate social norms and the management of natural resources within the community.
- The Enteli and Kantolo in West Nusa Tenggara utilize stone boundaries to define land ownership and safeguard land from livestock disturbances.

3.5.4 Gender Perspective in Adaptation Actions

Inclusive and gender-responsive decision-making processes are essential for accelerating transformative adaptation. The implementation of adaptation actions from a gender perspective requires attention to the specific needs of children, individuals with disabilities, local

[7] https://www.antaranews.com/berita/2408409/bnpb-bentuk-1116-desa-tangguh-bencana

[8] Interview with Kemenkes

communities, and the elderly. These groups are frequently regarded as vulnerable. The effects of climate change, when analyzed through a gender lens, exhibit significant variability and necessitate a comprehensive approach.

Adaptation actions in the agricultural sector are increasingly incorporating a gender perspective via multiple programs. Despite the limited access to financing options like the KUR and Agricultural Insurance for women, ongoing efforts aim to enhance equitable access. Agricultural infrastructure development activities have not fully engaged women; however, their roles in planting, maintenance, and harvesting are increasingly significant. Funding for extension services via the BOP and mobile data packages used to participate in online training ensures equitable opportunities for both female and male extension workers. In variety development, female breeders are afforded equal opportunities. Furthermore, agricultural initiatives like SIAP TANAM, EWS SIPANTARA, and SIRAMI KEBUNKU engage women in roles as researchers and analysts. Program socialization includes the involvement of female extension workers and farmers, facilitating their role in the dissemination of agricultural innovation.

Gender-based inequality exists within the water resources sector. Women, frequently tasked with water collection, experience an increased burden as water scarcity due to climate change. The absence of clean water adversely impacts health and increases daily workload. Conversely, men typically participate in decision-making related to water resources management. Enhancing the effectiveness of adaptation responses necessitates greater involvement of women in decision-making processes concerning water distribution and management.

Women, children, and the elderly in the health sector exhibit heightened vulnerability to the health consequences of climate change, including infectious diseases and malnutrition. Rising temperatures and altered precipitation patterns elevate the risk of vector-borne diseases. Prioritizing access to healthcare for women and vulnerable populations is essential in adaptation planning. Implementing gender-responsive health decision-making can mitigate the health effects of climate change and enhance community resilience.

The ecosystem sector underscores the significance of women's involvement in environmental management. Women possess significant traditional knowledge regarding local ecosystems; however, this expertise is frequently overlooked in formal decision-making processes. Incorporating women into ecosystem conservation and restoration initiatives enhances environmental resilience and promotes inclusivity in EbA. Consequently, climate change adaptation policies should address the distinct needs and functions of each gender group to achieve more equitable and effective results.

3.6 Monitoring And Evaluation Of Adaptation Actions And Processes

3.6.1 Regulatory Support for Monitoring and Evaluation Mechanisms

Monitoring and Evaluation (M&E) in climate change adaptation is essential for ensuring effective and sustainable implementation. Monitoring tracks the progress and achievements of adaptation actions, whereas evaluation assesses the success and impact on enhancing resilience. Monitoring and evaluation policies are governed by several regulations, including the PERMEN LHK No. 72 of 2017, which was revised by Presidential Regulation No. 98 of 2021. The regulations emphasize the attainment of NDC targets and climate change mitigation via MRV.

The monitoring and evaluation mechanism (Figure 3-21) is tailored to each phase of adaptation action, encompassing impact, vulnerability, risk, and resilience assessment. This process involves overseeing adaptation planning to guarantee that implementation aligns with the established plans. At the operational level, monitoring the implementation of adaptation actions involves the collection of data concerning barriers, benefits, and the impact of activities. Beneficiaries, including the central government, regional governments, and businesses, periodically report monitoring results through a specific reporting mechanism integrated with national and international systems.

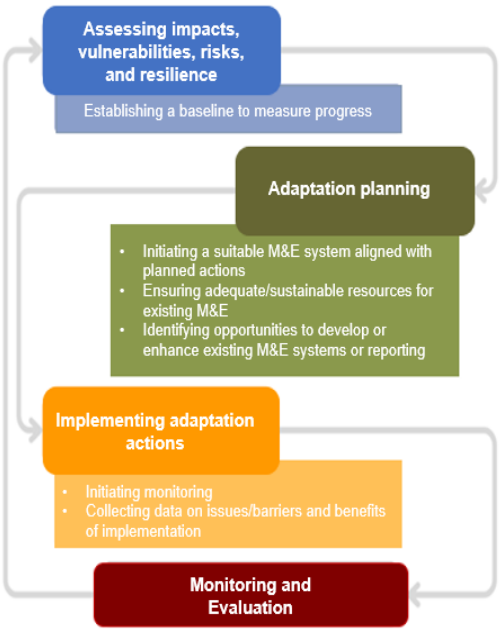


Figure 3- 21 Monitoring and evaluation process for the implementation of climate change adaptation actions (Source: P.72/KLHK/2017, Adaptation Committee 2019)

Evaluation is conducted to determine the effectiveness of adaptation actions using predefined criteria and indicators. This evaluation addresses critical domains including food, water, energy, health, and ecosystems, as stipulated in Presidential Regulation No. 98 of 2021. M&E establish a foundation for improved decision-making and guarantee the ongoing effectiveness of adaptation actions. The monitoring and evaluation process in climate change adaptation implementation has two primary focuses. Initially, M&E of adaptation actions involves assessing each intervention to ascertain its effectiveness on the intended beneficiaries. Secondly, M&E are essential for assessing resilience, defined as the cumulative impact of all adaptation measures in enhancing a region's capacity to withstand climate change.

3.6.2 Modalities and Tools for Monitoring and Evaluation

3.6.2.1 Participation and Contribution

Indonesia has initiated several climate change adaptation programs designed to enhance community capacity and bolster climate resilience; however, these initiatives have yet to be incorporated into a cohesive monitoring framework. Examples of ongoing initiatives include adaptation programs such as Climate Village Program, Disaster Resilient Villages, Adiwiyata Schools, and Disaster-Safe Education Units (SPAB). Nonetheless, the execution of M&E continues to encounter difficulties in coordinating the assessment of progress toward targets related to economic, social, livelihood, and ecosystem landscape resilience.

An instance of implementing monitoring and evaluation through the acknowledgment of community-based initiatives is demonstrated in the program ProKlim. ProKlim has been implemented in over 4186 locations across Indonesia as of 2022, demonstrating significant participation rates in provinces including Central Java, West Java, and East Java (Figure 3-22). Some provinces exhibit low participation, including Gorontalo and North Maluku, attributable to geographical factors, varying levels of understanding, and resource limitations.

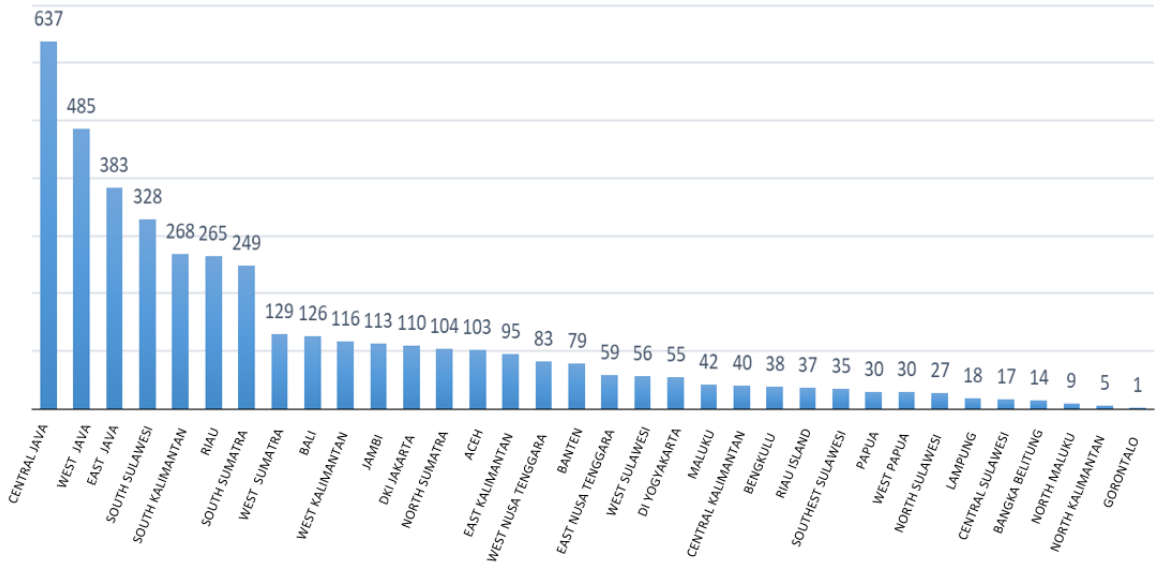


Figure 3- 22 Number of PROKLIM participants per province in Indonesia 2022

(Source: https://srn.menlhk.go.id/)

The Disaster Resilient Village (Destana) program, alongside ProKlim, enhances community resilience to disasters. This program entails specific actions, including the organization of resources and the identification of disaster threats. Nevertheless, the assessment of climate change-related risks remains unregulated within the Destana program's framework, despite the program's significant emphasis on disaster risk reduction. Programs like Adiwiyata Schools and SPAB contribute to the development of climate awareness within educational institutions. The implementation of climate change adaptation in these programs remains suboptimal. Adiwiyata Schools have not completely incorporated climate information into their planning, even with robust institutional coordination. SPAB primarily emphasizes general disaster risk reduction, while climate change adaptation remains in its nascent phase.

Challenges in implementing monitoring and evaluation are associated with disparities in funding across regions. Funding for initiatives such as ProKlim and Adiwiyata Schools remains reliant on the Public Budget / *Anggaran Pendapatan dan Belanja Nasional/Daerah* (APBN/APBD), which frequently lack the necessary resources to fully support adaptation efforts. The budget allocation is essential for the effective implementation of climate change adaptation across all sectors.

The climate risk management employed in the evaluation of adaptation programs promotes the needs for enhancement of climate change adaptation actions. The evaluation of the ProKlim program indicates that, although there is robust integration of climate change at the national level, enhancements in institutional coordination and funding are necessary. This is essential

for ensuring that each program operates synergistically and effectively enhances the resilience of communities and the environment.

3.6.2.2 Information Systems Related to Monitoring and Evaluation

Indonesia employs multiple modalities for monitoring and evaluation pertinent to climate change adaptation. A range of tools exists to facilitate M&E of climate change adaptation actions, as illustrated in Figure 3-23. Each tool serves a distinct purpose; for instance, SIGN-SMART inventories emissions and emission reductions at regional and sectoral levels, while SIS REDD+ addresses safeguard data at the provincial level. SIDIK offers data and maps detailing regional vulnerability at the village level, whereas SIPONGI concentrates on the monitoring of forest fire hotspots using specific coordinates. KCPI, web for knowledge center of climate change, serves as a repository for knowledge and information pertaining to climate change. SRN is a system that enables actions associated with the economic valuation of carbon, mitigation and adaptation strategies, and ProKlim data, along with carbon registries covering specific regions. Adaptation Portal enables the documentation of adaptation actions and offers maps detailing climate change projections and impacts. These tools aim to facilitate the attainment of NDC, emphasizing emission reduction and adaptation benefits across administrative, sectoral, and spatial domains, while also mapping mitigation and adaptation initiatives in diverse regions.

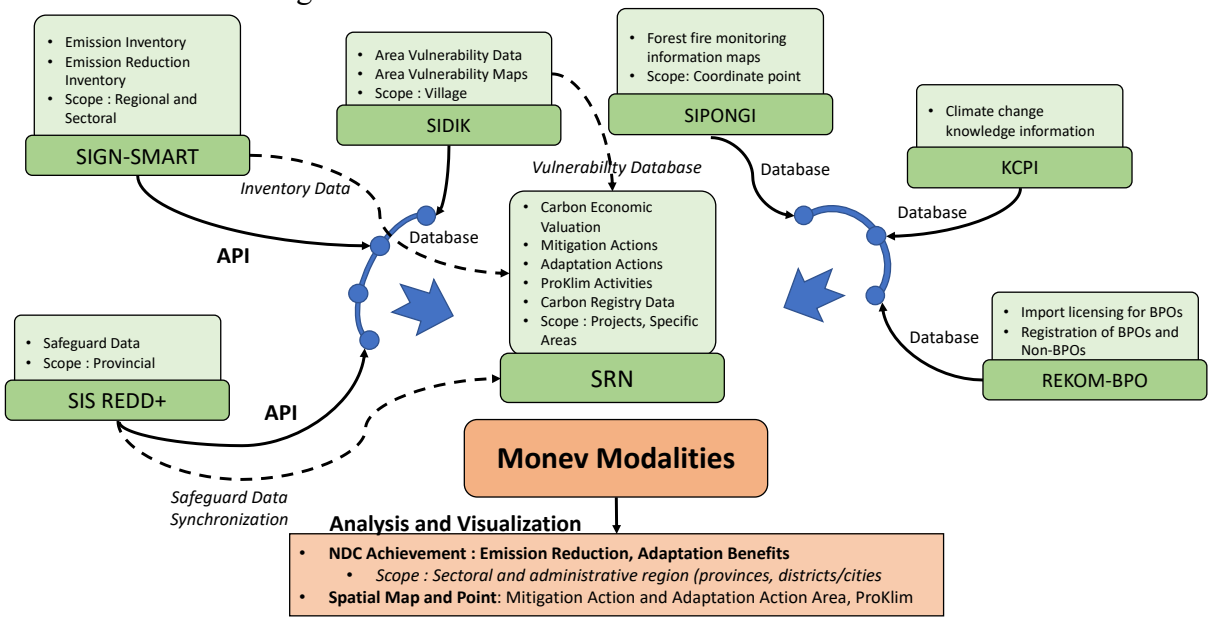


Figure 3- 23 Climate change-related modalities and tools operationalized by the National Focal Point.

SIDIK developed by MoEF, is a tool in Indonesia's efforts to address climate change. SIDIK calculates the vulnerability and climate risk levels of a region through various indicators, including social, economic, biophysical, institutional, infrastructure, and human resources. This approach enables SIDIK to deliver a thorough assessment of the potential risks and vulnerability levels of a region concerning the impacts of climate change.

The primary advantage of SIDIK lies in its capacity to facilitate the development of targeted and effective adaptation action plans. Local governments can utilize the generated data to identify suitable adaptation interventions according to the vulnerability levels of their regions. As of now, 17 provinces, including North Sumatra, DI Yogyakarta, West Kalimantan, and West Papua, along with 31 districts and 10 cities such as Semarang, Minahasa, Palembang,

Yogyakarta, and Bandar Lampung, have received training in using SIDIK. This indicates a robust dedication to broadening the implementation of SIDIK throughout Indonesia. Figure 3-24 illustrates the number of regions employing SIDIK.

The application of SIDIK is currently centered on identifying the sites for interventions and adaptation measures necessary to enhance regional conditions. Identifying specific vulnerability factors in each region enables the government to design suitable adaptation measures, including enhancing infrastructure susceptible to flooding and strengthening institutional capacity for managing climate risks. Each indicator reflecting these vulnerability factors can be directly associated with adaptation actions designed to enhance those indicators, making the adaptation process more targeted and effective.

Besides serving as a planning tool, SIDIK could develop the Monitoring and Evaluation framework of climate change adaptation. Recalculating the levels of vulnerability and climate risk in the intervened regions annually allows the government to assess the effectiveness of these interventions in mitigating regional vulnerability. A decrease in vulnerability levels indicates the effectiveness of the implemented adaptation actions. If vulnerability persists or escalates, additional assessment is required to modify the adaptation strategy. SIDIK serves as an effective instrument for assessing the implementation of climate change adaptation strategies.

Figure 3- 24 Distribution of regions utilizing the SIDIK system in the preparation of regional action plans

In the future, SIDIK may be integrated with similar sectoral systems to enhance a cross-sectoral adaptation strategy. For example, the MoH has developed a comparable system to assess vulnerability in the health sector, with the expectation that the integration of these two systems will be complementary. The MoA has devised a calculation for crop vulnerability, employing a methodology akin to SIDIK. This initiative is anticipated to be integrated into a more comprehensive system aimed at addressing the challenges posed by climate change within the agriculture sector.

Local governments at both the provincial and district/city levels, including DKI Jakarta and Ternate City, have widely utilized SIDIK to support regional planning efforts, where it has been incorporated into their regional development strategies. This exemplifies the application of SIDIK in planning that is responsive to climate risks, with the expectation that additional regions will adopt this approach to develop more resilient and sustainable adaptation policies.

The climate change adaptation actions also registered to SRN. This system integrates other systems related to climate change as presented in the above figure. SRN of MoEF serves as Indonesia's official platform for registering, tracking, and monitoring climate change adaptation and mitigation initiatives. This centralized system supports the country's climate goals by providing a transparent database where institutions, businesses, and communities can document their climate actions, thus contributing to Indonesia's NDCs under the Paris Agreement. To register, users must create an account on the SRN website, where they can input detailed project information, upload supporting documentation, and submit regular updates on project progress. Each registered action undergoes a verification process by MoEF officials to ensure alignment with national standards, fostering accountability and supporting data-driven policy making. The SRN enables Indonesia to track nationwide climate resilience efforts, enhance data transparency, and facilitate alignment with international climate commitments. For more information or to register climate actions, users can visit the official SRN platform at https://srn.menlhk.go.id/index.php?r=home%2Findex.

3.6.2.3 Development of Reporting, Monitoring and Evaluation System Connectivity

Reporting on the results of climate adaptation M&E is regulated under Presidential Regulation No. 98. of 2021 The reporting process is structured hierarchically across multiple levels: district/city, provincial, and national, as well as for sectoral ministries and agencies. Each level must follow the reporting guidelines as outlined in Presidential Regulation No. 98 of 2021, ensuring comprehensive documentation and alignment with national climate adaptation goals. The reporting responsibilities for climate adaptation M&E are described as follows:

1. **District/City Level**: Local government agencies at the district or city level are responsible for preparing and submitting adaptation reports. These are usually coordinated by the Environmental Agency (Dinas Lingkungan Hidup) or a similar agency within each district or city, which consolidates and submits data to the provincial government.
2. **Provincial Level**: Provincial government agencies, often led by the Provincial Environmental Agency, compile adaptation reports from district and city governments within their jurisdiction. The provincial agencies are responsible for consolidating this information and submitting it to the national level.
3. **National Level**: At the national level, the MoEF is responsible for gathering and synthesizing reports from provinces and coordinating the overall national adaptation report. MoEF aligns these reports with Indonesia's climate adaptation goals and international commitments.
4. **Sectoral Ministries and Agencies**: Each relevant ministry or agency (e.g., MoH, Kemen PUPR) is responsible for reporting adaptation activities within its sector. These sectoral reports are then submitted to, ensuring that adaptation measures are integrated across various sectors.

Furthermore, the initiative to develop a reporting, monitoring and evaluation system for climate change adaptation actions aims to create comprehensive climate-related information and data services for adaptation implementation. The classification of adaptation actions includes policies and regulations, infrastructure strengthening, technology adoption, and capacity building of human resources. The implementation and tracking of adaptation actions will be

carried out systematically by recording the location, sector, and beneficiaries of each initiative. Various tools and platforms such as the Climate Data Information System (SIDIK) and the National Registry System (SRN) from MoEF will be used to integrate technical data and information. In addition, budget tagging from the MoF and the Adaptation and Resilience Performance Application (AKSARA) from Bappenas will synergize action-planning and development as well as efficient budget financing and allocation (Figure 3-25). Through this system, it is expected that it will be easier to track adaptation actions as well as adaptation results and benefits, including improving community resilience within the framework of economic, social, and livelihood, and landscape ecosystem resilience.

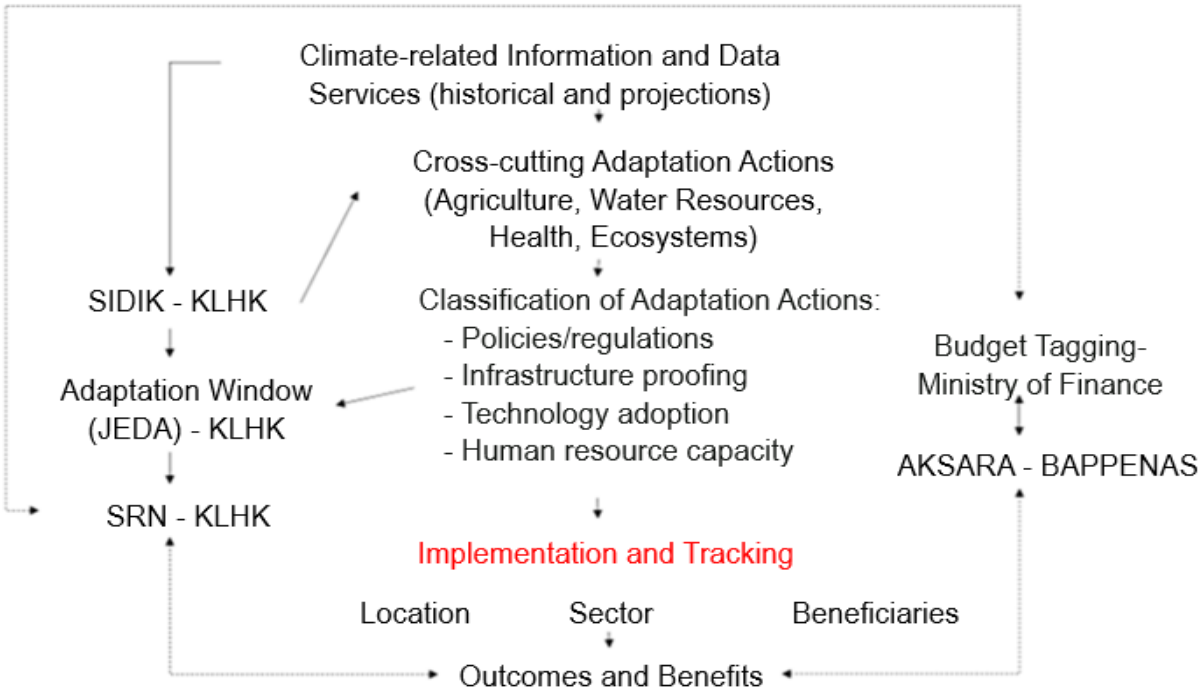


Figure 3- 25 Development of connectivity for the system of formulation and implementation of climate change adaptation actions, and systematic and comprehensive reporting, monitoring and evaluation

3.6.3 Monitoring and Evaluation of Priority Sectors

3.6.3.1 Food

M&E of agricultural financing schemes, specifically KUR, involves assessing the number of KUR applicants whose applications are approved and disbursed via agricultural offices at both provincial and district/city levels. The monitoring and evaluation process includes direct visits to farmers who are recipients of KUR to ensure its effective utilization. The compliance level with loan repayment is assessed via the Non-Performing Loan (NPL) ratio reported by each KUR distributor. The assessment results are submitted to the district or city agricultural offices and subsequently forwarded to the MoA for further evaluation.

The agricultural insurance program implements M&E in phases, conducted by the MoA alongside the provincial and district/City Agricultural Offices. The process employs the Agricultural Insurance Information System / *Sistem Informasi Asuransi Pertanian* (SIAP) application to oversee the implementation stages, which encompass participant registration, collection of self-help premiums, policy issuance, billing of subsidy premiums, claims

inspection, and claim payment. The monitoring and evaluation indicators in this context include the timely payment of claims by insurance companies and the allocation of claim funds for replanting expenses, which reflect the efficacy of insurance in aiding farmers.

M&E for the SIRAMI KEBUNKU system has not been conducted to date, attributed to suboptimal utilization that necessitates more precise and timely data and information updates. The central government typically participates solely in the initial survey, activity initiation, and dissemination phases. Furthermore, the M&E for the EWS SIPANTARA continues to be implemented for plant protection against pests and diseases through restricted field visits.Annual reports from Plant Pest Organism Control/Pengendali Organisme Pengganggu Tumbuhan (POPT) and Food Crop and Horticulture Protection Center/Balai Perlindungan Tanaman Pangan dan Hortikultura (BPTPH), along with additional documentation, are necessary for evaluation; however, a validation system to ensure the accuracy of the obtained prediction information is lacking.

VUB that exhibit tolerance to extreme climatic conditions and offer nutritional benefits are readily available. These white label/basic seeds are produced under strict supervision to ensure the purity of the varieties. The white label seeds are certified by the Plant and Horticulture Seed Monitoring and Certification Agency/Badan Pengawasan Sertifikat Benis Tanaman Pangan dan Hortikultura (BPSBTPH), responsible for certification, seed circulation supervision, planning, guidance, assessment, and variety adaptation/observation testing. The monitoring system is crucial for verifying that marketed seeds have completed rigorous trials and obtained valid certification.

The evaluation of extension activities is conducted via the e-*Pusluh application*, initiated by the MoA, and serves as a monitoring tool for evaluating and reporting agricultural extension activities using a web-based platform. The verification process for operational assistance for extension workers and mobile data packages is conducted in a tiered manner, involving the Agricultural Extension Offic / Badan Penyuluh Pertanian (BPP), district/city administrators, and provincial administrators.

M&E for the SIAP TANAM process remains manual, involving the verification of recommendations in various districts through interviews with farmers or farmer groups. This verification examines factors including planting time, varieties, productivity, cropping patterns, water availability, and types of plant pests and diseases/*Organisme Pengganggu Tanaman* (OPT). The modalities of M&E in the agricultural sector are anticipated to offer a thorough understanding of the program's effectiveness and bolster the sector's resilience to climate change challenges.

3.6.3.2 Water Resources

The responsibility for M&E of the water resources adaptation program lies with each relevant Ministries/Institutions. The outcomes of this monitoring and evaluation process are submitted annually as a program or activity performance index within the Ministries/institutions performance report. This process aims to elucidate the effectiveness and efficiency of water resources management in Indonesia in addressing climate change.

The indicators employed for the monitoring and evaluation of water resources activities differ based on the implementation of the program. Indicators are formulated for each dimension of water resources management based on established standards and criteria, including the Indonesian National Standard (SNI), and require stakeholder approval. The indicators for water management encompass five (5) key areas: conservation of water resources, utilization of water

resources, minimizing the potential water's damage, information systems for water resources, and empowerment and participation of communities and businesses.

Indicators for assessing success in water resources conservation include the percentage of land cover relative to the watershed area, land erosion and sedimentation rates, river sedimentation levels, and the ratio of maximum to minimum discharge. The assessment of watershed conditions is conducted every five years.

In the context of water resources utilization, indicators that reflect the success of water management encompass water balance per watershed (DAS), regulated groundwater use, and sustainable water exploitation. The control of water's destructive power is assessed through indicators such as the frequency of flood events, the extent of areas affected by flooding, andthe degree of vulnerability to flood and landslip disasters. Other components of the M&E include the water resources Information System and community empowerment. Indicators for the information system comprise the density of rainfall station networks, river water levels, and the presence and comprehensiveness of the water resources database. Conversely, in the context of community and business empowerment, the assessed indicators include the active role and autonomy of water user communities, as well as the engagement of the business sector.

The monitoring and evaluation of water resources is facilitated by particular application modalities. SIPDAS/SIMDAS, or the Watershed Information System (http://sipdas.menlhk.go.id/), serves as a platform for this information system, featuring geospatial data and metadata systematically organized as a catalog. SIH3 (National Hydrological, Hydrometeorological, and Hydrogeological Information System) (https://sih3.bmkg.go.id/main/) is a platform that serves as a data and information portal for the management of hydrology, hydrometeorology, and hydrogeology. This portal offers monitoring, early warning, and geospatial information accessible at both national and sub-national levels. SIATAB (Groundwater and Raw Water Information System) can be accessed through http://siatab.sda.pu.go.id/, is a comprehensive platform that functions as a big data website, offering real-time information regarding the infrastructure and status of wells, springs, river intakes, reservoirs, and Water Treatment Plants/Water Intake Structures from 37 River Basin Organizations (BBWS/BWS) throughout Indonesia.

The evaluation process of water resources management program encompasses assessing program implementation, conducting impact analysis, and identifying areas for improvement. Program evaluation involves the identification of constraints and obstacles, which are subsequently integrated into the following process. Impact analysis encompasses regular assessments of risk and vulnerability to evaluate changes in conditions and the effects of climate on water resources, along with the feedback component from stakeholders and the updating and adjustment of policies. The ultimate result of the process, manifested as capacity building, aims to enhance the capabilities, skills, and knowledge of those implementing the adaptation program.

3.6.3.3 Health

Monitoring and evaluation are essential components of adaptation initiatives in the health sector, implemented by working units employing a range of tailored methodologies. The dengue control program implemented by MoH employs 24 established indicators derived from multiple data sources. This M&E seeks to identify barriers to the implementation of the national strategy across all levels, from central to district/city, while also monitoring the progress of the developed improvement plans. The WHO contributes to the provision of technical assistance

in the monitoring and evaluation process, ensuring program adherence to expectations and facilitating necessary strategic adjustments (KEMENKES, 2021).

The EWRS (SKDR) program utilizes a systematic monitoring and evaluation approach. Monitoring is conducted by comparing the number of disease outbreaks identified through the routine surveillance system and assessing the reliability of the initial information sources (Kementerian Kesehatan, 2023c). The indicators utilized comprise the positive predictive value (PPV) of the initial event assessment and the response time from notification to confirmation. Periodic evaluations are conducted, at a minimum on two occasions, involving interviews with implementers at each level to formulate assessments and recommendations concerning system performance, thereby facilitating a swift and effective response to potential outbreaks.

Additionally, in the malaria elimination acceleration program, monitoring and evaluation are conducted through the establishment of indicators and targets to assess the progress of interventions and the impact of malaria control efforts (Figure 3-26). The indicators encompass impact, outcome, and output dimensions. KEMENKES (2023b) states that the program's progress is monitored via the Malaria Information System (SISMAL), which gathers routine data from health facilities, including primary health centers and hospitals. The data collected encompasses multiple malaria control activities, including case registration, case detection, and treatment. A data validation and epidemiological analysis process is implemented to enhance planning, while routine surveys are conducted to assess the program's impact.

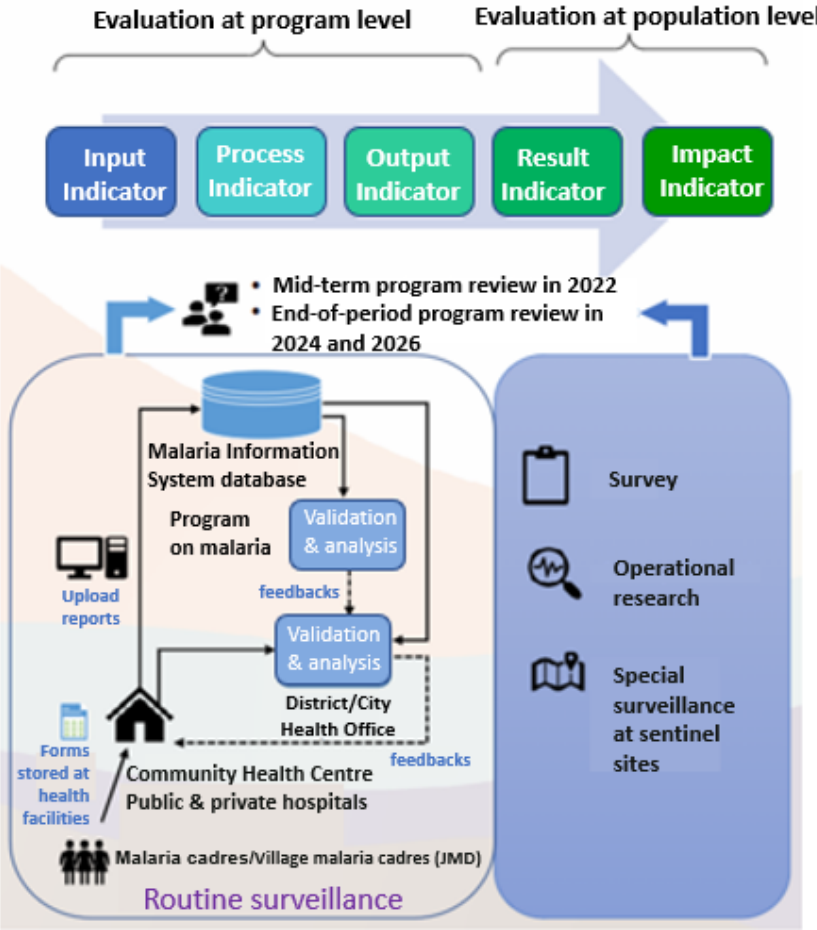


Figure 3- 26 Monitoring and evaluation mechanism for accelerating malaria elimination 2020-2026 (KEMENKES, 2023b)

In the pneumonia and diarrhea control program, monitoring and evaluation are conducted using pre-established indicators to identify emerging issues and derive lessons learned from program implementation. Assessment is carried out via both routine and non-routine reports, in addition to field visits to gather direct feedback on program implementation. The achievements of health adaptation indicators in 2022 is displayed in Table 3-4. This comprehensive monitoring and evaluation approach ensures effective program execution and establishes a robust foundation for improved decision-making in addressing community public health issues.

Table 3- 4 Achievements of several health adaptation indicators in 2022

No.	Indicator	Target	Achievement	Achieved	Reference
1.	Number of malaria-free districts/cities	365	372	Yes	KEMENKES (2023b)
2.	Dengue Fever Incidence Rate (IR) per 100,000 population	≤ 10	52,12	Not yet	KEMENKES (2023a)
3.	Diarrhea treatment services for children under five	20%	24,6%	Yes	KEMENKES (2023a)
4.	Treatment of Pneumonia cases according to standards	50%	95,5%	Yes	KEMENKES (2023a)
5.	Districts/cities with 25% of health centers implementing vector surveillance	360	411	Yes	KEMENKES (2023a)
6.	Number of accredited hospitals	90%	81,9%	Not yet	KEMENKES (2023a)

3.6.3.4 Ecosystem

The implementation of monitoring and evaluation for adaptation actions within the ecosystem field is conducted by relevant ministries and agencies, adhering to their designated roles and responsibilities, along with their specific indicators. Most of the identified ecosystem programs in the monitoring and evaluation scheme continue to depend on manual monitoring methods. Monitoring is typically conducted using performance index outputs, which are consistently reported in the annual performance reports of the ministries/agencies.

For MoEF , the monitoring of the vegetative forest and land rehabilitation program employs geo-tagging technology and is executed over a three-year duration. The forest and land rehabilitation program has also launched the monitoring and evaluation guidelines for assessing erosion control structures. Mangrove rehabilitation is monitored through regular reporting and updating the national mangrove map to assess the success of rehabilitation based on the increase in mangrove cover area. The environmental services for tourism in protected areas is monitored by site visits and the evaluation of permits for natural tourism service for a certain period of time.

For KKP, several specialized tools have been developed to conduct program evaluations. The effectiveness of marine protected area management is assessed through the Evaluation of

Conservation Area Management Effectiveness (EVIKA) tool. The protection and management of protected marine species is assessed using the Evaluation of Endangered and/or Protected Fish Species Management Effectiveness (EPANJI) tool. Meanwhile, the progress of coastal ecosystem rehabilitation is monitored manually by assessing growth rates, fragment conditions, and other relevant factors.

The 3R (Rewetting, Revegetation, and Revitalization) Peatland Ecosystem program by BRGM is monitored by measuring peat water table levels, maintaining a threshold of 0.4 meters, and managing water within the peatland ecosystem landscape.

3.6.3.5 Climate Services

The BMKG aims to ensure the availability of meteorological information services across public meteorology, aviation meteorology, and maritime meteorology activities. The indicators of success and performance can be assessed by the average percentage of accuracy in weather information. In 2016, the average information accuracy percentage was 79.8%. The value rose to 85.6% in 2019 (BMKG, 2020) and 95.19% in 2023 (BMKG, 2024). In climatology services, BMKG aims to ensure the provision of climatology information services, focusing on climate change information management and the application of climate information services. Performance achievement indicators can be assessed by the percentage of accuracy in climate information services at the sub-district level. In 2016, the average information accuracy percentage was 68.9%. The accuracy rose to 78.0% in 2019 (BMKG, 2020) and 93.04% in 2023 (BMKG, 2024).

