Republic of Indonesia

Indonesia Climate Change Sectoral Roadmap
ICCSR

Synthesis Report

December 2009

AUTHORS

Indonesia Climate Change Sectoral Roadmap - ICCSR

Adviser
Prof. Armida Salsiah Alisjahbana, State Minister of National Development Planning/Head of Bappenas

Editor in Chief
U. Hayati Triastuti, Deputy Minister for Natural Resources and Environment, Bappenas

ICCSR Coordinator
Edi Effendi Tedjakusuma, Director of Environmental Affairs, Bappenas

Sector Coordinators: Sriyanti, Montty Girianna, Wahyuningsih Darajati, Basah Hernowo, Yahya R. Hidayat, Bambang Prihartono, Mesdin Kornelis Simarmata, M. Donny Azdan, Arum Atmawikarta, Budi Hidayat

Editors
Irving Mintzer, Syamsidar Thamrin, Heiner von Luepke, Philippe Guizol, Medrilzam, Chandra Panjiwibowo, , Leyla Stender, Tom Harrison, Flossmann Krauss Ursula, Anna Amalia, Indra Ni Tua, Tri Dewi Virgyanti.

Synthesis Report
Coordinating Authors: Djoko Santoso Abi Suroso, Tri Wahyu Hadi, Wilmar Salim

Scientific Basis and Sectoral Reports
Authors: Ibnu Sofian, Tri Wahyu Hadi, Meirios Moechtar, Wendranirsa, Iwan Adhisaputra, Nur Masripatin, Ngaloken Gintings, I Wayan Susi Darmawan, Asep Sofyan, Enri Damanhuri, Agus Wahyudi, Endang Supraptini, Anandita Laksmi Susanto, Anja Rosenberg, Nicolette Boele, Bona Frazila, Ko Sakamoto, Irawan, Eleonora Runtunuwu, Oman Abdurrahman, Budhi Setiawan, Supratman Sukowati, Juli Soemirat Slamet, Hamzah Latief, M. Suhardjono Fitrianto

Technical Assistant and GIS
Hendra Julianto, Edi Riawan, Wahyunto

Supporting Team
Reziana Maulina, Altamy Chrysan Arasty, Risnawati, June Ratna Mia, Rinanda Ratna Putri, Siwi Handinah, Wahyu Hidayat, Eko Supriyatno, Rama Ruchyama, Arlette Naomi, Samil Akib.

ACKNOWLEDGMENTS

The Indonesia Climate Change Sectoral Roadmap (ICCSR) is meant to provide inputs for the 5 year Medium-term Development Plan (RPJM) 2010-2014, and also for the subsequent RPJMN until 2030, laying particular emphasis on the challenges emerging in the forestry, energy, industry, agriculture, transportation, coastal area, water, waste and health sectors. It is Bappenas' policy to address these challenges and opportunities through effective development planning and coordination of the work of all line ministries, departments and agencies of the Government of Indonesia (GoI). It is a dynamic document and it will be improved based on the needs and challenges to cope with climate change in the future. Changes to this document would be done through participative consultation among stakeholders.

High appreciation goes to Mrs. Armida S. Alisjahbana as State Minister of National Development Planning Agency/Head of Bappenas for the support and encouragement. Also, Mr. Paskah Suzetta as the Previous Minister of National Development Planning who initiated and supported the development of the ICCSR and Deputy Minister for Natural Resources and Environment, Ministry of National Development Planning/Bappenas, who initiates and coordinates the development of the ICCSR.

Steering Committee (SC)
Deputy of International Cooperation, Coordinating Ministry for Economy; Secretary of Minister, Coordinating Ministry for Public Welfare; Deputy of Demography, Health, and Environment, Coordinating Ministry of Public Welfare; Secretary General, Ministry of Energy and Mineral Resources; Secretary General, Ministry of Forestry; Secretary General, Ministry of Agriculture; Secretary General, Ministry of Marine and Fisheries; Secretary General, Ministry of Public Works; Secretary General, Ministry of Industry; Secretary General, Ministry of Transportation; Secretary General, Ministry of Health; Executive Secretary, Agency for Meteorology, Climatology; Deputy of Economy, Deputy of Infrastructures, Deputy of Development Funding, Deputy of Human Resources and Culture, Deputy of Regional Development and Local Autonomy, National Development Planning Agency; Chairman of the National Council for Climate Change.

Working Group
Ministry of Agriculture
Head of Planning Bureau, Irsal Las, Gatot Irianto, Astu Unadi, Elza Sumairni, Aris Pramudia, Suryo Wiyono, Sony Sumaryanto, Setiari Marwanto, Bambang Budiarto

Ministry of Energy and Resources
Head of Planning Bureau, Maritje Hutapea, Bambang Praptono, Djoko Prasetyo, Muhammad Ikbal Nur, Agus Rianto, Arief Sugiyanto

Ministry of Environment
Sulistyowati, Haneda Sri Mulyanto, Dadang Hilman

Ministry of Forestry
Head of Planning Bureau, Hilman Nugroho, Sunaryo, Ernawati, Bambang Edy Purwanto, Bambang Soepijanto, Haryadi, M. Ali Arsyad, Yuyo Rahayu, Adi Susmianto, Harry Santoso, Maman Mansyur Idris, R. Iman Santoso, Wardoyo, Adi Nugroho

Ministry of Health
Head of Planning Bureau, Wan Alkadri, Sri Endah S., Ann Natallia, Tutut Indra Wahyuni, Slamet, Mukti Rahadian

Ministry of Industry
Head of Planning Bureau, Endang Supraptini, Yasmita, Zurlasni

Ministry of Marine and Fisheries
Head of Planning Bureau, Subandono Diposaptono, M. Eko Rudianto, Sunaryanto, Toni Ruchima, Gellwyn Yusuf, Ida Kusuma Wardhaningsih, Umi Windriani, Budiasih, Agus Supangat

Ministry of Public Works
Head of Planning Bureau, Mochammad Amron, Susmono, A. Hasanudin, Djoko Mursito, Handy Legowo, Setya Budi Algamar

Ministry of Transportation
Head of Planning Bureau, Wendy Aritenang, Balkis K, Saladin

National Development Planning Agency
Hanan Nugroho, Jadhie Ardajat, Anwar Sunari, Hadiat, Arif Haryana, Tommy Hermawan, Suwarno, Erik Amundito, Rizal Primana, Nur H. Rahayu, Pungki Widiaryanto, Maraita, Wijaya Wardhana

Agency for Meteorology, Climatology and Geophysics
Edvin Aldrian, Dodo Gunawan, Nurhayati, Soetamto

National Institute of Aeuronatics and Space
Agus Hidayat, Halimurrahman, Bambang Siswanto

Research and Implementatiton of Technology Board
Eddy Supriyono, Fadli Syamsuddin

National Coordinating Agency for Survey and Mapping
Suwahyono, Habib Subagio, Agus Santoso

Universities and Professionals
ITB: Saut Lubis, Safwan Hadi, Retno Gumilang, Arwin Sabar; IPB: Rizaldi Boer, Handoko, Dietriech Geoffrey Bengen, Hariadi Kartodiharjo; UI: Budi Haryanto, Asia Carbon:

Architrandi Priambodo, Susy Simarangki: Dishidros, TNI-AL: Letkol Ir. Trismadi, MSi, LIPI: Wahyoe Hantoro, KNI WEC: Hardiv Situmeang, and Aziz Trianto

Who provide valuable comments and inputs in development of the ICCSR document, their contributions are highly appreciated and acknowledged.

Grateful thanks to all staff of the Deputy Minister for Natural Resources and Environment, Ministry of National Development Planning, who were always ready to assist the technical facilitation as well as in administrative matters for the finalization process of this report.

The development of the ICCSR document was supported by the *Deutsche Gesellschaft fuer Technische Zusammenarbeit* (GTZ) through its Study and Expert Fund for Advisory Services in Climate Protection and its support is gratefully acknowledged.

Remarks from State Minister of National Development Planning/Chairman of Bappenas

We have seen that with its far reaching impact on the world's ecosystems as well as human security and development, climate change has emerged as one of the most intensely critical issues that deserve the attention of the world's policy makers. The main theme is to avoid an increase in global average temperature that exceeds 2°C, i.e., to reduce annual worldwide emissions more than half from the present level in 2050. We believe that this effort of course requires concerted international response – collective actions to address potential conflicting national and international policy initiatives. As the world economy is now facing a recovery and developing countries are struggling to fulfill basic needs for their population, climate change exposes the world population to exacerbated life. It is necessary, therefore, to incorporate measures to address climate change as a core concer and mainstream in sustainable development policy agenda.

We are aware that climate change has been researched and discussed the world over. Solutions have been proferred, programs funded and partnerships embraced. Despite this, carbon emissions continue to increase in both developed and developing countries. Due to its geographical location, Indonesia's vulnerability to climate change cannot be underplayed. We stand to experience significant losses. We will face – indeed we are seeing the impact of some these issues right now- prolonged droughts, flooding and increased frequency of extreme weather events. Our rich biodiversity is at risk.

Those who would seek to silence debate on this issue or delay in engagement to solve it, are now marginalised to the edges of what science would tell us. Decades of research, analysis and emerging environmental evidence tell us that far from being merely just an environmental issue, climate change will touch every aspect of our life as a nation and as individuals.

Regrettably, we cannot prevent or escape some negative impacts of climate change. We and in particular the developed world, have been warming the world for too long. We must prepare therefore to adapt to the changes we will face and also prepare, with our full energy, to mitigate against further change. We have ratified the Kyoto Protocol early and guided and contributed to world debate, through hosting the 13th Convention of the Parties to the United Nations Framework Convention on Climate Change, which generated the Bali Agreement in 2007. Most recently, we have turned our attention to our biggest challenge yet, that of delivering on our President's promise to reduce carbon emissions by 26% by 2020. Action is urgent. But before action, we need to come up with careful analysis, strategic planning and priority setting.

I am delighted therefore to deliver *Indonesia Climate Change Sectoral Roadmap* or I call it ICCSR with the aim at mainstreaming climate change into our national medium-term development plan.

The ICCSR outlines our strategic vision that places particular emphasis on the challenges emerging in the forestry, energy, industry, transport, agriculture, coastal areas, water, waste and health sectors. The content of the roadmap has been formulated through a rigorius analysis. We have undertaken vulnerability assessments, prioritized actions including capacity-building and response strategies, complete with associated financial assessments and sought to develop a coherent plan that can be supported by line Ministries and relevant strategic partners and donors.

I commend ICCSR to you and I ask for your support and partnership in joining us in realising priorities for climate-resilient sustainable development while protecting our population from further vulnerability.

State Minister for National Development Planning
Head of National Development Panning Agency

Prof. Armida Salsiah Alisjahbana

Remarks from Deputy Minister for Natural Resources and Environment, Bappenas

To be a part of the solution to global climate change, the government of Indonesia has endorsed a commitment to reduce the country's GHG emission by 26%, within ten years, benchmarked to the emission level from a business as usual. The top two sectors that contribute to the country's emissions are deforestation and the energy sector, mainly emissions by power plants, which is in part due to the fuel used, i.e., oil and coal, and part of our high energy intensity.

With a unique set of geographical location, among contries on the Earth we are at most vulnerable to climate change. Measures are needed to protect our people from the adverse effect of sea level rise, flood, greater variability of rainfall, and other predicted impacts. Unless measures are taken, prediction tells us that a large fraction of our people could experience freshwater scarcity, crop yields could drop, and coastal communities and ecosystem could vanish.

National actions showing a roadmap sectoral measures are needed both to mitigate the global climate change and to identify climate change adaptation measures. A set of highest priorities of the actions are to be integrated into our national development plan. We have been working to build national concensus and understanding on climate change response options. The *Indonesia Climate Change Sectoral Roadmap* provides our long-term commitment to emission reduction and adaptation measures and it shows our ongoing, inovative, and future climate mitigation and adaptation programs.

Deputy Minister for Natural Resources and Environment
National Development Planning Agency

U. Hayati Triastuti

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

3R	Reduce, Reuse, Recycle
ADT	Absolute Dynamic Topography
AMI	Annual Malaria Incidence
ANI	Indonesian National Atlas
API	Annual Parasite Incidence
ASEAN	Association of South East Asian Nations
ASI	Indonesian Cement Association
Bappenas	National Development Planning Agency
BaU	Business as Usual
BMKG	Meteorology Climatology and Geophysics Agency
BPOM	Food and Drug Monitoring Office
CCS	Carbon Capture and Storage
CERs	Certified Emission Reductions
CFR	Case Fatality Rate
CGCM	Coupled General Circulation Model
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
EN	El Nino
ENSO	El Niño Southern Oscillation
ESCO	Energy Services Companies
FAO	Food and Agriculture Organization
FNC	First National Communication
GCM	General Circulation Model
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHGe	Greenhouse Gas Emissions
GoI	Government of Indonesia
HTI	Industrial Plant Forest
HTR	Community Plant Forest
IEA	International Energy Agency
IFFM	Integrated Forest Fire Management
IPCC AR-4	Intergovernmental Panel on Climate Change Assessment Report 4
IR	Incidence Rate
JITUT	Small Agriculture Level Irrigation Network
KPH	Forest Management Units
LN	La Nina
LUCF	Land Use Change Forestry
LULUCF	Land Use, Land Use Change and Forestry
MoMF	Ministry of Marine and Fisheries
MRI	Meteorological Research Institute

MtCO2	Million Tons Carbon Dioxide
MW	Mega Watt
NAPZA	Psychotropic Substances and Addictives
NOAA	National Oceanic and Atmospheric Agency
NO_x	Nitrogen Oxide
NPP	Nuclear Power Plant
NPV	Nett Present Value
OI	Optimum Interpolation
PTT	Integrated Crop Management
PUSKESMAS	Public Health Center
RAN-PI	National Action Plan on Climate Change
REDD	Reducing Emissions from Deforestation and Degradation
RPJMN	National Medium-Term Development Plan
RPJPN	National Long-Term Development Plan
RUPTL	Master Plan for Electricity Supply
SAT	Surface Air Temperature
SC1	Scenario 1
SC2	Scenario 2
SC3	Scenario 3
SC4	Scenario 4
SFM	Sustainable Forest Management
SLI	Field School of Climate
SLPHT	Field School of Integrated Pest Control
SL-PTT	Field School of Integrated Crop Management
SLR	Sea Level Rise
SRA	Special Report on Aviation
SRES	Special Report on Emission Scenario
SST	Sea Surface Temperature
TNA	Technology Need Assessment
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States (of America) dollars or US$
WP3K	Coastal Zones and Small Islands

1 BACKGROUND

Indonesia plays an active role in various international negotiations on climate change, and of being the host of the 13th Conference of the Parties to the UNFCCC in Bali which generated the Bali Action Plan. As one of the countries most vulnerable to the impacts of climate change, Indonesia needs to be at the forefront to push collective efforts against climate change. Indonesia recognises that mitigation and adaptation actions have to be taken jointly by all countries. Therefore Indonesia is ready to cooperate both bilaterally and multilaterally with the various parties.

Indonesia recognizes that tackling climate change is an integral part of the development program of a nation. Climate change planning cannot and should not be performed separately from general development planning, therefore mitigation and adaptation planning needs to be integrated into both the national and local development planning. Through the Roadmap to Mainstream Climate Change into Development Plans, it is expected that sectoral and cross-sectoral development programs have included climate change as a consideration.

On February 5th 2007 the Indonesian Government issued Law No. 17 of 2007 on National Long-Term Development Plan (RPJPN) Year 2005-2025. The Sixth mission statement of this document is:

> *"To make Indonesia wonderful and preserved by keeping the balance between utilization, sustainability, existence, and usefulness of natural resources and the environment, by protecting the function, capacity and the comfort of living in the present and the future, through balanced land use for settlement, social economic activities and conservation; augmenting the economic utilization of natural resources and environment sustainably; improving the management of natural resources and the environment to support the quality of life; providing the wonder and comfort of life; and enhancing the preservation and utilization of biodiversity as basic capital of development".*

In order to achieve this vision of sustainable development, it is realized that "the long term sustainability of development will face the challenges of **climate change and global warming** which affect activities and livelihood".

In November 2007 the Indonesian Government published the National Action Plan on Climate Change (RAN-PI), which contains the initial guidance and multi-sectoral coordination

effort to address mitigation and adaptation to climate change.

In December 2007 Bappenas (National Development Planning Agency) also published a document titled **"National Development Planning: Indonesia Responses to Climate Change"**, that has been revised in July 2008. The document is intended to strengthen and reinforce the RPJMN (National Medium-Term Development Plan) 2004-2009 as well as to include inputs for the preparation of RPJMN 2010-2014 in the context of integrating climate change.

To elaborate further on the documents mentioned above and also to speed up the implementation by the various relevant sectors, a roadmap for mainstreaming climate change issues into national development planning, or the "Indonesia Climate Change Sectoral Roadmap" (ICCSR) and it will be called as The Roadmap throughout this synthesis report.

2 APPROACH

The Climate Change Roadmap is prepared to cover a time frame of 20 years (2010-2029). Priority programs of the Roadmap are outlined in four phases of five years in the relevant RPJM (see Figure 1). The programs of the Roadmap will be integrated into the RPJMN 2010-2014. Further on, it will be considered in the strategic plans of each ministry/agency.

The Roadmap recognizes that regional approaches are needed. The policy response to climate change has been tailored to the characteristics of the main regions: Sumatra, Jamali (Jawa, Madura, Bali), Kalimantan, Sulawesi, Nusa Tenggara, Maluku, and Papua.