3.7 Information Related to Averting, Minimizing and Addressing Loss and Damage Associated with Climate Change Impacts

Loss and Damage denotes the consequences of climate change that remain unavoidable despite efforts in mitigation and adaptation, attributable to the presence of adaptation limits, leading to residual impacts (Tschakert et al., 2017; Addison et al., 2022). Adaptation limits are categorized into soft limits, where adaptation is feasible but obstructed by social, financial, or institutional barriers, and hard limits, where adaptation becomes unfeasible, leading to irreversible impacts such as biodiversity loss or coastal submergence (IPCC, 2022). Identifying adaptation limits presents a challenge due to the intricate and interconnected factors involved. This necessitates additional research and specialized methodologies to accurately determine these limits, particularly in relation to climate change.

Addressing loss and damage in Indonesia is intricately connected to the disaster management policy framework, with the BNPB serving as the principal stakeholder (Figure 3-27); however, the quantification of residual impacts remains inadequately integrated. Disaster management in Indonesia involves cross-sectoral collaboration and is underpinned by funding mechanisms established in Perpres No. 75/2021 regarding disaster pooling fund. This funding includes risk transfer mechanisms like insurance (Box 7-1); however, insurance coverage is restricted and fails to encompass all risks, especially non-economic losses. Article 10, Paragraph 1 of Perpres No. 75/2021 regulates the distribution of risk transfer funds via insurance mechanisms. This insurance mechanism is consistent with Article 8 of the Paris Agreement, which aims to mitigate the impacts of climate change.

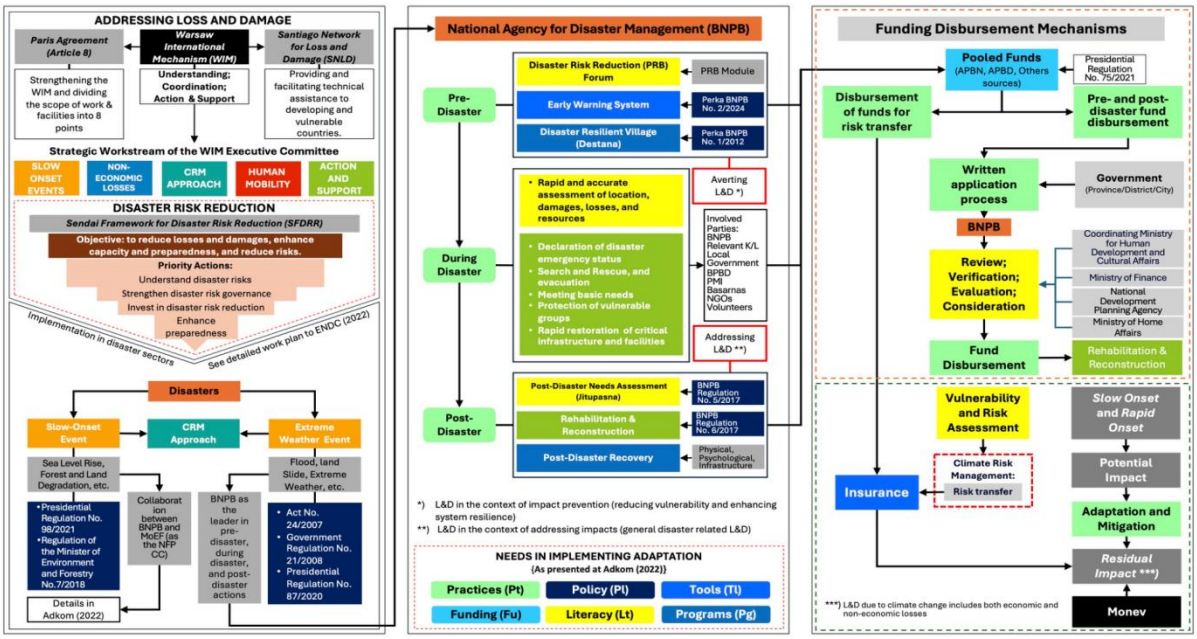


Figure 3- 27 Workflow of the loss and damage framework in Indonesia

BOX 7-1

MECHANISM FOR DISBURSING INSURANCE FUNDS TO ADDRESS RESIDUAL IMPACT

1. Climate Vulnerability and Risk Assessment

The initial stage entails evaluating climate vulnerability and risk to discern regions exhibiting differing levels of vulnerability, ranging from high to low. Risks are evaluated through the interplay of climate hazards, whether they are slow-onset or rapid-onset events, alongside the vulnerability and exposure of a region, as well as the probability and potential severity of an event's impact. This assessment establishes a fundamental basis for improved decision-making in risk management, particularly regarding the timing and application of risk transfer mechanisms. In the absence of a proper risk assessment, risk transfer strategies may exhibit reduced efficacy or fail to achieve their intended objectives.

2. Climate Risk Management

Following the vulnerability and risk assessment, climate risk management is executed to mitigate or manage risks associated with climate change through strategies of mitigation, adaptation, and risk transfer. This assessment identifies priorities in risk management, including the most vulnerable communities or regions that require additional protection, and facilitates the design of risk transfer strategies. Risk transfer mechanisms, such as insurance, are chosen according to risk assessments, which aid in establishing premium pricing based on the probability of climate-related disasters. Additionally, areas with high vulnerability necessitate more extensive insurance coverage.

3. Risk Transfer through Insurance

Insurance functions as a mechanism for risk transfer, offering financial resources to mitigate losses from anticipated disasters, as determined by risk assessment. Insurance alleviates the unavoidable financial burden that adaptation or mitigation cannot fully address, and assists in managing the residual impacts, albeit not completely. The Indonesian government has implemented risk transfer through insurance, exemplified by the Rice Farming Business Insurance (AUTP). The management of this insurance is conducted by PT Asuransi Jasa Indonesia (Jasindo) pursuant to a mandate from the MoA in accordance

with Act No. 19/2013 concerning Farmer Protection and Empowerment. AUTP offers safeguards for farmers against the risks associated with crop failure stemming from floods, droughts, pests, and plant diseases. Private entities have developed insurance products as a risk transfer mechanism. For instance, PT Asuransi Central Asia (ACA) offers protection to farmers against crop failure risks stemming from drought, tornadoes, specific natural disasters, pests, and plant diseases through Risk Mitigation-Based Micro Plant Insurance.

4. Potential Impacts and Residual Impacts

Despite the implementation of adaptation, mitigation, and risk transfer strategies, residual impacts persist as certain risks or losses cannot be entirely mitigated. Insurance covers financial losses resulting from impacts such as slow-onset events like sustained climate change effects on agriculture or rapid-onset events like hydrometeorological disasters.

5. M&E

Monitoring and evaluation are performed to assess the efficacy of the insurance fund disbursement mechanism. It is crucial to evaluate the effectiveness of the insurance fund disbursement in targeting appropriate recipients and to determine if the risk transfer mechanism has effectively alleviated the financial burden associated with climate impacts.

3.7.1 Loss And Damage From Extreme Weather/Climate And Slow-Onset Events

Loss and Damage encompasses the effects of climate change resulting from two categories of events: Slow-onset events and rapid-onset (extreme weather) events. Slow-onset events encompass rising temperatures, desertification, biodiversity loss, land degradation, glacier reduction, ocean acidification, sea level rise, and salinization. In contrast, rapid-onset/extreme weather events include phenomena such as floods, droughts, storm surges, and tropical cyclones. Indonesia, as a developing country susceptible to climate change, faces diverse geographical impacts from various events. These include a rise in average air temperature from 1981 to 2023, sea level rise in Jakarta, Pekalongan and cities along the northern coast of Java, glacier reduction in the Papua mountains, coral reef degradation in the Gili Matra waters of West Nusa Tenggara, salinization in Indramayu, ocean acidification in several Indonesian waters, and desertification in the Nusa Tenggara region. Extreme weather events, including floods in Jakarta, droughts in Java, Bali, and Nusa Tenggara, as well as tropical cyclones in East Nusa Tenggara, have resulted in substantial losses and damage.

BNPB reports that from 2008 to 2022, there has been a notable increase in the occurrence of hydrometeorological disasters, including floods, extreme weather events, landslides, and droughts. These disasters have led to millions of displaced individuals, numerous fatalities, and significant damage to infrastructure (BNPB Infographic Publication). According to data from BNPB, hydrometeorological disasters resulted in economic losses and damages amounting to IDR 48.90 trillion. Indonesia necessitates specific actions to mitigate and adapt to the impacts of climate change, along with strategies to address loss and damage.

3.7.2 Programs And Activities To Address Loss And Damage

The effects of slow-onset events and extreme weather events in Indonesia necessitate responses focused on prevention, reduction, and management of losses and damages across multiple levels. The Government of Indonesia has implemented strategic measures consistent with Article 8 of Paris Agreement, focusing on enhancing EWSs, emergency preparedness, and comprehensive risk management. EWSs that have been developed include the Flood EWS (FEWS), Landslide EWS (LEWS), and CEWS. Furthermore, adaptation programs including

the Disaster Risk Reduction, Safe Schools from Disasters, and the Fishermen's Weather Field School (SLCN) seek to improve community resilience to disasters.

The government implements nature-based programs, including peatland rehabilitation in Riau and mangrove restoration in the Thousand Islands, alongside infrastructure initiatives such as sea wall construction in Jakarta. Public campaigns, including the Disaster-Aware Culture Movement, along with community-based initiatives such as Destana and ProKlim, are essential for enhancing awareness and fostering community resilience to the impacts of climate change.

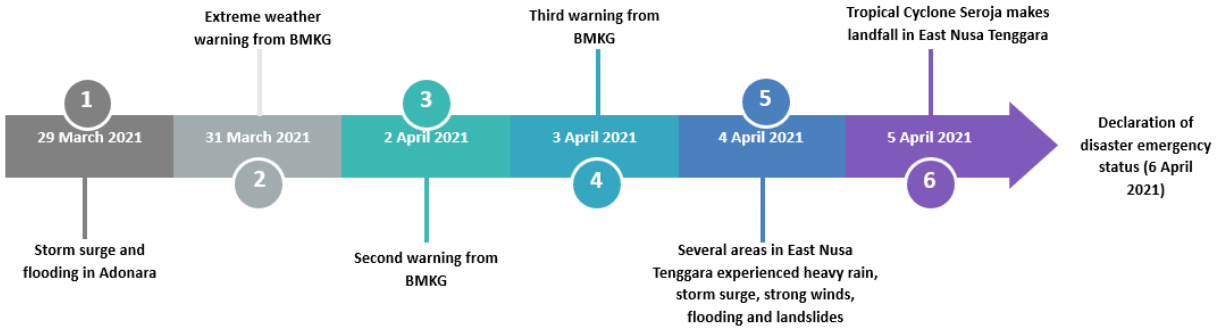
The calculation of loss and damage is conducted by BNPB via the Jitupasna, which assesses post-disaster economic losses and formulates rehabilitation plans. BNPB has calculated economic loss from tropical cyclone Seroja occurred in 2021 in Eastern Nusa Tenggara approximately IDR 7.3 trillion. This program was implemented in the rehabilitation and reconstruction efforts following tropical cyclone Seroja in East Nusa Tenggara (Box 7-2), with BNPB supporting the recovery of 16 affected districts and cities.

BOX 7-2

TROPICAL CYCLONE SEROJA

Conditions for the Occurrence of Tropical Cyclone Seroja

Over the past 40 years, the East Nusa Tenggara (NTT) province has frequently experienced climate-related disasters, including strong winds (30%) and floods (26%). Tropical cyclones represent a significant meteorological hazard in this region, forming over warm waters with temperatures exceeding 26°C and exhibiting wind speeds greater than 63 km/h. NTT is situated in a latitude that is susceptible to tropical cyclones. Tropical Cyclone Seroja, which occurred in 2021, inflicted considerable damage in NTT and was one of 17 cyclones that have impacted the region since 1908 (BPBD NTT, 2021). The timeline of Tropical Cyclone Seroja and the subsequent declaration of a disaster emergency status is illustrated in the following figure.



Impacts of Tropical Cyclone Seroja

The SIAP SIAGA program reported that over 95% of the East Nusa Tenggara (NTT) region was affected by Tropical Cyclone Seroja, resulting in 180 deaths, 40 individuals missing, 85,000 displaced persons, and 13,000 homes damaged (PSA, 2021). The cyclone resulted in damage to mangroves and coral reefs, though the extent of this damage has yet to be assessed. The total loss and damage from this disaster amounted to IDR 7.3 trillion, necessitating a recovery of IDR 6.7 trillion—approximately 4.5 times the NTT Regional Revenue (BNPB, 2021). The elevated risk of future tropical cyclones necessitates enhanced mitigation and adaptation efforts.

Activities for Averting, Minimizing, and Addressing Impacts

Activities aimed at averting, minimizing, and addressing losses and damages from extreme climate events in East Nusa Tenggara have been carried out through collaboration among BNPB, Provincial Disaster Management Agency, BMKG, the Ministry of Social Affairs, and the other provincial agencies.

Activities encompass the construction of disaster-resilient infrastructure, exemplified by the Waiburak 2 bridge, the establishment of EWSs, the enhancement of the Fishermen's Weather Field School, and the formulation of disaster management policies by the East Nusa Tenggara BPBD. The primary focus for impact reduction is the Disaster Resilient Village (Destana) program and the enhancement of economic resilience in response to extreme climate threats. Impact management activities are conducted via rehabilitation and reconstruction efforts.

Barriers, Challenges, and Lessons Learned

Barriers and challenges in disaster management in NTT encompass constrained regional budgets, inadequate community access to BMKG early warnings, and insufficient disaster mitigation facilities in Oesapa Fishing Village. The Fishermen's Weather Field School (SLCN) program initiated by BMKG serves as an exemplary model of best practices. Mr. Dewa, an alumnus, effectively rescued 120 residents from the effects of Tropical Cyclone Seroja by disseminating weather information from BMKG. The SLCN has been implemented multiple times, both prior to and following Tropical Cyclone Seroja.

3.7.3 Institutional Arrangements And Activity Facilitation

The institutional framework for addressing loss and damage entails coordination across various ministries and agencies, with the Coordinating Ministry for Human Development and Cultural Affairs/*Kementerian Koordinator Pembangunan Manusia dan Kebudayaan* (Kemenko PMK) serving as the central coordinating body to harmonize the functions of BNPB, MoEF, BMKG, MoF, Kemendagri, Bappenas, and Kemen PUPR. BNPB oversees disaster management operations and coordination, employing data from BMKG for early warning purposes. MoEF is dedicated to reducing environmental impacts, whereas the Ministry of Finance / Kementerian Keuangan (Kemenkeu) oversees financial management, including disaster insurance. Kemendagri oversees local governments to ensure effective implementation of national policies at the local level. Bappenas integrates climate change and disaster considerations into medium-term and long-term development planning, whereas the Kemen PUPR focuses on constructing disaster resilient infrastructure.

The government's institutional regulatory framework facilitates the implementation of various disaster management programs and activities. The legal framework for disaster management is established by Act No. 24 of 2007. PP No. 21 of 2008 governs the execution of disaster management at the Government Regulation level. Presidential Regulations, including Perpres No. 73 of 2018, outline a comprehensive master plan for disaster management extending to the year 2044. Institutions like BNPB issue regulations to facilitate program implementation, including BNPB Regulations No. 5 and No. 6 of 2017, which govern post-disaster rehabilitation and reconstruction plans and their execution. BNPB Regulation No. 1 of 2012 establishes general guidelines for the Disaster Resilient Village/*Desa Tangguh Bencana* (Destana).

3.7.4 Findings And Follow-Up

The key findings and subsequent actions regarding learning and development in the context of climate change in Indonesia are outlined as follows:

1. Extreme events are, to some extent, effectively managed through current emergency response mechanisms; however, there remain deficiencies in addressing slow-onset events and non-economic losses, which have not been fully recognized or addressed.

2. Specific policies are required to govern the management of slow-onset events within Indonesia's climate change strategy, alongside the development of suitable methodologies for quantifying non-economic losses to enhance a more comprehensive loss and damage response.

3.8 Cooperation, Good Practices, Experience and Lessons Learned

3.8.1 Collaboration And Efforts To Share Information On Best Practices

The collaboration for climate change actions includes multiple stakeholders, including government institutions, local communities, non-governmental organizations, and the private sector. A multi-stakeholder approach facilitates effective knowledge and resource exchange, enabling adaptation strategies to be customized for local contexts and enhancing inclusivity.

The mechanisms for collaboration in implementing climate change adaptation actions in Indonesia are governed by various regulations that establish the legal framework and implementation guidelines at national, sub-national, and local levels. Act No. 16 of 2016, which ratifies the Paris Agreement, serves as the primary basis for Indonesia's commitment to actions aimed at climate change mitigation and adaptation. Presidential Regulation No. 98 of 2021 underscores the necessity of incorporating adaptation into national policies, directing efforts to improve resilience to climate change across multiple sectors. PERMEN LHK No. 33 of 2016 outlines guidelines for the development of the Climate Change Adaptation Action Plan, aimed at fostering collaboration among diverse stakeholders. This regulation emphasizes collaboration among central and local governments, the private sector, academia, and civil society organizations. Consequently, a robust synergy can be established to improve community resilience to climate change. The participation of local communities is deemed significant, as local knowledge can enhance adaptation initiatives.

Additionally, initiatives to disseminate information and knowledge concerning the execution of adaptation actions in Indonesia are conducted through multiple mechanisms that integrate science, planning, policy, innovation, and collaboration among diverse stakeholders. This approach incorporates scientific data in policymaking, implements pilot projects to evaluate innovative policies, integrates adaptation into development plans, and enhances capacity through collaboration among multiple stakeholders. Efforts to share information are focused on the interconnection of Science, Planning, and Policy, utilizing Evidence-BasedApproaches and fostering Data and Information Collaboration. The evidence-based approach employs scientific data to inform adaptation policies, utilizing the SIDIK (MoEF) and InaRISK (BNPB) systems to deliver information on climate risks and the impacts of hydrometeorological disasters. Data and information collaboration integrates data from multiple sectors, including agriculture, water resources, health, and infrastructure, to inform the development of adaptation actions and promote a comprehensive approach.

Collaboration and information-sharing initiatives are implemented through pilot projects. Adaptation implementation frequently begins with pilot projects in targeted regions to evaluate innovative practices prior to broader application. The mangrove rehabilitation program on the north coast of Java aims to mitigate the effects of erosion and flooding. Following a favorable assessment, this project was implemented in additional coastal regions, including Kalimantan and Sumatra, to enhance coastal resilience (KKP, 2022). In certain areas, government initiatives have established incentive mechanisms that engage local communities, exemplified by the payment for ecosystem services system in Bali's agricultural sector, which incentivizes farmers

to sustain ecosystem balance. The integration of adaptation actions into development planning has prompted the government to embed climate resilience components within medium-term plans. The government has recorded this strategy in the Climate Resilient Development (2022) document. The integration of climate resilience into development planning fosters a deeper comprehension of climate risks and improves the efficacy of adaptation policies that align with development objectives. Collaboration in the implementation of adaptation actions should consider funding and financing patterns, as adequate financial support is essential for executing climate change adaptation initiatives (KLHK, 2020b). Challenges exist in distinguishing adaptation actions from general development implementation, necessitating a more thorough analysis of climate change impacts at the local level. The ability of local governments to secure funding for adaptation initiatives is crucial for the sustainability and efficacy of these efforts. The effectiveness of implementation is contingent upon local governments' capacity to efficiently utilize the funding provided by the national government. Development Financing Institutions (DFIs) serve a crucial function by providing necessary funding. Multilateral Development Banks (MDBs) function as intermediaries between developed and developing nations, facilitating the allocation of public funds. Bilateral development banks are also classified as DFIs, as they provide support to both the public and private sectors in developing countries. Furthermore, international climate resilience funding includes grants and loans (MDBs and DFIs, 2024). Public-Private Partnership / *Kerjasama Pemerintah dengan Badan Usaha* (KPBU) emphasizes infrastructure financing in accordance with established regulations. ProKlim exemplifies multi-stakeholder participation at the local level and facilitates the dissemination of best practices. ProKlim, overseen by the MoEF, is an initiative designed to enhance community engagement in local climate change mitigation and adaptation efforts. This program engages multiple community stakeholders, such as local governments, community organizations, business entities, and educational institutions, to develop comprehensive climate resilience at the local level. Concrete actions are implemented in various regions, including Caturharjo Village, Sleman Regency, where the community engages in land reforestation, constructs biopores to enhance water absorption, and adopts organic home-based agriculture practices. The initiatives have effectively diminished the risk of flooding and erosion, enhanced food security, and decreased landfill waste.

In Tamansari Village, Banyuwangi, an agroforestry system is implemented through the cultivation of hardwood and food crops to mitigate erosion, alongside the establishment of a basic irrigation system to secure water supply during the dry season. These actions have enhanced agricultural productivity and generated supplementary income for residents through non-timber forest products. In Batu Rotok Village, Sumbawa, the implementation of rainwater harvesting technologies and infiltration wells aims to enhance access to clean water. Additionally, the initiative includes the planting of drought-resistant endemic plants and the conservation of water resources. The initiatives have effectively enhanced water accessibility in the dry season and improved community awareness regarding the significance of water conservation and the utilization of indigenous drought-resistant flora. This program mitigates climate risks while enhancing community resilience and improving the quality of life for individuals across diverse regions.

Indonesia is enhancing the effectiveness and sustainability of climate adaptation implementation through a combination of scientific research, policy innovation, integration into planning processes, and collaboration among multiple stakeholders. Insights gained from

these projects are disseminated broadly to enhance the replication and capacity building processes from local to national levels.

3.8.2 Strengthening Research And Science

Adapting to climate change in Indonesia necessitates a thorough strategy that enhances research and scientific efforts, especially regarding systematic observation, M&E. Comprehensive research and systematic climate observation are essential for the development of effective and sustainable adaptation policies, enhancing EWS, and evaluating vulnerability and risks associated with climate change impacts.

The implementation of climate change adaptation necessitates climate observation, EWS, and systematic observation. The climate is systematically observed by BMKG, BRIN, and BIG. This observation encompasses atmospheric variables, including air temperature and rainfall, terrestrial factors such as surface temperature and soil moisture, and oceanic elements like sea surface temperature and salinity. This system facilitates projections of future climate trends and risk assessments, offering scientific evidence regarding the impacts of climate change. EWS have been established to address natural disasters and climate change. Notable examples include InaTEWS (https://inatews.bmkg.go.id/) for tsunami early warning, MEWS (https://signature.bmkg.go.id/) for extreme weather conditions, and CEWS (https://cews.bmkg.go.id/home.php) for monitoring meteorological droughts and potential El Niño/La Niña events. These systems utilize data from weather stations, radar, and satellites, along with modeling analysis, to forecast future climate conditions. Methodical Data Observation gathers data via a network of observation stations situated at 186 locations throughout Indonesia, in addition to utilizing instruments such as AWS, ARG, and weather radar.

Systematic observation aids in evaluating the vulnerability of different sectors to climate change. The collected data serves to identify the most vulnerable regions and populations, as well as to develop targeted adaptation strategies. Observations of variations in rainfall and temperature inform the development of Seasonal Zones (ZOM), which are essential for agricultural planning and food security. These observations provide a foundation for stakeholders to establish adaptation policies in essential sectors, including water, agriculture, and health. The application of advanced technologies in observation, including weather radar, satellites, and marine buoys, facilitates systematic data collection, thereby enhancing data accuracy and consistency. Observations from remote sensing and paleoclimate reconstruction yield insights into historical climate conditions, which inform projections of future climate scenarios. Public access to observation-based data services is available via the portals dataonline.bmkg.go.id and srgi.big.go.id. These services offer a range of historical data and climate projections.

Systematic observation aids in evaluating vulnerability across key sectors, including agriculture, water resources, health, and ecosystems. This information aids in identifying regions that are most susceptible to the effects of climate change, including droughts, floods, and rising sea levels. Systematic observation yields information that informs the development of evidence-based adaptation strategies. Indonesia is actively enhancing its observation capacity through the expansion of its network of stations, radars, and sensors, alongside the modernization of technologies to ensure data accuracy and continuity. Besides the weather and climate network, BIG manages a geospatial observation network to assess the effects of climate change, including sea level rise and land subsidence. The data can be accessed via the SRGI (Indonesian Geospatial Reference System).

These initiatives bolster Indonesia's objective of enhancing the national climate observation and adaptation framework, while also contributing to global climate action through the aggregation of precise, consistent, and accessible data by multiple stakeholders. Despite notable advancements, challenges persist, particularly the insufficient observation network in the central and eastern regions of Indonesia, which necessitates further attention. Increasing the number of stations and maintaining observation instruments are essential measures for ensuring data accuracy. Moreover, improving human resource capacity and integrating new technologies will bolster Indonesia's observation system and enhance its climate adaptation capabilities.

3.8.3 Best Practices And Lessons Learned

Best practices of climate change adaptation actions in Indonesia encompass diverse methodologies applied across various regions to enhance community resilience against the effects of climate change. The Climate Resilient Rural Development / Pembangunan Pedesaan Tangguh Iklim (PPTI) program exemplifies support for farmers in adopting climate resilient agricultural practices, including the utilization of weather-resistant crop varieties and sustainable farming techniques (Anggraini et al., 2023). Community-based water resources management in drought-prone regions, exemplified by East Nusa Tenggara, has demonstrated effectiveness through the establishment of community groups aimed at sustainable water resource management and capacity building to tackle water crisis (Bappenas, 2021d). The mangrove ecosystem restoration program in Indonesia's coastal areas has effectively reduced abrasion impacts and enhanced ecosystem resilience, while also empowering local communities through sustainable fishery activities (KLHK, 2023).

Several major cities, including Jakarta and Semarang, have incorporated climate change adaptation into spatial planning. They have established policies aimed at fostering climate resilient infrastructure through risk assessments and the identification of vulnerable areas (PUPR, 2022). Education and public awareness programs addressing climate change and adaptation have been implemented across various levels, including schools and communities, resulting in enhanced public knowledge regarding adaptation actions. Furthermore, the advancement of technologies, including mobile applications for weather monitoring and smart agriculture, has enabled farmers to make more informed decisions (Febrianda, 2021). These best practices illustrate that collaboration among government, communities, and the private sector is essential for developing effective and sustainable solutions to improve resilience to climate change throughout Indonesia.

3.8.3.1 Food

BOX 8-1

Farmer-Led Collaboration in Enhancing the Effectiveness of Irrigation Programs for Food Security

The limited availability of water presents a significant challenge to enhancing agricultural production. MoA has initiated programs including Tertiary Irrigation Network Rehabilitation, pipe irrigation, and reservoir construction to address this issue. The programs seek to enhance water availability, broaden cultivated areas, and elevate cropping intensity. The execution of these activities occurs via community-based management, engaging complete participation from

the recipient farmer groups throughout the stages of planning, implementation, utilization, and maintenance of the infrastructure. Local governments engage in the guidance, preparation of Design Investigation Studies (SID), and coordination of activity implementation. Certain regions allocate local government budgets to supplement units or activity components when central funding is inadequate.

Each Farmer Group / Kelompok Tani (Poktan) receives assistance only once to ensure broader coverage, with the provided funds intended to act as an initial stimulus. Some Poktans have redirected labor wages to finance the expansion of the irrigation network, acknowledging the substantial advantages of enhanced water availability. Poktans have expanded the irrigation network and enhanced irrigation services by adding pipes and pumps through member agreements. This self-help funding is derived from contributions made by farmers, calculated based on water usage and paid post-harvest. Furthermore, farmers voluntarily engage in infrastructure maintenance to ensure the optimal operation of the irrigation network. This collaborative self-help practice illustrates the effectiveness of active farmer involvement in improving irrigation program utility and enhancing food security through more sustainable water management.

3.8.3.2 Water Resources

Box 8-2
Weather Modification Operation Program (TMC/OMC), The Weather Modification Operation (OMC) represents a human intervention aimed at regulating atmospheric natural resources through the manipulation of weather parameters. Its objective is to increase or decrease rainfall intensity in targeted regions to mitigate the risks associated with climate and weather-related natural disasters. OMC has emerged as an effective solution for mitigating losses associated with disasters induced by climatic and meteorological factors. OMC is utilized in activities including reservoir refilling requests during the dry season, management of forest fire disasters, and coordination of major state events. Since 2021, OMC activities have been executed through coordination and collaboration among various ministries and agencies, including the Kemen PUPR, BMKG, BRIN, MoEF, and BNPB, alongside participation from the private sector and military/police entities. The primary aim is to enhance water availability in Indonesian dams, specifically the 43 dams located in Java Island that are utilized for irrigation. Evaluations of the OMC implementation indicate positive outcomes, with reservoir volumes increasing by approximately 270 million m^3 for Saguling, 201 million m^3 for Cirata, and 59 million m^3 for Djuanda. However, the water levels in these reservoirs have not yet attained the normal operating limits.

3.8.3.3 Health

Box 8-3
Early Warning and Response System (SKDR), SKDR functions as a real-time disease reporting system, facilitating the flow of information from primary health care centers (Puskesmas) to the district level and subsequently to the national level (MoH). The standard reporting frequency is weekly. In the presence of indications of an Extraordinary Event,

characterized by a high incidence of disease cases in a specific area, the reporting frequency is escalated to a daily basis. Upon the official declaration of KLB status by the local government, the reporting frequency is escalated to an hourly basis. The declaration of a KLB condition is executed via an official decree issued by the Head of the Local Government (District/City). In a declared KLB condition, swift coordination among stakeholders is essential to mobilize the Rapid Response Team (TGC) and deliver the required assistance without delay. The real-time information adjustments within the District Health Information System (DHIS) for various events, including disasters, exemplify an effective system. Community participation is a crucial factor in the effectiveness of this adaptation program, as the active engagement of both the public and the government facilitates a more rapid health response at the local level.

3.8.3.4 Ecosystem

Box 8-4

Peatland Rewetting, Revegetation, and Revitalization (3R) Program, Peatland degradation in Indonesia is primarily caused by excessive drainage, which leads to the desiccation of peatlands and increases their vulnerability to fires. The restoration of peatland ecosystems is carried out through the 3R approach: rewetting, revegetation, and revitalization of community livelihoods. Restoration efforts in Pandan Sejahtera, Jambi, began in 2017 and involved the construction of 64 canal blocks and 25 boreholes to reduce fire risks. Additionally, a water table monitoring system (APTMA) was implemented to enable real-time monitoring of peatland conditions. Economic development initiatives, including cattle farming, have significantly increased the community's income. In 2019, the establishment of Community-based Peatland Conservation and Restoration / *Desa Mandiri Peduli Gambut* (DMPG) helped integrate the restoration program into village planning for sustainability. The collaboration among various stakeholders has successfully reduced both the frequency and intensity of peatland fires, yielding positive effects for the environment and the local community.

3.8.3.5 Climate Services

Developing climate information services to address operational needs related to climate variability and extremes across various time scales, as well as for climate change research, necessitates collaboration among multiple stakeholders. BMKG necessitates collaboration with other research institutions, including the BRIN and universities, to fulfill its objectives effectively. Presidential Regulation No. 12 of 2024 regarding BMKG highlights the agency's role in meteorology, climatology, and geophysics. Its primary duties and functions are confined to observation, data management, service provision, infrastructure related to meteorological, climatological, and geophysical activities, and weather modification. Consequently, for research and development, especially in climate information services, BMKG must collaborate with BRIN. According to Presidential Regulation No. 33 of 2021, BRIN is tasked with conducting integrated research, development, assessment, application, as well as invention and innovation.

Establishing synergy requires the involvement of universities through educational and research collaborations. In the last decade, BMKG has engaged in multiple educational collaborations with various Indonesian universities to enhance the educational qualifications of its staff, facilitating their attainment of master's and doctoral degrees. A notable higher education

collaboration involves the partnership in master's and doctoral programs in Applied Climatology with the Department of Geophysics and Meteorology at the Faculty of Mathematics and Natural Sciences, IPB University. BMKG has collaborated with universities, including IPB University and the Bandung Institute of Technology (ITB), in the development of climate and weather prediction services. This collaboration involves direct participation in service system development and contributions as resource persons to enhance the prediction service systems under development.

The contribution of universities in climate projection studies is significant. Following the submission of Indonesia's First National Communication (FNC) to the Third National Communication (TNC), university researchers have contributed to climate projection modeling for Indonesia. Future climate projection scenarios for TNC activities were modeled utilizing dynamic and statistical downscaling methods applied to the output of CMIP5 GCM models under RCP scenarios. Dynamic downscaling utilized the RegCM4 regional climate model, incorporating output from the HadGEM2 model for RCP4.5 and RCP8.5 scenarios. This analysis covered the entire Indonesian region at a spatial resolution of 20 km x 20 km, spanning baseline and projection periods from 1980 to 2100. Statistical downscaling was performed on the outputs of 24 GCM models employing various methodologies. The calculation process was streamlined by the creation of a user-interface-based software known as Statistical Bias Correction for Climate Scenarios (SiBiaS, Faqih 2017).

SiBiaS is designed to facilitate the downscaling of CMIP5 GCM output data through a statistical bias correction method, using reference data from observations. This software is developed by academic institutions, which are integral to education, training, capacity building, and research concerning climate change impacts and adaptation. The SiBiaS software and its associated modules have been extensively utilized in training initiatives at both provincial and municipal levels, organized by MoEF, along with other training sessions involving local governments, BMKG, universities, and NGOs. A training session was conducted for the governments of 10 Indonesian cities (Cirebon, Bandar Lampung, Pekanbaru, Pangkalpinang, Samarinda, Banjarmasin, Kupang, Mataram, Gorontalo, and Ternate). This training improved the ability of regional stakeholders to develop climate change projections and allowed them to independently create scientific documents on climate change for their respective city regions. This capability enhances self-sufficiency in executing climate change research, encompassing impact, vulnerability, and risk assessments within the framework of adaptation strategy formulation.

Future efforts must focus on enhancing the synergy between educational and research collaborations to foster innovations in climate services among diverse stakeholders, both nationally and internationally. Advancements are required in the subsequent areas of climate research: i) Development of reanalysis data for Indonesia; ii) Development of high-resolution weather prediction systems for detailed forecasting of extreme weather; iii) Development of climate prediction systems across various time scales and lead times, including sub-seasonal to seasonal (S2S), seasonal climate prediction, and decadal climate prediction; iv) Climate change projections; v) Development of impact-based forecasting (IBF); vi) Climate studies to support loss and damage assessments.

Box 8-5

Climate Field School (CFS): Efforts to Translate Climate Information to Farmers

The cultivation of agricultural commodities necessitates climate information to ascertain the appropriate type of commodity for planting, optimal planting timing, and essential care practices to maximize yields. Evidence indicates that extreme climate conditions, such as prolonged drought and heavy rainfall, result in a significant reduction in agricultural commodity yields relative to normal conditions. The climate information disseminated by BMKG remains challenging for farmers to comprehend and apply effectively. Consequently, a connection is essential between BMKG and farmers to ensure that climate information is comprehended and effectively utilized by the agricultural community. BMKG employs the CFS activities as a strategic approach to disseminate climate information.

CFS serves as a climate literacy initiative aimed at enhancing food resilience within the framework of climate change adaptation. The implementation of CFS is conducted by BMKG in partnership with the MoA, local governments, and various community organizations. The primary aim of CFS is to enhance the comprehension of farmers and agricultural extension workers regarding climate data and information applicable to agricultural practices. The CFS has been implemented by BMKG since 2015, involving a total of 20,310 participants across 591 locations in 33 provinces. The composition of CFS participants encompasses both men and women. According to BMKG data, the distribution of CFS participants is 79% male and 21% female. This suggests that gender considerations are important, as access to information is available to both male and female participants.

CFS activities extend beyond rice plants to encompass a variety of agricultural commodities, including shallots, chillies, corn, peanuts, soybeans, melons and tomatoes. The implementation of the CFS curriculum in agricultural practices has resulted in higher yields for farmers relative to the regional average. In Maros Regency, CFS for peanuts achieved a yield increase of 50%. In Agam Regency, CFS for rice resulted in a 32% yield increase. Additionally, CFS for shallots in Temanggung Regency led to a 10% increase in yields, among other results (Figure 3-28). The rise in yields indicates the effectiveness of CFS initiatives, enabling farmers to apply the climate data supplied by BMKG. Studies conducted by BMKG indicate that farmers' understanding of climate information has improved by 20-30% following the implementation of CFS.

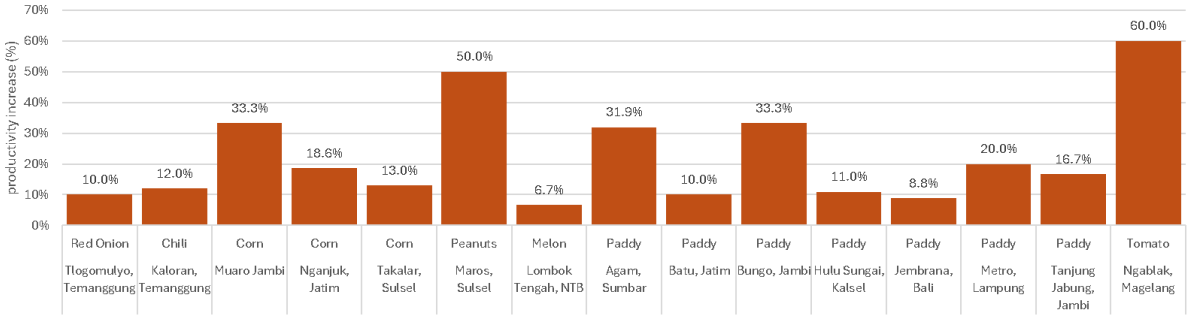


Figure 3- 28 Enhancing agricultural commodity productivity on land through the implementation of CFS (Source: BMKG; https://iklim.bmkg.go.id/SLI/main/)

BMKG has published several success stories related to CFS as part of the dissemination of CFS activities. BMKG has developed a mobile application-based technology, known as Climate-Smart Technology for Climate Field School (KIMONO-CFS), to facilitate the automation of climate information in support of CFS implementation. This technology is anticipated to facilitate farmers' comprehension of climate-

related information. The most recent updates regarding CFS activities undertaken by BMKG are available on the portal https://iklim.bmkg.go.id/SLI/main/.

3.9 Any Other Information related to Climate Change Impact and Adaptation

3.9.1 The Complexity of Analyzing the Impact of Climate Change Across Sectors

Climate change significantly affects multiple sectors, including agriculture, water resources, health, and ecosystems. The primary indicators for assessing the impact of climate change include risk areas, affected areas, and reduced production levels. Regions susceptible to disasters, including floods, droughts, and extreme weather events, necessitate increased focus for effective adaptation strategies. The affected area delineates the scope of the region impacted, whereas the reduction in production, especially within the agricultural sector, underscores the substantial effect of climate change on food security.

The availability of accurate and detailed data is essential for comprehending the effects of climate change in Indonesia. Accurate estimates of long-term impacts necessitate detailed historical climate data and projections. The absence of integrated data across different regions hinders the ability to forecast climate change trends. Consequently, gathering more specific local data and fostering collaboration among institutions can enhance the effectiveness of adaptation and mitigation planning.

The collection of observational data on rainfall patterns, droughts, and floods is essential in the agriculture sector for understanding the effects of climate change on crop productivity. Information regarding farmer adaptation is essential for assessing the efficacy of local responses to climate change. Observational data on river flow, water quality, and reservoir volumes in the water resources sector can significantly enhance adaptive water management strategies in the future.

Climate change in the health sector elevates the risk of transmission of infectious diseases, including dengue fever and malaria. Extreme weather conditions can exacerbate heat stress, respiratory issues, and mental health disorders. The collection of data regarding the effects of climate change on public health is essential for developing evidence-based adaptation strategies. In the ecosystem sector, observations regarding habitat loss, ecosystem damage, and biodiversity degradation are critical for sustainable conservation efforts. Monitoring changes in the ecosystem is essential for comprehending the comprehensive effects of climate change and guiding suitable mitigation and adaptation strategies.

3.9.2 Determining Priority Adaptation Action in Key Sectors

Addressing the impacts of climate change requires the selection of adaptation actions in priority areas (Figure 3-29), including agriculture, water resources, health, and ecosystems, to consider both climate impacts and local socio-economic conditions. A robust climate risk framework should effectively mitigate risks and improve adaptive capacity to facilitate transformative development. The selection of suitable adaptation options involves an evaluation of cost, effectiveness, sustainability, and social impact, ensuring that adaptation actions enhance the community's social and economic resilience.

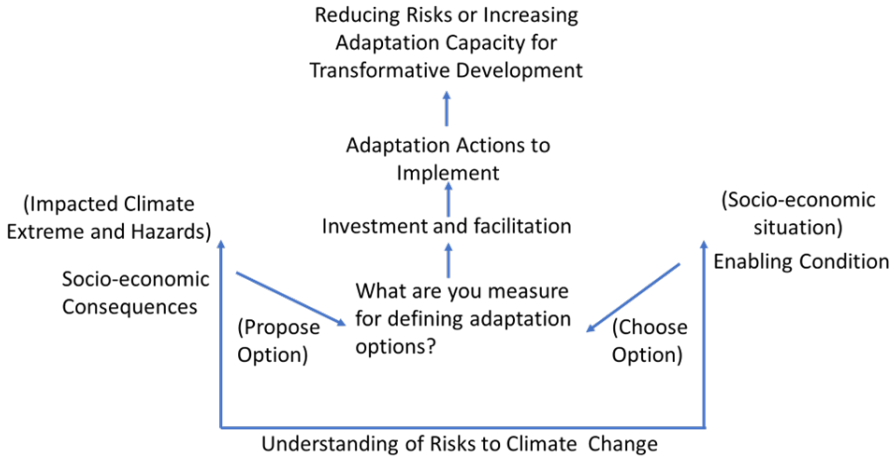


Figure 3- 29 Mechanism for formulating and implementing adaptation action options to reduce risks from the impacts of climate change toward transformative development

The availability of adequate infrastructure is key to the success of adaptation actions in the food sector, especially in agriculture and water resources. Without resilient infrastructure, such as roads and irrigation systems, the distribution of agricultural products and access to clean water can be hindered, impacting food security and public health. In addition, the adoption of technology in the agricultural sector, such as efficient irrigation and climate-resistant crop varieties, is also important, but is often constrained by the insufficient access of farmers to technology and adequate training. The execution of adaptation activities depends much on adequate financing. Often, the allocation of funds for adaptation programs in the food sector is inadequate, and there are complex bureaucracies in the distribution of funds. In addition, limited institutional capacity, especially related to inter-agency coordination, hinders the development of holistic and integrative policies required to effectively address climate change. To achieve effective climate change adaptation, wider community participation and improved access to accurate data and information are needed. A gender perspective, considering the differential impacts of climate change experienced by women, children, the elderly, and people with disabilities, adds complexity to measuring climate change impacts and formulating adaptation actions that need to be tailored to the needs of each group. A robust monitoring and evaluation system is also required to assess the impact of the actions taken. Uncertainties due to climate change require a flexible and responsive approach, so that adaptation plans can be adjusted to the continuously evolving conditions.

3.9.3 Measuring the Contribution of Actions to Increasing Resilience

Measuring the contribution of adaptation actions to the targets in the agriculture, water resources, health, and ecosystem sectors in enhancing Indonesia's resilience in the economic, social, livelihood, and environmental domains requires a comprehensive approach. In the agriculture sector, for example, adaptation actions such as the introduction of sustainable agricultural technologies and the use of climate-resistant crop varieties can increase productivity and food security. The use of economic indicators such as GDP and Gross Regional Domestic Product (GRDP) can help measure the positive impact of increased agricultural production on the national and regional economy.

In the water resources sector, more efficient water management through adaptive irrigation infrastructure is crucial for economic and social resilience. Access to clean water not only

impacts agriculture, but also the health and well-being of the community. Economic resilience is measured by the community's ability to withstand water crises and its impact on sectors dependent on irrigation. The assessment of the contribution of adaptation actions in this area can use indicators such as the number of areas experiencing improved access to clean water and reduced vulnerability to drought.

In the health sector, adaptation programs that address the health impacts of climate change, such as the increase in climate- sensitive diseases, influence social resilience. Adaptation actions in this field can be measured using health indicators such as morbidity and mortality rates related to climate-sensitive diseases. Additionally, improving access to healthcare services adapted to climate change contributes to enhancing the quality of life and social resilience.

The ecosystem sector also plays a key role in strengthening environmental resilience. Adaptation actions such as reforestation and wetland conservation help enhance the ecosystem's ability to provide important services like clean water provision and flood control. Environmental indicators such as the Environmental Quality Index / Indeks Kualitas Lingkungan Hidup (IKLH) can be used to measure the impact of adaptation actions on ecosystem health and their contribution to national resilience.

Coordination across sectors is key in measuring the contribution of adaptation actions to resilience targets. The agriculture, water, health, and ecosystem sectors are interrelated, so an integrated approach is required to achieve optimal results. Indicators of economic, social, and environmental resilience, such as GDP, Open Unemployment Rate (TPT), Food Security Index / Indeks Keamanan Pangan (IKP), and Gini Ratio, serve as holistic measurement tools to understand the impacts of climate change and the effectiveness of adaptation actions.

Overall, measuring the contribution of adaptation actions to Indonesia's resilience targets requires continuous monitoring using indicators that are aligned with national standards. By strengthening cross-sectoral coordination and enhancing technical capacity across sectors, Indonesia can better address the challenges of climate change and strengthen community resilience in various areas of life.

3.9.4 Needs for Adaptation Action Development

The implementation of climate change adaptation in Indonesia necessitates coordinated and comprehensive support to address the numerous challenges encountered. Support is essential for the development and application of methodologies for risk assessment and vulnerability assessment in light of climate change impacts. Standardized methodologies will facilitate Indonesia's development of targeted adaptation action plans grounded in consistent data, thereby ensuring the comparability of reports with other countries, as required by the MPGs of the UNFCCC.

Moreover, securing sufficient funding has emerged as a critical priority for the implementation of climate change adaptation strategies. Sustainable financing mechanisms are necessary from domestic and international sources to facilitate the implementation of adaptation actions in key sectors: agriculture, water resources, health, and ecosystems. The incorporation of adaptation into national and sub-national development plans, as stipulated in Presidential Regulation No. 98 of 2021, necessitates designated budget allocations to facilitate the implementation of adaptation measures. Additionally, strengthening institutional capacity, particularly at the local level, is essential to ensure that adaptation programs are effectively implemented and customized to meet the specific needs of each region.

Enhancing the MRV system is essential for tracking the advancement of adaptation implementation and its effects in real-time. An effective MRV system is essential for assessing

the efficacy of adaptation strategies and ensuring alignment with established objectives. Technical support and skilled human resources are crucial for ensuring precise data collection, analysis, and reporting.

The empowerment of vulnerable groups, such as women, children, individuals with disabilities, and adat communities, should be prioritized in the implementation of adaptation strategies. Inclusive policies and resource provision for these groups will ensure that climate change adaptation is both top-down and grounded in local needs, adhering to principles of equity. It is essential to integrate gender-responsive programs and initiatives that support vulnerable groups into all stages of adaptation planning and implementation, ensuring the active involvement of local communities.

Engagement with diverse stakeholders, including the private sector, civil society, academia, and the international community, is essential for fostering synergies in adaptation efforts. Multi-stakeholder platforms can enhance coordination and promote participation from all parties in the development and execution of adaptation policies. Furthermore, the introduction and widespread adoption of smart adaptation technologies/ adaptive technologies that provide mitigation co-benefits are essential for minimizing climate change risks and enhancing national resilience.

To successfully implement climate change adaptation, it is essential to improve knowledge management concerning adaptation, which includes the dissemination of best practices among stakeholders. Providing evidence-based information and enhancing accessible information systems will promote improved and sustainable decision-making. The platform initiated by MoEF named Adaptation Window, accessible at https://adaptasi.ppi.menlhk.go.id/, can be seen as a modality which is potential for further development to enhance the execution of adaptation actions. This collaboration will facilitate Indonesia's achievement of adaptation goals and the sustainability of ecosystems and community well-being amid escalating climate change threats.

CHAPTER IV
INFORMATION ON FINANCIAL, TECHNOLOGY DEVELOPMENT AND TRANSFER AND CAPACITY-BUILDING SUPPORT PROVIDED AND MOBILIZED

4.1 National Circumstances and Institutional Arrangement

The Indonesian government has actively collaborated with other developing countries with regard to global development, utilizing grants and technical assistance as primary instruments. The Government of Indonesia has long extended grants in international cooperation through various ministries and agencies. However, the provision of assistance has been characterized by ad hoc and spontaneous approaches, lacking a specific policy or criteria as guidelines, and remains unintegrated.

The Government of Indonesia enhances grant governance in international development cooperation through the enactment of Government Regulation Number 48 of 2018, which outlines the procedures for providing grants to foreign governments and institutions. Subsequently, Government Regulation Number 57 of 2019 was enacted to enhance the Procedures for Providing Grants to Foreign Governments and Foreign Institutions. This regulation introduced several improvements in grant provision, including (i) the establishment of a fund management unit functioning as a public service agency for financial management; and (ii) the formation of a cross-ministerial/institutional Steering Committee tasked with offering strategic policy directions to assist the fund management unit in grant distribution.

The fund management unit, functioning as a public service agency for financial management, is tasked with overseeing and distributing funds for grant provision. This mechanism is anticipated to facilitate a rapid implementation of the grant distribution process, and self-financing for grant provision is expected to be realized in the near future.

In accordance with Government Regulation Number 57 of 2019, the Minister of Finance issued Regulation Number 143 of 2019 on 15 October 2019, which established the International Development Cooperation Fund (LDKPI) for collaboration with international partners and institutions. LDKPI operates under the nomenclature of the Indonesian Agency for International Development (Indonesian AID).

4.2 Underlying Assumptions, Definitions, and Methodologies

The assumptions and methodology utilized for detailing financial support through the bilateral channel (Annex III.1), multilateral channel (Annex III.2), mobilized financial support (Annex III.3), technology development and transfer support (Annex III.4), and capacity development support (Annex III.5) are outlined in Table 4.1.

Table 4- 1 Underlying assumption, definition and methodology on financial, technology transfer and capacity building provided

Components	Underlying Assumption and Methodology
Recipient country or region	Recipient country of the grant
Title (of activity, program or project)	Title of activity or project as described in the project documents.
Amount	Financial support supplied in Annex III.1 is estimated in IDR and converted to USD using the BI mid-exchange rate (middle rate of Bank of Indonesia) for each year of 2021 and 2022. (The amount is provided in both domestic currency and United States dollars) The amount for Annex III.3 was calculated in IDR and converted to USD using the BI mid-exchange rate (middle rate of the Bank of Indonesia) for the years 2021 and 2022.
Expected time frame for support needed	The support needed is not well planned. Based on an ad hoc request, Indonesia received a request for technical assistance and grants.
Financial Instrument	Grant only
Time frame for support provided	Duration: the date of signing and the date of agreement closure Time frame: utilize the accounting period to represent the reporting period. Accounting Period: Annually (New signed agreement grant in 2021 – 2022)

4.3 Information on Financial Support Mobilized and Provided

During the period of 2021-2022, Indonesia extended financial assistance via grants through the Indonesia International Development Cooperation Fund to facilitate climate change mitigation and adaptation efforts in several developing nations impacted by climate-related disasters. Aid is delivered via bilateral mechanisms to recipient countries including Afghanistan, Antigua and Barbuda, Madagascar, Mozambique, Zimbabwe, Pakistan, and the member countries of the Melanesian Spearhead Group: Fiji, Papua New Guinea, Solomon Islands, and Vanuatu. The Indonesian government has allocated a total of USD 3,228,533 (Annex III.1). Funded projects emphasize humanitarian assistance and the mitigation of disaster impacts, including food crises, storms, droughts, and flash floods. All funds have been allocated and utilized for sectors susceptible to climate change, including agriculture, disaster management, air sanitation, and fisheries, with a primary emphasis on adaptation to climate-related disasters. This demonstrates Indonesia's substantial role in assisting developing nations in addressing the effects of climate change. Aid delivered via multilateral mechanisms is unavailable (Annex III.2).

4.4 Information on Financial Support Provided

Indonesia has mobilized financial support via public interventions to facilitate climate change mitigation and adaptation in developing nations. Financial mobilization primarily aims to

enhance climate change adaptation through various grant-based initiatives, including economic resilience, fisheries, health, disaster management, and waste management. In contrast, mitigation efforts are limited to a single project focused on renewable energy support for solar energy. The Indonesian government is projected to mobilize a total of USD 2,008,427 (Annex III.3).

4.5 Information on Technology Development and Transfer Support Provided

During the 2021-2022 period, the International Development Cooperation Fund Institute, Ministry of Finance, and Directorate of International Development Cooperation, Ministry of Foreign Affairs reported a lack of support for technology development and transmission (Annex III.4).

4.6 Information on Capacity Building Support Provided

Indonesia, through the Ministry of Foreign Affairs and the Directorate General of Asia Pacific and Africa, has finalized a fisheries capacity building training program for the member countries of the Melanesian Spearhead Group (MSG), comprising Fiji, Papua New Guinea, Solomon Islands, and Vanuatu. The program emphasizes the facilitation of climate change adaptation within the fisheries sector and has been successfully concluded. The training seeks to enhance the capacity of MSG countries to address climate change challenges in the fisheries sector through the fortification of technical and managerial skills (Annex III.5).

CHAPTER V
INFORMATION ON FINANCIAL, TECHNOLOGY DEVELOPMENT AND TRANSFER, AND CAPACITY BUILDING SUPPORT NEEDED AND RECEIVED

5.1 National circumstances, institutional arrangements, and country-driven strategies

5.1.1 National Circumstances

As an expanding economy, Indonesia faces challenges of striking a balance between economic growth and the pressing need to reduce greenhouse gas emissions. The country's high susceptibility to the effects of climate change, such as rising sea levels, extreme weather events, and disruptions to vital ecosystems further complicates this. These require substantial cost of adaptation measures to safeguard people and infrastructure.

Equally important to the implementation of mitigation and adaptation measures, financing mechanism, technology development and capacity building are pivotal. Programs relating to climate change receive about 3.9% of the state budget each year. Relevant sectoral ministries respective of their mandate and function, building the capacity at both institutional and staff levels to support the country’s climate targets. Climate change is also addressed by ministries and agencies with mandates on research, development, assessment, and application of technology.

Act Number 19/2019 concerning the national system of science and technology states that technology is a way, method, or process of applying and utilizing various scientific disciplines that are useful in meeting needs, sustaining, and improving the quality of human life. Conversely, technology transfer refers to the transfer of knowledge and skills in science and technology from one institution, organization, or individual to another, either domestically or internationally, or vice versa. This process underscores the collective effort among institutions in addressing technology transfer and development.

According to the Act, development is actions that enhance the advantages and enabling potential of science and technology whose efficacy and safety have been demonstrated to enhance their function and advantages. Meanwhile, the definition of the institutional of science and technology is an entity that forms a relationship between an organization and/or a group of people to work together in research, development, study, and/or application of science and technology activities. This institution comprises research and development institutions, study and implementation institutions, universities, business entities, and supporting institutions.

The Ministry of Environment and Forestry as the national focal point for the UNFCCC, is tasked with coordinating and submitting national reporting, including technology transfer and development issues needed to control climate change in Indonesia. MoEF plays a crucial role in this field, and its cooperation with pertinent Ministries and Agencies guarantees a thorough report on these technological concerns.

In addition to national endeavors, international supports also play an important role. International support may come from bilateral countries, multilateral institutions and international climate fund institutions (such as Green Climate Fund and Adaptation Fund which

provide funds exclusively for adaptation projects), etc. Indonesia Implementing Partners are the recipients of an international climate fund that has been managed under a specific national authority. These include the Green Climate Fund (GCF), Adaptation Fund (AF), and GEF, which have been crucial in promoting sustainable forest management, climate change mitigation, biodiversity and marine protection, and sustainable agricultural practices. In parallel, there are also specific supports such as REDD+ Results-Based Payments (RBPs) for forestry sector. This mechanism aims to incentivize verified emission REDD+) activities. The Indonesia Environmental Fund (IEF/BPDLH) is a key player in supporting climate change initiatives at the national level.

5.1.2 Country-Driven strategies and Institutional Arrangements

5.1.2.1 Country-Driven Strategies

Institutions for managing foreign loans and grants at the macro level in Indonesia are driven by five key institutions. These institutions include Ministry of Foreign Affairs, National Development and Planning Agency, Ministry of Finance, Implementing Agencies and State Secretariat (Figure 5-1). To guarantee that funds are used efficiently, in line with national priorities, and in compliance with relevant legislation, coordination between these organizations in handling foreign aid in Indonesia is governed by a number of regulations. One important mechanism is a formal forum that brings together the Indonesian government and international donors, such as the National Committee for Coordinating Foreign Assistance. In addition, monitoring and evaluation are carried out comprehensively to improve accountability in fund management. The Inspectorate General, the Financial and Development Supervisory Agency (BPKP), and the Audit Board of the Republic of Indonesia (BPK) are among the stakeholders involved in the monitoring and evaluation procedure and reporting the information in the National Registry System (SRN). A more thorough explanation of finance is provided in 5.1.2.2.1.

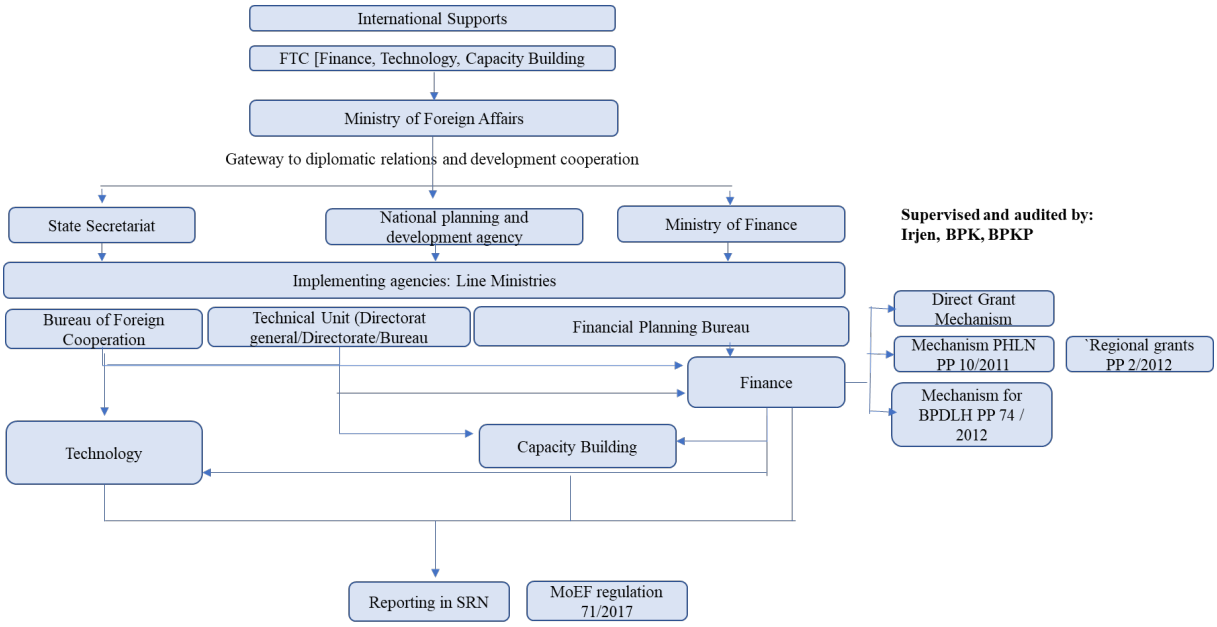


Figure 5- 1 Institutional arrangements of financial, technology, and capacity building (FTC)

Meanwhile, each ministry's Foreign Cooperation Bureau keeps track of any aid related to technology, whether it be in the form of cash for technology or direct support in the shape of pure sorts of technology. Technical units are responsible for the cross-ministerial deployment of this technology. Information on technology is reported in SRN. A more thorough explanation of the technology can be found in 5.1.2.2.2.

The Foreign Cooperation Bureau in each ministry also records funding for capacity building and comprehensive assistance in the form of direct capacity building (individuals, institutions, and policies). The implementation of these capacity-building activities is cross-ministerial and carried out by all technical units, guaranteeing a comprehensive approach. The information are reported in the SRN's capacity building information. Section 5.1.2.2.3 provides a more thorough explanation of capacity building.

5.1.2.1.1 Financial

Following the UNFCCC's shared but differentiated responsibilities (CBDR) concept, which states that developed countries have an obligation to spearhead global climate action and offer assistance in the areas of financing, technology and knowledge transfer, and capacity building. Most developed countries provided loans and grants for climate projects in Indonesia through bilateral and multilateral entities. This section on finances, examines how Indonesia has responded to international assistance, how the policy has been established, including the institutional arrangements for managing grants and loans, and which Indonesian institutions are supporting national climate change initiatives.

5.1.2.1.1.1 Policy on Managing Loans and Grants

Indonesia has established various policies that govern the administration and management of loans and grants, which are not exclusively focused on climate change initiatives. Initially governed by Act (UU), the regulation is subsequently shaped by various Government Regulations (PP), including technical regulations under Ministerial Regulation (MoF and Bappenas), followed by regulation from the directorate general and ministerial decree (refer to Figure 5.1). Financial sources for climate change mitigation and adaptation from bilateral and multilateral institutions/organizations are expected to align within the national system in terms of recording and reporting in the state accounting and financial system.

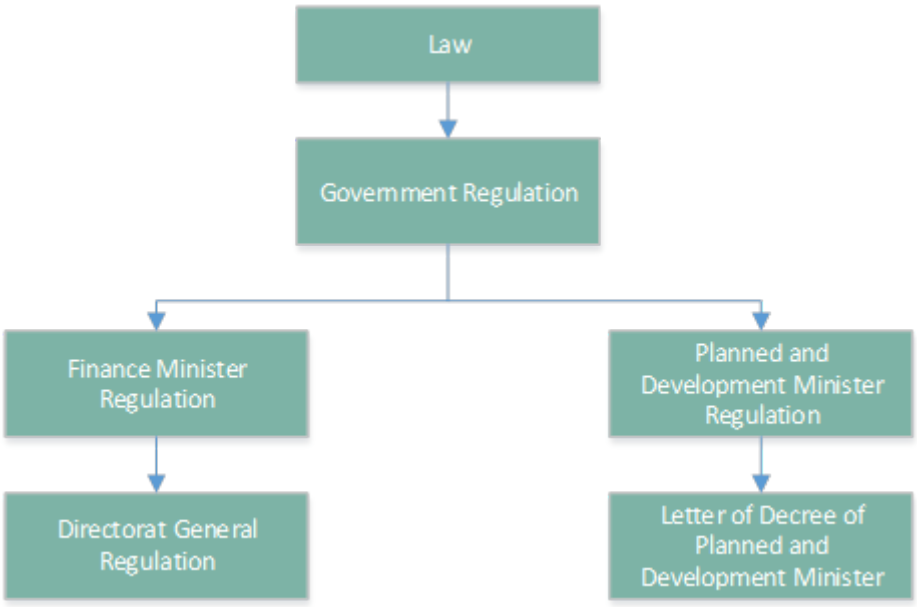


Figure 5- 2 Policy structure administration and management of loans and grants

In the context of Nationally Determined Contributions (NDC), the management of loans and grants is regulated at the central level by Government Regulation No. 10 of 2011, while at the sub-national level, it is governed by Government Regulation No. 2 of 2012. All loans and grants adhere to established accounting procedures, with the resulting assets recorded as state property, necessitating appropriate management and documentation. Government Regulation No. 10 of 2011 serves as a critical framework for the management of loans and grants, establishing the foundation for the proper allocation of funds aimed at supporting climate change mitigation and adaptation, among other objectives. The regulation highlights the significance of procedures and responsibilities in the acquisition, utilization, and reporting of international support, including bilateral and multilateral assistance, ensuring alignment with national development priorities such as infrastructure development, climate change, poverty alleviation, and economic growth. The technical regulations are governed by the Ministry of Finance and the Ministry of Planning and Development. Relevant ministries and agencies that receive loans and grants must adhere to all established procedures.

Table 5- 1 Type of loans and grants policies

Type	Classification of Loans and Grants policy	Regulation
Law	General Policy	UU No 1 of 2004 UU No 17 of 2003 UU No 1 of 2022
Government Regulation	Procedure on Loans and Grants	PP No 10 of 2011
	Sub-National related Loans and Grants	PP No 2 of 2012

	Accounting	PP No 71 of 2010
	Managing of State Property	PP No 28 of 2020
Minister Regulation		
Finance Minister Regulation	Detail Procedure on Loans and Grants – on planning, budgeting, implementing, recording accounting, reporting and monitoring aspect	PMK No 99 of 2017 PMK No 201 of 2021 PMK No 180 of 2012 PMK No 195 of 2019
	Detail Sub-National related to Loans and Grants	PMK No 224 of 2017
	Accounting System	PMK No 217 of 2022
	Managing of State Property	PMK No 53 of 2021 PMK No 40 of 2024 PMK No 83 of 2016 PMK No 165 of 2021
Planned and Development Planning Minister Regulation	Detail Procedure on Loans and Grants – on planning, reporting and monitoring aspect	PPN No10 of 2020 KM PPN No 75 of 2024

Source: Compilation from regulations

5.1.2.1.1.2 Indonesia's Modalities on Managing Loans and Grants

Indonesia's management of foreign loans and grants follows a cyclical process that includes planning process-preparation, approval, signing-budgeting-implementing-monitoring and evaluation.

Figure 5- 3 Foreign loan grant management cycle (source: adapted from PP No 10/2011)

Each stage of the cycle involves different institutions in the management of loans and grants, as outlined in Table 1 below.

Table 5- 2 Stages and involvement of institution

Stages	Institution involved
Planning	Bappenas & Line Ministries
Preparation, Approval and Signing	MoF & Line Ministries
Budgeting	MoF & Line Ministries
Implementation	Line Ministries
Monitoring and Evaluation	MoF & Bappenas

Source: Adapted from PP No 10/2011

Explanation of each stage

(i) Planning Stage

In the midterm national planning development, project activities identified for financing through loans and planned grants related to climate change will be incorporated intothe Foreign Loan Utilization plan (RPPLN), List of Foreign Loan Plans (DRPLN), List of Grant Activity Plans (DRKH).

The process of planning a budget for foreign loans is conducted in several stages, as detailed in four planning documents:

1) Outlines the framework for the Foreign Loan Utilization policy and specifies the anticipated amount of Foreign Loans to be utilized, particularly Activity Loans, over the next five years, aligning with the midterm development planning/RPJMN).
2) The Medium-Term Foreign Loan Plans (DRPLN-JM), commonly referred to as the Bluebook, comprises a compilation of activity proposals submitted by Ministries, Institutions, State-Owned Enterprises (BUMN), and Regional Governments in accordance with their requirements.
3) The List of Foreign Loan Priority Plans (DRPPLN) includes proposed activities that satisfy the majority of the readiness criteria as outlined in the provisions. DRPPLN is an annual planning document utilized by the proposing line ministry or agency, the Ministry of National Development Planning, and the Ministry of Finance to establish the indicative ceiling and budget ceiling for new Foreign Loan activities during the Draft State Budget (RAPBN) preparation cycle. DRPPLN serves as a reference for the ongoing formal coordination process with development partners, as the proposed activities outlined in the DRPPLN must indicate the funding source/potential lender.
4) The Activity List (DK) comprises planned activities outlined in the DRPPLN, which are prepared for negotiation with potential Foreign Lenders. The Activity List constitutes a recommendation presented by the Minister of National Development Planning to the Minister of Finance. The Minister of Finance engages in negotiations with prospective foreign lenders, taking into account the preparedness of the activities outlined in the Activity List.

The process of planning and preparing for foreign loans is outlined for each five-year midterm development plan as follows.

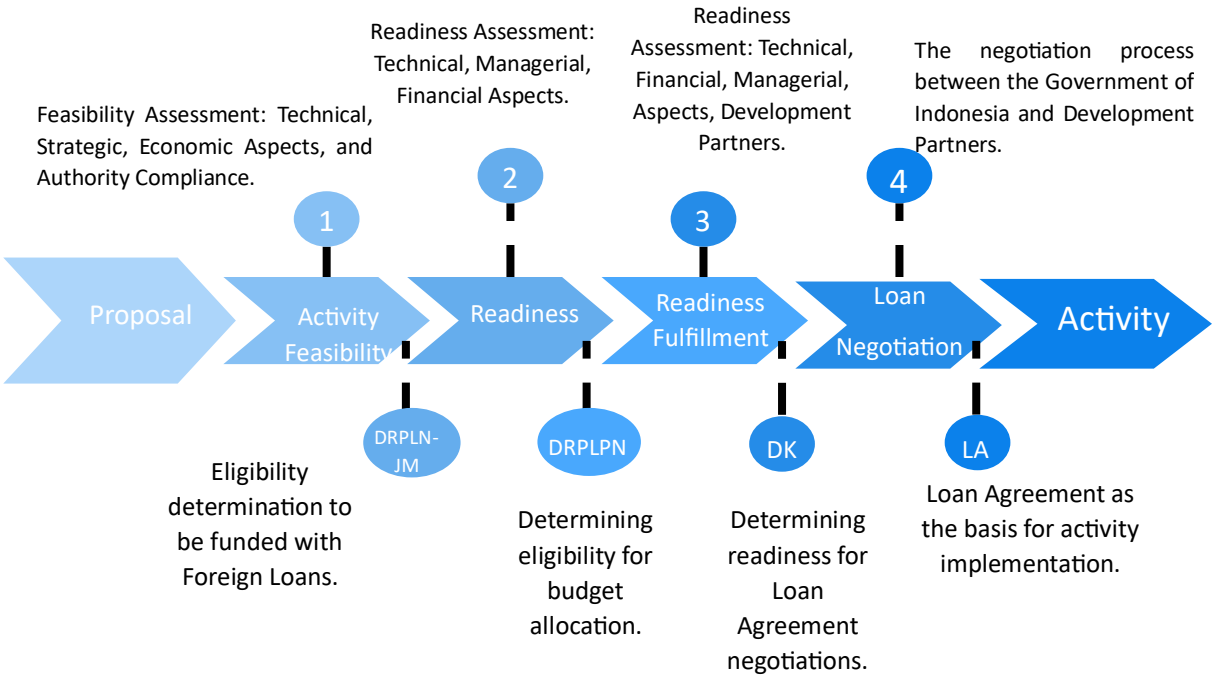


Figure 5- 4 Process of planning and preparation for foreign loans in National Medium-Term Development Planning (Source: Bappenas, 2017)

Bappenas will annually issue a report known as DRKH, or *Daftar Rencana Kegiatan Hibah*, which details the list of planned grants. The mechanism of the planned grant is also referenced in PP No 10/2011. The mechanism of the planned grant is illustrated in the image below.