The inter-linkages between the Climate Change Roadmap and Development Planning can be seen in Figure 1 below:

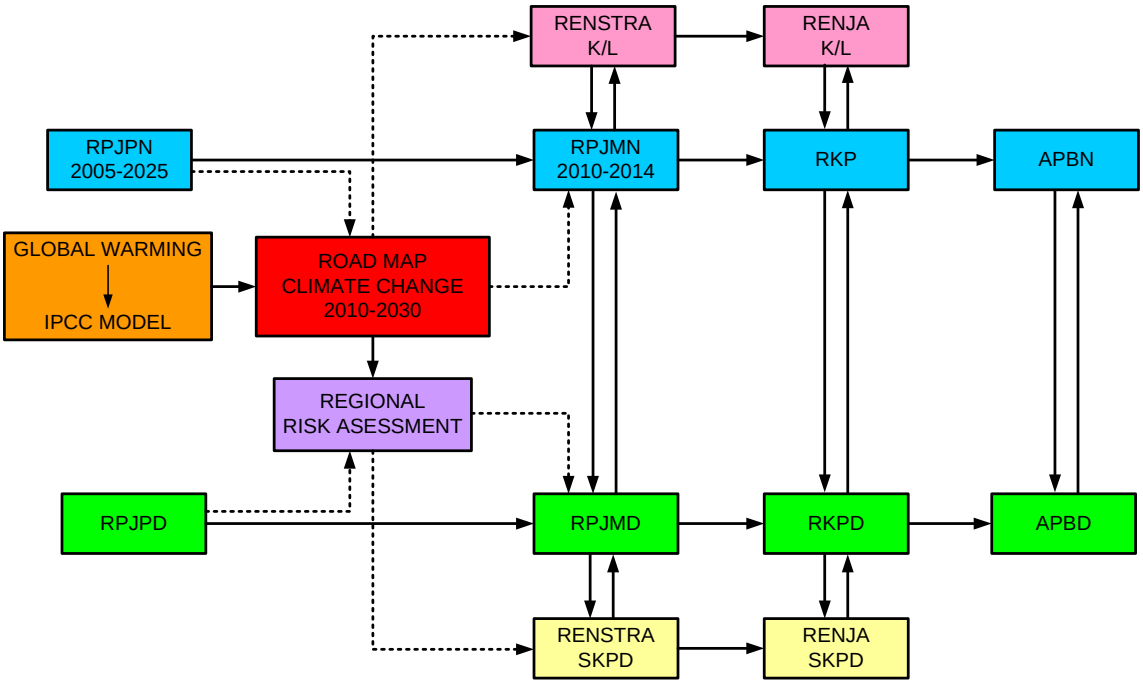

Figure 1 Inter-linkages between the Climate Change Roadmap and Development Planning

By applying risk assessments framework, adaptation strategy formulation begins with the identification of climate hazards. This is done by employing climate change projections, including the future projections of temperature, rainfall, sea level rise, and the occurrence of extreme events. The impact of climate change towards all relevant sectors (Figure 2) is then analyzed. Priority activities of adaptation will be then be formulated based on the potential impact. Meanwhile, the formulation of mitigation activities are based on the study of current emission levels (Greenhouse Gas Inventory) and the emission reduction scenario of each sector (energy, transportation, industries, forestry, and waste).

To ensure the related ministries and agencies involvement and ownership of the Roadmap, the development of the Roadmap is carried out through a participatory approach involving three parties; the National Development Planning Agency (Bappenas), the ministries/agencies, and the Technical Team. Through this process it is expected that priority activities developed in the Roadmap are prepared by each ministry/agency with Bappenas as a facilitator.

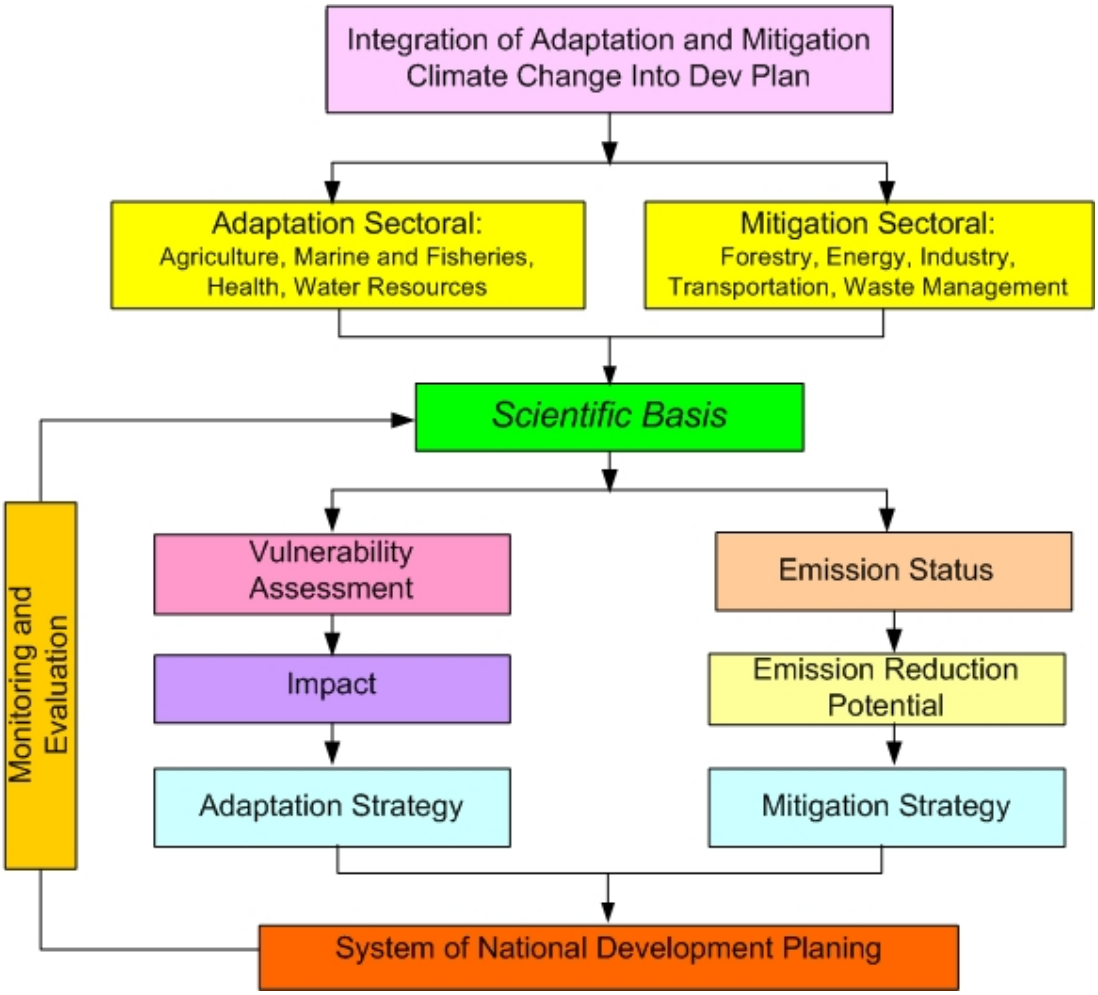

Figure 2 Roadmap Development Approach

This report starts with the background for and the approach of the Climate Change Roadmap, which is followed with a synthesis of the current state of the science regarding climate change in Indonesia, including projections of land surface air temperature change and precipitation change, as well as projections of sea surface temperature rise, sea level rise and the occurrence of extreme climate events. The report then will be followed by a National Roadmap for mainstreaming climate change into development planning that synthesizes the Roadmap of all sectors. The summary of Roadmap reports of each sector for adaptation consists of current conditions and projections, issues and prioritized programs, while the summary of Roadmap reports of each sector for mitigation consists of the emission status and the mitigation potential. This report is then closed with a discussion of cross-cutting issues and conclusions.

3 IDENTIFICATION OF CLIMATE CHANGE HAZARDS IN INDONESIA

3.1 Surface Air Temperature Increase and Precipitation Change

The increase of Surface Air Temperature (SAT) is seen as the main climate change issue caused by the anthropogenic driven increase of CO_2 and other greenhouse gas emissions. Results of observed monthly SAT in Indonesia over a period of 100 years shows that a certain degree of climate change has occurred in Indonesia. The data that have been collected from the limited number of stations suggest that a temperature increase of around 0.5ºC has occurred during the 20th century. This magnitude of temperature increase is in agreement with the rate of averaged global temperature increase as estimated in IPCC AR-4, which is about 0.7ºC ± 0.2 per century.

Based on the analysis of Global Circulation Model (GCM) output, projected average temperature increase in Indonesia is between 0.8º - 1ºC for the period of 2020-2050, relative to the baseline period of 1961-1990. The differences in projected SAT between Special Report on Emission Scenario (SRES) B1, A1B, and A2 are not significant for 2030, but become more distinct for the period of 2070-2100. The temperature increase in the Java-Bali region are projected to reach 2ºC, 2.5ºC, and 3ºC for B1, A1B, and A2 scenarios respectively. There are higher probabilities for higher temperature increase in Kalimantan and Sulawesi, but the largest temperature increase of around 4ºC will likely occur in Sumatra. The trend of temperature increase is generally different for each month by 0-2ºC.

Different from the projected temperature increase, the projected precipitation pattern has more significant temporal and spatial variation. For Indonesian rainfall, in general it is important to note that the trend of rainfall change may be quite different, not only seasonally but also from month to month. Based on analysis of observed rainfall patterns in Jakarta for example, there has been an increase of around 100 mm in rainfall around 1970 compared to that of 1900. Other results indicate that the rainfall over central and northern parts of Sumatra has been increasing by 10-50 mm over recent decades compared to that of 1960-1990.

Rainfall change projections based on observational data analysis indicate that there will not be significant changes from the current mean annual precipitation over the Java-Bali region for the period of 2010 to 2015. However, projected rainfall of the 2010 to 2020 period shows more significant increases in the rainfall of the December-January-February-March period

over large regions. Also, with larger variability, expected rainfall over Sumatra and Papua is expected to increase for almost all seasons until 2020. On the other hand, rainfall is projected to decrease during the July-Augusts-September periods for regions like Java-Bali, Sulawesi, Kalimantan, and Maluku. A rough summary of results from the trend analysis are shown in Table 1.

Table 1 Projected rainfall changes (mean and standard deviation) in Indonesia during the period of 2010-2020 (relative to 1980-2007 period), based on polynomial trend analysis of observational data

Region	Mean Rainfall												Standard Deviation											
	Month (January to December)												Month (January to December)											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Java-Bali	⮟	⮝	⮝	⮝	O	⮝	O	O	⮟	O	⮟	⮝	✸	✪	✪	⊙	⊙	⊙	⊙	⊙	⊙	✪	⊙	⊙
Sumatra	⮝	⮝	⮝	⮝	✦	O	⮝	⮝	⮝	⮝	✦	⮝	✸	✸	✪	✪	⊙	⊙	⊙	✪	⊙	✪	✪	✪
Sulawesi	⮝	⮝	⮝	⮝	✦	⮝	O	⮟	✦	⮟	✦	⮝	✸	✪	✪	⊙	✪	⊙	⊙	✪	✪	✪	⊙	⊙
Kalimantan	⮝	⮝	⮝	⮝	✦	O	⮟	⮟	⮝	⮟	✦	⮝	✪	✪	✪	✪	⊙	⊙	⊙	✪	⊙	✪	⊙	⊙
Maluku	O	⮝	⮝	O	O	⮝	⮟	⮟	O	⮟	✦	⮝	✪	✪	✪	✪	⊙	✪	⊙	⊙	⊙	⊙	⊙	⊙
Nusa Tenggara	⮟	⮟	⮝	O	O	O	O	O	⮝	⮟	O	⮝	✪	✪	✪	⊙	⊙	⊙	⊙	⊙	⊙	⊙	✸	⊙
Papua	⮝	⮟	⮝	⮝	✦	⮝	✦	⮝	⮝	O	⮝	⮝	✪	✪	✪	✪	⊙	⊙	✪	✪	⊙	⊙	⊙	⊙

⮝ : mainly increasing , ⮟ : mainly decreasing, ✦ : ⮝ and ⮟ are almost evenly distributed,
O : mainly unchanged , ✸ : mainly increasing (standard deviation), ✪ : most area increasing,
✪ : most area decreasing , ⊙ : unchanged or changes are not significant

Results from GCM output do not show significant change in the rainfall pattern during the period of 2020-2050. However, large changes can be found in the projected rainfall of the 2070-2100 period, especially for higher CO_2 emission scenario (SRES A2). The results of this projection are summarized in the following table:

Table 2 Trend of rainfall change in Indonesia based on GCM data with A2 scenario 2070-2100

Region	Sub-Region	Month (January – December)											
		J	F	M	A	M	J	J	A	S	O	N	D
Jawa-Bali	West	↗	↗								↘		↗
	Central	↗	↑		↘								↗
	East	↗	↑		↘								↗
	Bali Island		↑		↘								↗
Sumatra	North	↘	↘	↘	↘	↗	↗	↗	↑	↑	↗	↗	
	Central-North					↗	↗	↗	↑	↗	↗	↗	↗
	Central-South	↗	↗	↗	↗			↗	↗	↗		↗	↗
	South	↗	↗	↗	↗						↘		↗
Sulawesi	North				↗	↑	↗		↑	↗	↗		
	Central				↑	↗	↗	↘			↗	↗	↗
	South	↑	↗	↗	↗	↗			↘				↗
	South East	↗			↗	↗			↘				
Kalimantan	North West	↘		↘		↗	↗	↗	↑	↗		↗	
	South West	↑	↑	↗	↗	↗	↗	↗	↗	↗			↗
	North East					↗	↗		↗	↗			↗
	South East	↗	↗			↗				↗			↗
Maluku	North	↗			↑	↑	↑	↑	↑	↑	↑	↑	↑
	Central				↗	↗	↑		↗	↑	↑		
	West				↑	↗		↘					
	South				↗	↑	↗			↑	↑	↗	
Nusa Tenggara	West		↗		↘						↗		
	Central		↗										
	East				↘	↘					↗		
	Timor Island					↘					↗		
Papua	West	↑	↗	↗	↗	↑	↑	↗	↑	↑	↑	↗	↗
	Central	↑	↗	↗	↗	↗	↗	↗		↑	↑	↗	↑
	East	↑	↗	↗	↗	↗	↗	↗		↑	↑	↗	↑
	South	↗							↘				

↑ Highly significant increase (≥50 mm), ↗ significant increase (≥25 mm; <50 mm), ↘ significant decrease, ↓ highly significant decrease

3.2 Sea Surface Temperature Rise, Sea Level Rise and Extreme Climatic Events

Sea Surface Temperature (SST) rise is a direct consequence of surface air temperature increase. The average SST in Indonesian waters is projected to increase by as much as 0.65°C in 2030, 1.10°C in 2050, 1.70°C in 2080, and 2.15°C in 2100 (based on trend analysis from historical data). One of the immediate impacts of SST increase is a depletion and movement of fishing stocks away from Indonesian waters.

Sea Level Rise (SLR) is another important climate change issue. It is brought about by the melting of ice and glaciers at the poles, and by the thermal expansion of sea water. SLR for Indonesia has been projected from observed satellite altimeter and tidal data, as well as from GCM (IPCC AR-4) output. An average SLR of 0.6 cm/year to 0.8 cm/year has been estimated and more complete results are summarized in the following table.

Table 3 Sea Level Rise Projection since 2000

Period	Tide Gauge	Altimeter ADT	Model	Level of confident
2030	24.0cm±16.0cm	16.5cm±1.5cm	22.5±1.5cm	Moderate
2050	40.0cm±20.0cm	27.5cm±2.5cm	37.5±2.5cm	Moderate
2080	64.0cm±32.0cm	44.0cm±4.0cm	60.0±4.0cm	High
2100	80.0cm±40.0cm	60.0cm±5.0cm	80.0±5.0cm	High

With thousands of islands and a vast coastline, Indonesia is expected to suffer from the severe and drastic impacts of SLR. Many large cities such as Jakarta, Semarang, and Surabaya are expected to suffer from flooding and inundation. During extreme weather conditions, extreme waves with heights of 2-3 meters can be triggered. Below are future inundation projections for three major cities in Indonesia, based on the pessimistic scenario for 2100.

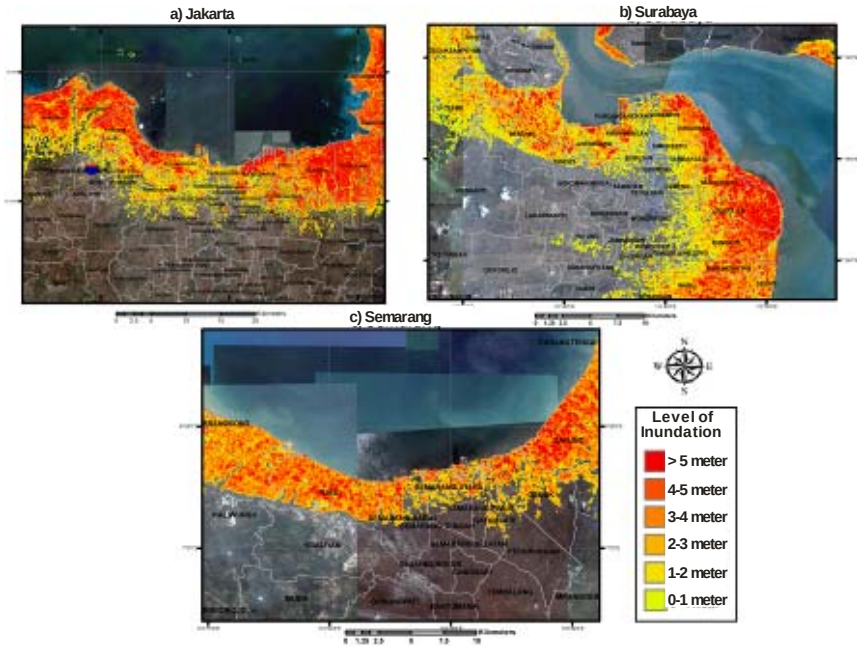

Figure 3 Projected Sea Level Rise in Jakarta, Surabaya and Semarang in 2100

Changing ocean environmental condition will also affect climate variability. For example, the projected frequency of ENSO events, El Niño and La Niña, is expected to increase from its current 3 to 7 years interval to happening every 2 to 3 years. El Niño and La Niña phenomena are well known to have impacts on rainfall variation in Indonesia but they also affect sea level and ocean weather by inducing more extreme waves. The occurrence of El Niño and La Niña is believed to induce wave height variations in the order of 2 to 5 meters. More complete projections of El Niño and La Niña occurrences in the future are shown in the following table:

Table 4 Projection of El Niño and La Niña

	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agus	Sep	Okt	Nop	Des
2001	-1.04	-0.86	-0.81	-0.33	-0.55	-0.29	0.12	0.26	-0.34	-0.85	-0.85	-1.02
2002	-1.04	-0.77	-0.47	0.13	0.77	0.75	1.00	1.37	1.47	1.77	1.79	1.60
2003	1.13	0.81	0.09	-0.35	-0.56	-0.61	-1.16	-1.16	-1.05	-0.67	-0.69	-0.95
2004	-0.83	-1.20	-1.19	-0.86	-0.37	-0.78	0.30	0.42	0.77	0.93	0.89	1.13
2005	0.84	0.29	0.00	-0.25	-0.38	-0.75	-0.45	-0.68	-0.32	-0.77	-1.07	-0.99
2006	-0.89	-1.12	-1.19	-1.79	-1.68	-1.04	-0.53	-0.41	-0.36	-0.30	-0.28	-0.55
2007	-0.63	-0.93	-0.80	-0.72	-0.91	-0.29	0.10	0.23	0.43	0.72	0.76	0.69
2008	0.78	0.53	0.23	0.06	-0.90	-0.76	-0.84	-0.36	-0.67	-0.82	-0.75	-1.01
2009	-1.07	-0.78	-0.11	0.07	0.29	1.21	1.39	1.58	1.36	1.29	1.38	1.31
2010	0.98	0.56	-0.26	-1.18	-1.48	-1.23	-1.44	-1.74	-1.56	-1.86	-1.93	-2.11
2011	-1.98	-1.91	-1.63	-1.28	-0.10	1.53	2.21	1.99	2.24	2.40	2.73	3.06
2012	2.75	2.37	1.61	1.00	0.83	-0.06	-0.20	-0.01	-0.78	-1.02	-1.18	-1.59
2013	-1.45	-1.22	-0.54	-0.50	-0.42	-0.11	0.04	0.50	0.38	0.07	-0.08	0.12
2014	0.03	-0.20	-0.27	0.31	0.04	-0.24	-0.35	-0.46	-0.44	-0.14	-0.59	-0.54
2015	-0.70	-0.91	-0.50	-0.13	-0.04	-0.44	-0.15	-0.39	-0.05	-0.26	-0.52	-0.55
2016	-1.09	-0.91	-0.36	0.02	0.11	0.12	0.67	-0.03	-0.43	-0.45	-0.84	-0.97
2017	-1.09	-1.18	-1.30	-0.68	-0.95	-1.33	-1.09	-1.67	-1.91	-2.00	-2.09	-2.20
2018	-1.93	-1.97	-1.80	-1.36	-0.52	1.09	2.24	1.65	1.74	1.94	2.23	2.36
2019	2.50	2.25	1.85	1.39	1.19	0.73	0.50	0.73	0.45	0.17	-0.42	-0.78
2020	-0.82	-1.03	-0.85	-0.74	-1.26	-1.13	-1.41	-1.71	-2.28	-2.16	-2.35	-1.87
2021	-1.51	-1.54	-1.50	-1.09	-0.15	0.14	0.06	0.24	-0.21	-0.27	-0.08	-0.02
2022	-0.06	-0.18	-0.53	-0.56	-0.50	-0.83	-0.48	-0.40	-0.60	-0.71	-0.95	-1.49
2023	-1.40	-1.32	-0.90	-0.46	-0.03	1.05	0.63	1.13	1.04	0.92	0.73	0.25
2024	0.47	0.36	-0.28	-0.94	-1.33	-1.25	-1.31	-0.95	-0.85	-1.03	-0.90	-0.88
2025	-0.86	-0.97	-0.47	-0.66	-0.65	-0.48	-0.53	-0.36	0.29	0.53	0.70	0.50
2026	0.73	0.71	0.42	0.23	-0.56	-0.83	-0.85	-1.23	-1.87	-1.59	-1.64	-1.43
2027	-1.38	-2.00	-1.94	-1.49	-0.48	0.11	0.12	0.40	0.44	0.38	0.06	-0.38
2028	-0.54	-0.26	0.03	-0.20	-0.81	-0.64	-0.27	-0.44	-0.04	0.28	0.02	0.08
2029	0.26	0.39	0.18	-0.34	-0.65	-0.88	-1.37	-1.47	-1.94	-2.25	-1.92	-1.24
2030	-0.92	-0.80	-1.14	-0.89	-0.77	-0.79	-0.19	-0.12	0.51	0.45	0.56	0.37

La Niña El Niño

4 NATIONAL ROADMAP FOR MAINSTREAMING CLIMATE CHANGE INTO DEVELOPMENT PLANNING

As stated in the Long-Term Development Plan (RPJP) 2005-2025, sustainability of development will face challenges of climate change. To anticipate these challenges the Roadmap sets several goals with regards to adaptation and mitigation of climate change to be achieved in the next 20 years, which will give comprehensive targets for all related sectors. The goals are as follows:

1. a. Advanced research on the impact of climate change and the mapping of local vulnerability will be performed to strengthen the information system for adaptation in 2015.
   b. Inventory of CO_2 emissions is refined and the target of emission reduction will be adjusted in 2015.
2. a. As the institutional capacity of national ministries and agencies to anticipate climate change impacts has been strengthened in year 2015, the climate-proof policy-making process and regulation will be achieved in 2020.
   b. The emission of greenhouse gas will decrease by 26% from the projected "business as usual" emission in 2020.
3. a. National development goals will be optimized with the influence of adaptation actions in 2025.
   b. Alternative sources for energy use will be significantly increased, while the use of non-renewable energy sources will be proportionately reduced.
4. a. The risks from climate change impacts on all sectors of development will be considerably reduced in year 2030, through public awareness, strengthened capacity, improved knowledge management, and the application of adaptive technology.
   b. All sectors that contribute to greenhouse gas emission will operate using low-carbon development concept.

It is expected from this Roadmap that national programs of sectoral or cross-sectoral development will take into consideration future climate change, especially the sectors relevant for adaptation and mitigation. The sectors that need to plan adaptation actions are the following: water resources sector; marine and fisheries sector; agriculture sector; and health sector, while for mitigation principally consists of forestry sector; energy sector; industry sector; transportation sector; and waste sector.

As a nationally concerted effort to cope with climate change, the Roadmap sets up three categories of activities in each development sector as follows:

Category 1. Data, Information and Knowledge Management (KNOW-MANAGE)

This category consists of activities related to data collection, information development and knowledge management about the impacts of climate change and of the contribution of

sectors towards climate change. This is to be achieved through scientific research, based on collaboration between universities, research institutions and the government.

Category 2. Planning and Policy, Regulation and Institutional Development (PLAN-PRIDE)

This category consists of activities related with formulation of plans for specific adaptation and mitigation actions that utilize the information resulting from activities in Category 1 and also capacity/institutional development. These programs are to develop plans, policies, regulations and institutional development, which will support the implementation of adaptation and mitigation actions.

Category 3. Plans and Programs Implementation and Control with Monitoring and Evaluation (ICON-MONEV)

This category consists of activities to implement plans for adaptation and mitigation of climate change. In addition to that control through monitoring and evaluation is embedded in this category to ensure effective implementation of those plans and programs.

In order to allocate national resources efficiently and effectively for achieving several goals for the next twenty years, ICCSR develops programming strategy for each period of RPJM as follows:

1) At the initial period of implementation of the Medium-Term Development Plan (RPJM) 2010-2014, activities are more concentrated on Category 1. Consequently, activities which are included in Category 2 and 3 will receive smaller portion of budget. This strategy aims to strengthen the capacity of institution in data and information management, climate risk assessment and greenhouse gas inventory. However, the proportion of activities in each category will depend on the capacity of each sector in responding climate change. Sectors that have already prepared for the climate change impacts may set up more advanced programs and activities.
2) At the later period, each sector will increasingly focus on activities which are classified into Category 2 and 3. The Roadmap sets a target that starting from the period of 2020-2025 each sector will be more concentrated on activities of Category 3 (Implementation of Program Actions for Adaptation and Mitigation).

The National Roadmap for mainstreaming climate change into development planning can be summarized as illustrated in the diagram below. Activities for adaptation and mitigation proposed in each sector are the elaboration of the three categories as illustrated by arrows. Thus the diagram below serves as a chart to read the Roadmap for climate change adaptation and mitigation as reported by the nine sectors.

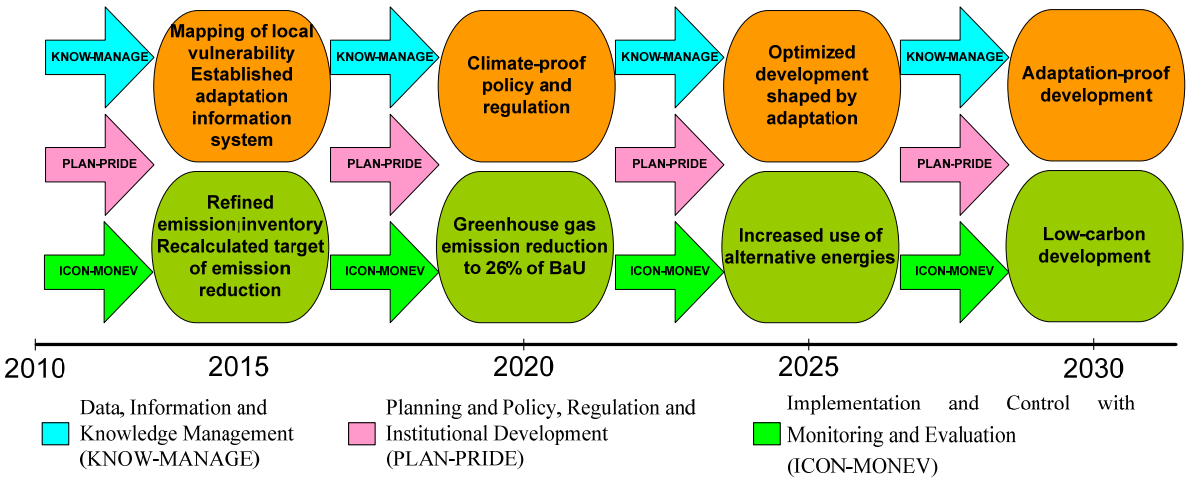

Figure 4 Chart of National Roadmap for Climate Change Adaptation and Mitigation

The following sections summarize the Roadmap report for each sector, starting from adaptation sectors (water, marine and fisheries, agriculture, and health) to mitigation sectors (transportation, forestry, industry, energy, and waste).

5 ADAPTATION IN THE WATER SECTOR

5.1 Current Condition and Projection of Water Sector

5.1.1 Water Shortage

The projected climate change in Indonesia will likely impose stress on water resources.. At present, the Java-Bali regions have already faced a deficit in its water balance, while for other regions like Sumatra, Sulawesi, Nusa Tenggara, and the Moluccas are projected in critical conditions. Based on climate projections, most regions in Indonesia will suffer from a gradual decrease of water supply due to temperature increase and rainfall changes that will affect the water balance as illustrated in the table below. Combined with estimated population growth rates, increased water demand will cause severe water shortages to occur, especially in Java and Sumatra for the period 2020-2030.

Table 5 Indonesia's current (2009) and projection of Water Budget (2015 and 2030)

No	Area	Supply *(S)*	Demand *(D)*	Balance 2009 *(S – D)*	Balance 2015s *(S – D)*	Balance 2030s *(S – D)*
1.	*Sumatra*	111,077.65	37,805.55	73,272.10	48,420.07	-67,101.34
2.	*Java-Bali*	31,636.50	100,917.77	-69,281.27	-118,374.36	-454,000.33
3.	*Kalimantan*	140,005.55	11,982.78	128,022.77	118,423.17	88,821.14
4.	*Sulawesi*	34,787.55	21,493.34	13,294.21	13,490.80	-21,021.99
5.	*Nusa Tenggara*	7,759.70	2,054.04	5,705.66	-17,488.89	-67,848.68
6.	*Moluccas*	15,457.10	540.23	14,916.87	12,648.91	9,225.75
7.	*Papua*	350,589.65	385.58	350,204.07	325,937.74	315,647.73

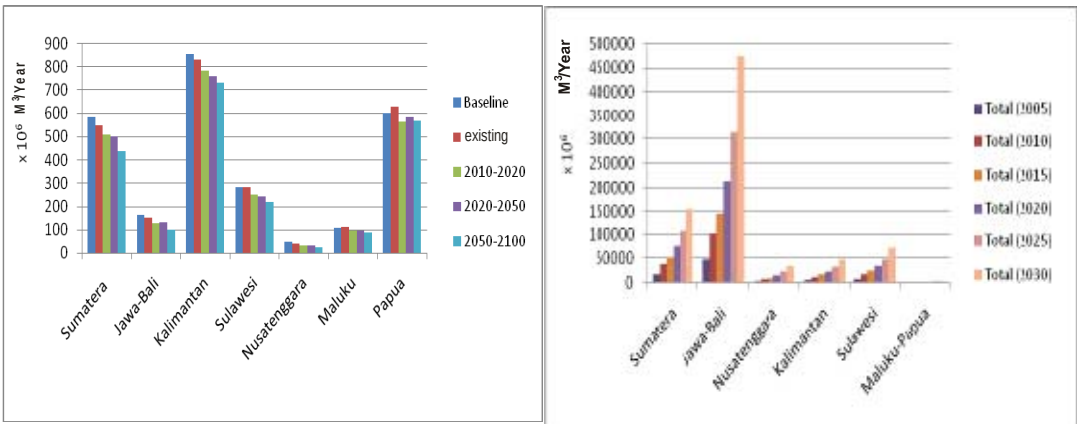

Figure 4 Water Supply (left) and Water Demand (right)

A risk analysis for projected water shortages has also been carried out under the framework of this study. Based on this risk analysis, the roadmap defines areas that have high risk or extremely high risk condition which need further attention for adaptation responses. For water sector, the priority areas are as follows:

1) **Extremely High Risk** is likely for parts of the Java-Bali region, especially in a few locations in the northern and southern of West Java, middle and southern of Central Java and East Java; as well as in the capital of the North Sumatra, West Sumatra, Bengkulu and Lampung (Sumatra), Nusa Tenggara Barat and South Sulawesi.
2) **High risk** is observed in about 75% of the Java-Bali region, in a small part in the northern, western, and southern, the island of Lombok (Nusa Tenggara) and South Sulawesi.

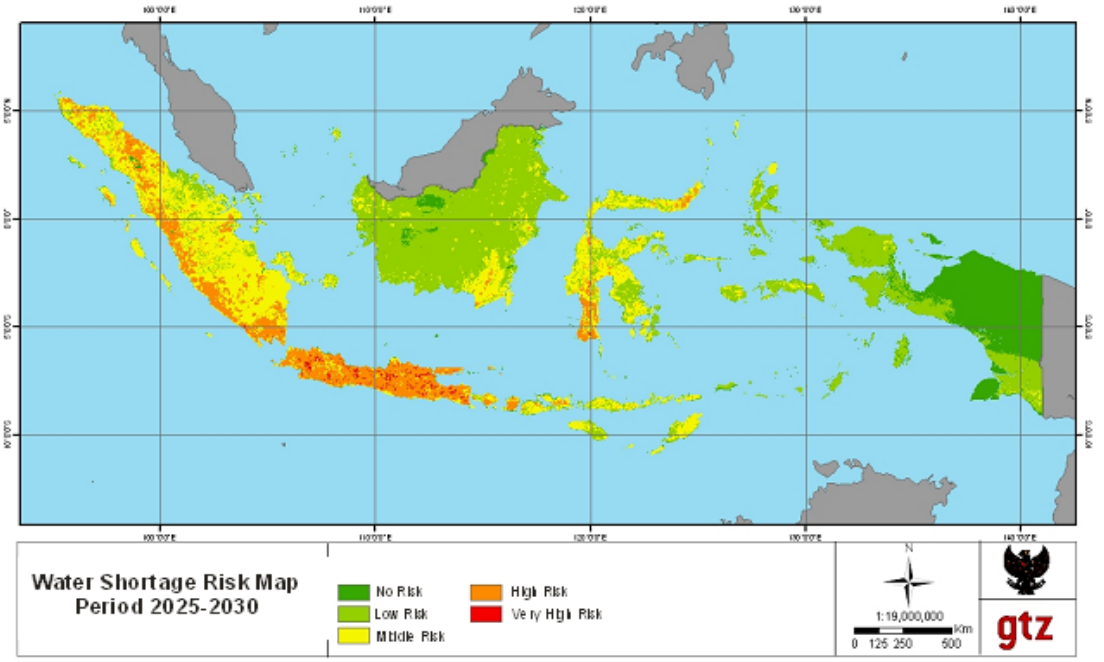

Figure 5 Water Shortage Risk Areas using IPCC's SRA2 Scenario 2025-2030

5.1.2 Flood

Almost all parts of Indonesia are vulnerable to flood hazards. According to the Indonesian National Atlas (ANI, Bakosurtanal), Sumatra and Java-Bali have the largest vulnerable areas. Factors contributing to flooding are: the extreme rainfall of up to 400/mm/month (as per BMKG); overloaded surface water sources or water reservoirs, such as rivers, ponds, dams, etc; land characteristics and conditions in the upper reaches of the catchment area. In some cases, floods are related to landslides, as happened in Sinjai, Southern Sulawesi, in July 2006, causing hundreds of casualties.

Based on the analysis of flood risk, the areas which are classified as extremely high and high risks are as follows:

1. Extremely **High Risk** of flooding is projected especially for areas along major rivers, particularly in downstream areas in Java, Eastern Sumatra; most parts of Western, Southern, and Eastern Kalimantan, Eastern Sulawesi and Southern Papua.
2. Areas which will face **High Risk** are concurrence to those with extremely high risk mentioned above.

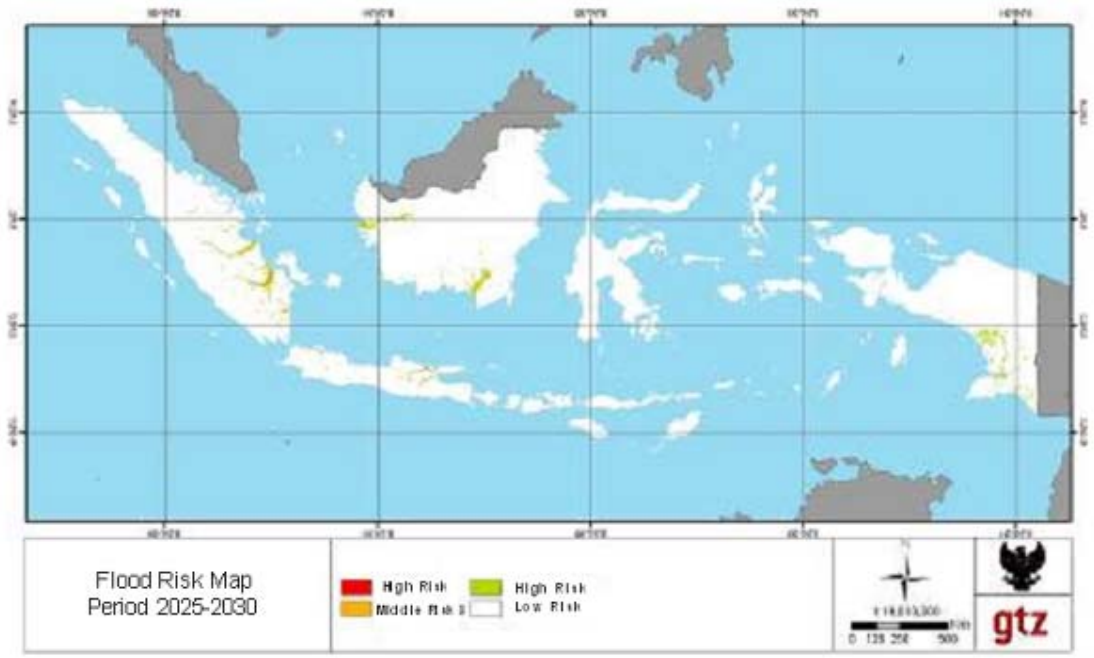

Figure 6 Flood Risk Areas based on Scenario SRA2 in 2025-2030

5.1.3 Drought

Drought can be defined in many ways such as from perspective of meteorological, hydrological, agricultural etc. The eastern part of Indonesia is vulnerable to meteorological drought. However, drought risk is particularly high in areas with high population numbers and density like Java-Bali. Drought can cause disaster, however, there is also potential for economic opportunities especially for the sea-fishery sector.

Findings from the drought risk analysis are as follows:

(1) **Extremely High risk** areas are stretched out over small areas of the Central Java, Northern Sumatra, and Nusa Tenggara; **(2) High risk** areas are found in large parts of Central Java, Sumatra, and Nusa Tenggara.