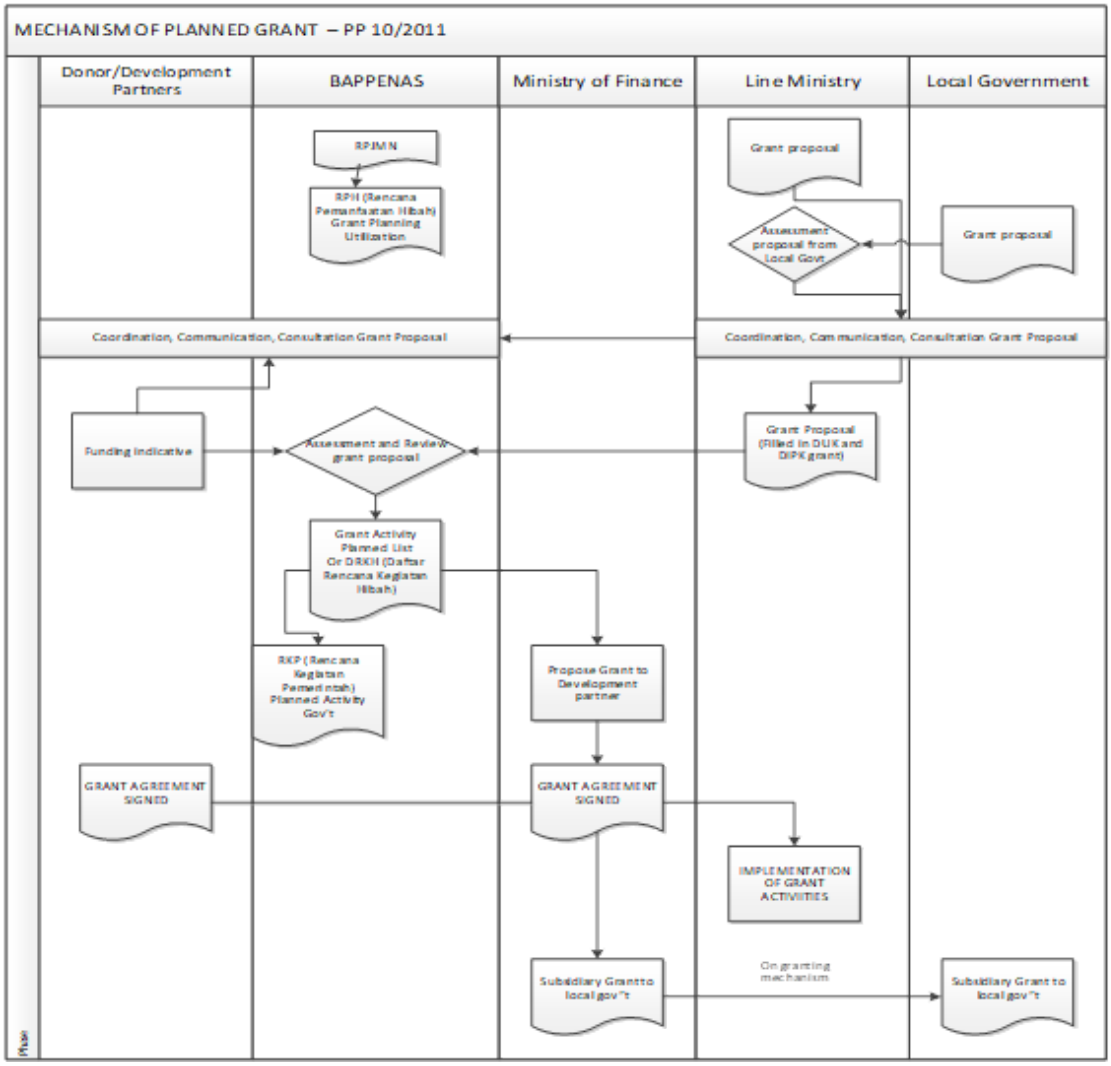


Figure 5- 5 The mechanism of planned grant (Source: PP No 10/2011)

(ii) Preparation, Approval and Signing

The Ministry of Finance cq DG of Debt Management (DJPPR) serves as a negotiator and is fully involved in the signing process of loans and grants agreements. This process resulted in the approval and signing of loans and grants agreements, along with the registration of each agreement's ID. The registered ID is then used as a reference for line ministries to withdraw funds via KPPN (*Kantor Pelayanan Perbendaharaan Negara*).

(iii) Budgeting Stage

At this stage, budgeting for loans and planned grants will adhere to the APBN budgeting cycle, necessitating planning one year in advance. Planning and budgeting for donors or development partners may differ and, at times, may not align with the APBN budgeting cycle. The loan adheres strictly to Government Regulation PP Number 10 of 2011, necessitating donor preparation in alignment with the APBN budgeting cycle, whereas grants exhibit greater flexibility. Donors may select either a planned grant or a direct grant to allocate their funds to the appropriate line ministries or local government entities.

(iv) Implementation

During the implementation phase, all planned loans and grants adhere to the state budget mechanism established during the planning and budgeting stage conducted one year in prior.

5.1.2.1.1.3 Indonesia Institution That Supports Climate Change Activities

At the national level, the institutions in Indonesia that support climate change activities include the Indonesian Environment Fund (IEF/BPDLH), ICCTF, SDG Indonesia One and Indonesian AID.

(i) The Indonesian Environment Fund (IEF/BPDLH)

Indonesia established the Indonesia Environment Fund in September 2019, which was launched in October 2019, concurrently with the initiation of Indonesian AID in the same month. The Indonesian Environment Fund (IEF/BPDLH) operates as a non-echelon entity within the Ministry of Finance, tasked with the management of environmental funds. The IEF/BPDLH is tasked with the collection and distribution of dedicated funds across various sectors, including forestry, energy and mineral resources, carbon trading, environmental services, industry, transportation, agriculture, marine and fisheries, and other environmental domains, in alignment with policies established by the Minister of Finance and applicable regulations.

IEF/BPDLH was established under Government Regulation No. 46 of 2017, which mandates that the management of environmental funding, derived from resources aimed at mitigating pollution and/or damage and restoring the environment, as well as trust funds and conservation assistance, to be conducted by the central government through the financial management framework of public service agencies. The mandate was subsequently conveyed through Presidential Regulation No. 77 of 2019, establishing that the organizational unit responsible for environmental fund management is a non-echelon unit created by the Minister of Finance, utilizing the financial management framework of public service agencies.

(ii) Indonesia Climate Change Trust Fund (ICCTF)

ICCTF was a funding entity designed to create innovative connections between international financing sources and national climate investment strategies. Founded in 2009, ICCTF concentrates on four sectors: land-based mitigation, energy, adaptation and resilience, and marine-based initiatives. The development partner funds include contributions from USAID, UKCCU, DANIDA, the World Bank, ADB, and GIZ. Since its inception, ICCTF has overseen 88 projects across 114 areas, comprising 46 land-based mitigation projects, 22 adaptation and resilience projects, 8 energy projects, and 12 ongoing marine-based projects. Since 2020, ICCTF has shifted its focus toward the coastal marine and blue economy.

(iii) SDG Indonesia One

On October 6, 2018, the Ministry of Finance initiated the SDGs Indonesia One. SDG Indonesia, One serves as a comprehensive funding cooperation platform aimed at facilitating infrastructure development in pursuit of sustainable development goals.

(iv) Indonesia International Development Cooperation Fund / Indonesian AID (*Lembaga Dana Kerjasama Pembangunan Internasional* - LDKPI)

Established in October 2019, International Development Cooperation Fund (*Lembaga Dana Kerjasama Pembangunan Internasional* - LDKPI) under Ministry of Finance and Directorate of International Development Cooperation, Ministry of Foreign Affairs who have been responsible for mobilization of financial and capacity building supports via South-South Cooperation – which recently is evolving into Indonesian AID.

5.1.2.1.2 Technology Transfer and Development

The MoEF serves as the national focal point for the UNFCCC, is tasked with coordinating and submitting national reporting, including technology transfer and development issues for addressing climate change in Indonesia. The Ministry of Environment and Forests plays a crucial role in this domain, and its collaboration with relevant Ministries and Agencies guarantees a thorough report on these technological matters.

As part of implementing and developing research and technology, the MoEF collaborates with the National Research and Innovation Agency (BRIN) to implement and develop research and technology in accordance with its mandate. Implementation associated with each technology, particularly in the context of climate change mitigation, is the responsibility of the respective technical ministries. The technical ministries possess defined responsibilities and roles as stipulated by relevant laws and regulations.

Moreover, MoEF, serving as the National Designated Entity (NDE) for the Climate Technology Center and Network (CTCN), is essential in aligning requests submitted to the CTCN with Indonesia's National Circumstances and priorities. NDE ensures that the support from the CTCN is effectively coordinated at the national level with other climate change initiatives. The coordination, managed by MoEF, guarantees the effective involvement of pertinent ministries, the private sector, civil society, and academia, thereby offering a holistic strategy for addressing climate change.

Recent activities, particularly in 2019 and 2020, included "Support for the e-mobility transition in Jakarta" and "Identification of technical practices for CSA in Indonesia." These activities demonstrate significant potential. The e-mobility transition in Jakarta is anticipated to have a significant impact. Transjakarta may utilize this technical assistance as a framework for executing extensive e-bus deployment, which is a crucial measure for mitigating greenhouse gas emissions. The CSA activity is anticipated to yield important insights regarding the current status, supply, and demand of climate-smart agriculture systems, facilitating the adaptation to climate change impacts on agricultural production in Indonesia.

In 2012, Indonesia completed its Technology Needs Assessment (TNA). The implementation of the technologies emphasized in the TNA may yield significant advantages for the nation. Indonesia is a participant in the Global TNA conducted by the United Nations Environment Program (UNEP).

At that time, BPPT was the entity responsible for technology development in Indonesia; however, in 2021, the Government of Indonesia merged all research and technology development units into a new institution known as the National Research and Innovation Agency (BRIN) (Refer to details in 5.1.2.2.2).

At present, there is no designated mandate pertaining to a specific institution at the national level that concentrates on technology transfer and development related to climate change. BRIN is tasked with advancing research, which encompassed issues related to climate change. Moreover, various ministries and institutions are committed to technology transfer and development in accordance with regulatory mandates. The regulations encompass the establishment of a MRV system to oversee climate change mitigation efforts, including technology transfer that aids critical sectors such as energy, industry, and forestry.

5.1.2.1.3 Capacity Building

There is no national institution that is exclusively dedicated to the development of capacity for climate change, nevertheless, each line ministry and agency has a human resource development center or capacity-building unit (*Badan Pengembangan Sumber Daya Manusia* – BPSDM). The capacity requirements at the individual level are addressed by relevant line ministries and agencies in relation to climate change through this unit.

The formal education curriculum in Indonesia has long included environmental issues (Core Curriculum - *Kurikulum Inti* 1980). Act No. 20/2003 on National Education System also stipulated that the curriculum of schools should consider the diversity of the region's potential and environment, as well as global developments and climate change. Furthermore, the most recent National Curriculum 2013 emphasizes the importance of climate change knowledge as a fundamental competency, particularly for primary school students, as part of the attitudes, skills, and knowledge that students are expected to acquire. In Indonesia, formal education is regulated by two ministries: the Ministry of Education, Culture, Research and Technology (Kemendikburistek), which is responsible for 84% of schools, and the Ministry of Religious Affairs, which is responsible for the remaining 16%. The Islamic education system in Indonesia encompasses primary schools, junior high schools, and Madrasah Aliyah at the senior high level. In 2021, the Ministry of Environment and Forestry, which serves as Indonesia's focal point for the UNFCCC, developed a concept for the practical integration of climate change into the Indonesian education curriculum. Additionally, the Ministry of Education and Culture (MoEF) has implemented the Indonesian Green School Program (*Program Sekolah Adiwiyata*) since 2006 to promote the integration of environmental-focused content in schools. The program incorporates climate change and maintains a comprehensive approach. The program endeavors to enhance the quality of learning, foster a sense of belonging and connection with nature, encourage sustainable resource use, and alter the conduct of students. The Directorate General of Climate Change of MoEF has established a Climate Change Knowledge Center, which provides a limited number of resources for educators and instructors to use in introducing climate change in the classroom. Additionally, Kemendikbudristek manages an online learning portal called Rumah Belajar.

5.1.2.2 Institutional Arrangement

5.1.2.2.1 Finance

Indonesia demonstrates effective management of foreign loans and grants, facilitated by the The Debt Management & Financial Analysis System (DMFAS) system at the MoF. DMAFS is designed to address the evolving requirements of debt management offices. This includes coverage of expanded debt instruments, adherence to new transparency standards, management of increasingly complex debt instruments, resolution of data quality issues, and enhancement of operational risk management.

At the macro level, the policies for managing foreign loans and grants in Indonesia, driven by five key institutions, play a crucial role in the coordination and administration of these financial resources:

1. **Ministry of Foreign Affairs**: functions as the primary entity tasked with the coordination and management of diplomatic issues concerning loans and grants. This ministry establishes the regulatory framework for cooperation between the Indonesian government and donors through diplomatic arrangements.
2. **National Development Planning Agency**: Tasked with coordinating programs funded by loans and grants, overseeing the execution of activities, and performing monitoring and evaluation of their implementation.
3. **Ministry of Finance**: Responsible for financial administration, which includes the allocation of counterpart budgets, as well as the supervision and evaluation of loans and grants from a financial perspective.
4. **Implementing Agencies**: These include ministries, government agencies, bureaus, or other governmental units that are responsible for executing activities funded by loans and grants. Their responsibility is to implement the programs in the field.
5. **State Secretariat**: Responsible for coordinating and addressing legal and administrative matters concerning loans and grants, which includes conducting research, providing clearance for foreign experts involved in projects, and overseeing import duty exemptions for goods associated with loans and grants initiatives.

The five institutions coordinate regularly to manage foreign loans and grants, ensuring effective use of funds in alignment with national priorities and compliance with relevant regulations in Indonesia.

Coordination among the five principal institutions responsible for managing foreign loans and grants in Indonesia is regulated by various frameworks to ensure the effective utilization of received funds, alignment with national priorities, and compliance with applicable regulations. A significant mechanism is a formal forum that unites the Indonesian government with international donors, exemplified by the National Committee for Coordinating Foreign Assistance. This forum serves to address development priorities, oversee implementation, and administer loans and grants.

In addition, comprehensive monitoring and evaluation are implemented to enhance accountability in fund management. The monitoring and evaluation mechanism includes multiple entities, such as the Inspectorate General, the Financial and Development Supervisory Agency (BPKP), and the Audit Board of the Republic of Indonesia (BPK). The monitoring process aims to ensure the transparent and effective use of loans and grants, in compliance with relevant regulations, to promote economic growth and sustainable development in Indonesia.

The Audit Board of the Republic of Indonesia (BPK RI): BPK RI plays a crucial role in the auditing of grants and loans received by Indonesia. They guarantee that the allocation of these funds aligns with the established provisions and objectives. BPK RI is actively involved in the Climate Scanner project, which evaluates government initiatives aimed at addressing climate change. BPK RI assesses the effectiveness and accountability of fund utilization in projects aimed at climate change mitigation and adaptation initiatives. The audits performed by BPK RI are designed to ensure that the funds received are effectively managed and yield a beneficial impact on society and the environment.

The Ministry of Finance comprises six Directorates General that are responsible for the functions and administrative tasks associated with the management of Foreign Loans and/or Grants:

1) Directorate General of Budget (DJA) is responsible for the budget allocation process and reviews the budget workplan of line ministries (RKA-KL) prior to the preparation of the draft Budget Implementation List (DIPA).
2) Directorate General of Treasury (DJPB), tasked with overseeing the process of:
    a) Reviewing and approving the budget implementation list serves as the foundation for effective budget execution.
    b) Authorizing the disbursement of loans and grants through the State Treasury Service Office.
    c) Reporting loans and grants in the financial statements of the State General Treasury through the State Treasury Service Office as part of treasury functions
3) Directorate General of Tax (DJP), responsible for managing Indonesia's tax facility concerning foreign loans and grants allocated for government projects.
4) Directorate General of State Assets (DJKN), oversees the process of asset handover.
5) Directorate General of Fiscal Balance (DJPK), responsible for managing the processes related to loans and grants at the sub-national level.
6) The Directorate General of Budget Financing and Risks Management (*Direktorat Jenderal Pembiayaan dan Pengelolaan Resiko* - DJPPR) is responsible for the process of:
    a) Registration of loans and grants
    b) Recording of loans and grants
    c) Reports on loans and grants (income and expenditure) compiled from financial statements
    d) Monitoring and evaluation of loans and grants

Each Directorate General has established a clear standard operating procedure for services, including defined time frames for the completion of loans and grants. All loans and grants associated with climate change adhere to the framework established by Government Regulation No 10 of 2011, with management organized as previously outlined. All loans and grants received are subject to annual audits.

5.1.2.2.2 Technology Transfer and Development

Since 2014, the MoEF has been at the forefront of coordinating Indonesia's main focus areas of climate change. Significantly, the government of Indonesia mandates MoEF as a national focal point for the UNFCCC, highlighting the ministry's critical role in global climate change initiatives. MoEF coordinates several crucial issues, including the reporting of means of implementation such as financing, technology transfer and development, and capacity building. In addition to the technical expertise of the Ministry of Environment and Forests, there is collaboration with relevant line ministries.

Prior to 2020, research and technological development in Indonesia were carried out by line ministries/agencies, such as the Agency for the Assessment and Application of Technology (BPPT), the National Nuclear Energy Agency (BATAN), the National Institute of Aeronautics and Space (LAPAN), and the Indonesian Institute of Sciences (LIPI), and research and development units in each ministry.

BPPT plays a significant role in technological development across various sectors, including industry, agriculture, maritime, health, and energy, as mandated by the national government. BPPT aims to enhance domestic technological capacity, reduce reliance on foreign technology, and promote the development of new technologies to support Indonesia's sustainable development through research and innovation. Research and development units were present in line ministries and government agencies. However, through Presidential Regulation No.33/2021, as amended by Presidential Regulation No.78/2021, has led the Government of Indonesia to consolidate all research and technological development units (BPPT, BATAN, LAPAN, LIPI and research and development units in each technical ministries) into a single entity known as the National Research and Innovation Agency (BRIN). After joining BRIN, each researcher who comes from different institutions enters the deputyship, research organization, and research center according to the area of expertise, experience, and knowledge brought from the previous institution of origin.

This consolidation sought to enhance the efficiency of research and development initiatives; although, it has posed a challenge in maintaining a direct connection between ongoing technological advancements and the requirements necessary for meeting NDC targets across various ministries addressing climate change, including the MoEF especially in waste and forestry sector, MEMR especially in energy sector, Ministry of Industry in IPPU sector, Ministry of Public Works and Housing (PUPR) especially in energy and waste sector, Ministry of Agriculture especially in agriculture sector, Ministry of Health especially in climate change adaptation, and Ministry of Marine Affairs and Fisheries. The Ministry of Industry has actively promoted industrial innovation and technology development, particularly in heavy industrial sectors such as cement, iron, steel, and chemicals. The Agency for Meteorology, Climatology, and Geophysics (BMKG) has been enhancing its services to deliver dependable climate data and analysis. Research and development units within ministries and agencies are essential for facilitating technology transfer and development via policies and programs, while also promoting both domestic and international investment in new technologies.

Besides BRIN, other institutions significantly contribute to research, innovation, and technology transfer. These institutions collaborate through national policies, international agreements, and development programs to improve Indonesia's technological capacity and promote sustainable economic growth:

1. The Ministry of Education, Culture, Research, and Technology (Kemendikbudristek), facilitates technology research, development, and innovation within universities.
2. The Indonesia Investment Coordinating Board (*Badan Kordinasi Penanaman Modal* – BKPM) promotes foreign investment in Indonesia, including in technology-related investments, and facilitates the transfer and development of technology by providing industrial incentives and streamlining regulatory processes.
3. Public-Private Partnerships (PPPs) facilitate collaboration among government entities, the private sector, and foreign investors to foster the development and implementation of new technologies, especially in the areas of infrastructure, energy, and digital innovation.

As previously explained, the absence of specific regulations or mandates for any institution/ministry in Indonesia regarding the transfer and development of technology, especially in climate change mitigation and adaptation, has significant implications. This lack of regulatory reference hampers the institutional arrangements on this issue, posing challenges for effective technology transfer and development. However, it also presents an opportunity to develop comprehensive and adaptive regulatory frameworks.

However, the potential for collaboration is significant, as regulations and mandates regarding tasks and functions related to research and technology generally lie with the ministries of RISTEKDIKTI and BRIN. Meanwhile, the investment process flow is based on the regulations and mandates at BKPM.

Emphasizing the importance of international support, which goes across ministries and generally comes through the Foreign Cooperation Bureau in each ministry, is crucial for our collective efforts. Technology transfers are documented in the International Cooperation Bureau (*Biro Kerjasama Luar Negeri* – KLN) within each ministry or agency. The assessment of needs for technology transfer and development necessitates close coordination and dialogue among the Planning Bureau (*Biro Perencanaan*), KLN, and technical directorates at the (Echelon 2 level).

5.1.2.2.3 Capacity Building

Capacity building at the international level is facilitated through a combination of governmental initiatives, international collaboration, and partnerships involving multilateral organizations, bilateral donors, NGOs, and the private sector. The majority of capacity-building initiatives are integrated with financial support mechanisms. Consequently, the organization of capacity-building support predominantly adheres to the process outlined in the Finance section. Technical directorates within ministries and agencies will obtain support through state budget allocations, blended finance, and grants or loans.

The MoEF is pivotal in coordinating key focus areas of climate-related capacity building, including methodological support, GHG Inventory reporting, the transparency framework under the Paris Agreement, climate resilience planning, budgeting, and other pertinent domains. The objective of these programs is to improve the technical skills of government officials, researchers, and local communities. The MoEF collaborates with the Ministry of

Finance and Bappenas to ensure that support is aligned with national priorities. Regarding technical skills, MoEF collaborates with relevant line ministries.

Indonesia engages with multiple international organizations, including the United Nations Development Program (UNDP), UNEP, World Bank, ADB, and the GCF, to obtain technical assistance, facilitate knowledge exchange, and secure funding for activities aimed at enhancing capacity to address climate change. Several countries, including Norway, Germany, Japan, the United States, and Australia, provide bilateral support to Indonesia for climate change capacity building. This support typically manifests as technical assistance, training programs, and exchange visits. Bilateral agreements, exemplified by the Indonesia-Norway Agreement on REDD+, which emphasize contributions to the implementation of the "Indonesia FOLU Net Sink 2030" plan, often include components aimed at capacity building.

Although there is no dedicated national institution for climate change capacity building, various ministries and agencies operate Capacity Building and Human Resource Development Centers (*Badan Pengembangan Sumber Daya Manusia* – BPSDM). The BPSDM primarily focuses on capacity building at the individual level, which is essential for enhancing the skills and knowledge of government officials (*Aparatur Sipil Negara* - ASN) engaged in climate change issues. It is important to recognize that various forms of capacity building, including institutional strengthening, policy design and development, and the enhancement of specific technical skills for ASN and other stakeholders (e.g., extension workers, NGOs, and communities), are frequently undertaken by technical directorates within ministries and agencies pertinent to climate change in collaboration with development partners. The relevant ministries encompass the MoEF, MEMR, Ministry of Industry, Ministry of Public Works and Housing (PUPR), Ministry of Agriculture, Ministry of Health, Ministry of Marine and Fisheries, and the Agency for Meteorology, Climatology, and Geophysics (BMKG). These entities are essential in delivering specialized training and capacity-building programs tailored to the distinct requirements of their sectors.

International support for capacity building related to climate change at technical directorates generally commences with the execution of an agreement or Memorandum of Understanding (MoU) with the International Cooperation Bureau (*Biro Kerjasama Luar Negeri* – KLN) within the relevant implementing ministries or agencies. This document formalizes the collaboration between international partners and the government, establishing the framework for project objectives and timelines. Subsequent to the agreement, KLN will commence coordination with the Legal Unit at the Secretariat of the pertinent technical Directorate General. A Project Management Unit (PMU) is frequently established to facilitate project coordination, management, and execution, thereby ensuring effective resource utilization. The implementation phase is conducted by the relevant technical directorates, which oversee the execution of capacity-building activities on the ground, incorporating international expertise to enhance their climate-related initiatives. Scheduled regular reporting, dialogue, and audits are implemented to ensure transparency and accountability with respect to the Audit Board.

5.1.2.3 Priorities and Strategies on Aspects of the NDC Under Article 4 of the Paris Agreement That Need Support

Article 4 Point 5 of the Paris Agreement stipulates that 'support shall be provided to developing country Parties for the implementation of this Article, in accordance with Articles 9, 10 and 11, acknowledging that increased support for these Parties will facilitate greater ambition in their initiatives. This recognition constitutes a specific plan rather than a general concept. Article 9

of the Paris Agreement addresses financial resources, Article 10 pertains to technology development and transfer, and Article 11 focuses on capacity building. The second paragraph offers a comprehensive overview of the required financial resources, while sub-section 5.5 delineates the necessary support for technology development and transfer, and sub-section 5.7 specifies the support needed for capacity building.

Priorities and strategies regarding aspects of the NDC requiring financial support, has been integrated into the planning and development process of the Government of Indonesia. The activities outlined in the DRPLN-JM or Bluebook are deemed feasible for funding through foreign loans for climate change projects. Additionally, the activities or projects specified in the DRKH pertain to planned grants. Donors or development partners are typically engaged during the phases of coordination, communication, and consultation regarding loans and grants. The examination of the program's substance involving Bappenas and the relevant line ministries. Both the DRPLN-JM and DRKH documents serve as foundational resources for the government's communication with development partners in the formulation of a development cooperation framework. Under BTR1 reporting, the planning adheres to the timeframe of the 2020-2024 RPPLN (Foreign Loan Utilization Plan). The utilization of Foreign Loans in the period of 2020-2024 has nine focused with mitigation and adaptation to climate change, energy security, water and food security, as well as resilience and management of natural and non-natural disasters included in the utilization number 6.

5.1.2.4 Description of the Systems and Processes Used to Identify, Track and Report Support Needed and Received, Including a Description of the Challenges and Limitations

The Systems and Processes Used to Identify, Track and Report Support Needed and Received

Indonesia employs two systems for the identification, tracking, and reporting of support received from development partners. Initially, according to Government Regulation No. 10 of 2011 regarding the management of foreign loans and grants. Secondly, Government Regulation No. 74 of 2012 applies exclusively to The Indonesian Environment Fund (IEF/BPDLH). Provide a detailed explanation of the mechanism as described below:

(i) Mechanism and Reporting under Government Regulation No 10 of 2011

In term of planning, budgeting and executing of loans and grants, there is three mechanisms cluster, as follows:

In the initial mechanism, **On-Budget On-Treasury**, this process adheres strictly to the State Budget (APBN) system. This method is employed by organizations like the World Bank and the ADB, which manages the Multi-Donor Fund. This mechanism is applicable to loans and certain grants, particularly those that are planned.

The second mechanism, **On-Budget Off-Treasury**, entails the disbursement of funds outside the national treasury while remaining reported within the APBN framework. Most direct grants utilize this second mechanism. This mechanism is utilized by bilateral countries, including the governments of Japan, Germany, France, and Korea.

The third mechanism, **Off-Budget Off-Treasury**, pertains to donors who did not utilize the government's budget system or disburse funds via the national treasury or its associated institutions, including the State Treasury Service Office (KPPN). This mechanism is commonly employed by NGOs, bilateral donors, foreign governments, think tanks, and multilateral agencies, including climate finance entities such as the GCF, AF, and GEF**.**

Loans are under the second and third mechanisms; however, grants exhibit greater flexibility. A grant classified as **On-Budget On-Treasury**, indicates that it has adhered to the government's planning and the APBN system from the outset. This mechanism is consistent with the principles of the **Paris Declaration**, particularly in terms of ownership, alignment, harmonization, managing for results, and mutual accountability.

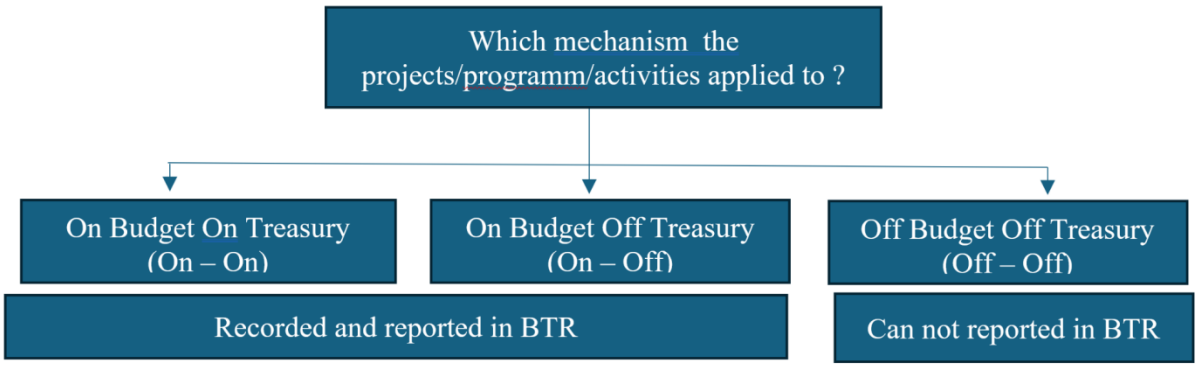


Figure 5- 6 Three mechanisms cluster

(ii) Mechanism and Reporting under Government Regulation No 74 of 2012

The mechanism for recording and reporting international support received by the Indonesian Environment Fund (IEF/BPDLH) differs from the management of loans and grants as outlined in Government Regulation No 10 of 2011.The legal basis for the operation of IEF/BPDLH **is Government Regulation No. 74/2012,** applies exclusively to the Indonesian Environment Fund (IEF/BPDLH). The IEF/BPDLH oversees the administration of environmental funds, encompassing climate finance, and facilitates the execution of Indonesia's NDC to meet climate change objectives.

IEF/BPDLH was established under Government Regulation Number 46 of 2017, which mandates that the management of environmental funding—derived from resources aimed at mitigating pollution and/or damage, as well as restoring the environment and trust funds for conservation assistance—be conducted by the central government through a public service agency financial management framework. The mandate was subsequently established through Presidential Regulation number 77 of 2019, which designates a non-echelon organizational unit, created by the Minister of Finance, to manage environmental funds utilizing the financial management framework of public service agencies.

The implementation of effective, efficient, accountable, and transparent financial management is outlined in the Decree of the Minister of Finance number 779/KMK.05/2019. Consequently, IEF/BPDLH was designated as a full public service agency, allowing for financial management flexibility in accordance with Government Regulation No. 23 of 2005, which pertains to the **Financial Management of Public Service Agencies as amended by Government Regulation No. 74 of 2012** and its implementing regulations.

The reporting is available in the Financial Report, which encompasses all financial aspects managed by the Indonesian Environment Fund (IEF/BPDLH). This Financial Report is generated via the Agency Accounting System (SAI), which encompasses a series of manual and computerized procedures that include data collection, recording, summarizing, and reporting on financial positions and operations within the Ministry of State/Institution. The Indonesia Environment Fund (IEF/BPDLH) implements the Agency Accounting System utilizing the Agency-Level Financial Application System (SAKTI). This application, developed by the Directorate General of Treasury, comprises several modules: Admin, Budget, Fixed Assets, Treasurer, General Ledger (GL) and Reporting, Commitment, Payment, Inventory, and General.

In general, the task of managing Indonesian Environment Fund (IEF/BPDLH) funds is manifested in the following activities: Management of program funds, with service users, namely donor institutions or countries that cooperate in managing environmental funds to be managed and distributed to certain parties in accordance with the agreed contract/agreement; Management of revolving funds.**iii) The National Registry System (SRN)**

In addition to the two reporting mechanisms outlined in (i) and (ii), Indonesia has another reporting system, the National Registry System, which can be considered for recognizing mobilization support. The National Registry System (SRN) serves as a vital data collection and reporting mechanism aimed at facilitating support for climate change mitigation efforts, aligned with quantifiable climate change control action data elements. A primary objective is to obtain government acknowledgment of the various contributions to climate change, encompassing adaptation, mitigation, funding, technology, and capacity building. This recognition reflects the collaborative efforts of multiple parties and is confirmed at the final stage of the SRN.

5.1.2.5 Description of Challenges and Limitations

The BTR1 outlines the challenges and limitations associated with climate finance flows during the years 2021 and 2022. Challenges were encountered in the collection, aggregation, and analysis of information from diverse sources, identified as follows:

(i) **Data uncertainty**: Most of the uncertainties associated with each source of data which have different underlying causes identified.

- Uncertainties regarding the data pertain to off-budget and off-treasury foreign grants.

- Uncertainties stem from the lack of transparency of data regarding the assessment of private climate finance, including both domestic public investments and international contributions.
- Uncertainties arise from the lack of transparency in data necessary for assessing alternative financial instruments.
- Uncertainties emerge from variations in the assumptions employed in the foundational formulas for attributing finance based on Donor Claimed on Climate Change activities and MDBs to developed nations; the categorization of sustainable or green finance; and the lack of comprehensive data on non-concessional finance flows to the private sector.

(ii) **Data gaps**: Significant gaps in the coverage of sectors and sources of climate finance remain, particularly with regard to GCF, AF and GEF that has been operationalized in Indonesia; any other nasional support such as SDG Indonesia One; the channeled to non-government institutions, off – off mechanism, Private investment, both for climate mitigation and adaptation and resilience. Understanding of the public and private financial instruments used remains inadequate.

High-quality data on off – off mechanisms is notably challenging to obtain, and there higher involvement of private investments in sustainable agriculture, forestry and land use, water management, waste management, and adaptation and resilience efforts are required. Estimates of adaptation finance, being context-specific and incremental, present challenges in comparison with estimates of mitigation finance. Further research is required to estimate investments that are resilient to climate change.

(iii) The MoF reporting system is restricted to climate finance flows directed solely to Government recipients, consequently, **certain flows outside the government will not be included or captured in this report.** This also applies to climate finance flows directed toward private sector entities that are not state-owned enterprises (SOEs) Climate finance flows to Government recipients can only be reflected in the Government Realization Report on Revenue, Spending, and Financing, distinct from the Financial Government Report. All received grants will be recorded as Grant Revenue, while all loans will be recorded as Financing. Another method to report climate finance flows from bilateral and multilateral institutions is through the reporting of IEF/BPDLH, categorized as Non-Tax Revenue/PNBP, which is comprehensively captured and documented in the Financial Government Report.

(iv) Climate finance flows from the GCF, AF, and GEF will not be comprehensively documented in the Financial Government Report. Despite the presence of GCF, AF, and GEF, bilateral grants and multilateral funds channeled through NGOs cannot be captured and recorded in the Financial Government Report. A discrepancy will exist

between the number of grants recorded in the donor report/website and the government report. The system is not yet available. Detailed information is presented in other data sources.

(v) **Data accessibility:** The availability of pertinent data from private institutions and NGOs posed a considerable challenge. Private entities often lack standardized reporting mechanisms that correspond with governmental processes, complicating the compilation of accurate data. It is advisable to conduct a thorough institutional review and establish a centralized entity tasked with the systematic collection and management of data for future BTR reports.

(vi) **Stakeholder engagement:** A comprehensive mapping of stakeholders involved in mobilizing, receiving, and requiring financial, technological, and capacity-building support is essential for a thorough understanding. Data collection initiatives should be more extensive and focused, especially at the Directorate Level (echelon 2) within ministries and agencies. This detailed level of analysis will enhance the understanding of specific requirements and needs, particularly regarding capacity and technology. Targeted efforts will enhance the actionability and precision of future transparency reports. Additionally, the participation of non-governmental entities, such as NGOs, private organizations, and multilateral partners, is essential to ensure comprehensive data collection. A significant amount of data regarding received supports is located within the Planning Bureau and Foreign Cooperation Bureaus of each Ministry or Agency. Nevertheless, specific details regarding capacity-building elements, including the scope of activities and related technological transfers, are frequently unavailable at this level. This data is generally overseen at the technical echelon level, indicating that increased interaction with these departments is essential.

(vii) **Institutional Arrangements and Mechanisms for reporting:** Mechanisms and a clear arrangement of institutional frameworks must be established to reduce the disparity in support received from international climate finance institutions, such as the GCF, GEF, AF, private sectors, and other relevant entities. In the future, strengthening the SRN instrument, currently underpinned by policies and a web-based platform, is essential. One solution involves incorporating user-friendly tools on the website that are specifically designed to enhance FTC data in reporting, monitoring, and verification. The tools will be designed for user-friendliness, allowing all participants in the SRN scheme in Indonesia to easily input FTC data.

5.2 Underlying Assumptions, Definitions, and Methodologies

The following outlines the assumptions and methodology for the common tabular format Support Needed (Tables 6, 8, 10), Support Received (Tables 7, 9, 11), as well as Transparency Support Needed Table 12 and Transparency Support Received Table 13.

5.2.1 General for Finance, Technology Transfer and Development, and Capacity Building

- **Title (of activity, program or project)**; title of activity or project as described in the project documents
- **Program/project description**; description as described in the project documents
- **Amount**
  - **Estimated amount for Table 6** is presented in both domestic currency and United States dollars for **financial support needed:** using the estimated amounts in IDR and converted to USD based on the BI mid-exchange rate for the years 2021 and 2022**.**
  - **The amount for Table 7**is derived from the actual disbursement detailed in the Audit Report, utilizing the actual currency in IDR and converting it to USD based on the BI mid-exchange rate for the years 2021 and 2022.
- **Expected time frame for support needed:** expected time frame is up to 2030
- **Time frame for support received:**
  - **Duration:** date agreement signed and agreement closing
  - **Time frame:** represent reporting period using accounting period
  - **Accounting Period**: Annually
    a) New signed agreement loan and grant in 2021 – 2022
    b) Extended agreement loan and grant from previous year 2021 – 2022
    c) Closing loan and grant in year 2021, 2022
- **Status of activity is categorized into** planned, ongoing, or completed.
- **Type of data:** Agreement Signed and disbursement.
- **Financial Instrument**: Concessional loan, Non-Concessional Loan, Grant.
  - **Concessional loans –** Below-market terms as outlined by the Organization for Economic Co-operation and Development (OECD) definition, where loans are deemed eligible as Official Development Assistance if they have a grant element of at least 25%; however, there is a spectrum of concessionally from "hard" (near-market) loans to soft (OECD, 2022).
  - **Non-concessional loans –** loans offered near or at market rates
  - **Grant –** amount that was received by GoI without any repayment**.**
- **Channeling delivery**: only to Government of Indonesia (including line ministries and agencies).

- **Recipients:** Initial recipients of flows as the first entities receiving money from the development partners.

- **Implementing entity:** Ministries or institutions in Indonesia that act as recipients and cooperate in leading the implementation of national-scale activities.

- **Double Counting:** Data is cross-referenced to individual country that mobilize support to GEF, GCF, AF, IBRD/World Bank, and UNDP. Therefore, the amount is presented individually, not as a sum.

- **Type of support:** cross-referenced to criteria of sectoral mitigation, adaptation, and cross-cutting activities in Enhanced NDC (sector and sub-sector).

- **Type of technology:** is identified based on sector and scope of the activity/program/ project.

- **Expected use, impact and estimated results:** in Tables of Technology Transfer and Development and Capacity Building refer to publications, articles and discussion processes with relevant ministries in the leading sector.

- **Use, impact and estimated results:** in Tables of Technology Transfer and Development and Capacity Building refer to publications, articles and discussion processes with relevant ministries in the leading sector.

5.2.2 Financial Support Needed and Support Received

In the BTR1 reporting, analysis of financial support received is focused on funding exclusively received by ministries and government agencies as regularly recorded in Government Realization Report (Revenue-Spending-Financing). This is a separate document from the Financial Government Report. Grants are recorded as Grant Revenue, while loans are categorized under Financing. In parallel, climate-related financial supports are also recorded by IEF/BPDLH as Non-Tax Revenue (PNBP), which is fully captured in the Financial Government Report. This document outlines the assumptions and methodology for data collection in a tabular format, detailing financial support needed (Table 6) and financial support received (Table 7).

Another method to report climate finance flows from bilateral and multilateral institutions is through the reporting of IEF/BPDLH, categorized as Non-Tax Revenue/PNBP, which is comprehensively captured and recorded in the Financial Government Report.

Definitions

1) **Climate finance**, refers to the financial support provided by developed countries to Indonesia, e categorized as concessional or non-concessional. Concessional finance includes Official Development Assistance (ODA), Other Official Flows (OOF), and contributions from private foundations. Non-concessional flows encompass both

public and private sources, such as multilateral development banks, foreign direct investment (FDI), remittances, and assistance through South-South Cooperation.

2) **Public finance** refers to supports via bilateral or multilateral partnership.

3) **Private financing** flows are directed to Indonesia from both international and domestic private sources.

4) **Official development assistance (ODA)** refers to international public financing designed to foster development in developing countries, provided as either grants or loans with below-market interest rates. This scheme is characterized by: (a) Actions taken by the official sector; (b) A primary objective of promoting economic development and welfare in developing countries; (c) Concessional financial terms, meaning that if a loan is involved, it must be concessional in nature and include a grant element of at least 25%.

5) **Other official flows (OOF)** refer to official development flows that do not satisfy the concessionally criteria outlined for ODA, yet can also be utilized to facilitate climate change initiatives. These flows occupy a position between pure aid flows and profit-seeking private flows, with the exception of export credits, which represent profit-seeking public sector interventions that mobilize private finance.

Finance Methodologies

Most of the finance data in this report comes from official sources, including the Directorate General of Budget Financing and Risk Management (DJPPR) and the DG of Treasury, based on Audited Reports of loan and grant realizations. Indonesia has established an efficient loan administration system under Government Regulation 10 of 2011. In the interim, all line ministries that have received grants through BAST (whether direct or planned) are required to submit grant data. The climate finance disbursements from bilateral countries are not included in this report if the government recipient fails to report BAST in these cases.

i) Data granularity: Audited Reports of Realization Loans and Grants, the Indonesian Environment Fund (IEF/BPDLH) and Ministry of National Development Planning Reports as well as activity project level in Ministry of Finance, along with other secondary sources, form the basis of this analysis. Government Regulation No 10 of 2011 and Government Regulation No 74 of 2012 for the Indonesian Environment Fund (IEF/BPDLH) mandated that all loan and grant disbursement transactions are subject to annual audit. Therefore, audited report of 2021-2022 loans and grants realization reports serve as the most reliable sources of information for BTR1. Estimates were compiled to align with operational definitions of climate finance and activities identified in the NDC/ENDC, with a focus on primary finance to avoid double counting.

5.2.3 Technology Transfer and Development, and Capacity Building Support Needed and Received

Followings are the assumption and methodology for common tabular format,

1) Information on technology transfer and development support needed (Table 8);
2) Information on technology transfer and development support received (Table 9);
3) Information on capacity-building support needed (Table 10);
4) Information on capacity-building support received (Table 11).

The assumptions and analyses required for technology transfer, development, and capacity-building support are as follows:

1) Assessment of technology needs relies on input from line ministries, NDC documents, and aligns with prior technology needs assessments.
2) Assessment of capacity building needs was informed by inputs from sectoral focus group discussions, experts, and academics, while considering ongoing efforts. This indicates a necessity for improvement, scaling up or expansion, and the identification of new areas for intervention.
3) The project description in the needs table remains general concerning relevant ongoing activities in the sectoral and sub-sectoral context. Additional information regarding specific activities necessitates more in-depth discussions with the appropriate units.
4) The situation in point 3 is also relevant for identifying the timeframe. Capacity building is essential at every stage of a country's pursuit of its NDC target. Nevertheless, the extent of detail regarding the capacity urgently required at present, as well as in the medium or long term, necessitates additional evaluation.
5) The anticipated results and outcomes of needs that advance or extend the ongoing programs pertain to the overall results or outcomes of those programs. Further assessment is still required. Additionally, it is challenging in certain areas to quantify the results in terms of tonCO2e.

The assumptions and analyses regarding technology transfer, development, and capacity-building support are as follows:

1) Data were collected from the donor's website, BR4 dan BR5 Annex I countries, and the national database.
2) Projects were organized by year of implementation.
3) Projects shortlisted for implementation between 2021 and 2021 were cross-referenced with the financial support list (Table 7).
4) Financial support assumptions regarding confirmed grants and loans, as outlined in the Handover Report, indicate that the corresponding list of CBs is deemed confirmed.
5) Additionally, the list was reviewed in collaboration with pertinent line ministries and agencies via digital questionnaires, focus group discussions, and bilateral consultations.
6) Only projects confirmed through BAST documents and sectoral consultations are reported in Table 11.

7) Projects with confirmed results, outcomes, or outputs are limited by the number of consulted implementing entities, and some projects remain ongoing, with not all activities completed.
8) Type of supports (mitigation/adaptation/cross-cutting) is determined through expert consultation.

The specific assumptions regarding the capacity-building supports received are as follows:

1) Some projects have outcomes that are not confirmed due to a limited number of consulted implementing entities, and some projects are still ongoing, with not all activities completed.
2) While results, outcomes, and outputs are measurable and indicated in the project documents, impacts are not always clearly defined or measured due to the nature of capacity building.

The specific assumptions regarding technology transfer and the support for development received are based on secondary data, as well as the input from activities, programs, and projects conducted by relevant ministries and institutions, which undergo validation and verification processes. The list is derived from the results of the verification process.

5.2.4 Transparency Support Needed Table 12 and Support Received Table 13

Table 12 and 13 provides information, to the extent possible and as applicable, on transparency-related activities for the implementation of Article 13. This includes transparency-related capacity building.

Underlying Assumption:

- **Title (of activity, program or project)**; The title of an activity or project cannot be accurately described by an individual project, as the activities are primarily founded on clusters and sectors in the context of adaptation and mitigation.
- **Program/project description**; as outlined in the BUR3 report for climate mitigation and roadmap adaptation.
- **Objectives and description;** as outlined in the BUR3 report for climate mitigation and roadmap adaptation.
- **Recipient entity**; Line Ministries
- **Channel**; exclusively for the Government of Indonesia (including line ministries and agencies)
- **Amount (in IDR and in USD)**;
  - **The estimated amount for Table 12** (in domestic currency and in United States dollars) for the **financial support needed** is calculated in IDR and converted to USD using the BI mid-exchange rate for each year in 2021 and 2022**.**

- **Amount for Table 13:** is calculated by utilizing the actual disbursement as reported in the Audit Report during the BTR report period. utilizing the real currency in IDR and converting it to USD using the BI mid-exchange rate for the years 2021 and 2022.

- **Expected time frame for support needed:** expected time frame is up to 2030.

- **Time frame for support received:**

  - **Duration:** date agreement signed and agreement closing
  - **Time frame:** represent reporting period using accounting period
  - **Accounting Period**: Annually
    a) New signed agreement loan and grant in 2021 – 2022
    b) Extended agreement loan and grant from previous year 2021 – 2022
    c) Closing loan and grant in year 2021, 2022

- **Status of activity:** Status of the activity; i.e. planned; ongoing; or completed

- **Use, impact and estimated results**: describe the estimated results, use and impact

5.2.5 Type of support Finance, Technology Transfer and Development, and Capacity building

Following assumption on type of support in tabular format, information on support needed Table 6, 8, 10 and support received Table 7, 9, 11.

Type of support classified into three types:
- Mitigation
- Adaptation
- Cross-cutting

However, in each mitigation and adaptation there will be cross-cutting internally and additional type of support called may lead to mitigation and may lead to adaptation.

5.2.5.1 Categories of Climate Mitigation

- Type 1: categorized as **mitigation**, provided that all meet the criteria for ENDC mitigation in a specific sector or sub-sector
- Type 2: categorized as **may lead to mitigation**, if the criteria for ENDC mitigation are not met
- Type 3: categorized as **cross-cutting within sub-sector mitigation**, provided that all meet the criteria for ENDC mitigation across the sub-sector

The detail explanation on each type are as follows:

Criteria for Mitigation Enhanced NDC

Mitigation: refers to the absorption of GHGs from the atmosphere or the reduction of their emissions into the atmosphere. Reductions are assessed in comparison to a "no-project" baseline. For instance, an activity is regarded as mitigation if it:

- Contributes to the reduction of greenhouse gas emissions, measured per unit of output or through alternative metrics;
- Limits the burning of fossil fuels for energy and employs lower carbon or renewable sources;
- Enhances energy efficiency in residential, commercial, and industrial settings;
- Plans and implements transport systems and urban development appropriately;
- Reduces emissions resulting from deforestation or forest degradation;
- Stores carbon in the soil by conserving forests and implementing more sustainable land management practices.

An activity, project, or program qualifies as a mitigation activity if it aligns with the criteria outlined in ENDC activities, encompassing both sector and sub-sector classifications. Refer to Table 5-3 and Table 5-4 for the criteria of mitigation activities aligned with Indonesia's Enhanced NDC.

Table 5- 3 List of mitigation activities criteria in energy, IPPU, and waste sector

Sector	Sub-sector	Mitigation Actions
Energy	Renewable energy	• The use of renewable energy in Power Plant • Biofuel • Solar rooftop, PV Wilus and hydro Wilus, off-grid EBT generator • Direct utilization • Co-firing biomass • Biogasoline • Co-processing alternative fuels in Industry
	Energy efficiency	Chapter 6 Enhanced Energy Management Mandatory Chapter 7 Energy Efficiency in household and commercial electrical equipment Chapter 8 Implementation of energy-efficient PJU Chapter 9 Energy-efficient cooking equipment

Sector	Sub-sector	Mitigation Actions
		Chapter 10 Implementation of electric vehicles; shift modes of KRL, BRT, Freight Train, Passenger Train, LRT, MRT, KCIC; implementation of transportation management and vehicle rejuvenation
	Low-carbon emitting fuels	• Fuel switching Oil fuel • Conversion of kerosene to LPG • Increasing Connections of Houses with Natural Gas Flow through Pipes (JARGAS)
	Implementation of clean energy generation	• Implementation of clean coal technology (CCT) • Implementation of gas generators
IPPU	Cement Industry	• Increasing blended cement by increasing the portion of alternative materials to reduce the clinker to cement ratio
	Ammonia Industry	• Ammonia plant revitalization project to reduce the intensity of natural gas consumption • Ammonia plant improvement (increasing plant efficiency and reducing IPPU emissions) • CO_2 utilization
	Other Industries	• Aluminum Industry: • CWPB (center work pre-bake cell tech) • Nitric Acid Industry: • No mitigation measures for N_2O and continues to use existing technology since 2010 (with EF 10-19 kg N_2O per ton HNO3) • Iron and Steel Industry: No mitigation measures

Sector	Sub-sector	Mitigation Actions
Waste	Municipal solid waste	• Utilization of LFG (waste-to-energy) • Waste reduction • Waste utilization by composting and paper recycling • Waste-to-Energy by utilization of Municipal Solid Waste for power plant (PLTSa) or Solid Recover /Refuse Derive Fuel (SRF/RDF) • Zero waste to landfill in 2050
	Domestic Liquid Waste	• Sludge treatment from septic tank in Aerobic Integrated Treatment Installation • Biodigester (communal septic tank) with biogas recovery and utilization of flare
	Industrial Waste	• Industrial solid waste management utilization from WWTP by composting, reuse as row material and fuel, etc. • Industrial Waste Water Management by methane capture and utilization (biogas) from WWTP in palm oil mills and other agro-industry, pulp and paper, fruits/vegetable processing and juice, oil and gas and other industries

Table 5- 4 List of mitigation activities criteria in AFOLU

Sector	Mitigation details activities
AFOLU	The use of emission crops
	Water efficient concept in agriculture
	Organic fertilizer
	Manure management
	Feed supplement for cattle

Sector	Mitigation details activities
	Deforestation and forest degradation
	Land Rehabilitation (afforestation/reforestation/timber plantation)
	Peat water management
	Peatland Restoration

Cross-cutting within sub-sector mitigation, occurs when an activity satisfies the criteria established for either all-sector or sub-sector within the mitigation framework.

5.2.5.2 Categories of Climate Adaptation

- Type 1: categorized as adaptation, if all meet the ENDC adaptation criteria for a specific area, sub-area
- Type 2: categorized as may lead to adaptation, if not meet the criteria ENDC adaptation
- Type 3: categorized as cross-cutting within sub-sector adaptation, if all meet the ENDC adaptation criteria across sub-area.

Criteria for Adaptation Enhanced NDC

Adaptation refers to the process of decreasing the susceptibility of human or natural systems to the effects of climate change and associated risks by sustaining or enhancing adaptive capacity and resilience

Generally, an activity qualifies as an adaptation activity if it:

- Reduces the risk, exposure or sensitivity of human or natural systems to climate change and climate variability;
- Enhances a system's ability to respond to the effects and impacts of climate stimuli;
- Enhances problem-solving capabilities to formulate responses to climate variability and change;
- Incorporates climate risk information into decision-making processes.

Tracing activities adaptation whether the activities contribute to ENDC or not. Activity/project/program is considered as adaptation activity if it meets with the criteria as listed in ENDC activities, both categories and sub-categories.

Table 5- 5 List of adaptation activities criteria

Adaptation categories	Sub-categories activites
Economic Resilience	Sustainable agriculture and plantations
	Integrated watershed management
	Reduction of deforestation and forest degradation
	Land conservation
	Utilization of degraded land for renewable energy
	Improved energy efficiency and consumption patterns
Social Resilience	Enhancement of adaptive capacity
	Development of community capacity and participation in local planning processes, to secure access to key natural resources
	Ramping up disaster preparedness programs for natural disaster risk reduction
	Identification of highly vulnerable areas in local spatial and land-use planning efforts
	Improvement of human settlements, provision of basic services, and climate resilient infrastructure development
	Conflict prevention and resolution
Ecosystem and Landscape Resilience	Social forestry
	Coastal zone protection
	Ecosystem conservation and restoration
	Integrated watershed management
	Climate resilient cities

Cross-cutting within sub-area adaptation, occurs when an activity fulfills the criteria established for either the all-area or the specific sub-area related to the adaptation activity.

5.2.5.3 Categories of Cross-Cutting

If an activity serves both mitigation and adaptation purposes, it can be considered to have dual benefits for both aspects.

5.2.6 METHODOLOGIES

5.2.6.1 Data Collection and Sources

A thorough examination of secondary data sources was carried out, utilizing a diverse array of reports, databases, and official documents to support the analysis.

The following secondary data sources are included:

- Annual Report on the Implementation Performance of Foreign Loans and Grants (*Laporan Kinerja Pelaksanaan Pinjaman dan Hibah Luar Negeri*) published by Bappenas (Bappenas, 2021e, 2021f, 2023)
- Annual Report of Loans and Grants (*Laporan Pinjaman dan Hibah*) published by Ministry of Finance
- Realization Loans and Grants Audited
- Ministries Annual Performance Report (Laporan Kinerja – LAKIN)
- Biennial Reports (BR4 and BR5) of Annex I countries available on the UNFCCC website, offering insights into climate finance flows from developed countries to developing countries
- The OECD credit reporting system database monitors ODA along with OOF
- The GCF, Adaptation Fund, and Climate Funds Update databases, offer insights into climate finance flows from multilateral climate funds
- Websites of MDBs and donors, offering insights into climate finance flows from MDBs and bilateral donors
- The last official publication of the TNA document was in 2012, primarily authored by the Agency for the Assessment and Application of Technology (BPPT). The documents from 2017 and 2021 did not fully address the criteria of TNA and require further refinement.
- Sectoral strategic plans submitted to the RPJMN
- Indonesia's BUR3
- Official Letter from line ministries regarding the agreement
- Official Letter from line ministries regarding the technology and capacity building received and needs.

In addition, information regarding financial support was gathered through discussions with essential financial management agencies:

- Directorate General of Budget Financing and Risks Management (*Direktorat Jenderal Pembiayaan dan Pengelolaan Resiko* - DJPPR) of the Ministry of Finance
- Fiscal Policy Agency (BKF)
- Directorates of International Development Partnership of Bappenas, and relevant line ministries

5.2.6.2 Analysis Data

The identified supports received from secondary data sources were summarized and categorized into three key areas: Financial, Technological, and Capacity-Building supports. The summary was disseminated to pertinent directorates within line ministries for validation and verification via a digital questionnaire. The questionnaire included an open-ended question to identify additional supports not listed. The survey results and communications with the ministries were enhanced through sector-specific Focused Group Discussions (FGDs). Simultaneously, the requirements in each sector were examined. Additionally, the information gathered from the focus group discussion was subsequently verified through both online and offline meetings with each Ministry. Three final consultations focused on future directions for financial, technical, and capacity-building support related to climate change, as well as institutional arrangements conducive to future BTR reporting.

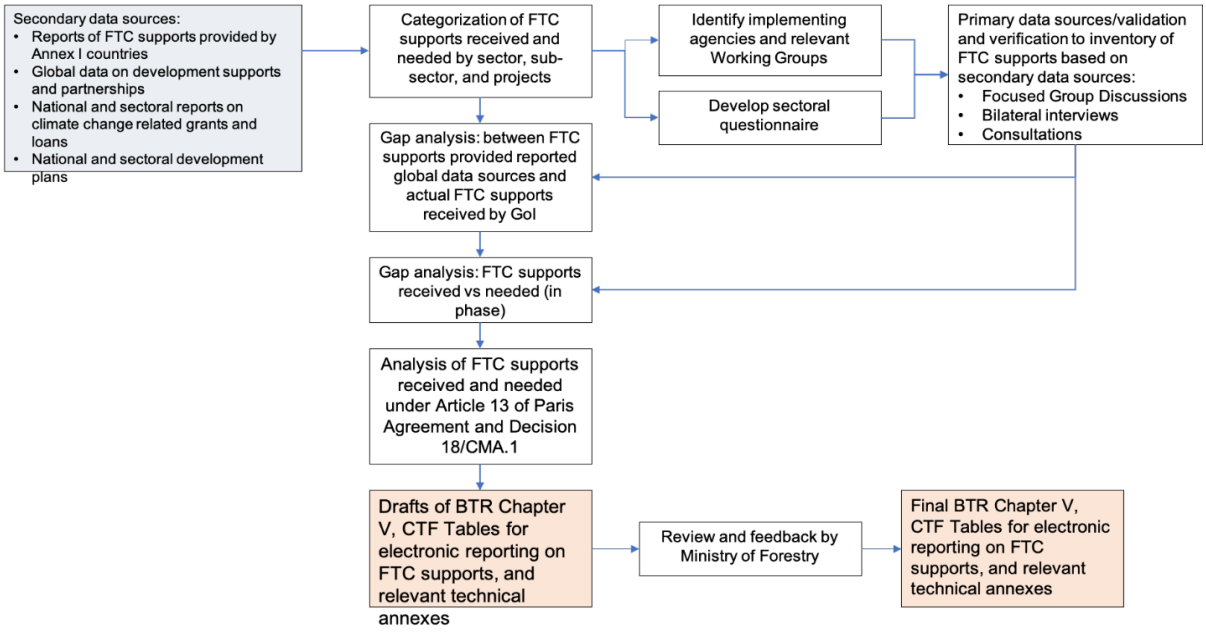


Figure 5- 7 Complete approach for development of Chapter V of BTR

Analysis by the FTC was conducted through collaborative effort involving FTC experts, additional thematic specialists, and four Thematic Working Groups (WG). The analysis included:

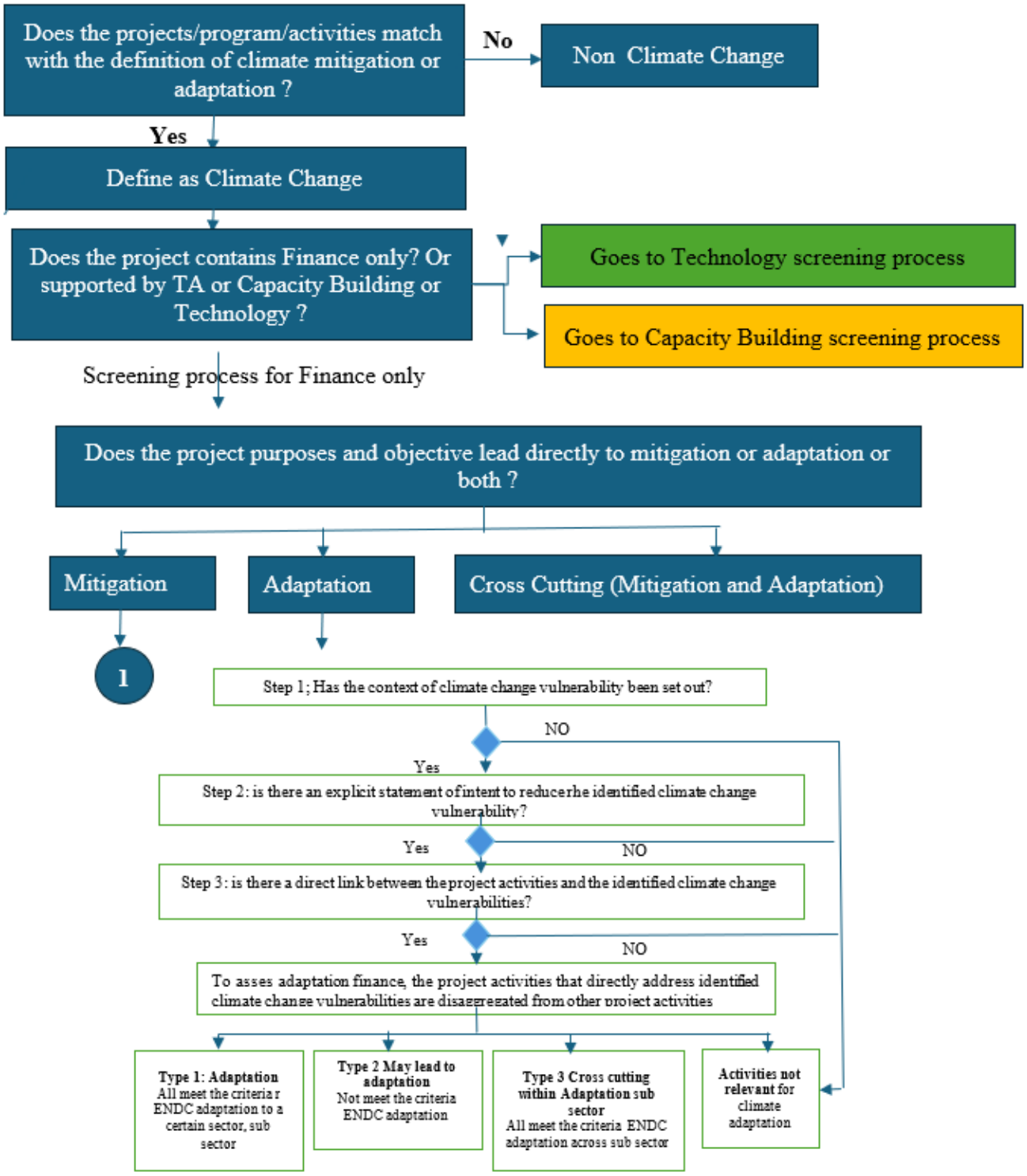
- Intensive coordination with Working Group IV led by Director of Sectoral and Regional Resources Mobilization, with participation from representatives of relevant Ministries/Agencies as members of the WG to collect data on the FTC supports needed and received during 2021-2022.
- The FTC supports needed and received are detailed in CTF tables in accordance with UNFCCC guidelines (Decision 18/CMA.1 and Decision 5/CMA.3).
- Final consultation with relevant ministries and agencies the WG concentrated on discussing the current institutional arrangements and the future directions for FTC support in monitoring, reporting, and evaluation.

The analysis is based on the following methodological assumptions and limitations:

- Focus on Public Funds: The analysis of FTC supports in BTR1 primarily centers on public funds, owing to the availability and accessibility of data.
- Private Sector Data: This report does not encompass the collection, analysis, and identification of institutional mechanisms for private sector funding.
- Stakeholder Mapping: A thorough and detailed mapping of stakeholders involved in mobilizing, receiving, and identifying FTC needs should be carried out, offering more in-depth analysis and insights in future reporting periods.
- Data Records: The International Cooperation Bureau in each Ministry/Agency usually documents data regarding the capacity-building support received. Nonetheless, the specific elements of technology that have been transferred or developed, along with the capacity-building initiatives, are frequently inadequately documented, resulting in gaps within the dataset.

5.2.6.3 Screening the FTC Support

The following screening approach is illustrated in Figure 5.8 below


Does the projects/program/activities match with the definition of climate mitigation or adaptation ?
No
Non Climate Change
Yes
Define as Climate Change
Does the project contains Finance only? Or supported by TA or Capacity Building or Technology ?
Goes to Technology screening process
Goes to Capacity Building screening process
Screening process for Finance only
Does the project purposes and objective lead directly to mitigation or adaptation or both ?
Mitigation
Adaptation
Cross Cutting (Mitigation and Adaptation)
1
Step 1; Has the context of climate change vulnerability been set out?
NO
Yes
Step 2: is there an explicit statement of intent to reducethe identified climate change vulnerability?
Yes
NO
Step 3: is there a direct link between theproject activities and the identified climate change vulnerabilities?
Yes
NO
To asses adaptation finance, the project activities that directly address identified climate change vulnerabilities are disaggregated from other project activities
Type 1: Adaptation
All meet the criteria r ENDC adaptation to a certain sector, sub sector
Type 2 May lead to adaptation
Not meet the criteria ENDC adaptation
Type 3 Cross cutting within Adaptation sub sector
All meet the criteria ENDC adaptation across sub sector
Activities not relevant for climate adaptation

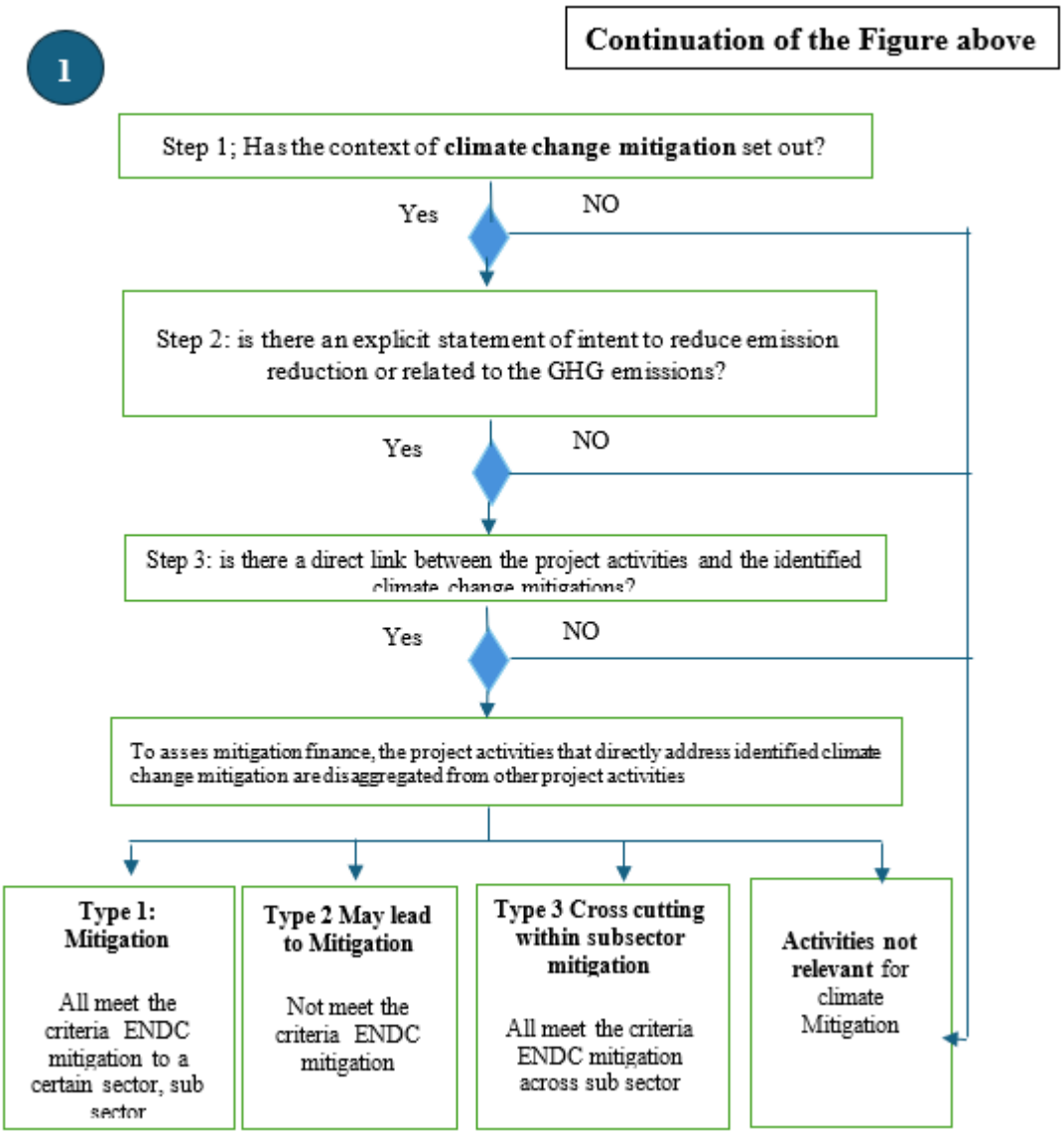


Figure 5- 8 Screening FTC support on climate change action

The screening process for technology transfer and development, as well as capacity-building, involves evaluating activity, project, or program support according to the mitigation and adaptation criteria outlined in Indonesia's ENDC activities (refer to section 5.2.1.2 for details). The information is presented in tabular format in Table 5-11.

5.3 Information on Financial Support Needed

Financial support needed are detailed in two separated table FTC, Table 6 and Table 6a. Table 6 illustrates the financial need derived from the BUR3 and the Roadmap Adaptation. The assessment of financial need for the complete implementation of Indonesia's NDC targets by 2030 and long-term climate objectives indicates that the cost of mitigation necessitates estimated financial requirements across various sectors, including energy and transportation, forestry and land use, waste, agriculture, and IPPU. To meet NDC targets by 2030, the estimated cost for adaptation is USD 816.52 million, or approximately IDR 12.84 trillion, as outlined in the NDC Adaptation roadmap aimed at enhancing economic, social, ecosystem, and landscape resilience.

Additionally, Table 6a illustrates the financial requirements for a Just Energy Transition. It includes a list of projects from the GCF Country Program Indonesia and various activities necessary to support adaptation, which are also presented in Table 6a. The GCF country program in Indonesia has indicated financial support of approximately USD 2,614.56 million for climate mitigation projects. Project agreement established to support the Just Energy Transition, amounting to approximately USD 792.26 million.

5.4 Information on financial Support Received

Indonesia received a total of USD 1,782.31 million for financial support in mitigation, adaptation, and cross-cutting multilateral sectors from 2021 to 2022. However, only 46% are significantly related to Enhanced NDC (Adaptation USD732.12 million, Mitigation USD 82.83 million and cross-cutting USD 9.89 million), while 54% may lead to ENDC with composition recorded as may lead to mitigation USD 27.76 million and may lead to adaptation USD 929.71million.

Adaptation associated with the NDC amounts to USD 732.12 million, which includes economic resilience funding of USD 514 million primarily allocated for irrigation, sustainable agriculture, and plantation initiatives totaling USD 513.42 million. A minor allocation of USD 0.95 million is designated for livelihood and community-based programs. Adaptation for ecosystem and landscape resilience allocates USD 166.70 million for integrated watershed management, USD 12.36 million for coastal zone protection, and only USD 0.02 million for ecosystem conservation and restoration. The adaptation for social resilience, amounting to USD 10.57 million, focuses on infrastructure for disaster and climate resilience.

May lead to adaptation (USD929.71million) includes provisions for basic services and infrastructure development totaling USD 797.39 million, integrated watershed management at USD 132.31 million, and disaster rehabilitation amounting to USD 107.11 million.
The total mitigation received amounts to 6%, which includes USD 47.32 million for forestry, USD 22.79 million for emission reduction in solid waste management, USD 47.32 million for engineering services related to MRT and railway capacity enhancement, USD 0.21 million for renewable energy, and USD 27.76 million for sewerage development, which may contribute to mitigation efforts.

International support from bilateral countries totals USD 200.29 million, while multilateral support amounts to USD 1,505.45 million. Additionally, support from commercial banks is recorded at USD 76.57 million. The five largest donors are the World Bank, followed by the ADB, the Asian Infrastructure Investment Bank (AIIB), Japan, and Germany. Loans constitute the predominant financial instrument, accounting for 95%, while grants represent only 5%.

1) Bilateral Support

Indonesia received in total USD 200.31million in financial support between 2021 -2022 from bilateral agreements, comprised of loan USD 176.71million, grant is only USD23.60 million with the highest contribution from JICA Japan (USD 156.82 million), followed by KfW Germany (USD 43,38 million), AFD France USD 0.09 million and Norway USD 0.02million. The highest is for adaptation on agriculture water irrigation (USD 127.19 million), mitigation

USD 54.87 million, may lead to mitigation USD 9.54million, may lead to adaptation USD2.36 million and cross-cutting USD 6.32 million.

Ministry of Public Works and Housing received the highest amount of USD164.96million were for irrigation, integrated watershed management and provision of basic services and infrastructure development. Ministry of forestry for forest program USD 19.57million, Ministry of Industry for technical assistance USD 3.16million, Ministry of Transportation USD 12.51million, National Research and Innovation Agency USD 0.09million for multipurposes research vessels. And BPDLH USD0.02million FOLU cooperation with Norway.