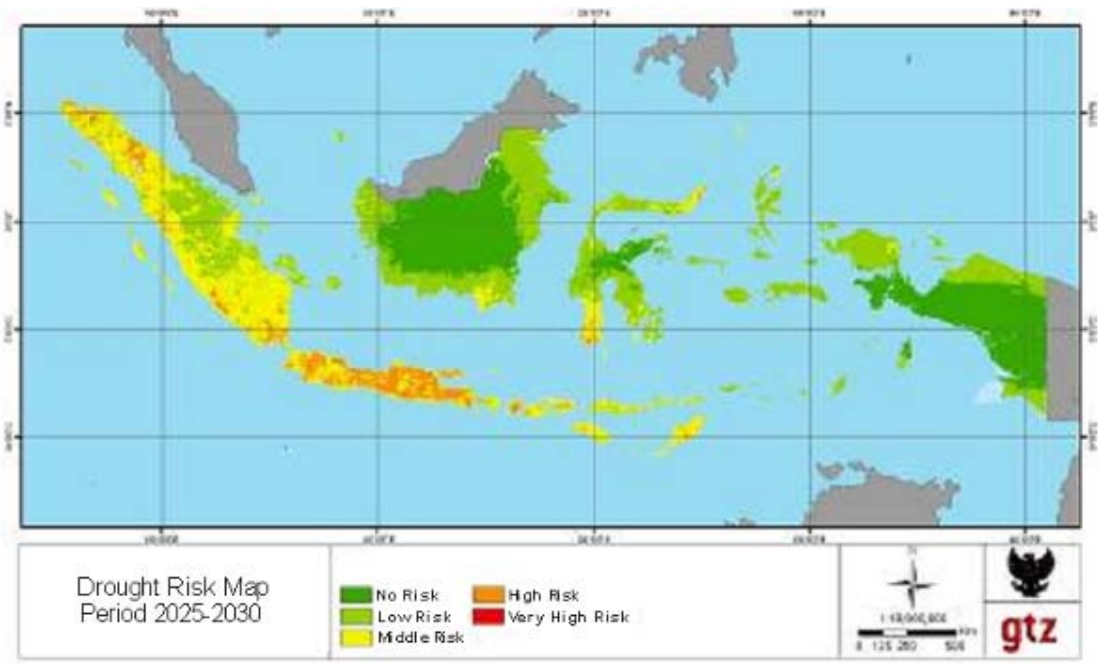

Figure 7 Drought Risk Areas based on Scenario SRA2 for 2025-2030

5.2 Strategic Issues for the Water Sector

As a result of the risk analysis, the following issues have to be addressed in order to successfully adapt the water sector to climate change:

1. Maintaining the balance between water availability and demand (water balance).
2. Sufficient water infrastructure and the provision of alternative water sources in certain areas.
3. Availability of data, technology and research as a basis for water resource management.
4. Reduction of vulnerability and risk from water shortage, flood and drought.
5. Finding of synergetic solutions for cross-sector issues with agriculture, forestry, health, energy, and industry sectors.
6. Integrated water resources management and flood control.
7. Water conservation based on innovation, community participation and local wisdom.

When addressing these key issues, the demands for water for domestic, urban and industrial use have to be balanced. In order to ensure this, the following approaches should be pursued:

1. Prioritizing water demand for domestic use, especially in regions with water scarcity and in regions of strategic importance.
2. Controlling the use of ground water and enhancing the use of surface water for water

supply.

3. Intensifying the development of water storages for water supply and optimization and maintenance of existing resources.
4. Encouraging involvement of the private sector for financing the development of water infrastructure.

Moreover, the performance of water resource management must be improved by:

1. Encouraging the acceleration and completion of implementing regulations of the Law No. 7 of 2004.
2. Enhancing the capacity to communicate, cooperate, and coordinate between institutions involved in water resource management.
3. Building the capacity of institutions involved in water resource management and increasing community empowerment and participation at local level.
4. Nurturing initiatives and increasing community participation in water resource management.
5. Implementing water resource management by partnership between government and community.

5.3 Activities of Water Sector

From many activities that had been discussed during several focus group discussions and stakeholder consultations, five "champion" activities for adapting the water sector to climate change are recommended and illustrated in the table below. The details of the activities for water sector for the next 20 years by main Indonesian regions are available in the Roadmap for water sector.

Table 6 Activities of Long-Term Development Plan in Water Sector

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
Data, Information and Knowledge Management	Vulnerability and risk assessment at regional level and strategic zone	Focus area: *BBWS* Sumatera I and Mesuji Sekampung in Sumatera, *BBWS* Bengawan Solo and Pemali Juwana in Java, *BWS* Kalimantan II in Kalimantan, *BBWS* Pompengan Jenebarang in Sulawesi, *BWS* Nusa Tenggara I in Nusa Tenggara, *BWS* Maluku, and *BWS* Papua.	Focus area: *BBWS* Brantas and Ciliwung-Cisedane; *BBWS* Sumatera II dan V; *BWS* Kalimantan III; *BWS* Sulawesi II; *BWS* Nusatenggara II; Maluku and Papua	Focus area: *BBWS* Serayu-Opak, Cimanuk-Cisanggarung and Bali; *BBWS* Sumatera IV and VI; *BWS* Kalimantan I; and *BWS* Sulawesi I	Focus area: *BBWS* Citarum-Citanduy and Cidanau-Ciujung-Cidurian; *BBWS* Sumatera VIII and Sumatera III; Kalimantan I; and Sulawesi
Planning and Policy, Regulation and Institutional Development	Revitalization of local wisdom and building the capacity and participation of community in adapting to climate change	Focus area: *SWS* Musi in Sumatera, *WS* Citarum, Ciliwung and Citanduy in West Java and Jakarta, *WS* Mahakam in Kalimantan, and *SWS* Jeneberang in Sulawesi.	Focus area: *WS* Bengawan Solo, Pemali, Comal; *SWS* Krueng; *WS* Kapuas	Focus area: *WS* Brantas; *SWS* Batangharileko; *WS* Barito; and Tondano	Focus area: *WS* Opak; *SWS* Mesuji; *WS* Kahayan; and North Sulawesi
	Enhancement of water conservation and reduction of hazard and disaster related to climate change	Focus area: West Sumatera Province, Banten and West Java Province, West Kalimantan Province, Gorontalo Province, East Nusa Tenggara Province, Maluku Province, and West Papua Province.	Focus area: Central Java; Bengkulu; South Kalimantan; East Sulawesi; West Nusatenggara	Focus area: DI Yogyakarta; Lampung; Central Kalimantan; and North Sulawesi	Focus area: East Java; Aceh; East Kalimantan; and Southeast Sulawesi
Implementation and Control with Monitoring and Evaluation	Enlargement of water supply using appropriate technology and development of local water resources	Focus area: *BBWS* Sumatera VIII in Sumatera, and *BWS* Kalimantan II in Kalimantan; Papua: *BWS* Western Papua	Focus area: *BWS* Kalimantan III; *BWS* Northern Papua	Focus area: *BWS* Kalimantan I; *BWS* Southern Papua	TBD
	Improvement of storage capacity and water infrastructure for safeguarding water balance and disaster prevention	Focus area: construction of dams in Deli Serdang, North Sumatera, in Ponorogo, East Java, in Wajo, South Sulawesi, and in East Lombok, West Nusa Tenggara	TBD	TBD	TBD

Note: Thicker shade represents stronger weight

6 ADAPTATION IN THE MARINE AND FISHERIES SECTOR

6.1 Current Condition and Projection of Marine and Fisheries Sector

6.1.1 Coastal Inundation

Indonesia is an archipelagic country consisting of 17,480 islands with total coastline of 95,181 km. Coastal inundation due to SLR will cause serious problems along coastal zones where a large part of population (about 50-60% of total) resides. Significant infrastructure and economic assets are located in these areas. As an example, there are about 968 fishery ports that have been built without considering SLR projection. Many important tourist destination and attractions, both natural and man-made, lie in coastal areas. The estimated average rate of SLR in Indonesia is around 0.6 cm/year. Based on available SLR scenarios, maps of inundated area have been developed as exemplified for Java Island below and the projection of the size of inundated areas in each region in Indonesia in 2030 is illustrated below.

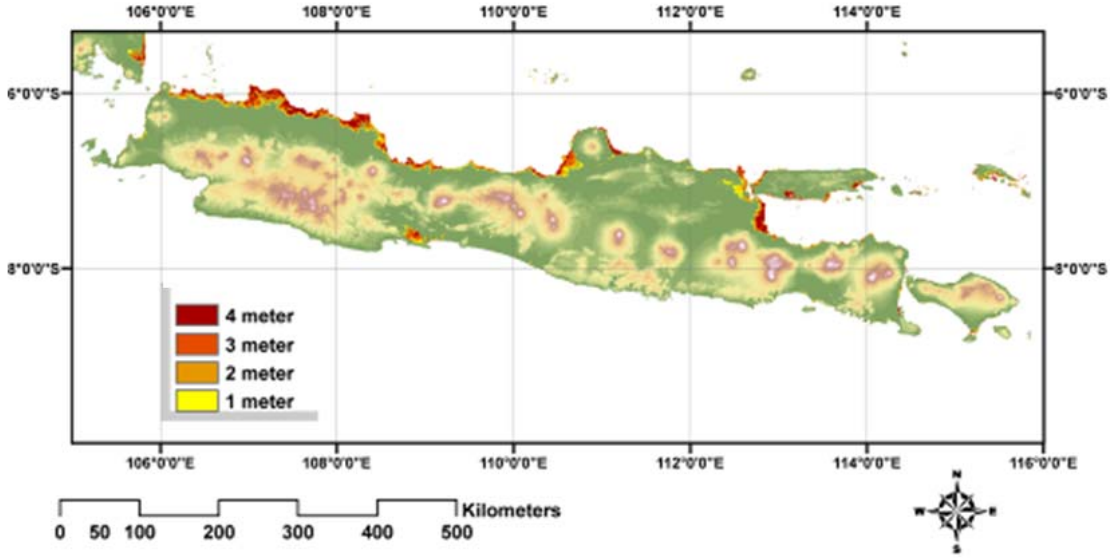

Figure 8 Simulation of Coastal Inundation in Java-Madura-Bali

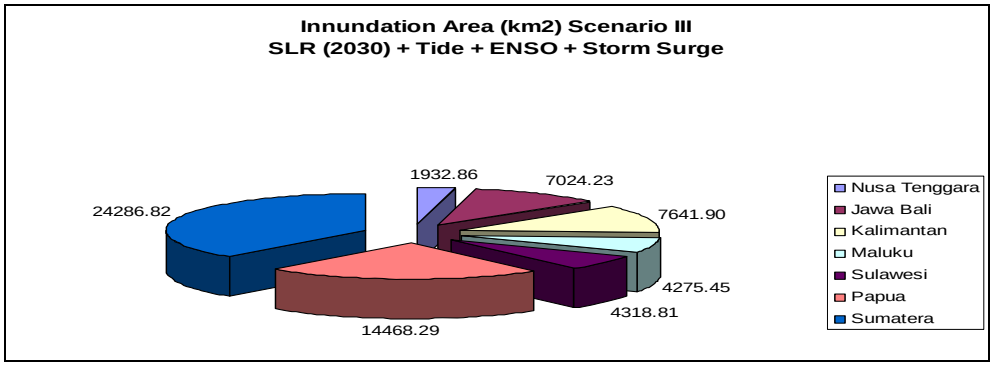

Figure 9 Projection of Inundation Area in 2030

6.1.2 Sea Surface Temperature

Based on National Oceanic and Atmospheric Agency (NOAA) optimum interpolation (OI) data from 1983 to 2008, the average of SST trend over the Indonesian Seas is 0.65°C ± 0.05°C in 2030. Coral reefs are very vulnerable towards abrupt change of temperatures. Temperature increase of 1°C to 2°C from long-term average will also cause coral bleaching.

Indonesia also possesses the largest area of coral reef in the world, with an area reaching 60,000 km^2 which is around 18% of the world's coral reef. According to the Directorate General of Coastal and Small Islands, Ministry of Marine Affairs and Fisheries (DKP, 2005), the current condition of Indonesia's reefs is as follows: damaged (42.78%), moderate (28.30%), preserved (23.72%). However, the reefs which are still considered to be in pristine condition are only 6.20% of the total. In the meantime, the warmer SST may shift fishing grounds from tropical area to the sub-tropical regions with a lower temperature.

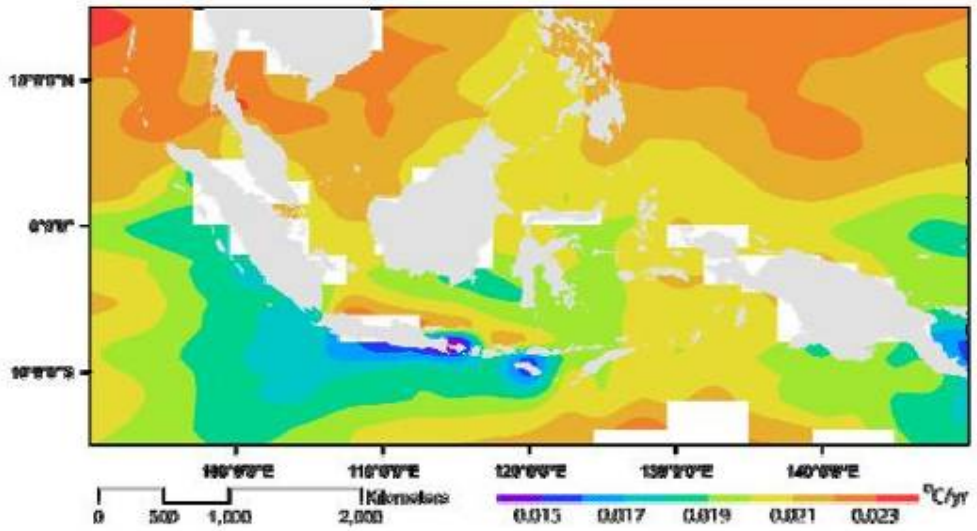

Figure 10 Sea Surface Temperature Increase Based on SRES a1b Using MRI_CGCM 3.2 Model

6.1.3 Extreme Events

Many oceanographers argue that global warming has a strong relationship with a higher frequency of extreme event, such as El Niño and La Niña (Timmermann et. al., 1999 and Timmerman, 2000). Generally, El Niño and La Niña occur once every 3-7 years, but since 1970, the frequency of El Niño and La Niña increases to once every 2-6 years (Torrence and

Compo, 1999). La Nina could also heighten wave height by around 20 cm. Additionally, rising SST will lead to an increase of extreme weather events (storms, cyclone). According to Saunders and Lea (2008), an increase in SST by 0.5ºC is correlated with an increase of hurricanes by as much as 40%. Although very few tropical cyclones hit land in Indonesia, extreme marine weather events that occur in other areas may cause significant impact (in the form of massive high waves and storm surges) to vulnerable coastal areas.

6.2 Issues and Strategies of the Marine and Fisheries Sector

Several issues that were initially identified in the marine and fisheries sector from risk analysis are:

1. Existing regulation and policy have not specified the need for climate change adaptation
2. Inundation of settlements, businesses and ports because of SLR and damage caused by storms have not been considered.
3. Shifting of fishing grounds, depletion of fishing stocks, and the changing pattern of winds will bring severe damages Inundation of fishponds on coastal areas because of SLR
4. Degrading and sinking small islands in the remote areas of Indonesia border

The strategies for Roadmap of climate change adaptation in marine and fishery sector are as follows:

1. Physical adaptation in coastal zones and small islands by an integrated management and environmentally sound physical engineering.
2. Population management
3. Infrastructure and public facility management
4. Resource management of fisheries, water resources and defense and security (small strategic islands on the border)
5. Integrated ecosystem management of coastal zones, small islands and ocean
6. Formulation of regulation and policy for adaptation
7. Data and research inventory and human resource development

6.3 Activities of the Marine and Fisheries Sector

Several activities to anticipate hazards brought by intensified climate change were discussed in several focus group discussions with stakeholders from marine and fisheries sector and illustrated in the table below.