2) Multilateral Support

The total financial support derived from multilateral agreements amounted to USD 1,505.43 million. The IBRD World Bank Group contributed the most, with USD 751.92 million, followed by the ADB at USD 479.52 million, and the AIIB at USD 216.82 million. From the multilateral support, USD 1,446.97 million was provided in the form of a concessional loan, while the rest in the form of grants USD 58,46 million. The loan was used to finance the adaptation sector (USD 529.80 million) for economic resilience USD397.36 million, ecosystem and landscape resilience USD122.89 million, social resilience USD9.55 million. May lead to adaptation (USD 899.64 million) comprised for DAM operational USD132.31 million, provision of basic services and infrastructure development project USD 660.22 million and disaster rehabilitation USD107.11 million. May lead to mitigation USD 14.62 million and cross-cutting USD 2.90 million.

In summary, the grants allocated were primarily for forestry (USD 27.73 million), followed by energy (USD 0.21 million), and cross-cutting initiatives (USD 0.66 million). Adaptation for livelihoods and economic resilience received USD 2.16 million, while adaptation efforts totaled USD 27.70 million, predominantly for basic health provisions within the Pamsimas project. The cross-cutting component includes technical assistance from the World Bank to IEF/BPDLH, amounting to USD 0.66 million.

The Ministry of Public Works and Housing received the largest allocation of USD 1,307.25 million, followed by infrastructure development, which included the Ministry of Public Works, Ministry of Agriculture, and Ministry of Home Affairs with USD 72.91 million. The Ministry of Transportation was allocated USD 36.05 million for emergency assistance related to the reconstruction of transport infrastructure affected by hydrometeorological disasters. Ministry of Agriculture allocated USD 34.82 million for integrated farming systems and agricultural development; Ministry of Forestry involved. USD 23.58 million was allocated to the BioCarbon Fund Initiative for Sustainable Forest Landscapes (BioCF ISFL) Trust Fund, specifically for community-focused investments aimed at addressing deforestation and forest degradation. The FIP is focused on promoting sustainable community-based natural resource management and institutional development through the Forest Program VI, which aims to protect mangrove forests and strengthen social forestry initiatives in Indonesia. Meteorological, Climatological, and Geophysical Agency allocated USD 9.55 million for the Indonesia Disaster Resilience Initiatives Project (IDRIP). The National Research and Innovation Agency received USD 2.9 million, while IEF/BPDLH was granted USD 5.82 million for the Community-Based

Program. Dana TERRA, Project Mangrove for Coastal Resilience (M4CR) Grants; Sustainability Energy Fund - Solar Panel Incentive (Global Environmental Facility); Sustainability Energy Fund (SEF) - Solar Panel Incentive (Global Environmental Facility); UNDP GCF REDD+ Result-based Payment - Green Climate Fund; World Bank Technical Assistance.

3) Commercial Banks or Other Financial Institutions

Indonesia obtained financial assistance through non-concessional loans from Natixis Banque France, Exim Bank of China, and Exim Bank of Korea. The commercial loan amounted to USD 71.97 million and was allocated for financing the adaptation sector, specifically focusing on ecosystem and landscape resilience. The allocation of USD 45 million, with USD 27.97 million designated for cross-cutting initiatives, is intended for BMKG climate weather services and the meteorological information system. The development of a sewerage system in the Batam Islands, with an investment of USD 3.6 million, may facilitate waste mitigation.

5.5 Information on Technology Development and Transfer Support Needed

Indonesia necessitates the advancement and dissemination of technology to effectively tackle climate change. The nation possesses significant renewable energy potential, encompassing solar, geothermal, wind, and hydropower, which can be utilized to mitigate greenhouse gas emissions. To attain the goal of a 23% energy share by 2025, Indonesia must enhance its policies and technological advancements, particularly regarding electricity transmission lines, grids, and the approval processes for renewable energy projects.

Indonesia must encourage the adoption of energy-efficient technologies and practices within energy-intensive industries, including cement, steel, and manufacturing, as well as the expanding construction sector. The country seeks to achieve a 70% reduction in marine plastic debris by 2025 in the waste sector, necessitating the development and implementation of waste reduction technologies and waste management infrastructure. Emerging initiatives in the agriculture sector pertain to CSA. Smallholder farmers in Indonesia require assistance to implement CSA technologies, including precision farming, drought-resistant crops, and efficient irrigation systems. Enhancing climate data management and monitoring is essential, especially in rural and remote regions. Effective climate action requires accurate data for monitoring emissions, assessing climate impacts, and evaluating the effectiveness of mitigation and adaptation strategies.

Indonesia has conducted a TNA twice: the first in 2010, which focused on climate change mitigation, and the second in 2012, addressing both mitigation and adaptation to the impacts of climate change. Considering evolving circumstances and the NDC targets, in 2017, Indonesia launched an initial study on Capacity Building and Technology Needs Assessment (CBTNA). In 2023, the country developed a roadmap outlining the Means of Implementation for the Indonesian Enhanced Nationally Determined Contribution (ENDC) for 2023-2030. This

roadmap provides details on the transfer and development of climate change technology and outlines capacity-building efforts for climate change mitigation and adaptation.

Information gathered regarding technological requirements focuses on addressing climate change by transitioning to cleaner, sustainable energy systems, improving energy efficiency, and encouraging the adoption of renewable energy sources. Mitigation in the energy (including transportation) and industry (IPPU) sectors necessitates a broader spectrum of technology transfer and development compared to other sectors. The predominant technological requirements in IPPU sectors are classified as being at the expansion stage rather than the initiation of new technology. Sectoral consultations have identified technological needs for the period 2025-2030, which include, but are not limited to, the following:

- Generation of new and renewable energy: emphasizing the development and enhancement of current renewable energy sources including solar power (PLTS), hydropower (PLTA), and mini hydro.
- Cleaner transportation: Reducing emissions from transportation by promoting the use of electric vehicles powered by renewable sources including solar charged electric vehicle systems. In addition to reducing dependence on fossil fuel, EVs also contribute to energy efficiency, as they typically operate with greater efficiency than conventional internal combustion engine vehicles.
- Policies and regulations aimed at enhancing energy efficiency in industrial process, such as the creation of boiler optimization guidelines or the development of technology catalog to facilitate decision making in the adoption of renewable energy within industrial process.
- Improve energy security: Transitioning to domestically produced renewable energy reduces dependency on imported fossil fuels.
- Improvement of agricultural emission calculation tools necessitates the facilitation of satellite utilization for MRV, as well as the implementation of emission calculators and eddy covariance equipment
- Improvement of technology is essential to achieve NDC in the agriculture sector. This includes advancements in sustainable intensification practices, the development of high-yield and low-emission crop varieties, balanced fertilizer application, soil fertility restoration, manure management, enhancement of grassland productivity and feed quality for livestock, and increasing Carbon Stock from horticulture and estate crops.
- Improvement of technology is essential to achieve NDC in the waste sector, including domestic solid waste management. Key technologies include sanitary landfills with LFG recovery, semi-aerobic landfills with LFG recovery, in-vessel composting, open window composting systems, low and high solid biodigesters, and MBT. Gasification technologies include vertical fixed bed and fluidized bed systems. Pyrolysis technology encompasses fluidized bed systems for the aerated, centralized treatment of domestic liquid waste, as well as industrial waste through thermal conversion methods, including mass-fired combustion, RDF-fired combustion, and fluidized bed combustion.

- Improvement of technology for adaptation, including the application of technological innovations and social-environmental safeguards in ecosystem restoration in regions impacted by climate change; Establishment of an online health database across Indonesia and provision of internet support. Technological advancements for the swift identification of Malaria and Dengue cases.

The lack of comprehensive information regarding endogenous capacity and technology in this report (BTR1) is attributable to the restricted data present in country documents, especially concerning TNAs. The absence of specific requirements in the TNA process to incorporate endogenous capacity and technology elements exacerbates this issue. The necessity of these requirements for enhancing the TNA process is significant.

In conjunction with international support, Indonesia is actively advancing indigenous technologies to combat climate change, including research and development of drought-tolerant rice varieties and the application of local planting patterns.

The primary objective of these initiatives is to foster economic growth and facilitate job creation. Investments in renewable energy and energy-efficient technologies can stimulate economic growth and generate employment in sectors such as manufacturing, research and development, infrastructure development, and maintenance.

5.6 Information on Technology Development and Transfer Support Received

In 2023, MoEF has created the Roadmap of NDC Means of Implementation 2023 – 2030 (Book II on Technology) to function as an operational guide and strategy for Technology Transfer and Development (TTD) in accordance with NDC targets. The roadmap delineates the current status of technological development and implementation across each sector related to mitigation and adaptation resilience targets. Some technology is also derived from international support. In the bilateral consultations and FGDs with sectoral ministries, the list of technology supports from other data sources, BR4 and BR5 of Annex Countries, was neither validated nor confirmed.

The analysis of technology support data from the Ministry of Finance Grant Pocket Book (2016-2023) and the Fiscal Agency-Ministry of Finance Grant Pocket Book (2023) indicates that the predominant focus of international technology support is on mitigation or a combination of mitigation and adaptation categories. The supports focus on reducing carbon emissions, enhancing energy efficiency, and fostering sustainable infrastructure. Below is the summaries of key technological initiatives, organized according to the Roadmap of NDC Means of Implementation for the period 2023 – 2030 (Book II on Technology). Technology status in each mitigation sector and resilience target is outlined in the document:

1) **Research**; The basic principles of the technology are undergoing observation, formulated, and subjected to proof-of-concept processes.

2) **Development**; The technology is currently undergoing validation within a laboratory setting, and the prototype is being showcased in an operational environment.
3) **Implementation**; The technology prototype is currently demonstrated within an operational environment; the actual technology has been successfully implemented in an operational environment.
4) **Expansion**; The technology is accessible for consumer use.

Table 5- 6 Summary of technology received status

Type of Technology and Title of Activity	Status and Description*
Type of technology: solar ice maker Title of activity: Solar Ice Maker Pilot Project	Status: Implementation Description: This project accelerates the use of renewable energy by employing solar technology to produce ice, which is crucial for preserving perishable goods, especially in remote areas. The successful deployment of this technology demonstrates its viability in reducing reliance on fossil fuels and enhancing energy efficiency in food supply chains.
Type of technology: PV boat Title of activity: Photo Voltaic Boat Pilot Project	Status: Implementation Description: This project involves the development of electric boats powered by solar energy and the establishment of solar-powered charging stations. It promotes sustainable transportation and reduces emissions in maritime activities, which are critical for Indonesia's extensive archipelagic geography.
Type of technology: Remote Monitoring System (RMS) Title of activity: Installation of RMS at Rooftop PLTS DKI Jakarta Province	Status: Implementation Description: This system enhances the monitoring capabilities of rooftop solar power installations, ensuring optimal performance and efficient energy management. It contributes to the overall effectiveness of solar energy utilization in urban settings.
Type of technology: Solar PV Title of activity: Solar PV Testing	Status: Implementation Description: Testing focuses on performance and efficiency metrics, which are essential for maintaining high standards in renewable energy deployment.
Type of technology: Cold Storage Title of activity: Monitoring and Evaluation of Rooftop Solar Power Plant for Cold Storage	Status: Implementation Description: This project reviews the implementation of rooftop solar systems for cold storage facilities, offering recommendations for improvement. It underscores the importance of integrating renewable energy solutions in sectors critical to food security.

Type of Technology and Title of Activity	Status and Description*
Type of technology: Solar energy Title of activity: Feasibility Study on PLN Solar Replacement Project	Status: Research Description: This study supports the transition to a cleaner energy system by evaluating the potential for solar energy replacement in existing PLN infrastructure. It reflects Indonesia's commitment to enhancing its energy mix and reducing carbon footprints.
Type: Solar ice maker Title of activity: Replication of Solar Ice Maker Pilot Project in Kawa, Maluku	Status: Implementation Description: Replicating the Solar Ice Maker technology that was launched in 2022, with improvements in several aspects, especially from the business side.
Type: forest monitoring system Title of activity: Strengthening Indonesian Forest and Land Monitoring for Climate Actions	Status: Implementation Description: Strengthening technical capacity and institutional coordination for sustainable and appropriate IHN and NFMS in accordance with current and future developments to meet the needs of forest management decision-making in Indonesia.
Type: Web-based spatial data portal Title of activity: Improving and updating the national mangrove map	Status: Implementation Description: The GoI is working with the World Bank to implement the Mangroves for Coastal Resilience (M4CR) program. IPSDH directorate in MoEF support Project Implementation Unit MoEF in Sub-Component 1.2 (Improving and updating the national mangrove map), which include (a) Identification and inventory of mangrove data, (b) design and implementation of a web-based spatial data portal, (c) Improvement of institutional capacity in mapping mangroves and provision of related infrastructure; (d) generation and dissemination of data and mapping products.
Type of technology: Forest monitoring (MRV) Title of activity: Management and program monitoring to measurement and program reporting	Status: Implementation Description: FCPF Carbon Fund 2021-2025 has 5 activities, including Program Management and Monitoring. IPSDH's main objective is to improve emission factors and activity data, including forest and land cover, and capacity building.

Type of Technology and Title of Activity	Status and Description*
Type of activity: LED lamps Title of activity: Advancing Indonesia's Lighting Market to High-Efficient Technologies (ADLIGHT)	Status: Expansion Description: This initiative prepares energy performance standards for LED lamps, promoting the adoption of high-efficiency lighting technologies. It plays a vital role in reducing energy consumption and associated emissions in urban and rural lighting applications.

These projects demonstrate effective technology transfer and deployment but also faces some challenges regarding the validation and quantifiable impacts of international support:

1. Opportunity for Enhanced Monitoring and Evaluation: The absence of specific, quantifiable data on impacts such as CO_2 reduction or energy savings in project documentations highlights an opportunity to enhance the monitoring and evaluation framework. Indonesia will set clear, measurable targets to enhance the demonstration of the effectiveness of technology deployment.
2. Potential for Strengthened Technological Partnerships: The international collaborations identified in BR4 and BR5 from Annex Countries have not yet been fully validated or confirmed, underscoring the potential to enhance these technological partnerships. Engaging in additional dialogue and aligning expectations can facilitate the effective implementation of documented support in Indonesia.

5.7 Information on Capacity Building Support Needed

The ENDC indicates that capacity building on climate change in Indonesia has been undertaken by government entities, NGOs, private institutions, and international organizations. Nonetheless, the collection of comprehensive data and information regarding the scope, progress, experiences, and lessons learned from these initiatives presents a considerable challenge due to the absence of a specific monitoring mechanism. Consequently, assessing gaps and needs proves challenging. A monitoring mechanism is essential to facilitate future reporting.

A national level capacity gaps and needs assessment was conducted in 2018, focusing on two pillars of Indonesia's First NDC: (i) Implementation strategy; (ii) Implementation concept. The assessment covered two levels of capacity, system and institution. The identified gaps pertain to the development of ownership and commitment programs, as well as the limited integration of climate change issues into the planning phase at planning phase and dominantly focus on institutions under MoEF. The limited ownership and commitment of institutions outside the MoEF resulted in inadequate connectivity and coordination, hindering comprehensive measures to tackle climate change.

Identification of capacity-building needs in this report is also grounded in the recent National Medium-Term Development Plan (RPJMN) and sectoral consultations. Relevant needs for adaptation measures and the enhancement of social, livelihood, and economic resilience include the following:

- In agriculture, Indonesia will enhance the capacity of extension workers to address climate impacts, foster resilience, and reduce emissions from agricultural practices. Enhancing existing EWSs and creating digital tools for real-time climate impact assessment will be of great significance.
- In the ecosystem and environmental restoration sector, Indonesia will concentrate its capacity-building initiatives in the ecosystem and environmental restoration sector on peatland and forest rehabilitation, while also implementing innovative technologies for ecosystem monitoring and protection. This will aid in the preservation and restoration of essential natural assets.
- In health sector, Indonesia will strengthen its capabilities in improving the quality of surveillance data and managing climate-sensitive diseases, such as dengue and malaria, especially in remote and climate-vulnerable areas. Collaboration and strategic alliances will be crucial for advancing the development of vaccines and other solutions.
- In water resource management, Indonesia will focus on capacity-building initiatives to improve the management of irrigation systems, restore forests for water conservation, and encourage sustainable water use practices. This will enhance the effectiveness and resilience of water resource management.
- For disaster resilience, Indonesia will enhance disaster resilience by investing in community-level training, facilitating knowledge exchange, and promoting learning on disaster risk reduction (DRR). Furthermore, improving communication infrastructure and EWSs for hazards like strong winds in at-risk areas will bolster overall disaster preparedness.
- In climate services, Indonesia will establish educational and training initiatives focused on improving climate literacy, maximizing the use of EWSs, and expanding field schools for agricultural and fishing communities.

However, for adaptation, no specific inputs from experts and sectoral consultation on timeline of these needs (short, medium, or long term).

Relevant needs for technical knowledge in mitigation include energy planning, hydrogen development, and certification for low-carbon technologies, with anticipated timelines spanning from 2025 to 2030. The projects are associated with ministries, including the Ministry of Energy and Mineral Resources (MoEMR), and pertinent SOEs such as Pertamina. In all other sectors, Indonesia sees an urgent necessity to: :

- **Technical capacity for emission monitoring and analysis**: Establishing country-specific EFs, estimating precursor gases, identifying sources, and understanding uncertainties in AD.

- **Technical and institutional capacity to access climate finances**: Ensuring government access to climate finance resources, especially for local authorities, including drafts of funding proposals and project plans.
- **Data sharing and institutional strengthening**: Enabling continuous data exchange among ministries for an integrated system that links GHG inventories, mitigation, adaptation, and implementation. This system would improve accuracy and timeliness in national reporting for the BUR, BTR, and National Communications.

5.8 Information on Capacity Building Support Received

Aligned with Indonesia's ENDC, capacity building is implemented through two interconnected instruments: the General Instrument and the Technical Instrument. The General Instrument aims to establish a comprehensive foundation by integrating climate change into the national education, training, and capacity-building framework. This entails raising public awareness, improving information accessibility, engaging stakeholders, and promoting collaboration across multiple levels. The Technical Instrument aims to develop targeted capacity-building programs for institutions and individuals engaged in climate change mitigation and adaptation efforts. This is essential for addressing the technical and practical components of the ENDC. Refer to Figure 5.9 below for a summary of the received capacity-building categories.

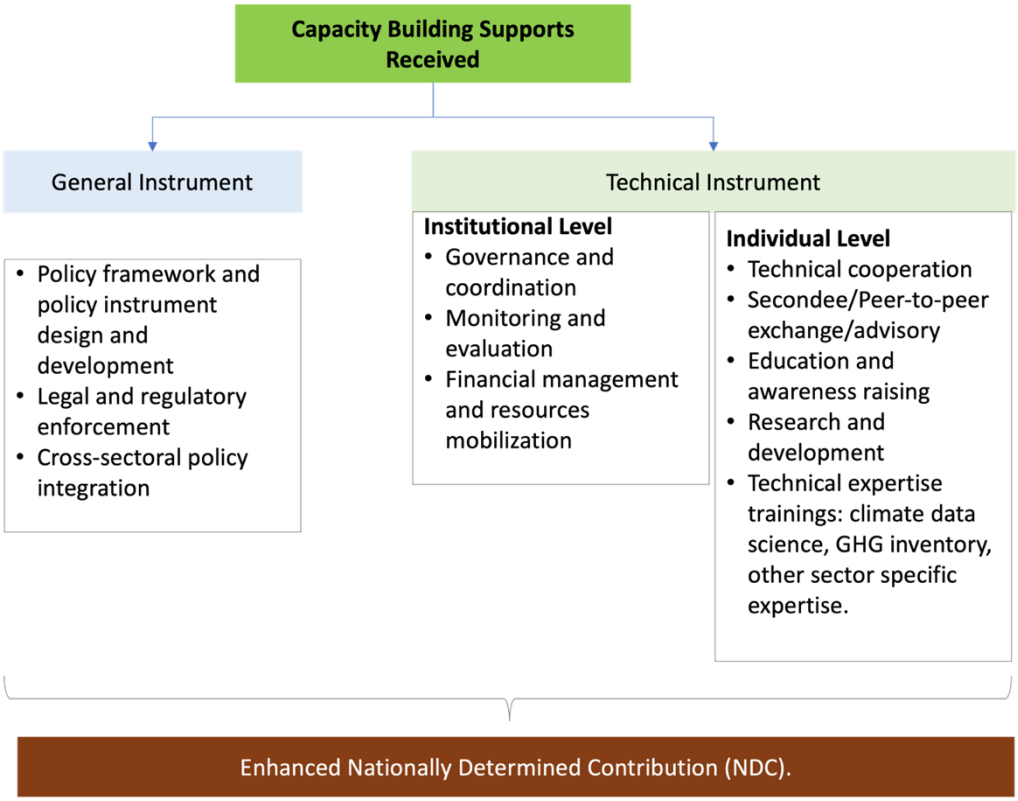


Figure 5- 9 Received capacity building categories

Policy Design and Development: Indonesia has established various policies and regulations at the policy level that pertain to climate change mitigation and adaptation:

- **Policy framework and instrument:** This includes international workshops and sharing sessions on policy design, supports for development of social forestry policy and

framework, and framework for translating national low-carbon plans into sub-national planning.

- **Legal and regulatory context:** This support seeks to ensure that laws and regulations are enforceable and consistent with international commitments as well as national circumstances.
- **Cross-sectoral policy integration:** Capacity-building initiatives from 2021 to 2022 focused on enhancing the communication framework for disaster risk management.

Received supports for institutional strengthening:

- Establishing institutional frameworks: Data from 2021 to 2022 indicated that no specific supports received at the ministry level were identified for the establishment of a new structural framework, such as the formation of a working group. However, several supports involve the establishment of an institutional framework, including a cross-sectoral mechanism for GHG Inventory.
- Governance and coordination: supports exist to improve the governance structure in greenhouse gas inventory reporting and facilitate sectoral coordination.
- Monitoring and evaluation: encompass capacity building for establishing M&E frameworks, including the development of the National Registry System (SRN) and the Information System of Vulnerability Index (SIDIK)
- Financial management and resources mobilization: This include training in climate-responsive budgeting, financial planning for mitigation and adaptation, understanding the requirements of international climate funds (e.g., Green Climate Fund), developing bankable project proposals, and leveraging both public and private finance for climate initiatives.

Received supports for individual capacity development:

- Technical skills development: This includes technical cooperation, secondee, peer-to-peer exchange, and seminar relevant to development of regulations and policies as the main function of the institutions. Also, technical capacity building on climate science and data analysis, GHG inventories, and sector-specific knowledge such as renewable energy technologies, sustainable agriculture concept and practices, forest management, and other relevant topics. Data of other training and capacity building for individuals at national level, is traceable at BPSDM and relevant directorate at each ministry while at local and project implementation level the data still need further tracking. Project names are recorded in the ministries but details on the impact, results, and implementation are available at direct beneficiaries such as local institutions, field management level, or communities.
- Education and awareness-raising: There are supports to promote education and awareness-raising on climate change especially to community level.
- Research and development: International partners have been providing opportunities for individuals to engage in research and development on climate change. As an example, government officials are often sent abroad (exclusively with international supports funds

or with state budget) for the period of one to six months to participate on research and development of technologies at foreign institution relevant to climate change mitigation and adaptation efforts in Indonesia.

The majority of capacity-building supports received in Indonesia are focused on policy design and development (the proportion is around 57%), reflecting the primary functions of ministries and agencies (Figure 10 A). This is likely due to data collection currently being focused on public funds and government-led activities. Further detailing could reveal additional technical capacity supports at the individual level, currently estimated at only 12% of total support, but likely higher with complete data from private and NGO-led initiatives. Also, this proportion can be a lot higher once government data is further detailed to list of activities at Echelon 2 level.

Supports have largely been directed toward adaptation (51%), followed by mitigation (28%) and cross-cutting areas (21%) (Figure 10 B). Additional reporting is required to fully capture the extent of these supports, especially Indonesia as a major forested nation, continues its global climate change mitigation commitments. Actual supports for mitigation might be a lot higher than 28%.

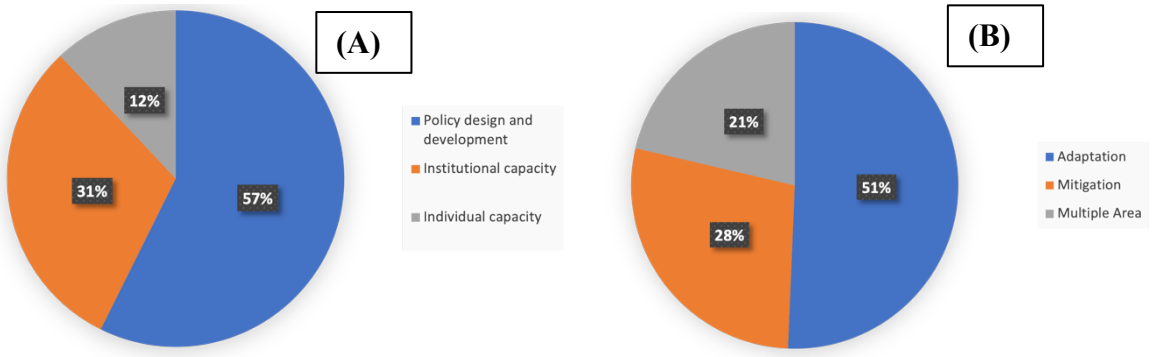


Figure 5- 10 (A) The proportion of type CB supports received by category and (B) type of CB supports

Among the capacity-building supports received, one notable success is the continuous assistance provided at sub-national level through the Pre-Investment for the BioCarbon Fund Initiative for Sustainable Forest Landscapes in Jambi Province. Ministry of Environment and Forestry, worked closely with provincial and district governments to reduce GHG emissions in land-use sectors. Additionally, there was also Community Movement on Forest and Land Fire Prevention project where MoEF engaged community-level stakeholders in priority provinces (Riau, West Kalimantan, and Central Kalimantan) to mitigate GHG emissions from forest degradation, enhance peatland management, and strengthen community resilience to climate change.

5.9 Information on Support needed and received by developing country Parties for the implementation of Article 13 of the Paris Agreement and transparency-related activities, including for transparency-related capacity building

(a) Preparation of reports in accordance with Article 13 from GEF requires approximately USD 4.75 million (see Table 12). Support received is not reported for the period of 2021 and 2022, as there is no grant realization documented (see Table 13).

The support from GEF under (1) Project Fourth National Communication and Fourth BUR to the United Nations Framework Convention on Climate Change (UNFCCC) and Project (2) Strengthening the Capacity of Institutions in Indonesia to comply with the Transparency Requirements of the Paris Agreement (CBIT) will be reported based on realization of grant occurred in the time period 2023 – 2024 (Table 12)

(b) Support is required totaling approximately USD 14.10 million to address the areas for improvement identified by the technical expert review teams, as outlined below:

- Institutional Mechanism for Climate Transparency
- Strengthening the commitment of Party and Non-Party Stakeholders
- Institutions and Policies
- Implementation of Transparency Framework in fulfillment of NDC progress tracking
- Implementation of Transparency Framework in climate change adaptation
- The development and establishment of robust systems for GHG Inventory, and to MRV emissions in compliance with the Paris Agreement
- Lesson Learned and Sharring Experience for the Transparency Framework under article13
- Data Collection Systems
- Developing local emission factor for key categories
- Annual operation and maintenance of advanced MRV
- Expansion to Include Co-benefits

No grants or loans can be reported as support for addressing transparency-related activities, including capacity-building efforts, during the periods of 2021 and 2022

5.10 Other Information

International Climate Fund in Indonesia

Despite of bilateral countries support for climate change for Indonesia, there are several international climate funds operating in Indonesia which Indonesia as NDA in Ministry of Finance for GCF and NFP in Ministry of Environment and Forestry for the GEF and Adaptation Funds. The climate finance flows from GCF, GEF and AF can be reported in BTR if the Implementing Partners received and report to Government of Indonesia through BAST followed the mechanism of PP No 10/2011. In the meantime, flows to private sectors and other institutions as well as regional project is excluded in this BTR1.

GCF Indonesia

In Indonesia discussions propose that the GCF funds will be counted as contributions to achieve the unconditional emissions reduction (29%) target only when they are received as loans. When the GCF fund is received as a grant, it could contribute to the achievement of the conditional emissions reduction (41%) target. Within period 2021 and 2022 support from GCF identified (i) Indonesia Geothermal Resource Risk Mitigation Project USD 100million Reporting mechanism follows loans and grants mechanism procedure of Government Regulation No 10 of 2011 and reporting Direct Grant; (ii) Indonesia REDD-plus RBP for results period 2014-2016 USD 103.78million reporting mechanism recorded as Non-Tax Revenue (PNBP), follows the procedure of Government Regulation 74/2012; (iii) Supporting Innovative Mechanisms for Industrial Energy Efficiency Financing in Indonesia with Lessons for Replication in other ASEAN Member States USD105 million accredited entity KDB channeled to the private currently the system to capture flows to private sector is not available yet.

Meanwhile for GCF Regional project, it is hard to measure how much allocated for Indonesia specifically through which Line Ministries that the regional project will be performed the activities. If the regional project using instrument loan, it has to be follows the mechanism of managing loan through Ministry of Finance administration and the Ministry of National Development Planning - Bappenas administration regulated under Government Regulation 10/2011. If the regional project using instrument grant, the line ministries who receipt this grant has to follow the procedure of managing and reporting grant. If planned grants, it has to be planned one year before, if it is direct grants, the line ministries could report at the end of cycle year through BAST.

Adaptation Fund (AF)

The Adaptation Fund provides financial support for projects and programs aimed at assisting vulnerable communities in developing countries in their adaptation to climate change. Initiatives are grounded in the specific needs, perspectives, and priorities of each country. Since 2010, the AF has allocated more than 1.2 billion for climate change adaptation and resilience initiatives, encompassing 176 specific, localized projects in the most vulnerable communities of developing countries globally, benefiting over 45 million individuals in total. It pioneered Direct Access and Enhanced Direct Access, enabling countries to obtain funding and develop local projects directly via accredited national implementing entities. Within period 2021 and 2022 gap climate finance flows from AF identified for adaptation (i) coastal marine: project Safekeeping-Surviving-Sustaining toward Resilience: 3S Approach to Build Coastal City Resilience to Climate Change Impacts and Natural Disasters in Pekalongan City, Central Java Province USD 547.992 for 2021-2023 (ii) Community Adaptation for Forest-Food Based Management in Saddang Watershed Ecosystem USD 547.992.

Global Environment Facility (GEF)

Within the period of 2021-2022, gap identified that some climate finance flows were for Market Transformation through Design and Implementation of Appropriate Mitigation Actions in Energy Sector (MTRE3), flow to private, grants USD 8.03 million; IBRD Geothermal

Energy Upstream Development Project, flow to private, grants USD6.25million; Sustainable Management of Peatland Ecosystem in Indonesia (SMPEI), flow to public sub-national, grants USD1.04million; Enhancing Readiness for the Transition to Electric Vehicles in Indonesia (ENTREV), flow to public, grants 1.82 million.

CHAPTER VI
INFORMATION ON FLEXIBILITY

6.1 AREA OF FLEXIBILITY

6.1.1 GHG INVENTORY

The GHG Inventory implemented flexibility in four areas: (i) Completeness, (ii) Types of greenhouse gases, (iii) Time series, and (iv) Quality Assurance and Quality Control.

a. Completeness

The application of flexibility involves defining insignificant sources as those contributing less than 0.1% to the national total GHG emissions (without LULUCF) or 1,000 kt CO_2 equivalent, whichever is lower. Additionally, the total emissions from these insignificant categories must be less than 0.2% of the national total GHG emissions (without LULUCF). A total of 34 source/sink categories are designated as "NE, potentially indicating insignificance (Table 6.1). However, there are categories for which no data is currently available to ascertain their significance.

Table 6- 1 Not estimated (NE) source categories

Code and Source/Sink Categories	Type of gases
1.A.1.c.iii. Others Energy Industries	CO_2, CH_4, N_2O
1.B.1.c. Fuel transformation spontaneous combustion & burning coal dump)	CO_2, CH_4, N_2O
2.F.1. Refrigeration and air conditioning	HFC & PFC
2.F.2. Foam blowing agents	HFC & PFC
2.F.3. Fire protection	HFC & PFC
2.F.4. Aerosol	HFC & PFC
2.F.5. Solvent	HFC & PFC
3.C.12. Emission from Aquaculture	N_2O
3.C.13. Emissions from Rewetted and Created Wetlands	CH_4
3.D.1.c. Urine and dung deposited by grazing animals	N_2O
3.D.1.e. Mineralization/immobilization associated with loss/gain of soil OM	N_2O
3.I. Other carbon-containing fertilizers	CO_2
4.A.2. Land converted to forest land*	CH_4, N_2O
4.B.2. Land converted to cropland*	CH_4, N_2O
4.C.2. Land converted to grassland*	CH_4, N_2O
4.D.1. Wetlands remaining wetlands	CO_2, N_2O
4.D.2. Land converted to wetlands*	CH_4, N_2O
4.E.1. Settlements remaining settlements	CO_2, CH_4, N_2O
4.E.2. Land converted to settlements*	CH_4, N_2O
4.F.2. Land converted to other land*	CH_4, N_2O

Note: *GHGs emissions from FOLU which are not estimated are only emissions from fire on land converted to other land categories. The IPCC only calculates emissions from fire only on land that remains in its original categories.

b. Type of Greenhouse Gases

The application of flexibility involves the exclusion of HFCs, PFCs, SF6, and NF3. Indonesia's GHG Inventory encompasses carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and perfluorocarbons (PFCs). The inventory includes NOx, CO, SOx, and NMVOC, which are released both directly and indirectly from biomass combustion during grassland and forest fires, as well as from the burning of dead organic matter (DOM), open burning of waste in landfills, incinerators, and fossil fuel combustion. These gases are classified as precursors and are excluded from the national GHG Inventory estimates. The estimation of emissions of these gases should employ a higher tier, which presents challenges in implementation. The emission of these gases is deemed negligible and, consequently, is not included in the national GHG Inventory.

c. Time Series

The application of flexibility to time series does not reflect the emissions data from 1990. The inventory offers only an estimation of emissions from 2000 to 2022.

d. QA/QC

The application of flexibility in QA/QC lacks a detailed process for conducting QA/QC for the GHG Inventory as outlined in the 2006 IPCC GL. The Directorate General of Climate Change Control, operating under the MoEF in Indonesia, oversees the coordination, execution, and management of quality assurance and quality control for the GHG Inventory.

6.1.2 Area of Flexibility Applied for Tracking Progress

In tracking the progress of mitigation policies and measures, certain flexibilities in reporting are adopted which exclude information on (i) the economic and social impacts of response measures, (ii) costs, non-GHG benefits, and interactions among policies and measures, (iii) mitigation co-benefits associated with adaptation actions, and (iv) incorporation of non-GHGs indicators to track some progress.

6.1.3 Area of Flexibility Applied for Reporting FTC

Indonesia provides a report on the financial, technology transfer, and capacity building support required and received in accordance with Articles 9, 10, and 11 of the Paris Agreement, adhering to the MPGs specified in Decision 18/CMA.1. The supports identified within BTR1 are primarily focused on government-managed systems, excluding those received by NGOs and the private sector. This leads to a substantial data deficiency. No mechanism is currently in place to report and document direct support that international entities provide to private sectors and NGOs in order to address climate change. Furthermore, the components in the Common Tabular Format Tables remain incomplete and necessitate additional development. Similarly, the data on provided and mobilized supports is not presented in full detail as requested in Chapter IV of BTR due to the limited data and information available at this time.

6.1.4 Adaptation

All elements recommended for reporting in relation to adaptation, as outlined in Decision 18/CMA.1, are included to the fullest extent feasible.

6.2 Capacity Constraints

Many categories remain unestimated due to a lack of available data. The institutions responsible for data collection have not been identified. Support may be necessary to address these capacity constraints, given the lack of guidance and resources for this process.

6.3 Plan for Improvement

The plan for improvement aimed at reducing and eliminating the use of the area of flexibility has not been thoroughly evaluated. A number of improvement plans have been identified and are outlined in Table 6.2.