Among those activities, there are five champion activities recommended for the marine and fisheries sector based on current and projected conditions as follows:

1) Activities of formulation or adjustment of regulation, policy and institutional capacity of the marine and fishery sector to adapt to climate change in coastal areas and small islands consists:
   - Formulating norms, standards, guidelines, and criteria for climate change adaptation and mitigation
   - Adjustment of regulation and policy related to climate change
   - Acceleration of the issuance of local government decision on Strategic Plan of Coastal Zone And Small Islands (*WP3K*) that has incorporated climate change and a risk map

Table 7 Activities of Long-Term Development Plan in Marine and Fisheries Sector

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
Data, Information and Knowledge Management	Research and Development of Marine Science and Technology: - Inventory of data, information system and research	**Focus** in Ocean Area: Western Pacific Ocean (Maluku, Papua) **Focus** in Coastal Area: High Risk Region (Sumatera, Java)	**Focus in Ocean Area :** Makasar Strait (Kalimantan, Sulawesi); Lombok Strait (Nusa Tenggara) **Focus** in Coastal Area : Medium Risk Region (Sumatera, Nusa Tenggara, Kalimantan, Sulawesi)	**Focus** in Ocean Area: Eastern Indian Ocean (Sumatera, Java, Nusa Tenggara) **Focus** in Coastal Area : Low Risk Region (Maluku, Papua)	**Focus** in Ocean Area: South China Sea (Sumatera, Java, Kalimantan) **Focus** in Coastal Area : Low Risk Region
Planning and Policy, Regulation and Institutional Development	Optimalization of Coastal and Marine: - Integration of Adaptation into coastal planning	**Focus**: Northern Java, Bali, Region: Eastern Sumatra	**Focus**: Medium Risk Region (Sumatera, Nusa Tenggara, Kalimantan, Southern, Western Sulawesi)	**Focus**: Low Risk Region (Maluku, Southern Papua)	**Focus**:National and Kota/Kab level in coastal areas and small islands
	Spatial Planning and Management Planning of Marine, Coastal and Small Islands: - Adjustment of regulation and policy related to climate change	**Focus**: High Risk Region: Northern Java, Bali, Eastern Sumatra	**Focus**: Medium Risk Region (Sumatera, Java, Kalimantan, Southern, Western Sulawesi)	**Focus**: Low Risk Region (Maluku, Southern Papua)	**Focus**:National and Kota/Kab level in coastal areas and small islands
Implementation and Control with Monitoring and Evaluation	Optimalization of Coastal and Marine: - Adjustment of elevation and enhancement of building structures and vital facilities in coastal areas	**Focus**: High Risk Region: Northern Java, Bali, Eastern Sumatra	**Focus**: Medium Risk Region: Sumatera, Nusa Tenggara, Eastern, Western, Southern Kalimantan, Southern, Western Sulawesi	**Focus**: Low Risk Region (Maluku, Southern Papua)	**Focus**: All areas in coastal and small islands
	Management and Development of Zone Conservation: - Adjustment of	**Focus**: mangrove ecosystem and Coral reef	**Focus**: Coral reef ecosystem and mangrove	**Focus**: wet land ecosystem and sand dune	**Focus**: estuaria ecosystem and continental land

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
	integrated natural resources and ecosystem management				
	Optimalization of Small Islands: - Adjustment of strategic small islands management	**Focus**: Borderline region with ASEAN countries and India	**Focus**: Borderline region with Australia, Timor Timur, and New Guinea	**Focus**: All strategic small islands	**Focus**: Small islands for Conservation
	Optimalization of Coastal and Marine: - Strengthening disaster mitigation capacity	**Focus:** Pacific Ocean (Kalimantan, Sulawesi, Maluku, Papua)	**Focus:** Indian Ocean (Sumatera, Java, Nusa Tenggara, Maluku, Papua)	**Focus:** Southern China Sea (Sumatera, Kalimantan, Sulawesi)	**Focus:** Other regions within Indonesia's internal water territory
	Management of Fishery Resources: - Adjustment of captured fishery management	**Focus**: Sulawesi, North of Halmahera Island; Cendrawasih Bay, Pacific Ocean; Aru Sea, Arafuru Sea, Eastern Timor Sea	**Focus**: Makassar Strait, Bone Bay, Flores Sea, Bali Sea; Tolo Bay, Banda Sea; Tomini Bay, Maluku Sea, Halmahera Sea, Seram Sea, Berau Bay;	**Focus**: Malaka Strait, Andaman Sea; Karimata, Natuna Sea, Southern China Sea; Java Sea;	**Focus:** Indian Ocean in Western Sumatra,Sunda Strait; Indian Ocean in Southern Java through Southern Nusa Tenggara, Sawu Sea, West of Timor Sea;
	Development of Fishes Health and environment of cultured fishery: - Adjustment of cultured fishery management	**Focus**: Eastern Fishery Cluster: Pangkep, Sulsel; Gorontalo, Tomini Sulteng; Mamuju, Sulbar	**Focus**: Central Fishery Cluster Dompu, NTT; East Sumba, NTB.	**Focus**: Western Fishery Cluster 1. Serang, Banten; 2. Sumenep, Jatim; Karimun, Kepri	**Focus**: 9 Fishery Clusters and outside clusters

Note: Thicker shade represents stronger weight

2) Activities of "Elevation adjustment and enhancement of buildings and vital facilities on coastal areas prone to climate change" consists of these activities:
   - Identification of existing and projected condition of all infrastructure and vital facilities in the coastal areas
   - Elevation adjustment and enhancement of building and vital facilities
   - Study elevated house construction and its socialization
   - Construction and maintenance of beach protection structures

3) The adjustment of integrated captured fishery management activities consists of some activities as follows:
   - Development and socialization of information system, and mapping of the dynamic fishing ground
   - Development and socialization of real-time weather information system
   - Capacity building of fishermen in order to reach off-shore fishing grounds
   - Development and improvement of stock/logistic management, using cold storage

4) Adjustment of cultured fishery management activities that includes saltwater, brackish water and freshwater fish farms consists of:
   - Development of fish breeds that are resilient to climate change
   - Expansion and improvement of fishponds and the water channels)
   - Development and improvement of fish market depots as part of stock management
   - Development of cultured fishery on wetlands

5) Adjustment of strategic small islands management activities consists of these activities
   - Identification of current and projected conditions of strategic small islands including the remote islands on the border
   - Construction and maintenance of beach protection structure and navigation safety facilities
   - Surveillance and protection of remote strategic small islands

7 ADAPTATION IN AGRICULTURE SECTOR

7.1 Current Condition and Projection of Agriculture Sector

7.1.1 Food Production

Indonesia's agricultural sector has succeeded in increasing rice production during the last three years, with a rate of about 5.2% per year. However, impacts of climate change should be considered seriously because climate change is foreseen to directly or indirectly reduce agricultural food production. The climate change impact on agriculture is highly dependent on the locally specific context and hence its vulnerability. For example, agricultural land located near coastal areas is more vulnerable to sea level rise (SLR). Comparing the areas affected by SLR with that of paddy field distribution shows that by 2050, the area of paddy fields will be reduced by 182,556 ha in Java and Bali, 78,701 ha in Sulawesi, 25,372 ha in Kalimantan, 3,170 ha in Sumatra, and 2,123 ha in Lombok.

Global warming will potentially alter water vapor flux and may increase humidity, hence more intensive rainfall in one area. However, projected rainfall change shows that precipitation will be more concentrated during the wet season, while the dry season tends to be dryer. The decrease of food production due to rainfall change in 2050 compared to current condition is predicted to be as follows: rice (-4.6%), maize (-20%), soy (-65.2%), sugar (-17.1%) and palm oil (-21.4%)

Agricultural food production is also vulnerable to the increase in temperature. This is because plants need a certain range of climate (temperature, precipitation etc) for optimal growth and harvest. The decrease in planting area caused by an increase of temperature in 2050 is predicted to reach 3.3% in Java and 4.1% outside of Java from the current total paddy production area. Decrease in productivity due to early ripening reaches around 18.6%-31.4% in Java and around 20.5% outside Java. Decrease in productivity, including rice, caused by increase in temperature which influences rate of plant respiration is predicted to reach 19.94% in Central Java, 18.2% in DI Yogyakarta, and 10.5% in West Java, also 11.7% outside of java and Bali (Handoko *et al,* 2008)

Extreme climatic events like those triggered by ENSO could reduce food production due to harvest failure. It has been reported by Sofian (2009) in the scientific basis analysis that in 20 years, there will be about 13-15 years of alternating El-Nino (EN) or La Nina (LN) and only

few normal years. The detailed ENSO sequence can be described as : (1) EN-LN in 2010-2012 (with 1 year transition period), (2) EN-LA in 2017-2021 (1.3 year transition), and (3) EN-LN 2023-2027 (6-9 months transition), and (4) EN in 2029-2030. Based on the historical ENSO data (El-Nino 1991, 1994, 1997, and La-Nina 1988, 1995), average impact of harvest failure caused by drought and flood was reaching 3.95% of total crop area.

7.1.2 Plantation Production

Directorate General of Estate Crops, MOA (2009) has examined impact of drought to commodities, such as coffee, cacao, rubber and palm oil. Impact of drought to coffee is highly dependent on the plantation's biophysical condition (land, elevation, and climate), plant condition, drought intensity, and also planting methods. Robusta coffee is more vulnerable to drought than Arabica due to shorter root. Robusta is common to be planted in lowlands area (with higher soil surface temperature). Loss from drought reaches 44-76% in wet areas and 11-19% in dry areas.

Cacao is vulnerable to drought which is continuous for 3 months. Loss from drought could reach 40% in dry areas and 20-26% in wet areas depending on the length of drought and wet season in the following years. On the other hand, long drought will affect the growth of productive rubber and cause potential loss of latex production by as much as 175 kg/ha. Drought during July-September will decrease latex production as much as 10% or 250 kg/ha.

Palm production will decrease due to water deficit under drought condition. Loss of fresh fruit bunches may reach as much as 21% if there is 200-300 mm annual water deficit, and 65% if water deficit is more than 500 mm. Wild fire may occur collaterally with long drought, which often causes 100% damage to palm plantation.

Plant damage in plantation caused by drought and inundation that happen in several regions are reported by community through related governmental institutions. As an example, damage of sugar in Pati, Central Java and cacao in Mamuju, West Sulawesi show the vulnerability of plantation plants to climate change.

7.2 Issues and Strategies of Agriculture Sector

Various adaptation and mitigation activities have been conducted by the Ministry of Agriculture. These include the development of climate field school; integrated plant

management field school; integrated pest control field school; development of new superior varieties of rice, development and usage of organic farming on paddy field; development of soil cultivation technology and water-economical plant; building improved water storage; dissemination of compost-making devices; manure management to generate bio-energy; monitoring of flood and drought-prone on paddy field area; and Adjustment of planting calendar for Java and Sumatra Island.

There are three primary targets in responding to climate change: (1) reducing the uncertainty and risk due to climate variability and improving societal awareness of climate change itself, (2) reducing the risk and impact of climate change upon infrastructure, production systems, and social-economic aspect of agriculture, and (3) increasing the role of the agriculture sector in mitigating greenhouse gas (GHG) emissions. The three strategies to achieve the targets are: (1) improvement of human resources in the agriculture sector for more detailed analysis of climate change impact, (2) preservation of fertile productive land, and application of technology that is adaptive to climate change, and (3) reduction of agricultural GHG emission.

In response toward climate several regulation/guidelines have been established, including the Minister of Agriculture Regulation No. 47/2006 on Guidelines for Agriculture Cultivation in Highlands; Minister for Agriculture Regulation No.26/2007 on Guidelines of Plantation License; and Minister of Agriculture Regulation No.14/2009 on Guidelines of Peat Land Utilization for Oil Palm Plantation. The latest regulation tightens the requirement of peat land utilization for oil palm plantation, which not only consider the depth of peat bog (<3m) but also the main composition of soil under the peat, the maturity of peat, and the fertility of peat land.

7.3 Activities of Agriculture Sector

Activities that are recommended for adaptation in agriculture sector, with the activities for each program are depicted in the table below. The breakdown of each program in each five-year period is available in the Roadmap report for agriculture sector.

Table 8 Activities of Long-Term Development Plan in Agriculture Sector

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
Data, Information and Knowledge Management	Crafting and preparation of crop variety tolerant against drought, flood, salinity, and pest, short-lived and high productivity	20 packages	20 packages	20 packages	20 packages
	Development of adaptive technology innovasion, including superior variety, cultivation technic, and land and water management		Productivity of crop outside Java (especially Sumatera, Sulawesi) can be equal with Java and Bali	Productivity of crop outside Java (especially Sumatera, Sulawesi) can be equal with Java and Bali	Productivity of crop outside Java (especially Kalimantan, Nusa Tenggara) can be equal with Java and Bali
	Impact analysis of climate anomaly to planting season shifting		Planting calendar update in Java and Bali	Planting calendar update in Sumatera and Sulawesi	Planting calendar update in Kalimantan and Nusa Tenggara
Planning and Policy, Regulation and Institutional Development	Coordination with authorities, vertically and horizontally, including socialization on climate information	30 Provinces	33 Provinces	33 Provinces	33 Provinces
	Development of clean water safeguarding, handling, and storage system during post-harvest activities and production		25 Regencies	25 Regencies	25 Regencies
	Building and development of cold chain system (CCS) and warehousing during post-harvest activities and food storing		25 Regencies	25 Regencies	25 Regencies
	Field development of integrated crop management on rice (SL-PTT padi)	13 – 14 million ha of planting area	17-18 million ha of planting area	20-21 million ha of planting area	23-24 million ha of planting area
	Field development of integrated crop management on secondary crops (maize, soybean, peanut) (SL-PTT Palawija)	10 – 11 million ha of planting area	15-16 million ha of planting area	18-19 million ha of planting area	22-23 million ha of planting area
	Development of food crop varieties tolerant to drought, inundation, and or pest	6-6.5 million ha of planting area	6.5-7 million ha of planting area	6.5 – 7 million ha of planting area	6.5 – 7 million ha of planting area
	Extent estate crops on mineral soil, non-peat and non-forest land	1-1.3 million ha	0.3-0.4 million ha	0.2 – 0.3 million ha	0.5-0.6 million ha

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
Implementation and Control with Monitoring and Evaluation	Reduction of harvest-failure areas	≤ 3 % of planting area	< 3 % of planting area	< 3 % of planting area	< 3 % of planting area
	Implementation of climate change adaptation and management of food scarcity through development of food independent village program	125 Regencies/Cities	-	-	-
	Acceleration of food consumption diversity and fresh food security	-	16 Provinces	17 Provinces	-
	Increase of storage and handling on food scarce regions	-	160 Regencies	160 Regencies	130 Regencies

Note: Thicker shade represents stronger weight

8 ADAPTATION IN HEALTH SECTOR

8.1 Current Condition and Projection

Being one of the most populated countries in the world, Indonesia is still facing serious public health problems. These health problems are becoming more complex due to climate change impacts that affect human health either directly and/or indirectly. The direct effect of climate change is its influence to human health by exposure to changes in weather patterns, while changes in environment due to climate change may increase the prevalence of certain illnesses. Potential impacts of climate change on the health sector include:

- Morbidity and mortality due to climate-related disasters. Climate change is projected to cause an increase in the frequency of extreme weather events that will trigger more water-related disasters such as floods, landslides, and destructive storms.
- Malnutrition can occur in certain regions because of reduced food production under changing climate, and the disruption of food supplies and failure of crop harvest due to extreme weather.
- Deaths and morbidity due to illness. Climate change-related diseases triggered by a change in temperature, air pollution, water congenital diseases, food, and congenital disease vectors and rodents.

Vulnerability assessment and risk analysis of health sector against projected climate change in Indonesia have been carried out but, due to limited data availability, only those related to infectious disease are presented below.

8.1.1 Vector-borne infectious disease: Malaria and Dengue fever

Malaria and Dengue Fever is probably the most well-known climate related diseases that currently have a high incidence rate (IR) in Indonesia. The first appearance of dengue fever in Indonesia was reported in 1968, with an IR of 0.05/100,000 population and mortality of 14.3%. Since then, Dengue Fever has spread widely all over Indonesia (see table below).

Table 9 Lists of Dengue Fever events in Indonesia

Year	No. of Incidence	Incidence Rate (IR)	Deaths/Case Fatality Rate (CFR)	Remarks
1968	-	0.05/100,000	-/14.3%	First occurence
1998	73,133	-	1411/2%	Extreme event
2004	28,077	-	1.36%	334 districts/cities
2007	156,767	71,18/100,000	1570/1.00%	357 districts/cities
2008	98,869	43,62/100,000		346 districts/cities

During the last decade, malaria in Indonesia has been reoccurring, and around 35% of Indonesia's population is living in an endemic area. Cases of malaria in Java and Bali, which is stated in the annual parasite incidence (API) during the period of 1995-2000 has increased drastically from 0.07% (1995) to 81% (2000). During 2002 and 2003 API has be decreased to consecutively 0.47% and 0.32%. Malaria cases outside Java and Bali which are stated in annual malaria incidence (AMI) during 1995-2003 period fluctuates sharply from time to time starting from 20% (1995) to 22.7% (2003). Projections of future risks of dengue fever and malaria because of climate change are illustrated in the following maps.

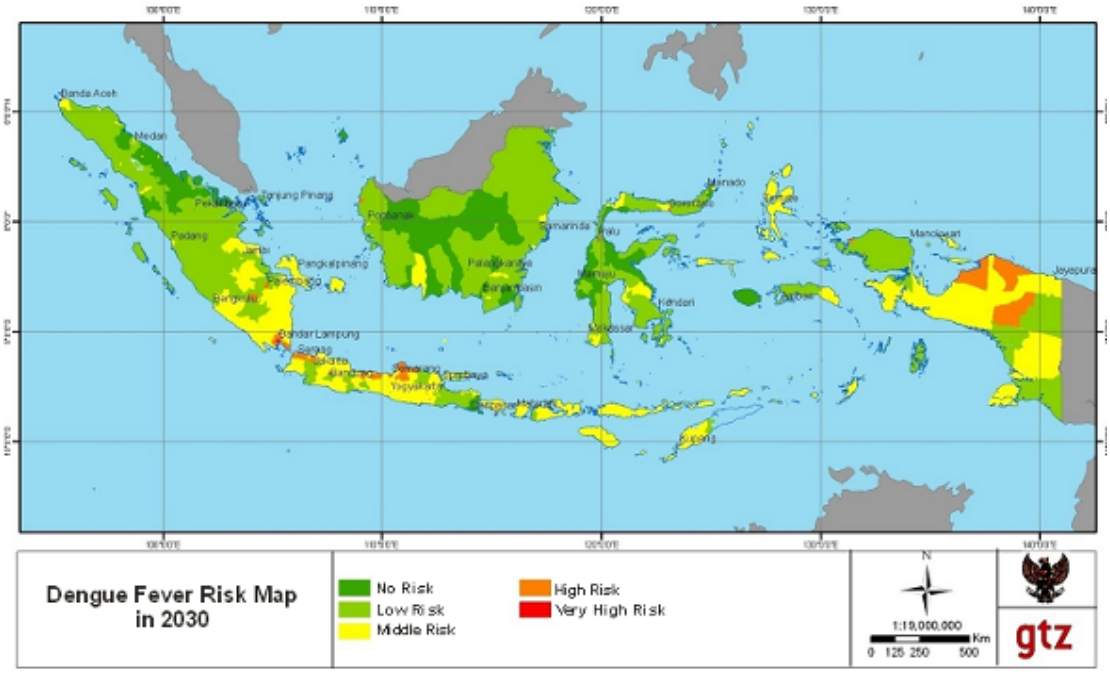

Figure 11 Map of Dengue Fever Risks in 2030

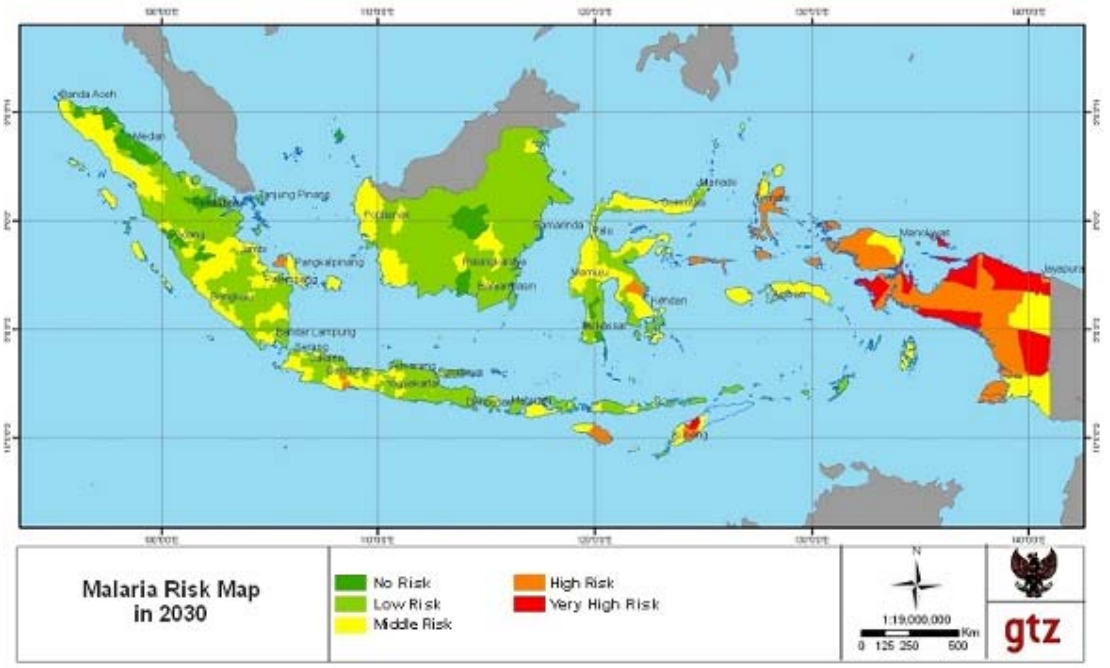

Figure 12 Map of Malaria Risks in 2030

8.1.2 Diarrheal Disease

Direct contagious diseases such as diarrhea are still a problem for public health. Extreme events which decrease the quality of drinking water and poor sanitation occur yearly. The 2004 and 2005 data show that diarrhea events are always high during January-March, however during 2006 diarrhea events are constantly high throughout the year with the peak of events during January, April, and October. In general, contagious diseases are not directly environmental based, and often occur within vulnerable society (toddlers and pregnant women) especially in villages which in majority have low income and difficult access from health services. Projection of future risks due to climate change on diarrhea is illustrated in the map below.

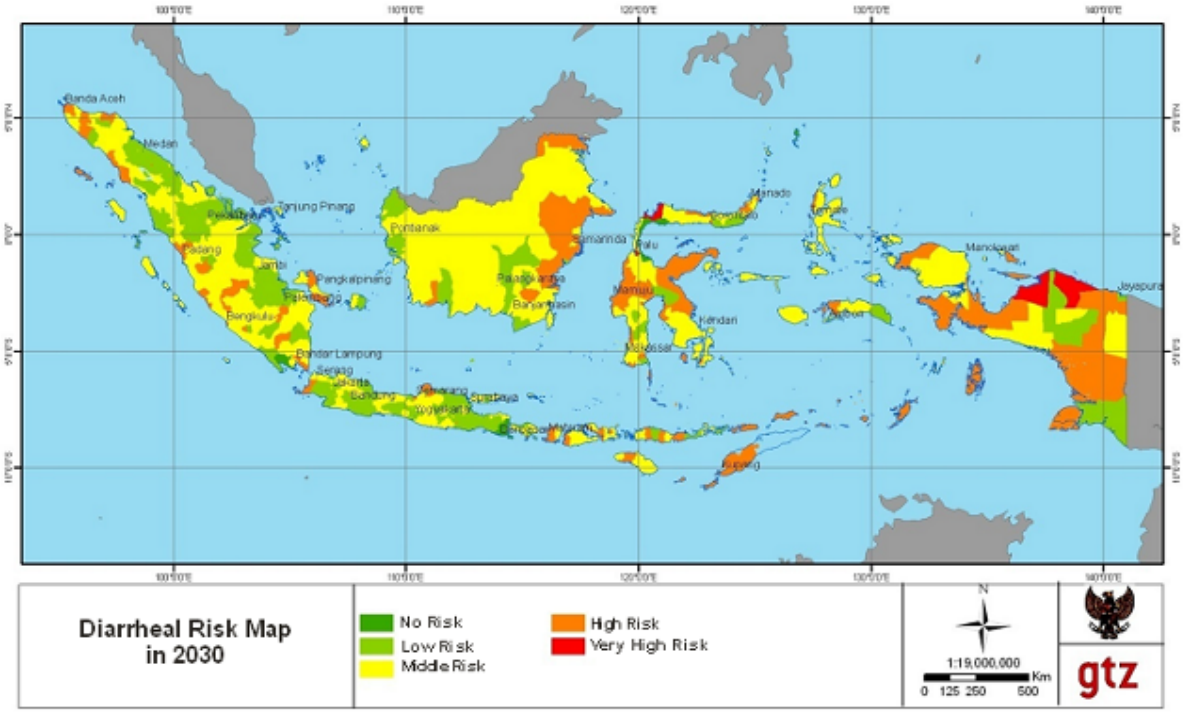

Figure 13 Map of Diarrheal Risk in 2030

8.2 Issues in the Health Sector

The risk analysis in the Roadmap for adaptation in the health sector has identified several potential risks associated with climate change in the future. Those risks are:

- Diseases or deaths caused by disasters related to extreme climate events and diseases that might be outbreak in the refugee sites
- The increase of respiratory diseases as a result of increasing air pollution, in particular ozone and NO_2, which are associated with the rise of surface temperature
- The increase of agents of water-borne diseases or contagious diseases, which normally take place during droughts or floods
- Malnutrition during famine due to failed harvests
- Changing pattern of diseases brought by vectors such as mosquito due to land use conversion and climate change. Moreover, temperature rise of 2-3 degree Celsius is projected to increase the number vector-borne diseases by 3-5% and also to increase the distribution of the vectors
- Precipitation level also contribute to the type and intensity of vectors' habitat

8.3 Activities of Health Sector

A number of recommended activities for climate change adaptation in health sector are the results of focus group discussions with the stakeholders. Beside a number of activities that will be conducted at the national level, the focus of these activities are in provinces where the occurrence of the diseases is highest, especially the regions of Papua and Nusa Tenggara that are prone to Malaria, Dengue, and Diarrhea. Focus will also put on some areas in Java and Southern Sumatra that are prone to Dengue Fever, and some areas in Kalimantan, Sulawesi and Eastern Sumatra that are prone to Diarrhea.

In particular, development of health-related adaptation to climate change should focus on:

- Improving access, equality, affordability and quality of health services especially for the poor, through services for poor people in the class III Hospitals, public health center (PUSKESMAS) and increase infrastructure facilities and basic health services (in part financed through the Special Allocation Fund);
- Increasing the availability of medical and paramedical staff, especially for basic health services in remote areas
- Prevention and eradication of infectious disease, through proper infectious disease treatment, increased surveillance, discovery and proper case treatment methodology;
- Preparation and implementation of surveillance, handling of patients/people with bird flu, bird flu drug provision, facilities and infrastructure, handling cases in the hospital;
- Treatment for malnutrition in pregnant women, infants and children aged below five years old, through community education for nutrition awareness, increased nutrition surveillance

Table 10 Activities of Long-Term Development Plan in Health Sector

Category	2010-2014	2015-2019	2020-2024	2025-2029
Data, Information and Knowledge Management	Analysis of climate change hazard, vulnerability, risk and impact to health on province and regency/city level	Improvement of analysis on climate change hazard, vulnerability, risk and impact to health on province and regency/city level		
	Database, information system, and community health profile arrangement and modernization	Database, information system, and community health profile modernization	Implementation of integrated online GIS database to support information system and community health profile	Expansion and integration of climate change management information system in public service and national planning
Planning and Policy, Regulation and Institutional Development	Strengthening of policy and regulation based on community health	Strengthening of policy and regulation based on community health	Strengthening of policy and regulation based on community health	Strengthening of policy and regulation based on community health
	Climate change adaptation strategy training and networking at central, province, and regency/city level	Climate change adaptation strategy training and networking at central, province, and regency/city level	Climate change adaptation strategy training and networking at central, province, and regency/city level	Climate change adaptation strategy training and networking at central, province, and regency/city level
Implementation and Control with Monitoring and Evaluation	Early warning system campaign for climate change impact areas	Improvement of early warning system for climate change impact areas		
	Strengthening of health service system as response to climate change	Strengthening of integrated health service system considering community growth, demographic change, poverty, general health infrastructure, sanitation, health facility, nutrient, healthy lifestyle, pesticide resistance, and environmental damage		
	Improvement of financial support, equipment, and infrastructure to support disease control program, for instance, through international cooperation	Improvement of financial support, equipment, and infrastructure to support disease control program, for instance, through international cooperation	Improvement of financial support, equipment, and infrastructure to support disease control program, for instance, through international cooperation	Improvement of financial support, equipment, and infrastructure to support disease control program, for instance, through international cooperation

Category	2010-2014	2015-2019	2020-2024	2025-2029
	Improvement of public access to health service in several regencies/cities	Improvement of public access to health service in several regencies/cities	Improvement of public access to health service in several regencies/cities	Improvement of public access to health service in several regencies/cities
	Strengthening of monitoring system, surveillance, and health information system in climate change	Strengthening of monitoring system, surveillance, and health information system in climate change	Strengthening of monitoring system, surveillance, and health information system in climate change	
	Community involvement through Communication, Information, and Education module making, campaign, and health promotion	Improvement of community involvement especially preventive effort to fix environmental sanitation	Improvement of community involvement through ongoing socialization	Improvement of community involvement through ongoing socialization
	Appropriate adaptation technology development	Implementation of adaptive healthy housing technology to climate change		

Note: Thicker shade represents stronger weight

9 MITIGATION IN TRANSPORTATION SECTOR

9.1 Emission Status

Transportation is the biggest and most rapidly growing primary energy consuming sector in Indonesia. Approximately 48% of Indonesian primary energy is consumed by the transportation sector, with an estimated 67 million tones of CO_2 (TNA, 2009). The industrial, household, and power plant sector consume respectively 22%, 19%, and 11%. Road transportation stands in the first rank of energy consumption, consuming 42% of energy in Indonesia, while other modes (air and sea) only consume 6%. It is therefore vital that efforts in mitigating future emissions would need to focus particularly on the road transport sub-sector. Road transport consumes about 88% of total energy in the transport sector, while sea transportation, air, trains, and interconnections (ferries) consume respectively 7%, 4%, and 1% of energy.

Currently, the large energy usage by the transportation sector means that this sector produces the highest concentration of (air) pollution, especially in urban areas that have a high number of road vehicles. Emission of local pollutants from road transport is growing at an average annual rate of 8-12%. Based on the Ministry of Environment's research in 2005, in Java's big cities such as Jakarta, Bandung, Semarang, and Surabaya, motorized road vehicles are the most dominant air polluters. They contribute up to 98.8% of Jakarta's total emission of local pollutants, including 73.4% of NO_x and 88.9% of HC gas emissions.

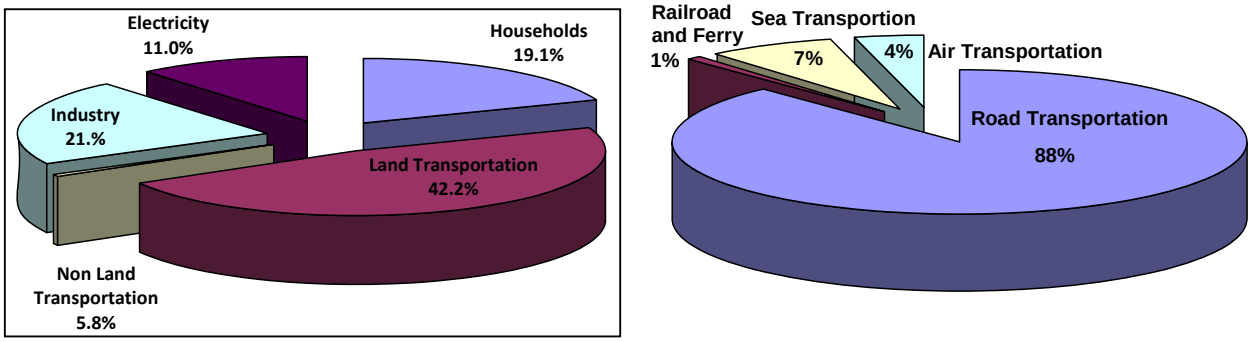

Figure 14 Energy Consumption by Each Sector (left) and by Subsectors of Transportation

9.2 Mitigation Potentials

The mitigation of transport emissions can be achieved through a comprehensive strategy as follows:

1. **Avoid** or reduce the need to travel through developing land use and urban development patterns that allow people to access essential facilities without excessive travel.
2. **Shift** travel to, or at least retain the share of carbon efficient travel modes, which include non-motorized transport (e.g., cycling and walking), public transport, and water based transport.
3. **Improve** the energy and carbon efficiency of motorized vehicles through technological improvements on engines and fuels.

Exercise on some policy measures has been carried out using the multimodal-multiuser transport network model, which might take account of the activity intensity (trips of passenger and freight), as well as the effect of transport infrastructure capacity (effect of congestions). The CO_2 estimation from the transport sector using this model is differentiating the interurban and urban transport network based on the following proportions (in terms of total trip length).

Table 11 Estimation of CO_2 Proportion based on Travel Type in Indonesia (2006 data)

Type	Remarks	CO_2 Proportion	
		2006	2029
Regional Trips	Based on estimation using transport network model and national origin destination data	80.1%	63.3%
Urban Trips	Derived from Jabodetabek transport network and up scaled for all 23 main cities in Indonesia	15.8%	24.8%
Others	Local transport and idle vehicle	4.1%	12.0%
Total		**100.0%**	**100.0%**

These CO_2 proportions will be used as the basis for distributing the total CO_2 emissions from previous data and predictions. Furthermore, the transport network model is employed to assess the effect of some measures that apply to the network (and the demand). The main advantage of this approach is that the subject of the analysis is the trip itself, not merely the vehicle.

There are several scenarios that project CO_2 emissions of transportation in the future, as follows:

- Business as usual
- Modal split
- Transport Demand Management
- Integrating Transport and Land Use Planning
- Better Combustion Engines
- Better Fuels

Each of the scenarios is quantified to find out total CO_2 emissions and their costs. The CO_2 emissions of most scenarios tend to keep on growing, except the Land Use-Transport policy program. But this policy program is estimated to be very limited in its implementation, creating an insignificant amount of CO_2 reductions. The better combustion engine and better fuel scenarios also promise significant CO_2 reductions, yet again; their limited implementation has lessened the policy program's effectiveness.

It is discovered that the most effective policy program in reducing CO_2 emissions is Modal Shifting (20.2% less, compared to BaU scenario). This policy also provides a significant improvement in transport network performance (co-benefit), with improvements of 19.9% better than the BaU scenario in the year 2029. The other policy programs, particularly the Better Combustion Engine and Better Fuel options are not expected to reduce the number of vehicles on the road, and hence will not contribute to a reduction in traffic congestion.

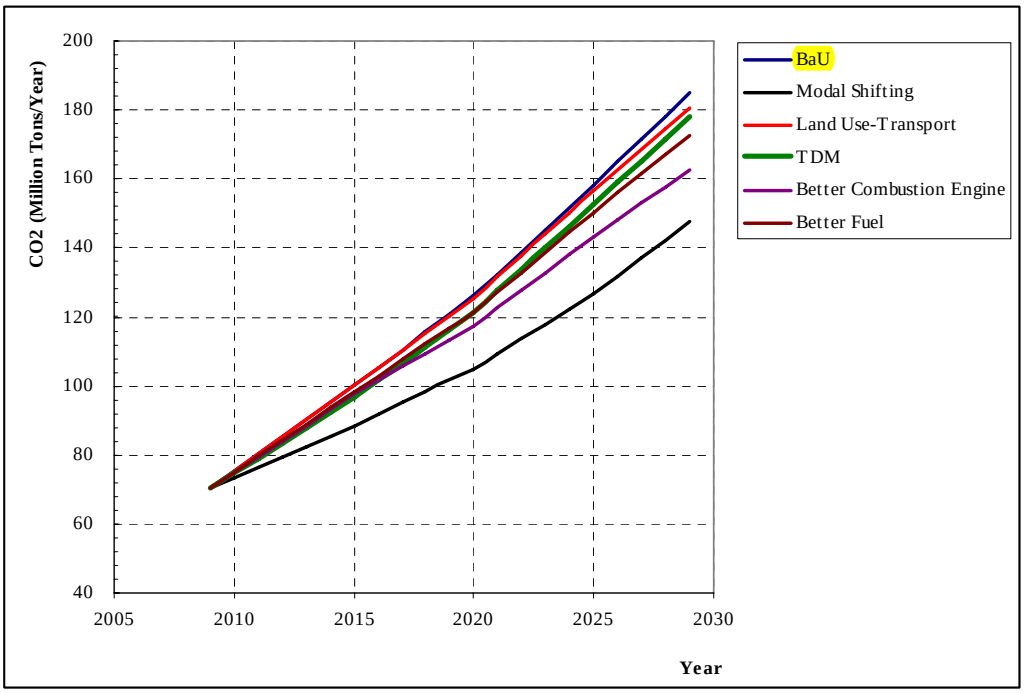

Figure 15 CO_2 Estimation Based on Some Policy Measures

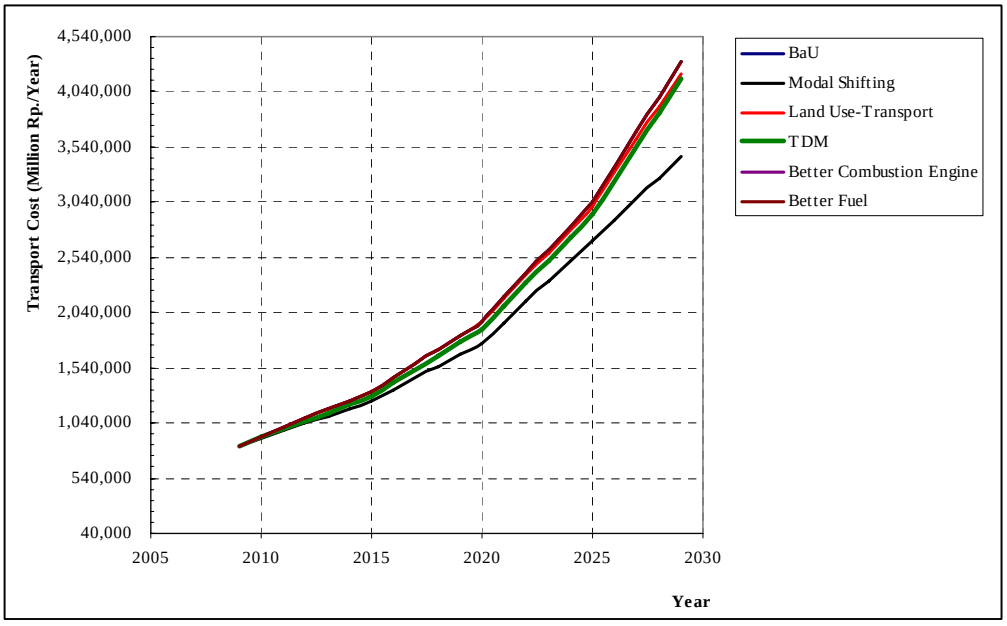

Figure 16 Estimation of Total Transport Cost for Some Policy Measures

Finally, the abatement cost is calculated in USD/ton CO_2. It is obtained by taking account of the cumulative CO_2 reductions during the analysis period, and the present value of the associated cost. Results are presented in the table below.