Table 6- 2 Summary of area of flexibility for GHG Inventory

No	Area of Flexibility Being Applied	Challenges and Plan for Improvement	Estimated Timeframe
A	GHG Inventory		
1	Completeness	The government is in the process of evaluating emissions from source categories currently reported as NE. This evaluation aims to determine the significance of these sources and prioritize future data collection efforts. To enhance the GHG Inventory, an assessment to identify data sources and establish a centralized entity for systematic data collection and management will commence in 2025. During the interim period, in the absence of activity data, Indonesia will utilize innovative methods to generate preliminary emission estimates. These may involve utilizing data from neighboring countries with similar conditions to Indonesia or employing expert judgment, ensuring a comprehensive and thorough inventory.	2025-2028
2	Quality assurance/quality control	The advancement of the QA/QC system in accordance with the IPCC 2006 GL will commence in	2025-2028

No	Area of Flexibility Being Applied	Challenges and Plan for Improvement	Estimated Timeframe
		early 2025 to established the mechanism for implementing quality assurance and quality control.	
3	Reporting of HFCs, SF6 and NF3	The reporting of the emissions of the three fluorinated gases is scheduled for January 2029. The F Gases and alternative products utilized as substitutes for ODS encompass the following: Refrigeration and air conditioning (2.F.1); foam blowing agents (2.F.2); fire protection (2.F.3); aerosol (2.F.4); solvent (2.F.5); and other product uses as substitutes for ODS (2.F.6).	2029
4	Time series	The process for collecting AD from 1990 will be established in the forthcoming years, encompassing the development of methods and approaches for generating historical data.	2026-2028
B	Tracking Progress of mitigation		
1	Economic and social impacts of response measures	A comprehensive assessment of the economic and social impacts of mitigation will be conducted for key sectors, contingent upon resource availability.	2028
2	Cost, non-GHG benefit as well as interaction among PaM,	A thorough study and consultation with relevant parties to collect this information will be undertaken in the coming years, contingent upon resource availability.	2028
3	Mitigation co-benefits of adaptation actions		2028
C	Tracking Progress on FTC received and needed		
1	Data on financial support received	Channeled to private investment, focusing on climate mitigation, adaptation and resilience.	2028
		Identification of public financial instrument (beyond loans and grants) and private financial instruments.	2028
2	Institutional arrangements and mechanisms for reporting	Mechanisms and a clear arrangement of institutions will be established to reduce the disparity in support received from international climate finance entities such as the GCF, GEF, AF, private sectors, and other relevant organizations.	2026 - 2028
3	Detailed information on Expected Use, Impact, and Estimated Results in CTF table	To enhance the reporting and transparency, Indonesia is proactively planning a	2026-2028

No	Area of Flexibility Being Applied	Challenges and Plan for Improvement	Estimated Timeframe
		comprehensive study and stakeholder consultation process. This initiative, scheduled to commence in 2026, will focus on collecting detailed information on the expected use, impact, and estimated results for the common tabular format (ctf) table.	
4	Financial needs estimation	Improvement of estimating finance need methodology for all sectors categories.	2026-2028
5	Capacity building and technology needs	Indonesia recognizes the importance of continually evaluating and addressing our evolving needs in finance, technology, and capacity building. An in-depth study and intensive consultation with relevant parties will be conducted to assess needs.	2026- 2028
6	Data accessibility	Indonesia acknowledges the importance of comprehensive data across all sectors, encompassing private institutions and NGOs. To harness this potential, Indonesia is formulating strategies to standardize reporting across diverse stakeholders to leverage this potential, such as through strengthening SRN function for systematic data collection and management to enhance transparency and efficiency..	2028

CHAPTER VII
IMPROVEMENTS IN REPORTING OVER TIME

Plan of improvements to reduce and eliminate the use of the area of flexibility has not been thoroughly evaluated. A brief assessment with relevant ministries has identified and defined several improvement plans. Improvements in the GHG Inventory focus on enhancing completeness, addressing time-series data, incorporating various types of F gases, and refining the QA/QC process. Special attention will be placed on improving the quality of activity data and developing country-specific EFs, particularly for key categories.

In the area of mitigation, the enhancement will concentrate on evaluating the economic and social impacts of response measures. This includes evaluating the costs associated with implementing prioritized mitigation strategies, non-GHG benefits, and the co-benefits of adaptation actions.

In the area of adaptation, Indonesia strengthens its framework to improve resilience to climate impacts, strengthen adaptive capacities, and reduce vulnerabilities. Adaptation actions are developed by leveraging existing modalities while taking into account the country's varied socio-economic and geographical vulnerabilities. Resources such as the SIDIK (Data and Vulnerability Index Information System), InaRisk (Indonesia Disaster Risk Mapping), and BMKG's climate information services are essential for developing adaptation plans and strategies for effective implementation. To fully address adaptation needs, Indonesia plans to improve data collection, stakeholder engagement, sustainable financing, and multi-stakeholder coordination.

Improvements of FTC aim to minimize the data gap related to financial support received. This includes the establishment of institutional arrangements and reporting mechanisms, alongside the specification of information on the expected use, impact, and estimated results of the support received and climate actions.

Specifically, to enhance transparency and accurately monitor climate action progress, improvements will be focused on the following aspects: (1) Strengthening and standardizing data collection across agencies and regions to ensure comprehensive and high-quality datasets; (2) Enhancing MRV systems to accurately track climate actions and emissions reductions, which includes capacity building at regional levels and establishing independent auditing systems; (3) Utilizing advanced technologies such as satellite monitoring, artificial intelligence for land-use change detection, and digital platforms to enhance data collection and analysis; (4) Enhancing collaboration among government agencies, the private sector, and non-governmental organizations; (5) Incorporating co-benefits from climate actions, including biodiversity, air quality, and social impact indicators which provides a comprehensive perspective on the effects of these actions and expands the assessment of progress beyond mere emissions reductions; (6) Developing clear roadmaps for policy alignment to establish consistency in reporting and a transparent framework for tracking; and (7) Investing in training programs for technical and operational teams within relevant ministries to enhance expertise in MRV and reporting processes for climate actions.

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ANNEX I: TECHNICAL ANNEXES FOR REDD+

Pursuant to Decision 14/CP.19

Results achieved by Indonesia from Reducing Emissions from Deforestation and Forest Degradation for REDD+ Result-based Payments

A1.1 INTRODUCTION

Indonesia welcomes the opportunity to submit the Third Technical Annex to its First Biennial Transparency Report (BTR1) in the context of result-based payments for reducing emissions from deforestation and forest degradation activities, conservation of forest carbon stocks, sustainable forests, management and enhancement of forest carbon stocks in developing countries (REDD+), in accordance with the United Nations Framework Convention on Climate Change (UNFCCC).

Indonesia emphasizes that the submission of this Third Technical Annex with REDD+ results is voluntary and solely to obtain and receive payments for the implementation of REDD+, in accordance with Decision 13/CP.19, paragraph 2, and 14/CP.19, paragraphs 7 and 8. This submission does not modify, revise, or adjust the Nationally Determined Contributions (NDCs) voluntarily submitted by Indonesia under the Paris Agreement within the UNFCCC framework.

This submission also refers to the baseline reported in Indonesia's Second Forest Reference Level (FRL) that was submitted at the beginning of 2022 in accordance with Decision 13/CP.19. The submitted FRL successfully completed the technical assessment in 2022 and served as the official baseline for Indonesia's REDD+ implementation following 2020. This document outlines the outcomes attained by Indonesia through the implementation of REDD+ from 2021 to 2023 across the national territory.

The REDD+ activities included in the submissions encompass the reduction of emissions from deforestation and forest degradation, alongside the increasing removals from the enhancement of forest carbon stock. This includes mitigating emissions from peat fires, peat decomposition and mangrove conversion. The assessment of the REDD+ results covers the terrestrial areas of Indonesia, incorporating both forested and non-forested categories.

The Third Technical Annex outlines a comprehensive methodology for evaluating REDD+ outcomes, aligning with the approach utilized in the FRL. This submission presents the essential information for the computed results. The current status of the NFMS and the roles and responsibilities of relevant stakeholders are also presented. The submission also demonstrates ongoing advancements in data and information aimed at enhancing Indonesian submissions.

The Government of Indonesia prepared this submission with assistance from a team of Technical Experts appointed by the Ministry of Environment and Forestry (MoEF), which included national experts who contributed to the development of the Second FRL and its technical assessment process.

A1.2. SUMMARY INFORMATION FROM THE TECHNICAL ASSESSMENT REPORT OF FREL

In early 2022, Indonesia modified and submitted its national FRL to the UNFCCC Secretariat[9], updating the prior FREL submitted in 2016. The modified FRL, referred to as the Second FRL, was created utilizing updated data and supplementary REDD+ activities, specifically the enhancement of forest carbon stock. The initial submission encompasses the reference period spanning from 2006 to 2020.

The REDD+ activities outlined in the Second FRL encompass the reduction of emissions from forest-related sources, as well as from peat decomposition, peat fires, and mangrove conversion. The FRL calculation encompasses Indonesia's terrestrial regions, comprising 101.1 million hectares of forest, while non-forest categories cleared prior to 2006 total 89.3 million hectares (Figure A1-1). Forest classifications comprise natural forests and forest plantations.

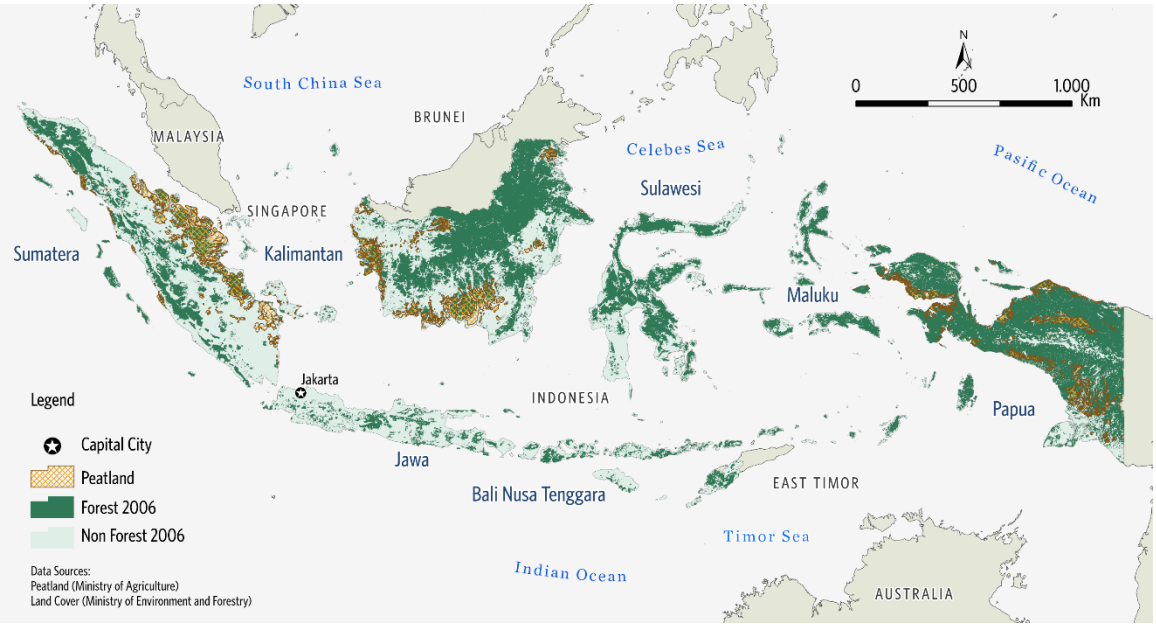

Figure A1 - 1 The scope of the area for the FREL calculation includes forest classes in 2006 (101.1 million ha) and non-forest classes (89.3 million ha)

In 2006, the area of primary forests, totaling 48.4 million hectares, was factored into the assessment of emissions resulting from forest degradation. The area designated for the assessment of forest carbon stock enhancement encompasses all non-forest categories as of 2006. The methodology for quantifying emissions from peat decomposition, peat fires, and mangrove conversion aligns with that used for assessing emissions from deforestation and forest degradation, especially in regions where peatland and mangrove distributions intersect.

Five carbon pools, namely AGB, BGB, litter, dead wood and soil organic carbon (SOC), were incorporated into the FRL accounting. Emissions from SOC were estimated exclusively from peatland and mangroves. The Second FRL excluded changes in SOC stock in minerals resulting from deforestation and the enhancement of forest carbon stock. CO_2 emissions and removals from biomass and soil carbon were quantified, encompassing emissions from deforestation, forest degradation, and the enhancement of forest carbon stocks. Furthermore, emissions of CH_4 and N_2O were derived from peat fire emissions.

In March 2022, a technical assessment team from the UNFCCC Secretariat evaluated the submitted Second FRL. The assessment report indicated that the data and information utilized by Indonesia in

[9] https://redd.unfccc.int/media/2nd_frl_indonesia_final_submit.pdf

developing its Second FRL are transparent, complete, and generally align with the guidelines outlined in Decision 12/CP.17. The initial submission, addressing the reference period from 2006 to 2020, established the FRL at 267,705,902 tons of carbon dioxide equivalent annually. As a result of the facilitative process in the technical assessment, the FRL was adjusted to 192,921,295 tons of carbon dioxide equivalent annually.

Table A1 - 1 Forest reference level from 2006 - 2020

REDD+ Activity	Activity	Mean	Standard Error	Uncertainty (%)
Deforestation	Deforestation emission - Biomass	139,646,704	21,637,882	30.4
	Peat decomposition emission	4,774,760	384,232	15.8
	Peat fire emission	20,907,142	3,984,197	37.4
	AGB+DOM fire emission	4,463,225	678,668	29.8
	Mangrove soil emissions	554,210	116,007	41.0
Forest Degradation	Forest degradation emission - Biomass	38,513,245	6,834,315	34.8
	Peat decomposition emission	183,692	48,181	51.4
	AGB+DOM fire emission	21,142	4,348	40.3
Enhancement of Forest Carbon Stock	Enhance forest carbon stock (EFCS)	(16,705,642)	7,438,900	87.3
	Peat decomposition emission	562,816	199,930	69.6
Total emission deforestation, forest degradation and EFCS		**192,921,295**	**24,223,560**	**24.6**

Deforestation emissions represent the largest portion of the overall FRL, comprising 75.3% of total absolute emissions and removals. The contributions of forest degradation and the enhancement of forest carbon stocks to the constructed FRL are 17.1% and 7.6%, respectively. he three primary sources of emissions are biomass emissions resulting from deforestation, biomass emissions from forest degradation, and peat fire emissions due to deforestation, contributing 139.6 Mt CO_2e, 38.5 Mt CO_2e, and 20.9 Mt CO_2e respectively. These figures represent absolute contribution of 61.7%, 17.0% and 9.2%, respectively. Biomass removals from the enhancement of forest carbon stock account for -16.7 MtCO2e, representing an absolute contribution of 7.4% to the total FRL.

The uncertainty associated with the FRL estimates was reported to be 24.6%. The primary source of uncertainty stemmed from the estimates regarding the enhancement of forest carbon stocks and forest degradation, both of which typically exhibit uncertainties exceeding 30%. The uncertainties associated with emissions from deforestation are comparatively lower than those related to other REDD+ activities.

The national Second FRL functions as the revised benchmark for assessing a nation's progress in mitigating emissions from REDD+ initiatives. The Indonesian Second FRL is applicable for evaluating emission reductions from 2021 to 2030. The emissions during the reduction periods are compared to the baseline values established in the Second FRL.

A1.3. Results in Tons of CO2-Equivalent per Year, Consistent with the Assessed FREL

The estimation of CO_2 emissions from deforestation, forest degradation, peat decomposition, fire, and the enhancement of forest carbon stock for the resulting phase utilized the same emission factors, approaches, and procedures outlined in the FREL. The calculation of CO_2 emissions involved subtracting the emissions recorded during the reference period from those observed in the 2021-2023 timeframe. Results are shown in Table A1-2.

Table A1 - 2 Reference level and actual emission (in tCO2-e.yr-1) from deforestation, forest degradation, peat decomposition, fire and enhancement of forest carbon stock activities

REDD+ Activity	Activity	Reference 2006 - 2020	Actual 2021 - 2023
Deforestation	Deforestation emission - biomass	139,646,704	42,574,062
	Peat Decomposition emission (in deforested area)	4,774,760	514,815
	Peat fire emission	20,907,142	125,900
	AGB+DOM fire emission (in deforested area)	4,463,225	99,694
	Mangrove soil emissions (in deforested area)	554,210	227,747
Total Deforestation		**170,346,041**	**43,542,219**
Forest degradation	Forest degradation emission – Biomass	38,513,245	26,064,174
	Peat Decomposition emission (in forest degraded area)	183,692	56,811
	AGB+DOM fire emission (in forest degraded area)	21,142	123
Total Fores Degradation		**38,718,079**	**26,121,108**
Enhancement of forest carbon stock	Enhance forest carbon stock (EFCS) - Biomass	(16,705,642)	(989,220)
	Peat Decomposition emission (in EFCS area)	562,816	306,572
Total Enhancement of Forest Carbon Stock		**(16,142,825)**	**(682,648)**
Total Emission Deforestation, Forest Degradation and EFCS		**192,921,295**	**68,980,679**

The reference for CO_2 emissions from deforestation was based on historical emissions from 2006 to 2020, totaling 170.3 million tCO2-e per year $tCO_2\text{-}e.yr^{-1}$. Emissions resulting from deforestation activities, especially from biomass, have significantly decreased from 139.65 million $tCO_2\text{-}e.yr^{-1}$ (Table A1-2). Emissions from deforestation activities, particularly from biomass, have drastically declined from 139.65 million $tCO2\text{-}e.yr^{-1}$ in the reference period to 42.57 million $tCO2\text{-}e.yr^{-1}$ during 2021–2023. This significant decrease indicates effective policy measures and practical efforts focused on forest conservation. Furthermore, emissions resulting from peat decomposition and combustion in deforested regions exhibited notable reductions, indicating the effective execution of fire prevention strategies and improved management of peatlands. The results underscore the essential importance of enhanced governance and local community involvement in the preservation of forested landscapes.

Emissions from forest degradation decreased significantly from 38.7 million $tCO2\text{-}e.yr^{-1}$ (reference) to 26.1 million $tCO2\text{-}e.yr^{-1}$. This reduction demonstrates progress in reducing pressures on forests through enhanced control on logging and unsustainable forest exploitation. Additionally, the marginal decrease in emissions from peat decomposition and fire in degraded forest areas indicates a gradual improvement in the management of these ecosystems. This trend indicates Indonesia's effectiveness in advancing sustainable land-use practices in at-risk forest regions.

Challenges in Enhancing Forest Carbon Stocks (EFCS), indicate a significant reduction in the net removal of CO_2 associated with EFCS, decreasing from -16.7 million $tCO2\text{-}e.yr^{-1}$ during the reference period (2006 – 2020) to -1 million $tCO2\text{-}e.yr^{-1}$ in 2021 – 2023. This trend indicates various challenges associated with the expansion of reforestation and carbon sequestration efforts.

Table A1-3 illustrate the annual emissions reduction of 123.9 million $CO_2\text{-}e.yr^{-1}$ from REDD+ activities during the 2021-2023 reporting period. The estimated emission reductions were calculated by subtracting the actual emissions from the reference level (192.9 million $CO_2\text{-}e.\ yr^{-1}$) for the years 2021-

2023 (69.0 million CO_2-e. yr^{-1}). The REDD+ activities from 2021 to 2023 resulted in a total emission reduction of 371,821,848 tCO2-e.

Table A1 - 3 Results of emission reduction estimates (in tCO2e. yr-1) from reducing the deforestation, forest degradation, peat decomposition, fire and enhancement of forest carbon stock activities 2021 - 2023

	Nett emission (tCO2-e. yr^{-1})	
	Mean	Standard error
Reference 2006-2020	192,921,295	24,223,560
Actual 2021-2023	68,980,679	12,661,227
ER 2021-2023	123,940,616	27,332,902

Addressing uncertainty is essential for achieving international climate objectives. Monte Carlo Simulation, as utilized in Table A1-4, is a statistical method that represents uncertainty by generating a diverse array of possible outcomes derived from input variability. Table A1-3 presents a greater standard error for emission reductions in comparison to Table A1-4. The Monte Carlo Simulation presented in Table A1-4 offers a more precise estimate diminished variability.

Table A1 - 4 Uncertainty analysis of the emission reduction estimates (in tCO2e. yr-1) from reducing the deforestation, forest degradation, peat decomposition, fire and enhancement of forest carbon stock activities 2021 - 2023 using Monte Carlo Simulation

Summary 2006-2020: Reference					
	mean	standard error	lower bound 95% C.I.	upper bound 95% C.I.	half width 95% C.I.
Deforestation Emission - Biomass	139,547,455	15,561,331	109,902,684	170,426,105	21.7%
Peat Decomposition Emission (in deforested area)	4,776,833	478,680	3,878,213	5,751,790	19.6%
Peat fire emission	21,018,961	4,031,000	13,407,141	29,234,412	37.6%
AGB+DOM fire emission (in deforested area)	4,460,076	702,913	3,112,257	5,855,275	30.8%
Mangrove soil emissions (in deforested area)	555,747	117,302	330,162	792,790	41.6%
Forest degradation emission - Biomass	38,537,780	6,679,236	25,854,911	51,980,468	33.9%
Peat Decomposition Emission (in forest degraded area)	183,724	47,678	99,623	285,570	50.6%
AGB+DOM fire emission (in forest degraded area)	21,217	5,006	12,197	31,915	46.5%
Enhance of forest carbon stock (EFCS) - Biomass	(16,715,154)	6,910,691	(30,508,708)	(3,352,060)	81.2%
Peat Decomposition Emission (in EFCS area)	563,799	141,476	299,428	851,105	48.9%
Total emission deforestation, forest degradation and EFC	192,950,438	18,865,536	156,525,209	230,163,723	19.1%
Summary 2021-2023: Result					
	mean	standard error	lower bound 95% C.I.	upper bound 95% C.I.	half width 95% C.I.
Deforestation Emission - Biomass	42,625,987	8,552,995	25,997,455	59,721,158	39.6%
Peat Decomposition Emission (in deforested area)	507,717	45,730	420,822	599,566	17.6%
Peat fire emission	134,693	14,893	105,894	164,063	21.6%
AGB+DOM fire emission (in deforested area)	99,496	18,763	65,046	138,934	37.1%
Mangrove soil emissions (in deforested area)	228,290	51,406	131,301	334,426	44.5%
Forest degradation emission - Biomass	26,145,340	5,600,691	15,422,461	37,236,903	41.7%
Peat Decomposition Emission (in forest degraded area)	56,933	16,054	28,817	91,142	54.7%
AGB+DOM fire emission (in forest degraded area)	124	37	60	203	57.9%
Enhance of forest carbon stock (EFCS) - Biomass	(899,913)	487,144	(1,857,609)	68,213	107.0%
Peat Decomposition Emission (in EFCS area)	306,373	55,337	202,053	419,670	35.5%
Total emission deforestation, forest degradation and EFC	69,205,041	10,304,495	49,105,186	89,781,071	29.4%
2021-2023: Result/Year					
Emission Reduction 2021-2023	**123,745,397.39**	**20,609,619.29**	**84,016,118.40**	**164,541,641.91**	**32.5%**

A noteworthy observation is that the mean results for net emissions and emission reductions in Table A1-3 and Table A1-4 are nearly identical. The consistency illustrates the reliability of the emission reduction estimates and strengthens the validity of the findings, even when sophisticated statistical methods are employed to evaluate uncertainty.

The Monte Carlo results provide quantification of uncertainty levels: reference period emissions exhibit 19.1% uncertainty, actual emissions from 2021 to 2023 demonstrate 29.4% uncertainty, and emission reductions reflect 32.5% uncertainty. The primary sources of uncertainty stem from the ECS and forest degradation, exhibiting uncertainties exceeding 30%. The uncertainties associated with deforestation vary between 17.6% and 44.5%. The data underscore the inherent difficulties in obtaining accurate measurements, especially regarding recent reductions. Assessing and communicating uncertainty enhances trust and transparency regarding Indonesia's emissions reduction achievements.

A1.4. Demonstration that the Methodologies Used to Produce the Results are Consistent with Those Used to Establish the Assessed FREL

The emission reduction calculations in this report employed the same methodology as that used in the construction of the Second FRL, which has undergone assessment and validation by the UNFCCC Secretariat. The activity data was derived from land cover maps created by the National Forest Monitoring System (NFMS). The emission factors were obtained from the database utilized in the Second FRL. Finally, the definitions, assumptions, and procedures utilized to produce the emission reduction results for 2021 to 2023 align with those employed in the Second FRL.

The analysis of emission reduction was conducted for the implementation period from 2021 to 2023 across all land jurisdiction areas of Indonesia. The total land area reported in the Second FRL was 190.4 million hectares, comprising 101.1 million hectares of forested land and 89.3 million hectares of non-forest classes in 2006 (Figure 1). For this analysis, the updated Indonesia boundary base map utilized has a total area of 191.3 million hectares. The difference resulted from alterations in the coastline or land caused by sedimentation in coastal areas.

The definitions of forest, deforestation, forest degradation, and forest gain are consistent with those in the Second FRL. The definition of a forest is “a land area of more than 0.25 hectares with trees higher than 5 meters at maturity and a canopy cover of more than 30 percent, or trees able to reach these thresholds in situ” (MoFor, 2004). This encompasses both natural forest classes and plantation forests. Deforestation refers to the transformation of natural forests into non-natural forests, such as timber plantations. The minimum mapping unit (MMU) for general land cover mapping is 6.25 hectares. For the deforestation analysis, a minimum spatial unit of 1 hectare was applied.

Forest gain or enhancement of forest carbon stock refers to the conversion of non-forest classifications into forest classifications, which encompasses timber plantations. Conservative principles were employed to prevent overestimation of emission reduction calculations, especially in the context of defining land converted to forest or forest gain. During the three-year monitoring period (2021 - 2023), only specific non-forest classes were considered in the assessment of forest gain. These included shrubs, wet shrubs, and mixed agriculture transitioning to secondary and plantation forests; bare lands converting to plantation forests and secondary mangrove forests; and fishponds changing to secondary mangroves.

A1.4.1. Generating activity data

A land cover change analysis was performed to generate a transition matrix for forest and land cover changes during the monitoring periods of 2021-2023. The analysis compared land cover (LC) maps from two consecutive monitoring periods: the previous period (T0), 2020, and the current period (T1), 2023. Land cover mapping utilizes Landsat satellite imagery, which has a medium spatial resolution of

30 meters, as the main data source for visual interpretation. This method accurately identifies transitions between forested and non-forested areas.

The analysis produced activity data for multiple REDD+ initiatives, encompassing deforestation (Def), forest degradation (Deg), peat decomposition (P Def and P Deg), peat fires (B P Def), mangrove conversion (MF Def), and enhancement of forest carbon stock.

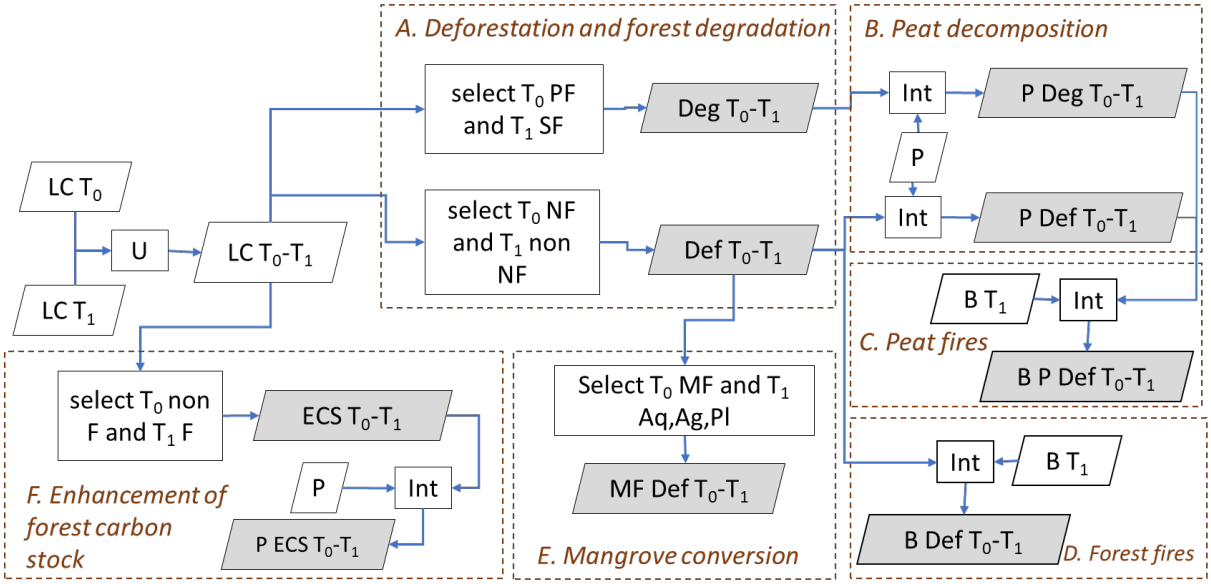

Figure A1 - 2 Flowchart for generating activity data

Figure A1-2 illustrates the methodology for producing REDD+ activity data derived from changes in forest and land cover, encompassing data related to peat decomposition, fires, and mangrove conversion. In this context, "LC" denotes land cover, "T0" and "T1" signify the previous and current years, respectively. "NF" refers to natural forest categories, including primary forests ("PF") and secondary forests ("SF"). "F" encompasses forests, including timber plantations. "Def" and "Deg" indicate deforestation and forest degradation, respectively. "ECSN onF-F" pertains to carbon stock enhancement from non-forest to forest. "MF" stands for mangrove forest, "Aq" represents aquaculture, "Ag" denotes agriculture, "Pl" indicates plantations, while "U" and "Int" refer to GIS functions for union and intersection overlays, respectively. Lastly, "P" and "B" represent peatland and burned areas.

We identify shifts from natural forests to non-natural forests brought on by human activities like agriculture, plantations, towns, fires, and natural disasters in order to produce activity data on deforestation. Monitoring forest degradation concentrated on level one degradation, defined as the transition from primary forest to secondary forest. This level indicates a partial loss of primary forest stands. Forest degradation detection in Landsat imagery incorporates a 1 km buffer surrounding human influences, including land clearing, road access, settlements, land management, and forest fires. Activity data were generated from the enhancement of forest carbon stocks by analyzing transition matrixes to monitor changes from non-forest to forest and the improvement from secondary to primary forest.

Alongside the three primary REDD+ activities, we also produced supplementary subset activity data, which includes:

1. Peat Decomposition: Areas of deforestation and forest degradation were analyzed in conjunction with peatland data to assess peat decomposition activity.
2. Peat Fires: Burned deforested peatlands were identified by intersecting deforested peatlands with burned areas to estimate emissions.
3. Biomass Burning: Activity data for biomass burning were produced by intersecting deforested regions with burned areas.

4. Mangrove Conversion: An analysis of land cover transitions revealed the deforestation of mangroves for agricultural purposes.

A1.4.2. Emission factors used

Emissions factors utilized in this report correspond to those applied in the analysis of the REDD+ baseline as detailed in the Second FRL, encompassing carbon stocks of both forest and non-forest categories (Tabel A1-5 and A1-6), parameters to estimate peat fires (Table A1-7), emission factors for non-CO_2 emissions from biomass burning (Table A1-8), emission factors of peat decomposition from various land cover types (Table A1-), and emission factors for estimating emissions from mangrove conversions (Table A-10).