Table 12 Abatement Cost Estimation by Policy Measure

Policy	Spending type	Total Cost Relative to BAU (Mill. $)	NPV (rel. to BAU) (disc. rate: 12%) (Mill. $)	Cumulative CO2 abatement (Ton)	Abatement cost ($/ton CO2)
Modal Shifting	public	35,222	15,509	405,231	56.6
	private	20,038	7,439		
Better Combustion Engine	public	108,881	35,762	180,334	1,010.3
	private	335,418	146,428		
Better Fuel	public	180,537	58,463	99,483	587.7
	private	-	-		

To pursue the Avoid-Shift-Improve strategy effectively, it is important that the following barriers are addressed:

- Policy paradigm – whereby the existing development model based on high rates of motorization can be replaced by one that balances economic, social and environmental sustainability, and which recognizes the benefits of pursuing a low carbon transport strategy
- Political acceptance – whereby policies which may currently prove publicly unpopular can be designed and packaged in a way that highlights the benefits of the policy change in tangible and easily understood ways. Public awareness campaigns and other measures to raise awareness of the issue can also play a large role in increasing political acceptability
- Financing – whereby the current lack of financial resources for low carbon transport can be alleviated through the development of new funding mechanisms, or the reallocation of existing resources towards low carbon transport, including international financial flows such as ODA and UNFCCC related funding.
- Capacity building – whereby institutions and their staff are fully empowered to implement the identified low-carbon transport policies.
- Technology and knowledge transfer – whereby appropriate technologies and knowledge are transferred to enable policies on low carbon transport
- Data and monitoring – whereby data on transport activity and emissions can be collected systematically and regularly, to alleviate the current lack of statistics

Proposed activities to support the above policy options are depicted in the table below:

Table 13 Activities of Long-Term Development Plan in Transportation Sector

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
Information and Knowledge Management	Modal Shifting: Holistic improvement of public transport quality in urban area	Dissemination of the programs to local government			
	Modal Shifting: Improvement of the carbon efficiency of transport facilities and operations	Determination of port, airport and terminal hierarchy			
		Determination of optimum transport operational management			
	Transport Demand Management (TDM) in Cities: Trip shifting to different time and place to improve traffic conditions in cities	Determination of the most suitable TDM scheme for each city			
	Integrating Transport and Land Use Planning: Developing and implementing land use and infrastructure planning to reduce/avoid vehicle trips.	Review of city master plans			
		Problem identification and solutions for implementing master plans			
		Identification of incentives for apartments development and subsidies			
	Better Combustion Engine: Engine replacement of land transport vehicles with the more carbon efficient engine		Identification of incentives for better engine vehicles		
	Better Fuel: Use of improved or alternative fuel for transport operations	Research on alternative fuels			
		Determining the most suitable better fuel			
Planning and Policy, Regulation and Institutional Development	Modal Shifting: Holistic improvement of public transport quality in urban area	Integration of BRT in the public transport system	Planning of Developing BRT systems in 23 cities	Planning of Developing BRT systems in 23 cities	Planning of Developing BRT systems in 23 cities
		Guidelines for developing the BRT system			
			Public transport service standardization		

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
		Guidelines for developing the rail-based mass transit system		Planning of rail-based mass transit systems in 9 metropolitan cities	Planning of rail-based mass transit systems in 9 metropolitan cities
			Identification of subsidies for public transport		
		Developing of master plan for public transport for every city			
		Regulation for City government obligation to provide mass transit system			
		Regulation for Public transport ownership			
	Modal Shifting: Promotion of non-motorised transport in urban area	Integration of pedestrian and cycling ways in the city plans	Planning in improving pedestrian and cycling facilities	Planning in improving pedestrian and cycling facilities	Planning in improving pedestrian and cycling facilities
		Traffic regulation for non-motorized transport			
	Modal Shifting: Improvement of the carbon efficiency of transport facilities and operations	Improvement of master plan of terminal and port system			
		Regulation of local government, related to TDM scheme			
		System development of Electronic Document System			
		System development for integrated scheduling and ticketing			
		Regulation on overloading			
		Regulation on air traffic management			
			Planning for improving management of fleet, route and other operational aspects for better carbon efficiency.	Planning for improving management of fleet, route and other operational aspects for better carbon efficiency.	Planning for improving management of fleet, route and other operational aspects for better carbon efficiency.
	Transport Demand Management (TDM) in Cities: Trip shifting to different time and place to improve traffic conditions in cities	Regulation of local government, related to TDM scheme	Planning of TDM scheme in main cities	Planning of TDM scheme in main cities	Planning of TDM scheme in main cities

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
	Integrating Transport and Land Use Planning: Developing and implementing land use and infrastructure planning to reduce/avoid vehicle trips.	Local regulation on land use-transport master plan implementation			
			Planning of state/local government owned apartment housing	Planning of state/local government owned apartment housing	Planning of state/local government owned apartment housing
	Better Combustion Engine: Engine replacement of land transport vehicles with the more carbon efficient engine	Development of regulation on vehicle age limitation			
			Planning of reforming vehicle tax		
			Planning of vehicle emission standard		
	Better Fuel: Use of improved or alternative fuel for transport operations	Planning for better fuel provision and distribution			
			Fuel economy (fuel standardization)		
			Fuel tax reform		
\Implementation and Control with Monitoring and Evaluation	Modal Shifting: Holistic improvement of public transport quality in urban area		Implementation of BRT systems in 23 cities	Implementation of BRT systems in 23 cities	Implementation of BRT systems in 23 cities
		Integration of rail-based mass transit in the public transport system		Implementation of rail-based mass transit systems in 9 metropolitan cities	Implementation of rail-based mass transit systems in 9 metropolitan cities
			Implementation of subsidies for public transport		
			Provision and operation of school buses	Provision and operation of school buses	Provision and operation of school buses
	Modal Shifting: Promotion of non-motorised transport in urban area		Implementation in improving pedestrian and cycling facilities	Implementation in improving pedestrian and cycling facilities	Implementation in improving pedestrian and cycling facilities
		Car free day			
	Modal Shifting: Improvement of the carbon efficiency of transport facilities and operations		Improving railway terminal seaport and airport facilities (Eco-ports & Eco-airport)	Improving railway terminal seaport and airport facilities (Eco-ports & Eco-airport)	Improving railway terminal seaport and airport facilities (Eco-ports & Eco-airport)
			Implementation for improving management of fleet, route and other operational aspects for better carbon efficiency.	Implementation for improving management of fleet, route and other operational aspects for better carbon efficiency.	Implementation for improving management of fleet, route and other operational aspects for better carbon efficiency.

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
	Transport Demand Management (TDM) in Cities: Trip shifting to different time and place to improve traffic conditions in cities		Implementation of TDM scheme in main cities	Implementation of TDM scheme in main cities	Implementation of TDM scheme in main cities
		Campaign for driving with more environmentally friendly behavior (eco-driving).			
		Promotion of traffic operations equipment with alternative energy source	Promoting traffic operations equipment with alternative energy source	Promoting traffic operations equipment with alternative energy source	Promoting traffic operations equipment with alternative energy source
	Integrating Transport and Land Use Planning : Developing and implementing land use and infrastructure planning to reduce/avoid vehicle trips.	Incentives for development of self-sustained area/city	Promotion of self-sustained area/city development	Promotion of self-sustained area/city development	Promotion of self-sustained area/city development
			Implementation of state/local government owned apartment housing	Implementation of state/local government owned apartment housing	Implementation of state/local government owned apartment housing
	Better Combustion Engine: Engine replacement of land transport vehicles with the more carbon efficient engine	Promotion of the better combustion engine, hybrid, electric vehicle or other more carbon efficient engine			
		Promotion of small cars or lighter material vehicles, especially for urban traffic			
		Campaign for proper engine maintenance			
			Implementation of reforming vehicle tax		
			Implementation of vehicle emission standard		
	Better Fuel: Use of improved or alternative fuel for transport operations		Incentives for the better fuel		

Note: Thicker shade represents stronger weight

10 MITIGATION IN FORESTRY SECTOR

10.1 Emission Status

The forestry sector including peat fires contributed the highest emission (945MtCO_2/year) or about 61% of total National GHGs emission in Indonesia. About 2/3 of these emissions comes from the Land Use Change of Forestry (LUCF) excluding peat fire but as most of the peatlands are on forest land these two sectors are tightly linked. Peat lands on forest land are recorded as the highest carbon storage as well as source of emissions.

In Indonesia, the Ministry of Forestry controls 133 million ha on land, comprising 23 million ha of conversion forest, while permanent forestland covers 111 millions ha or 60% of the total area of Indonesia. Indonesia has lost approximately 1.7 million ha of its forest per year during the period of 1985-1997. The highest forest lost occurred during 1997-2000, reaching 2.8 million ha per year. The latest published data (MoF, 2007) showed that net forest lost has decreased during 2000-2005, reaching about 1.1 million ha annually. Common deforestation and forest degradation drivers include: conversion of forests to annual cropland, conversion to perennial plants (oil palm, shrubs, and short-rotation pulpwood plantations), conversion to slash-and-burn (shifting cultivation) lands, and conversion to exploit mineral resources, urban lands or other human infrastructure.

The roadmap covers the period 2010-2029; and can be divided in two periods. The target to reduce GHG emissions by 26 % (Presidential announcement, September 2009) refers to efforts during the first period (2010-2019), but an outlook on the second period (2020-2029) can be provided as well.

Table 14 Forest lands (millions ha)

	Forest Land						
	Conservation	Protection	Limited Production	Production	Total Permanent Forest Land	Conservation Forest	Total Forest Land
Forest Cover	14	22	18	21	75	11	86
Non-Forest Cover	4	6	6	13	28	11	39
Data eficiency	2	2	2	2	8	1	9
Total	20	30	26	35	111	23	134
%	0.11	0.16	0.14	0.19	0.59	0.12	0.71

Source
Forstry Palnning Agency
MoF, Stat, 2007

10.2 Mitigation Potentials

Past trend of emission in forestry depended largely on the rate of deforestation, forest degradation and conversion of forest land into other land uses such as crop land, grassland and settlement. Meanwhile, removal of CO2 from the forestry sector comes from the growth of forests (natural forests and plantations) as well as reforestation.

Forests, in the context of climate change, can be a source or a sink of greenhouse gas emissions. Good practice in management of production forest, conservation and protection forest, as well as limiting the conversion of forest to non-forest areas, and forest fire prevention, contributes to the reduction of CO_2 emissions and increases resilience to negative climate change impacts. Rehabilitation of degraded forest, timber and estate crops plantation development in degraded land could also enhance the sink capacity of forests. Furthermore, through those activities, forest functions such as biodiversity and genetic resources conservation, watershed protection, as well as social-economic function especially for forest dwellers, can be sustainably maintained.

Addressing climate change issues in the forestry sector can not be separated from the effort in tackling the challenges in sustainable forest management and other government objectives as to provide sustainable source of employments to its population. It requires also addressing the root causes of unsustainable forest management starting by improving the control over forest resources and over access to forest land, which also means improving the forest management at local level.

Development of forest management units (KPHs) is an important means to achieve sustainable forest management (SFM) at local level and mitigation of climate change at global level. As an administrative unit with strong knowledge of local conditions, stakeholders, forest status, concession operations and regulatory standards, the KPHs has the potential to play a critical role in managing conflict over land with neighboring communities and ensuring the legitimacy and effectiveness of forest carbon projects.

The Ministry of Forestry has proposed a number of activities for this roadmap to support SFM and emission reduction from forestry sector. The key mitigation measures of Ministry of

forestry can be summarized as follows:

- Sink enhancement
  - Forest rehabilitation activities mostly on protection forest and watershed
  - Development of industrial plantations (HTI), plantations with private entrepreneurs and communities (HTR) on production forest
  - Stimulate plantations outside forest lands for rehabilitation or wood production
  - Management of natural secondary forests in production, protection and conservation forests.
- Emission reduction
  - Improved silviculture and logging activities in productive natural forest
  - Reducing emissions form forest land conversion particularly on peat forest land
  - Reducing emissions from illegal logging and fire.

They are also some supporting measures:

- Strengthening Forest Area
- Development of KPH (Forest Managing Units)
- Capacity building
- Research and Development on Forest & Climate change
- Forest Enforcement

The key field activities are 1) plantations for rehabilitation, 2) plantations for wood production (HTI or HTR) and 3) development of forest management units (KPHs). We scrutinize them below in a scenario analysis.

As KPHs will allowed a better control on forest land, a string of field activities for SFM will be allowed on the field, which contributes to forest mitigation and which would not have been possible in the current context. The results will be: improved forest management, development of forest neighboring communities, managed conflicts, reduced deforestation due to encroachments, reduced illegal logging and fires.

All these three activities are actually inter-dependent. With no improvement in forestry management the same causes will create the same effects, and deforestation will go on. The development of forest management units offers the opportunity to improve on long term the management of all state forests: natural forests, rehabilitated forest, and productive

plantations.

With no investment in productive plantations (HTI/HTR) the wood demand from domestic, regional and global market will menace the remaining natural forest and future REDD activities will be jeopardized. About 6 to 7 millions ha of (HTI/HTR) are required in 2020 for the development of wood industries and ensuring employment generation of 675-836000 people in this sector (FAO outlook 2009). As Indonesia has already about 3 million ha of productive plantations an additional 3-4 millions would be required.

10.2.1 Different strategies and different scenarios

The result of each of these above activities depend of budget allocation efforts but are also constrained by other factors as capacity to implement rehabilitation targets, wood market demand for timber plantations, and human capacity development for KPHs. The question is also to identify at constant budget, which strategy has more chance to deliver the biggest share of GHG emission reductions. Knowing these constraints, Bappenas did several mitigation scenarios to identify how these different activities could be efficiently articulated. These scenarios are built on the assumption that if forest management remains the same, no improvement of natural forests management will happen. The following scenarios and strategies were built, based on what was deemed realistic and promising for an optimum mix of activities for mitigation, given the sector conditions, technical feasibility and budgeting limits:

Business as usual scenario (BAU)

The BAU scenario assumes constant parameters until 2020, i.e., an annual deforestation rate of approx 1 Mio ha, in combination with forest rehabilitation (Gerhan) efforts of 1 trillion IRD per year[1] and HTI development of 150 000 ha a year. It assumes annual emissions of 800 Mio tCO2[2]; this estimation is based on the second national communication (2009) data for the period 2000 - 2005.

[1] It is very difficult to estimate the mitigation impact of these rehabilitation efforts as no monitoring of plantation growth is made after 3 years, so no fair estimation of mitigation is possible. MoF announce results in ha which are a mix of full plantations, enrichment and agroforestry plantations.

[2] Second National Communication indicates and average annual emissions of 638 Mio tCO2 for LUC Forest and 307 Mio tCO2 for peat fires, as most peat are located in forest lands, we choose 800 Mio tCO2 for the forest sector.

SC1 Increasing the sink capacity through forest rehabilitation activities (current trends)

Scenario 1 (SC1) explores what will happen if efforts are put on rehabilitation activities during the first period. As most rehabilitation efforts took place on protected forest land, which is in a situation of open access, survival fall to 40 % after 3 years and mean annual growth at 10 years is 8 m^3/ha/year. In this scenario there is also an investment in industrial plantations (HTI/HTR). No changes in natural forest management are projected.

SC2 Increasing the sink capacity and creating a resource for industries

Scenario 2 (SC2) examines what will happen if efforts are put more on productive plantations (HTI/HTR) during the first period. In this scenario there is a strong investment in industrial plantations (5.5 million ha HTI/HTR) and less in rehabilitation. Industrial plantations mean annual growth at 10 years is 30 m^3/ha/year. No changes in natural forest management are projected.

SC3 Increasing the sink capacity and creating conditions for preventing further deforestation (KPH – HTI- Sustainable Forest Management scenario)

With scenario 3 (SC3) Indonesia invests heavily into Forest Management Units (KPH) to guarantee sustainability. Mitigation efforts in SC3 are based on a mix of activities: 1) industrial plantations established on dry land, where KPH have been developed; 2) emission reduction enhancement comes from better management of production, conservation and protection forests under the KPHs (11.4 tCo2/ha/year), 3) some modest REDD activities during the first period[3]. In SC3 4 million ha of HTI/HTR are planted on 24 million ha of KPH. Mitigation of GHG emissions comes also from better management of natural forest, less illegal logging and fire.

[3] 300 000 ha of peat lands with forest cover on conversion forest have been transferred to existing KPH under sustainable management and not converted into oil palm but on mineral soil, 1300 tons Co2/ ha are mitigated (Germer, 2008).

Table 15 Mitigation Scenarios

	SC1 Trends		SC2: Second national communication		SC3 Focus on wood demand		SC4 KPH+ HTI	
Key activities per period in million ha	2010-2014	2015-2020	2010-2014	2015-2020	2010-2014	2015-2020	2010-2014	2015-2020
HTI	0.75	0.75	1.95	1.95	1.00	1.00	1.00	1.00
HTR	0.50	0.50	1.00	1.00	1.75	1.75	1.00	1.00
RHL Gerhan / rehabilitation	2.50	2.50	1.25	1.25	1.50	1.50	0.50	0.50
Development of FMUs controlling x millions ha	0.50	0.50	5.00	5.00	0.50	0.50	24.00	24.00

Results of mitigation scenarios

The trajectory of emissions in the three scenarios as well as the business as usual scenario is reflected in million t CO_2-e in figure 18 below. It can be clearly seen that scenario 3 results in a maximum of emissions reductions. Continuation of current trends (SC1) leads to rather insignificant lowering of emissions levels from 800 – 700 MtCO2/year, whereas SC 2 emissions reductions is half of what the potential of SC3 can do.

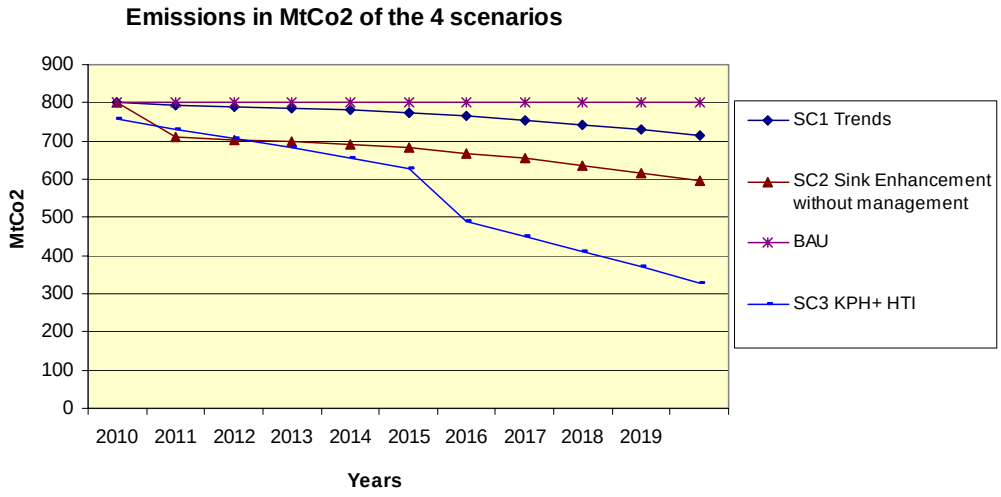

Figure 17 Development of emissions ($MtCO_2$-e) of the Business as usual scenario and three mitigation scenarios

Table 16 Result of Scenario

	BAU	SC1 Trends	SC2 Sink Enhancement without management	SC3 KPH+ HTI
Total emissions 2010-2019 in MtCO2	8000	6944	6049	4961
Annual emissions MtCO2	800	694	605	496
Avoided annual emissions in MtCo2	0	106	195	304
Estimated annual Cost in Trillions IRD	5.01	6.51	6.01	6.28
Annual cost in US$/ tCO2		6.2	3.1	2.1

SC1 is the most expensive scenario and is not efficient in terms of mitigation as trees are not properly managed by someone once they have been planted. SC2 intends to develop sinks by increasing efforts in plantations but with insufficient efforts to develop KPHs and lacking improvement forest management the gain in mitigation is modest. SC3 is a feasible scenario to reach the target of Indonesia to reduce emissions by 26%. Most of the mitigation in SC3 comes from an improvement of forest management in KPH areas. SC3 has also the lowest abatement cost per unit of emission reduction.