Table A1 - 5 Forest biomass stocks in each forest type in Indonesia

Forest Type	Main Island	AGB (t.d.m ha^{-1})		BGB (t.d.m ha^{-1})		Total Biomass (t.d.m ha^{-1})		U (%)
		Mean	SE	Mean	SE	Mean	SE	
Primary Dryland Forest	Bali Nusa Tenggara	280.45	11.69	81.33	3.39	361.78	12.17	6.6
	Java	347.88	51.35	100.89	17.29	448.77	54.19	23.7
	Kalimantan	325.90	10.05	94.51	2.89	420.41	10.45	4.9
	Maluku	237.85	19.01	68.98	5.88	306.83	19.90	12.7
	Papua	268.57	9.12	77.88	2.63	346.45	9.49	5.4
	Sulawesi	248.28	7.44	72.00	2.14	320.28	7.74	4.7
	Sumatra	340.72	10.17	98.81	2.93	439.53	10.59	4.7
	Indonesia (Average)	291.24	4.35	84.46	1.25	375.70	4.52	2.4
Secondary Dryland Forest	Bali Nusa Tenggara	138.73	7.09	40.23	2.11	178.96	7.40	8.1
	Java	209.78	13.26	60.84	3.97	270.61	13.84	10.0
	Kalimantan	222.91	4.48	64.64	1.32	287.55	4.67	3.2
	Maluku	168.82	8.43	48.96	2.52	217.78	8.80	7.9
	Papua	224.77	10.99	65.18	3.27	289.95	11.47	7.8
	Sulawesi	166.12	5.46	48.17	1.62	214.29	5.69	5.2
	Sumatra	221.45	6.20	64.22	1.84	285.67	6.47	4.4
	Indonesia (Average)	204.10	2.72	59.19	0.80	263.29	2.84	2.1
Primary Swamp Forest	Bali Nusa Tenggara*	248.80	12.92	54.74	3.20	303.53	13.31	8.6
	Java*	248.80	12.92	54.74	3.20	303.53	13.31	8.6
	Kalimantan	285.09	24.16	62.72	7.10	347.81	25.18	14.2
	Maluku*	248.80	12.92	54.74	3.20	303.53	13.31	8.6
	Papua	222.87	14.04	49.03	3.49	271.90	14.46	10.4
	Sulawesi*	248.80	12.92	54.74	3.20	303.53	13.31	8.6
	Sumatra	355.63	36.23	78.24	9.68	433.87	37.50	16.9
	Indonesia (Average)	248.80	12.92	54.74	3.20	303.53	13.31	8.6
Secondary Swamp Forest	Bali Nusa Tenggara*	204.61	4.98	45.01	1.23	249.62	5.13	4.0
	Java*	204.61	4.98	45.01	1.23	249.62	5.13	4.0
	Kalimantan	215.71	7.38	47.46	1.83	263.17	7.60	5.7
	Maluku*	204.61	4.98	45.01	1.23	249.62	5.13	4.0
	Papua	139.88	13.90	30.77	3.55	170.65	14.35	16.5
	Sulawesi*	204.61	4.98	45.01	1.23	249.62	5.13	4.0
	Sumatra	207.06	7.36	45.55	1.83	252.61	7.58	5.9
	Indonesia (Average)	204.61	4.98	45.01	1.23	249.62	5.13	4.0
Primary Mangrove Forest	Bali Nusa Tenggara*	236.17	15.26	73.45	4.66	309.62	15.96	10.1
	Java*	236.17	15.26	73.45	4.66	309.62	15.96	10.1
	Kalimantan	247.98	14.39	77.12	4.43	325.10	15.05	9.1
	Maluku*	236.17	15.26	73.45	4.66	309.62	15.96	10.1
	Papua	240.64	28.00	74.84	8.57	315.48	29.28	18.2
	Sulawesi*	236.17	15.26	73.45	4.66	309.62	15.96	10.1
	Sumatra*	236.17	15.26	73.45	4.66	309.62	15.96	10.1
	Indonesia (Average)	236.17	15.26	73.45	4.66	309.62	15.96	10.1
	Bali Nusa Tenggara*	118.02	15.72	13.57	1.78	131.59	15.82	23.6
	Java*	118.02	15.72	13.57	1.78	131.59	15.82	23.6

Forest Type	Main Island	AGB (t.d.m ha^{-1})		BGB (t.d.m ha^{-1})		Total Biomass (t.d.m ha^{-1})		U (%)
		Mean	SE	Mean	SE	Mean	SE	
Secondary Mangrove Forest	Kalimantan	155.74	19.21	17.91	2.32	173.66	19.35	21.8
	Maluku*	118.02	15.72	13.57	1.78	131.59	15.82	23.6
	Papua	150.13	12.80	17.26	1.46	167.39	12.88	15.1
	Sulawesi*	118.02	15.72	13.57	1.78	131.59	15.82	23.6
	Sumatra*	118.02	15.72	13.57	1.78	131.59	15.82	23.6
	Indonesia (Average)	118.02	15.72	13.57	1.78	131.59	15.82	23.6

Table A1 - 6 Non-natural forest biomass stock in Indonesia

Non-Natural Forest Type	AGB (t.d.m. ha^{-1})		BGB (t.d.m. ha^{-1})		Total Biomass[1)] (t.dm. ha^{-1})		U[2)]
	Mean	SE	Mean	SE	Mean	SE	%U
Plantation forest	161.23	16.00	52.40	5.20	213.63	16.83	15.44
Dry shrub	128.49	15.36	30.32	3.63	158.81	15.78	19.48
Estate crop	102.35	14.67	33.26	4.77	135.61	15.43	22.30
Settlement	4.61	2.48	1.34	0.72	5.95	2.58	85.18
Bare ground	5.11	2.89	1.21	0.68	6.31	2.97	92.17
Savanna and Grasses	8.64	4.13	2.04	0.98	10.68	4.25	77.88
Open water	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wet shrub	41.15	8.44	9.71	1.99	50.86	8.67	33.42
Pure dry agriculture	29.95	16.38	5.99	3.28	35.94	16.71	91.10
Mixed dry agriculture	137.52	4.89	27.50	0.98	165.03	4.99	5.93
Paddy field	21.27	8.26	5.02	1.95	26.29	8.49	63.27
Fish pond/aquaculture	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Port and harbor	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transmigration areas	29.95	16.38	5.99	3.28	35.94	16.71	91.10
Mining areas	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Open swamps	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A1 - 7 Parameters to estimate peat fire emissions

Parameter	Mean (SE)	Unit	Source
Cf (combustion factor)	0.54 (0.05)	-	Krisnawati *et al.* 2021;
Gef CO_2 (CO_2 emission factor)	1670.13 (34.03)	g kg^{-1} CO	Stockwell *et al*.2016; Stockwell *et al*.2015; Stockwell *et al*. 2014; Christian *et al.* (2003); Huijnen *et al*.2016; Setyawaty *et al*.2017; Wooster *et al*.2018; Nara *et al*.2017
Gef CH_4 (CH_4 emission factor)	177,87 (24,36)	g kg^{-1} CO_{2eq}	Stockwell *et al*.2016; Stockwell *et al*.2015; Stockwell *et al*. 2014; Christian *et al*. (2003); Huijnen *et al*.2016; Setyawaty *et al*.2017; Wooster *et al*.2018; Nara *et al*.2017
BD (bulk density)	0.16 (0.015)	g cm-^{3}	Konecny *et al.* 2016; Warren *et al*. 2012, Agus *et al*. 2011; Lampela *et al*.2014; Kononen *et al*. 2015; Shimada *et al*.2001
Db (Burn depth)	31.88 (4.68)	cm	Stockwell *et al*.2016; Ballhorn *et al*.2009; Konecny *et al*. 2016; Usup *et al*.2004; Page *et al*.2002; Saharjo 2007; Simpson *et al*.2016; Saharjo and Munoz 2005

Table A1 - 8 Emission factors for non-CO2 emissions from biomass burning

Land cover	Fuel-Biomass (t ha^{-1} DM)	Combustion Factors	G_{ef} CH_4 (g kg^{-1} DM)	Gef N_2O (g kg^{-1} DM)	GWP CH_4	GWP N_2O	L_{fire}_EF CH_4 (tCO_2)	L_{fire}_ EF N_2O (tCO_2)
Primary dry land forest	352.4	0.36	6.8	0.2	21	310	18.12	7.87
Secondary dry land forest	275.0	0.55	6.8	0.2	21	310	21.60	9.38
Primary mangrove forest	249.9	0.36	6.8	0.2	21	310	12.85	5.58
Primary swamp forest	297.6	0.36	6.8	0.2	21	310	15.30	6.64
Secondary mangrove forest	132.4	0.55	6.8	0.2	21	310	10.40	4.52
Secondary swamp forest	256.3	0.55	6.8	0.2	21	310	20.13	8.74

Table A1 - 9 Emission factors of peat decomposition from various land cover types

Land Cover	Mean (t CO_2 $ha^{-1}yr^{-1}$)	95% Confidence Interval (t CO_2 $ha^{-1}yr^{-1}$)		Uncertainty %
Primary dryland forest	0			
Secondary dryland forest	32.42	24.85	40	23.38
Primary mangrove forest	0			
Primary swamp forest	0			
Plantation forest	72.95	50.04	95.87	31.42
Dry shrub	45.04	26.21	63.87	41.81
Estate crop	36.63	27.6	45.65	24.62
Settlement areas	45.04	26.21	63.87	41.81
Bare ground	63.79	49.61	77.98	22.24
Savanna and Grasses	45.04	26.21	63.87	41.81
Open water	0			
Secondary mangrove forest	32.42	24.85	40	23.38
Secondary swamp forest	32.42	0	0	-100.00
Wet shrub	45.04	26.21	63.87	41.81
Pure dry agriculture	45.42	25.12	65.72	44.69
Mixed dry agriculture	54.66	30.42	78.91	44.37
Paddy field	33.71	-0.72	68.14	102.14
Fish pond/aquaculture	0			
Port and harbor	0			
Transmigration areas	54.66	30.42	78.91	44.37
Mining areas	63.79	49.61	77.98	22.24
Open swamp	0			

Source: Novita et al, 2021

Table A1 - 10 Emission factors for estimating emissions from mangrove conversions

Type of Mangrove Conversion	Soil Type	EF (CO_2eq ton ha^{-1})	SE	Source
Conversion to fishpond	Peat	90.06	22.82	Arifanti et al, 2019
Conversion to fishpond	Mineral	90.06	22.82	Arifanti et al, 2019
Conversion to cultivated land	Peat	28.97	5.75	*IPCC (2014)*
Conversion to cultivated land	Mineral	28.97	5.75	IPCC (2014)

A1.4.3. Emissions and removals calculation

A1.4.3.1. Emissions and removal calculation from deforestation, forest degradation and enhancement of forest carbon stock

Emissions and removals were estimated using the stock-difference approach, which involves subtracting the total carbon stock at time T1 from the total carbon stock at time T0. Total carbon stocks were determined by multiplying the area of REDD+ activities (in hectares) by the corresponding carbon stock values (see a general equation below). To calculate emissions and removals in tCO2 equivalent, a conversion factor of 44/12 was applied to convert carbon into carbon dioxide.

$$E/R_{bio} = \frac{\sum_{i=1}^{n}(A_{it0}\times C_i)-\sum_{j=1}^{m}(A_{jt1}\times C_j)}{t1-t0} \times \left(\frac{44}{12}\right);\ \sum A_i = \sum A_j$$

Where E/R_{bio} is CO_2 biomass emission or removal (tCO_2 yr^{-1}). A_{ito} is area of land cover class-*i* on *t0* changed into land cover type-*j* (in hectares). A_{jt1} is the area of land cover class-*j* on t1 (in hectares). C_i and C_j are the carbon stock from of land cover class-*i* from t_0 and land cover class-*j* from t1, respectively (tCO_2 ha^{-1}).

Therefore, to estimate emission from deforestation ($Edef_{bio}$) using above equation: A_i is area of land cover natural forest class - i that deforested change into land cover non-natural forest class - j, A_j is area of land cover non-natural forest class post deforestation.

To estimate emission forest degradation ($Edeg_{bio}$)using above equation : A_i is area of land cover primary natural forest class - i that degraded into land cover secondary natural forest class - j, A_j is area of land cover secondary natural forest class post forest degradation.

To estimate annual removals from enhancement of forest carbon stock (EFCS), we used a modified above equation that considers transitional change. We applied a 14-year transitional period, considering a gradual cummulation of carbon stock from EFCS activityRemovals from EFCS are calculated using the equation below.

$$\text{Refcs}_{bio} = \frac{\sum_{i=1}^{n}(A_{it0}\times C_i)-\sum_{j=1}^{m}(A_{jt1}\times C_j)}{(t1-t0)\times 14} \times \left(\frac{44}{12}\right); \sum A_i = \sum A_j$$

Where Refcs_{bio} is biomass removal (tCO_2 yr^{-1}) from EFCS. A_i is area of land cover non-natural forest class - i that change into land cover natural forest class - j, A_j is area of land cover natural forest class post planting/regrowth (hectares). C_i and C_j are the carbon stock from of land cover class-i from t_0 and land cover class-j from t1, respectively (tCO_2 ha^{-1}).

The transition from secondary forests to primary forests was excluded, as such a change is not feasible within our terminology. According to the definition utilized in map classification, secondary forests display evidence of logging activities, as evidenced by patterns and indicators such as the presence of roads and logged-over areas. This spatial processing analysis suggests that the observed condition may

arise from polygons that transitioned into primary forest located at the perimeter of the primary forest, rather than from individual polygons.

A1.4.3.2. Emission calculation from peat decomposition

Emissions from peat decomposition are calculated the equation below:

$$E_{pd} = \frac{\sum_{i=1}^{n}(A_{it0} \times EF_i) + \sum_{j=1}^{m}(A_{jt1} \times EF_j)}{2};\ \sum A_i = \sum A_j$$

Where E_{pd} is CO_2 emission ($tCO_2e\ yr^{-1}$) from peat decomposition in peat forest area that experiencing deforestation (Def), forest degradation (Deg) and enhancement of forest carbon stock (Efcs). A_{ito} is area of peat land cover -*i* on t_0 changed into land cover type-*j* (hectares). A_{jtl} is area of peat land cover - *j* on t_1 (hectares). EF_i and EF_j are the emission factors from peat decomposition of land cover class-*i* from t_0 and land cover class-*j* from t_1, respectively ($tCO_2e\ ha^{-1}\ yr^{-1}$). We used the average emission factors (both EFs divided by two), assuming that the forest cover change was happening in the middle of the reference period. Therefore, to estimate emissions from peat decomposition for each REDD+ activity using the above equation, we applied the explanation below.

- Deforestation ($Edef_{pd}$) : A_i is area of land cover natural forest class - i that deforested change into land cover non-natural forest class - j, A_j is area of land cover non-natural forest class post deforestation.
- Forest degradation ($Edeg_{pd}$) : A_i is area of land cover primary natural forest class - i that degraded into land cover secondary natural forest class - j, A_j is area of land cover secondary natural forest class post forest degradation.
- Enhancement of forest carbon stock ($Eefcs_{pd}$): A_i is area of land cover non-forest class - i that change into land cover forest class - j, A_j is area of land cover forest class post planting/regrowth.

To avoid double counting with emissions from mangrove forests converted to cultivated lands in peatland, we excluded this emission from peat decomposition calculation. Because the emissions from mangrove conversion into cultivated lands in peatlands were accounted in emissions from mangrove conversion.

A1.4.3.3. Emissions calculation from fires

There are two types of emissions caused by fires, i.e., peat fires and biomass burning from deforestation and forest degrading areas. Emissions from peat fires (E_{pf}) are calculated using the below equations derived from IPCC, 2014.

$$Epf_i = AD_{pf} \times DB_{pf} \times BD \times Cf_i \times Gef_i \times GWP_i \times 10^{-1}$$

Where Epf_i represents the emission from peat fires for a specific gas- i in $tCO_2\ yr^{-1}$, AD_{pf} denotes the activity data of burned peatland in deforested areas ($ha\ yr^{-1}$) , DB_{pf} indicates the average burned peat depth in cm, BD is bulk density of peat soil in $g.cm^{-3}$, Cf_i is combustion factor for a specific gas - i , Gef_i is emission factor for a specific gas - i of burned peat soil in $g.kg^{-1}$, i is specific gas and source category : 1 (CO_2), 2 (CH_4). GWP_i is global warning potential values for 100-year time horizon used for converting non-CO_2 gases to CO_2 equivalent. For CO_2 gas, the GWP therefore equals to 1. For CH_4 and N_2O we used GWP of 21 and 310, respectively, following the IPCC Second Assessment Report (AR2).

To estimate total emissions from peat fires in deforested area ($Edef_{pf}$) we used the below equation:

$$Edef_{pf} = \sum_{i=1}^{n} Epf_i$$

where $Edef_{pf}$ is the total peat fires emissions from deforestation activity.

We include only SOC pool when calculating peat fire emissions to avoid double counting with deforestation and forest degradation emissions.

We estimated the emissions from biomass burning (E_{bb}) using the equations below, which include only non-CO_2 gases, i.e. CH_4 and N_2O, to avoid double counting with biomass emissions from deforestation and forest degradation.

$$E_{bbi} = ADburnt_j \times DM_j \times Cf_j \times EF_i \times C_{frac} \times GWP_i \times (44/12)$$

$$E_{bb} = \sum_{i=1}^{n} E_{bbi}$$

Where E_{bbi} is the total emission from biomass burning of a specific non-CO_2 gas-i in $tCO_2\,yr^{-1}$, $ADburnt_j$ is the activity data of burned areas (ha yr^{-1}) in natural forest class-j that deforested (Def) or experiencing forest degradation (Deg), DM_j = Fuel-biomass from AGB and DOM (t.d.m ha^{-1}) in natural forest class-j, Cf_i is combustion factor for a specific gas - i , EF_i is emission factor for a specific gas - i of in $g.kg^{-1}$, C_{frac} is Carbon fraction in (tC $t.d.m^{-1}$), i is specific gas and source category, i.e.: N_2O and CH_4, GWP is global warming potential values for 100-year time horizon used for converting non-CO_2 gases to CO_2 equivalent.

A1.4.3.4. Emissions calculation from mangrove conversion

Emissions from mangrove conversion are calculated using the below equation.

$$Edef_m = \sum(AD_i \times EF_i)$$

Where $Edef_m$ is Mangrove soil emissions from deforestation for aquaculture development and cultivated land in $tCO_2\,yr^{-1}$, AD_i is activity data of after deforestation, and EF_i is the emission factor for soil extraction in activity - i, i = 1 (aquaculture development), and 2 (cultivated land).

Conversion from mangrove forests into aquacultures involves deforestation directly and indirectly. Some fishponds may be built from previously unforested areas, such as shrubs or swamps, which were deforested in the previous monitoring period. Meanwhile, this analysis covers only the development of aquaculture that consists of mangrove forests.

A1.4.4. Uncertainty calculation

A spreadsheet template for uncertainty analysis utilizing Monte Carlo Simulation was developed by FAO[10]. The spreadsheet employed a hybrid methodology, integrating approach 1 and approach 2, to quantify the uncertainty associated with each category and the overall emissions. Approach 2 was employed to estimate the uncertainty associated with each activity data and the emission factor of individual carbon pools. Approach 1 was employed to integrate uncertainties from various carbon pools and the total uncertainties from all activities, utilizing error propagation methods. The uncertainty estimates were integrated using two established rules for combining uncorrelated uncertainties in the context of addition and multiplication.

Furthermore, we performed Monte Carlo Simulation using the following steps. Initially, we performed an accuracy assessment of the activity data to evaluate the precision of the land cover change maps, including deforestation, forest degradation, and forest gain. Furthermore, the assessment included non-change categories, specifically stable forests and stable non-forest areas. Secondly, we performed sample-based area estimation to modify the land cover change areas in accordance with the uncertainty analysis of the activity data.

Thirdly, we entered all means and standard errors of ADs and EFs into the Monte Carlo Simulation spreadsheet. The mean and standard error of the EFs were calculated independently using the most reliable data available. The Probability Density Function (PDF) was utilized to estimate the 2.5% and 97.5% quantiles, which represent the lower and upper uncertainties of total emissions from a category. A 95% confidence level was employed for estimating the random values of ADs and EFs. The annual emissions for each activity were simulated using 10,000 iterations based on the selected random values of ADs and EFs.

[10] https://www.fao.org/redd/information-resources/tools/en/

Given that both activity data estimates and emission factor estimates derive from samples, it is reasonable to assume a normal distribution for these variables. The IPCC Good Practice Guidance and Uncertainty Management A1.2.5 recommend the use of a normal distribution in the absence of evidence indicating the necessity for an alternative distribution. A normal distribution is defined when the mean exceeds twice the standard error, while a truncated normal distribution is characterized by the mean being less than twice the standard error. However, it was observed that not all data follows a normal distribution. Consequently, we employ normal and truncated normal distributions for the Monte Carlo Simulation. Truncating the normal distribution is an effective method for managing significant variation, as it eliminates highly improbable values in the simulation.

A1.5. Description of the National Forest Monitoring System (NFMS) and the Institutional Roles and Responsibilities for MRV of the Results

A1.5.1. The National Forest Monitoring System of Indonesia

The NFMS was established in 1989 by the Ministry of Forestry through the NFI project. This project was conducted over multiple years in partnership with the Government of Indonesia and the Food and Agriculture Organization. The NFI was designed to gather data on forest distribution, cover types, and standing stock volumes for various forest types, including mangroves, peatlands, lowland forests, and mountain forests. The NFI project utilized satellite imagery, primarily Landsat data, to generate land cover maps. Following the conclusion of the NFI project in 1997/1998, the responsibility for operational land cover mapping was assigned to the Forestry Planning Agency/Directorate General of Forestry Planning within the Ministry of Forestry, which subsequently developed into the NFMS, now referred to as SIMONTANA.

The NFMS system utilizes remote sensing technology to consistently generate a series of land cover maps for monitoring purposes. The land cover maps were initially generated triennially and subsequently updated on an annual basis. The maps include 23 land cover classes, which encompass categories for cloud cover and no data. The NFMS is available online at https://nfms.menlhk.go.id/ or data presentation, viewing, and basic analysis. Since the early 1990s, the primary data sources for the NFMS in Indonesia have been Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+). Utilizing optical remotely sensed data, such as Landsat, in tropical areas like Indonesia presents challenges related to cloud cover and haze. Since 2008, the United States Geological Survey (USGS) has revised its Landsat data policy to provide free access to Landsat data via the internet. The policy shift, initiated around 2009, has significantly enhanced data availability for Indonesia's NFMS. Approximately 218 scenes of Landsat data are utilized to encompass the entirety of Indonesia across selected annual intervals for the NFMS.

The 23 land cover classes in the NFMS were derived from the physiognomy of bio-physical covers, which can be visually differentiated using Landsat remote sensing data with a spatial resolution of 30 meters. The classification process primarily emphasized the visual characteristics of land cover, rather than the potential land uses or types. Several ancillary datasets were employed as references during the delineation process to collect valuable information for subsequent classification.

The visual classification process entailed the digitization and interpretation of essential image elements displayed on the screen. Distinctive existing features were captured and manually delineated using standard GIS software to create closed polygons, which were subsequently assigned to designated land cover classes.

Quality control and quality assurance (QC/QA) for the land cover data in the NFMS were conducted utilizing imagery data of superior quality compared to the imagery data used as the source for land cover production. Ground check data and additional supporting information are also incorporated into the QA/QC process. Assessments of accuracy and uncertainty in land cover and land cover changes

employed reference data derived from a sample of 5,000 to 10,000 points corresponding to the Landsat satellite image time series from 1990 to 2020. This validation method has been in use since 2018.

QA and QC processes are implemented in the production of land cover data, carbon stock data, and the calculation of greenhouse gas (GHG) emissions. Quality control for land cover data is conducted at the regional office level by BPKH, while QA is performed by the Forest Resources Inventory and Monitoring Directorate of MoEF. The QA process conducted by the Forest Resources Inventory and Monitoring Directorate includes an assessment of overall accuracy and kappa analysis, utilizing 5,000 to 10,000 samples.

At the end of 2014, the Ministry of Forestry (now the Ministry of Environment and Forestry/MoEF until 2024) signed a Memorandum of Understanding with the National Space Agency (LAPAN), currently known as ORPA BRIN, to ensure data sustainability for the NFMS. This agreement stipulates that LAPAN will supply mosaics of Landsat data for Indonesia, primarily utilizing Landsat imagery, including the Landsat 8 Operational Land Imager (OLI) and supplementary data from Landsat 7 Enhanced Thematic Mapper Plus (ETM+), on a regular schedule. Recently, ORPA BRIN has prepared both Landsat mosaic data and high-resolution imagery, including SPOT 6/7 imagery. Since 2017, the MoEF has partnered with ORPA BRIN and IPB University to establish a deforestation alert system utilizing de-vegetation data, which is regularly published on the SIMONTANA website every eight days. The de-vegetation data facilitates the annual updating of land cover and land cover changes, primarily for the identification of deforestation and forest degradation.

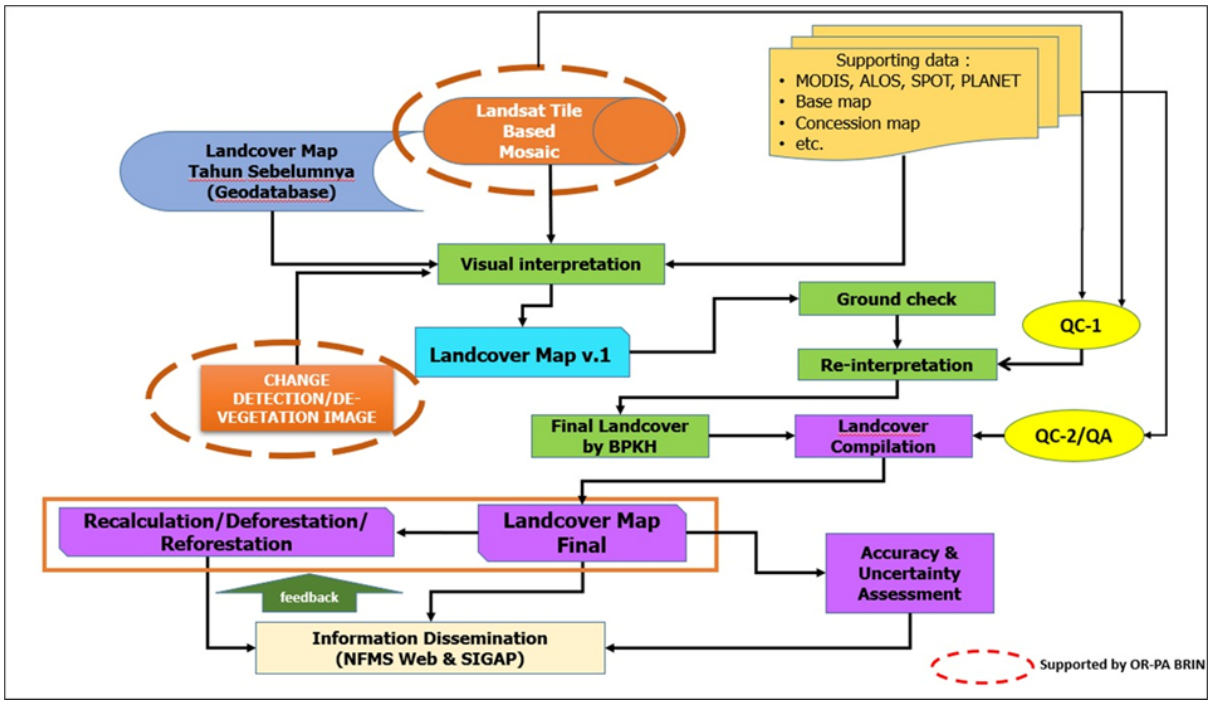

Figure A1 - 3 General Indonesian Land Cover map workflow

The NFMS portal integrates internet capabilities with forest resource information systems to facilitate information sharing. The primary aim is to enhance forest governance by fostering transparency. The system guarantees that uploaded information is updated in real or near-real time, ensuring completeness and accuracy are maintained. The NFMS promotes public participation by facilitating access to shared information for the public's benefit. Comprehensive information regarding the NFMS is outlined in the FREL document (MoEF, 2016) (http://ditjenppi.menlhk.go.id/reddplus/images/resources/frell/FREL-Submission-by-Indonesia-2016.pdf) and the method used in NFMS is explained in Margono *et al.* (2016) (https://www.researchgate.net/publication/306233863_Indonesias_Forest_Resource_Monitoring).

A1.5.2. NFMS: the Institutional roles and responsibilities for MRV

MRV process is founded on the principles of transparency, accuracy, completeness, and consistency. Credible data and information, supported by an appropriate system, are necessary for this support. In the context of REDD+ measurement, the NFMS is significant due to its role in providing continuous information on activity data and sources of emission factors. NFMS has undergone improvements over the years and functions as an active system with inter-institutional relationships.

The collaboration between institutions begins with the processes of QC/QA. The QA and QC processes are implemented in the production of land cover data, carbon stock data, and the calculation of greenhouse gas (GHG) emissions. Quality control for land cover data is conducted at the regional office level by BPKH, while QA is performed by the Forest Resources Inventory and Monitoring Directorate of the MoEF.

Furthermore, emission factors undergo quality control at the plot level (PSP) conducted by the regional office. The conversion of biomass volume data into carbon stock data involves collaboration between academics from the University and the National Research and Innovation Agency of Indonesia.

The GHG emission calculation process involved quality control conducted by the GHG Inventory & MRV Directorate and the Forest Resources Inventory and Monitoring Directorate. QA is conducted through the involvement of external experts, including MRV specialists, academics, and representatives from the National Research and Innovation Agency of Indonesia.

The NFMS has received substantial support from the government, specifically from the MoEF of Indonesia. The Forest Resource Monitoring System is sanctioned by the Environment and Forestry Ministerial Regulation No. 18/2015, under the authority of the Directorate General of Forestry Planning and Environmental Arrangement. The authority for MRV is situated within the Directorate General of Climate Change, under the MoEF. The two institutions operate independently yet must collaborate and integrate their tasks. The document on REDD+ Performance (MoEF, 2018) elaborates on the arrangement and sharing of authority in managing NFMS for MRV purposes in Indonesia.

Indonesia has developed modalities for the National MRV System to ensure transparent, accurate, consistent, comparative, and comprehensive (TACCC) implementation, comprising of:

- National MRV Scheme (Ministerial Regulation No 72/2017; http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/permen/P72.pdf)
- Registry System (Ministerial Regulation No 71/2017; http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/permen/P71.pdf)
- Guideline for MRV REDD+ (Annex of Ministerial Regulation No 70/2017; http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/P.70.pdf)
- MRV team under DG CC Regulation Number SK.8/PPI-IGAS/2015. Indonesia's MRV scheme for REDD+ outlines the flow of general national MRV process with proper adjustments to accommodate alignment with REDD+ funding schemes and its requirements
- Indonesia's MRV scheme for REDD+ is officially presented in the Annex of Ministerial Regulation on the guidance for implementing REDD+ in Indonesia. The detail guideline for the MRV for REDD+ is provided in Guideline for MRV REDD+ activities (http://ditjenppi.menlhk.go.id/reddplus/images/adminppi/dokumen/pedoman_mrv_redd.pdf)

A1.6. NECESSARY INFORMATION THAT ALLOWS FOR THE RECONSTRUCTION OF THE RESULTS

The necessary data sources for reconstructing the FREL and REDD+ results are available at the following sites:

1. Data on forest cover, burned areas that were produced from Landsat imageries through NFMS are accessible online at https://nfms.menlhk.go.id/peta as online interactive and links to the website of the map server (http://dbgis.menlhk.go.id/arcgis/rest/services/Simontana for the land cover of 2021-2023 period;
2. The peatland spatial data/map produced by the Ministry of Agriculture (MoA)in 2011 could be accessed at http://tanahair.indonesia.go.id. The data also can be accessed via the One Map Web GIS, at http://tanahair.indonesia.go.id managed by Geospatial Information Agency or https://portalksp.ina-sdi.or.id/ under Coordinating Ministry for Economic Affairs.
3. Emission factors used for the calculation of the emission reduction results are presented in the Second FRL document.
4. Comprehensive information on emission reduction estimation which provides data for reconstruction calculation can be accessed upon request.

Indonesia developed a database to generate activity data on deforestation, forest degradation, and EFCS. This database compiles forest and land cover maps from the monitoring period of 2021 to 2023, incorporating peatlands and fire burn scars. Forest cover transition was derived from activity data related to deforestation, forest degradation, and forest gain Table A1-11.

Carlo Simulation for estimating emissions, removals, and emission reductions (Table A1-11). This spreadsheet contains all data related to emission factors, carbon conversion, activity data, and the associated uncertainty levels. It includes the formulas and quantification of emissions, removals, and combined uncertainties.

Table A1 - 11 An example of activity data derived from the land cover change transition matrix as an input in the Monte Carlo Simulation spreadsheet

Parameters for estimating ER	Strata	Units	Input for simulations		
			mean	std error	distribution
Deforestation					
Activity data - initial natural forest (t0)					
AD deforestation	Primary dry land Forest	ha /yr	29,636	8,870	normal
AD deforestation	Secondary dry land Forest	ha /yr	359,853	30,908	normal
AD deforestation	Primary Mangrove Forest	ha /yr	3,060	2,850	normal
AD deforestation	Primary Swamp Forest	ha /yr	17,224	6,762	normal
AD deforestation	Secondary Mangrove Forest	ha /yr	14,305	6,163	normal
AD deforestation	Secondary Swamp Forest	ha /yr	175,153	21,564	normal
			599,232	**39,885**	
Activity data post deforestion (t1)					
AD Plantation forest	Plantation forest	ha /yr	60,050	12,626	normal
AD Dry shrub	Dry shrub	ha /yr	116,339	17,574	normal
AD Estate crop	Estate crop	ha /yr	170,065	21,248	normal
AD Settlement	Settlement	ha /yr	4,300	3,379	trunc normal
AD Bare ground	Bare ground	ha /yr	24,524	8,069	normal
AD Savana and grases	Savanna and Grasses	ha /yr	9,047	4,901	trunc normal
AD Open water	Open water	ha /yr	3,741	3,152	trunc normal
AD Wet shrub	Wet shrub	ha /yr	66,413	13,278	normal
AD Pure agriculture	Pure dry agriculture	ha /yr	17,711	6,857	normal
AD Mixed agriculture	Mixed dry agriculture	ha /yr	108,203	16,949	normal
AD Paddy field	Paddy field	ha /yr	3,785	3,170	trunc normal
AD Fish pond/aquaculture	Fish pond/aquaculture	ha /yr	5,343	3,766	trunc normal
AD Port and harbor	Port and harbor	ha /yr	59	397	trunc normal
AD Transmigration area	Transmigration areas	ha /yr	335	943	trunc normal
AD Mining	Mining areas	ha /yr	6,901	4,280	trunc normal
AD Open swamp	Open swamps	ha /yr	2,416	2,532	trunc normal
			599,232	**39,885**	

A1.7. Description of How the Elements Contained in Decision 4/CP.15, Paragraph 1 (c) and (d), Have been Taken into Account

Decision 4/CP. 15 instructs developing country Parties to consider the guidance on measurement and reporting for REDD+ activities. This includes utilizing the latest Intergovernmental Panel on Climate Change guidance and establishing comprehensive and transparent NFMSs.

A1.7.1. Use of the most recent IPCC Guidance and Guidelines

The calculation methods employed in this Technical Annex align with those utilized in the assessed FRL and adhere to the methodologies outlined in the 2006 IPCC Guidelines for National Greenhouse Gas Inventory (IPCC, 2006), the 2013 Supplement to the 2006 Guidelines for National Greenhouse Gas Inventory: Wetlands or Wetlands Supplement (IPCC, 2014), and the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventory.

The 2006 IPCC Guidelines, specifically Volume 4 (Agriculture, Forestry and Other Land Use (AFOLU) Sector), served as the foundation for estimating emissions resulting from deforestation, forest degradation, and removals associated with the EFCS. According to the IPCC Guidelines, emissions from deforestation are defined as alterations in carbon stocks resulting from the conversion of forest land to alternative land uses. In contrast, emissions from forest degradation pertain to changes in carbon stocks occurring when primary forest is transformed into secondary forest, categorized under the subcategory of forest land remaining forest land. The EFCS pertains to the reductions resulting from the transition of non-forest classes to forest classes.

The 2013 IPCC Wetlands Supplement served as a foundation for estimating emissions resulting from peat decomposition linked to deforestation and forest degradation in peatland areas. Emissions from peat decomposition pertain to those released from drained organic soils as outlined in the IPCC Wetlands Supplement. In the evaluated FREL, emissions from peat decomposition were calculated based on land cover changes following conversion, which established decomposition rates. The rate in peatlands with annual crops varied from that in peatlands with secondary forest or plantations. The Wetlands Supplement is designed for application solely to “drained organic soils”; however, the evaluated FREL did not differentiate between drained and undrained areas, categorizing all secondary forests as drained forests.

The IPCC Guidelines outline a gradual transition of carbon removals as non-forest classes are converted to forest classes, prior to reaching equilibrium phases. This report examines a 14-year transitional period to facilitate the gradual adjustment of biomass removals.

The IPCC Guidelines advocate for Parties to utilize the latest updates of scientific data. The emission factors presented in this report are primarily based on Tier 2 data, compiled from studies conducted in Indonesia. These factors pertain to the estimation of carbon stocks in forest and land cover classes, as well as emission factors related to peat decomposition, peat fires, and soil mangrove emissions.

A1.7.2. Establish, according to National Circumstances and Capabilities, Robust and Transparent National Forest Monitoring System.

The established NFMS utilize a combination of remote sensing and ground-based forest inventory, incorporating satellite-based forest cover mapping alongside the National Forest Inventory (NFI) system. The outputs of both systems, namely forest cover mapping and the NFI, serve as the primary data sources for this report. This system has been developed since the 1990s, with continuous enhancements utilizing advancements in technology.

Indonesia's land cover mapping has evolved through three distinct periods:

- **Period 1 (pre-2000)**: This period utilized a combination of analog data and physical copies of Landsat scenes, which were manually delineated and digitized. The available Landsat data, regardless of being in CCT format or hard copies, frequently exhibited inconsistent temporal intervals. The data utilized for generating land cover maps was obtained in diverse formats and conditions.

- **Period 2 (2000–2009)**: In this period, digital data emerged as the principal resource for land cover mapping. Nonetheless, the continued reliance on manual classification methods rendered the process labor-intensive and resulted in delays in product delivery. Challenges including insufficient experience in wall-to-wall mapping and ongoing cloud cover in certain Indonesian areas impeded progress. Alternative approaches utilizing SPOT Vegetation (1,000 meters) and MODIS (250 meters) data were implemented for expedited reporting.
- **Period 3 (2009 onward)**: This period represented a significant shift, as the resolution of data availability issues enabled Landsat imagery to serve as the exclusive data source. Notable progress commenced in the second period (2006) and emerged as a primary focus in the initial phase of the third period. The process involved migrating sequential land cover data into a unified geodatabase, thereby enhancing interdependence and consistency across layers. The geodatabase offered a viable approach to addressing data integration challenges. Current efforts focus on mitigating the time-consuming aspects of manual classification processes.

The NFI system was developed in 1989 with assistance from the World Bank and FAO for the purpose of conducting forest resource enumeration from 1989 to 1996. The main aim of the NFI project was to facilitate the creation of a forest resource information system and institution, which included the establishment of a Forest Resource Assessment (FRA).

This initiative resulted in the establishment and measurement of numerous forest inventory plots nationwide. The study incorporated permanent sample plots (PSPs) and temporary sample plots (TSPs), systematically arranged in a 20 km x 20 km grid throughout lowland regions situated below 1,000 meters above sea level. In 1996, the NFI project published the inaugural comprehensive statistical report regarding Indonesia's forest resources. This report presents comprehensive data on forest resources, land and forest cover, and timber stocks across different forest functions in Indonesia, excluding Java. The Indonesian government provided the sole comprehensive national report on forest resources.

In 2024, the Ministry of Environment and Forests refined the NFI system to enable the comprehensive enumeration of all plots within a five-year monitoring period. The full implementation of NFI version 2.0 is anticipated in 2025. The plot sizes are structured to facilitate effective measurement and yield accurate data on forest resources, encompassing carbon stocks from biomass, dead organic matter, and SOC. A total of 3,632 clusters of forests and trees outside of forests are systematically distributed according to stratified sampling on a hexagonal grid system. By 2030, it is anticipated that all clusters will be measured, enabling a complete FRA for thorough national reporting.

ANNEX II: COMMON REPORTING TABLES FOR THE ELECTRONIC REPORTING OF THE NATIONAL INVENTORY REPORT OF ANTHROPOGENIC EMISSIONS BY SOURCES AND REMOVALS BY SINKS OF GREENHOUSE GASES

Common Reporting Table

ANNEX III: COMMON TABULAR FORMATS FOR THE ELECTRONIC REPORTING

1. Common Tabular Format Table of NDC Tracking
2. Common Tabular Format Table of Finance, Technology and Capacity Building

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