Outlook on the second Period 2020-2029

SC3 during the first period prepares the subsequent period by making further investments in the forestry sectors more efficient, effective, and reducing future mitigation costs. After 2020, REDD is facilitated thanks to SC3 because the precondition, the development of FMUs and productive plantations took place already. Emission reductions will not come anymore from investment in industrial plantations as the market demand may not allow further HTI development, but will come mostly from SFM of secondary natural forests.

Thanks to the investments done by SC3 during the first period, efficient rehabilitation efforts during the second period can take place because the control over forestland is then possible in KPH areas. Forest control will be improved and it will contribute to avoid natural forest degradation due to illegal logging and fires. Efforts to develop KPHs should be maintained

during the next period 2020-2029 to increase the Indonesian capacity to further reduce its emissions until Indonesian forestlands will turn from a source to a sink and fully benefit from REDD schemes.

Key recommendation for the roadmap 2010-2029

The results of the mitigation scenarios suggest that the forestry sector could reduce GHG Emissions by 300 Mt Co2/year by 2020 with a reasonable increase in operational budget. To allow measuring the results of the mitigation activities described above, the existing monitoring systems should be adjusted for the issues of climate change under the UNFCCC (Monitoring, reporting and verification, MRV). To contribute to this future national carbon accounting, the Ministry of Forestry should further develop a monitoring system gathering forest management data.

In the forestry sector, at constant budget, development of KPHs should be prioritized. KPHs will give to Indonesia the capacity to control and manage its extensive 110 millions ha of forest land. It is not an easy task as land tenure and demarcation should be clarified and human capacities to manage be developed. It will be progressive as it will take time to develop hundreds of KPHs, the rhythm of development will depend on the development of human capacity and budgets. This activity conciliates most of the climate change objectives with development objectives and will boost efficiency of other forest mitigation activities during next periods. It will help to collect taxes revenues from forest. In this sector, it is the most cost efficient state budget affectation on medium and long term.

Activities for reducing emissions from deforestation and degradation (REDD), including peat land degradation, are the most promising mitigation measures. It is far more effective to avoid deforestation than to rehabilitate forestland.

REDD involves i) to build up a National REDD Architecture, ii) a reference emissions level and iii) an Indonesian National Carbon Accounting system. Importantly REDD implementation requires also institutional and human capacities and effective control over forest land, which means efforts in KPHs development and local community capacity building. Major threats to REDD implementation are leakage (the risk that REDD activities merely displace deforestation) and non permanence (i.e., lower emissions at current time,

followed by higher emissions at future time). KPHs should address the risk of non-permanence as the KPHs are conceived to manage the forest sustainably and so the carbon stock. If not mitigated, these risks would jeopardize financial returns Indonesian can expect from REDD.

There is risk that illegal activities moved from places where KPHs ha been developed to places where they have not yet been (i.e., leakage); this should be tightly monitored. Development of KPHs is key regarding REDD and should be done as fast as possible.

Rehabilitation activities should be focused in order to increase the efficiency of this activity and to use state budgets wisely. During the period of the first RPJM (2010-2014) it should be targeted to forestland in place where KPHs have already been established and outside forestland with communities and private entrepreneurs, where market forces support plantations activities. Rehabilitation activities could come in force in following periods on forestland along with the development of KPHs.

HTI-HTR plantations should be prioritized during the first period as they are more efficient in term of mitigation than rehabilitation activities. HTI can be develop at a moderate cost for the state, as most of this cost is bear by the private companies. HTI could be facilitated by the development of KPHs as land security is a key incentive to attract investors in plantation business.

Table 17 Activities of Long-Term Development Plan in Forestry Sector

Category	Strategies	Activities	2010-2014	2015-2019	2020-2024	2025-2029
Information and Knowledge Management	Strengthening forest institutions	Forest management unit development (KPHs) - Number of KPHs developed per year	199	244	340	340
		Forest area enforcement in million ha (Cumulative)	90	93	126	126
		Capacity building Master degree	1,992	1,293	1,500	1,500
		Capacity building Doctoral degree	352	322	420	420
Planning and Policy, Regulation and Institutional Development	Increasing carbon absorption capacity/sink	Reforestation / Afforestation				
		a. GERHAN / RHL	5,000,000	5,000,000	5,000,000	5,000,000
		b. 1 million trees program	100,000	100,000	100,000	100,000
		c. Industrial plantation forest (HTI).	2,000,000	2,000,000	1,100,000	1,000,000
		d. People plantation forest (HTR)	3,650,000	850,000	850,000	850,000
		e. Community forest (HR)	2,600,000	1,700,000	1,700,000	
		f. Community forest (*Hutan kemasyarakatan*)	2,099,404			
		g. Village forest (*Hutan Desa*)	2,000,000			

Category	Strategies	Activities	2010-2014	2015-2019	2020-2024	2025-2029
		h. Natural forest (HA: SILIN)	500,000	750,000	500,000	
		Increase stock on degraded forest land under SFM				
		Protected forest stock enhancement	1,100,000	1,700,000	1,700,000	2,600,000
		Conservation forest stock enhancement	2,000,000	1,300,000	1,200,000	1,300,000
Implementation and Control with Monitoring and Evaluation	Reducing emission/ conservation of carbon stock	Increase of Protection forest land under SFM:	1,760,000	2,120,000	2,120,000	2,380,000
		Increase of Conservation forest land under SFM:	5,920,000	2,120,000	2,110,000	250,000
		Prevention of forest fire	37,440	28,600	26,000	23,400
		Management of productive natural forest	23,120,000	23,120,000	23,120,000	23,120,000
		Reduction of forest fire	10,132	9,599	9,066	8,533
		Management of peat land area	7.2 million ha in Sumatra, 5.8 million ha in Kalimantan and 8.0 million ha in Papua	7.2 million ha in Sumatra, 5.8 million ha in Kalimantan and 8.0 million ha in Papua	7.2 million ha in Sumatra, 5.8 million ha in Kalimantan and 8.0 million ha in Papua	7.2 million ha in Sumatra, 5.8 million ha in Kalimantan and 8.0 million ha in Papua

Note: Thicker shade represents stronger weight

11 MITIGATION IN INDUSTRY SECTOR

11.1 Emission Status

The purpose and objectives of the Industry Sector Roadmap are (1) to estimate Indonesia's potential greenhouse gas emissions (GHGe) resulting from industrial activity with a particular emphasis on cement industry; (2) to estimate the size of abatement potential from the industry sector as a contribution to Indonesia's national commitments to reduce GHGe, with a particular emphasis on the cement industry; (3) to incorporate the industry sector's emission reduction efforts into the national economic development plans; (4) to position the cement industry as a priority for action in the short and medium-terms; and (5) to identify technologies, programs, and funding required to support activities that can reduce GHGe from the industry sector.

The National Industry Development Policy established in Presidential Decree No. 28/2008 is aimed at strengthening the competitiveness of the manufacturing industries as a driver of economic growth. It is the intention that Indonesia's industry sector will become "world class" – supported by "macro economic stability, qualified public institutions" and "an improved industry structure". Based on the National Analysis of Industrial Development Policies incorporated into Presidential Decree no. 28/2008 the national policy target for economic growth in the industry sector is set to 7.5% in 2025.

In 2000 greenhouse gas emissions (GHGe) from manufacturing industries was the 9th largest source of GHGe in Indonesia (excluding LULUCF). In late September 2009, the Ministry of Industry decreed that GHGe reductions from the cement industry are a priority for Indonesia's industry development for the next 20 years.

Indonesia is joint with Thailand as the 10th largest cement producer in the world (2005) producing 37million tones p.a. The Indonesian government predicts the gross domestic product (GDP) to grow 7% p.a. for the following years with the cement industry rising in proportion to that figure. The largest Indonesian cement manufacturers and the Indonesian Cement Association (ASI) therefore internally plan with a cement industry growth rate of 5% - 8% p.a. until 2025. Accordingly, cement production is projected to increase from 33.92 million tones in 2005 to 74.13 million tones in 2020 and to 123.47 million tones in 2030. This, combined with the cement companies' sophisticated level of greenhouse management,

international participation and efficiency of emissions reduction potential, means that the cement industry is the focus of this Industry Sector Roadmap.

Excluding emissions from land use change and forestry, the cement production process (2.6%) was the equal tenth largest GHGe contributor in 2000 after fuel combustion from petroleum and gas refining (26.2%), industrial wastewater and discharge (20.8%), transportation (9.4%), electricity and heat production (6.2%), rice cultivation (5.9%), residential fuel combustion (4.7%), fugitive emissions from oil and natural gas (4.0%), agricultural soil (3.9%) and fuel combustion from other manufacturing industries and construction (3.0%).

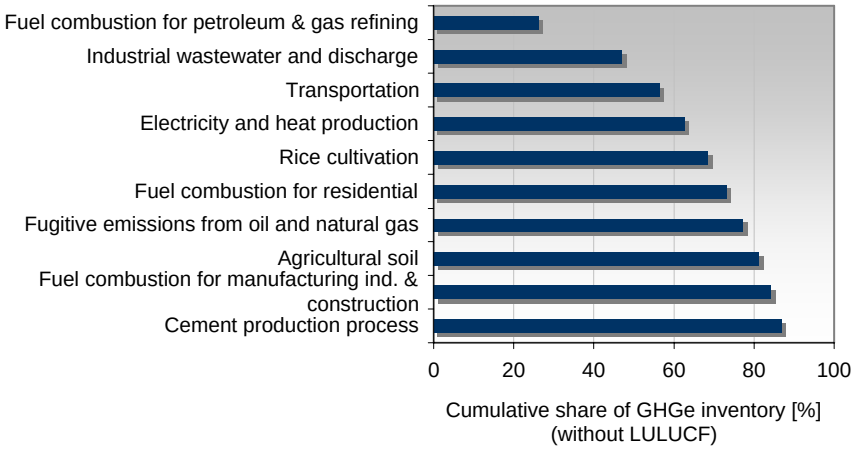

Figure 18 The Relative Contribution of Cement to Indonesia's GHG Inventory in 2000

Each industry has its own metrics for measuring environmental performance. In the case of cement, the IEA suggests CO_2 emission intensity, which describes the CO_2 emissions from process and energy consumption (including electricity) per tone of cement produced. Globally the Indonesian cement industry has a relatively high emission intensity. In average emission intensity in Indonesia counts 0.833t CO_2/t cement. It must be noted that the specific CO_2 emissions per tonne of cement are heavily influenced by different factors. The most important of these factors are the specific energy consumption, the fuel mix used to provide the required energy and the clinker content in cement. Figure 20 shows the potential for the Indonesian cement industry to improve its cement emissions intensity.

.

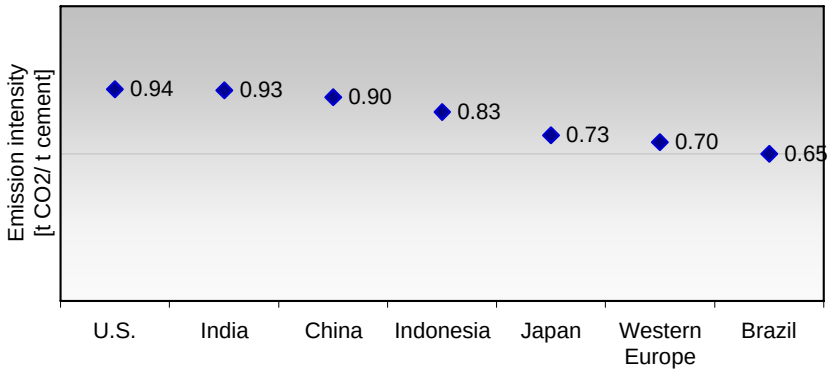

Figure 19 Examples of Emission Intensity in Cement Production

11.2 Mitigation Potentials

According to non-Annex 1 countries contributing to the UNFCCC TNA, there are over 60 individual technologies currently available to reduce GHGe from the cement industry. The technical opportunity for mitigation emissions from the cement manufacturing process can be divided into three, currently proven categories:

- Energy efficiency –reducing energy consumption from non-kiln activities such as lighting, motor efficiencies, air-conditioning and fuel in machinery including trucks. Only small opportunities remain compared to other categories; new plants in most parts of the world are already highly energy efficient;
- Alternative fuels – biomass as agricultural waste, fuel crops, municipal and industrial waste, including hazardous wastes. Opportunities exist where large scale agricultural waste sources are within proximity to cement factory with guaranteed supply and close to large cities supply municipal sold waste;
- Blending materials – using substitutes for clinker (including recycled concrete, fly-ash);

Accordingly four scenarios have been developed for this Industry Sector Roadmap:

1) The *Business-as-Usual scenario* describes the development if no change in cement production process takes place but demand rises at 4.5% to 6.0% p.a. In 2008, the cement industry emitted approximately 31.25 million tones CO_2; 57% was contributed by the calcination process alone. Heat production led to 32% and electricity production to 11% of total GHGe. Emission intensity counted 0.833t CO_2/t cement.
2) For the *Energy-Efficiency scenario*, a reduction of the emissions from fossil fuel combustion and electricity use is assumed, due to the implementation of energy efficiency measures.

This reduction will lead to a decrease of CO_2 emissions of 2.0% p.a. (1.3 million tones CO_2 p.a.) in 2020 and up to 3.6% p.a. (3.8 million tones CO_2 p.a.) in 2030 compared to Business-As-Usual. Emission intensity can be reduced from 0.832t CO_2/ t cement in 2008 to 0.815t CO_2/ t cement in 2020 and 0.802t CO_2/ t cement in 2030.

3) The *Alternative-Fuel scenario* shows, that by substituting 30% of fossil fuels with alternative fuels, which are for heat production during clinker making, overall emissions from cement production can be reduced. Emission intensity can be decreased to 0.796t CO_2/t cement in 2020 and 0.765t CO_2/t cement in 2030, which will result in 4.4% CO_2 reduction p.a. (2.8 million tones CO_2 p.a.) in 2020 and almost 8.2% CO_2 reduction (8.6 million tones CO_2 p.a.) in 2030 compared to Business-as-Usual.

4) The highest potential of GHGe reduction bears the *Blended-Cement scenario.* Reducing the clinker content in the produced cement from 0.9t clinker/ t cement in 2008 to 0.85t clinker/ t cement in 2020 and 0.75t clinker/ t cement in 2030 will result in a total CO_2 emission reduction of 4.9% p.a. (3.1 million tones CO_2 p.a.) in 2020 and almost 15% p.a. (15.67 million tones CO_2 p.a.) in 2030. Emission intensity will decrease to 0.790t CO_2/ t cement in 2020 and 0.705t CO_2/ t cement.

Table 18 GHGe Abatement Under Different Scenarios, 2005 - 2030
Total Emissions (t CO_2)

Year	Total Cement production (t)	Business-as-Usual-Scenario	Energy-Efficiency-Scenario	Alternative-Fuel-Scenario	Blended-Cement-Scenario
2005	33,916,980	31,247,915	31,247,915	31,247,915	31,247,915
2008	38,946,883	35,365,651	35,365,651	35,365,651	35,365,651
2014	55,246,898	48,640,246	48,142,183	47,230,306	47,227,196
2020	74,036,127	64,278,709	62,976,957	61,439,804	61,147,351
2025	92,262,484	79,448,688	77,190,792	74,312,338	71,644,205
2030	123,468,016	105,421,365	101,580,480	96,809,761	89,755,125

Figure below shows an ambitious but achievable abatement goal in the order of 11% p.a. (7.3 million tonnes CO_2e p.a.) by 2020 and 27% p.a. (28.1 million tonnes CO_2e p.a.) by 2030 using the three abatement scenarios described above and without any major technological advancement (i.e. new kiln technology for lower temperature treatments, carbon capture and

storage, emerging cement technology that sequesters CO_2 as part of the bonding process in cement). It is assumed that the price of fossil-fuel energy rises quicker than that of biomass and that the price of CERs and other tradable carbon commodities increase over this period, further driving efficiency demands, alternative fuels and blending practices in the cement industry.

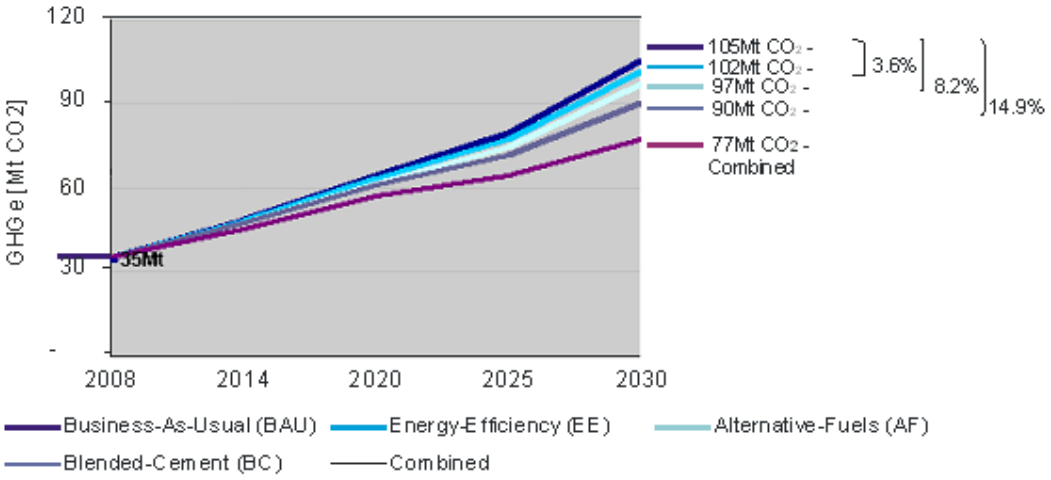

Figure 20 Cement Industry - Total Estimated Abatement Potential 2008 - 2030

To achieve the above goal of GHGe reduction, focused cooperation between industry and government is key, along with effective government regulation, policies and their enforcement. Generally speaking a blend of policy approaches is required to achieve both short and longer-term emission reductions. Some policies when implemented may not directly create behaviors that reduce emissions, but they will improve the likely success of other policies in reducing emissions. Other policies again will be slow to achieve emission reductions but will be necessary to achieve a genuine shift to a domestically responsive and internationally competitive low-carbon industry sector into the future.

Proposed programs for mitigation in industry sector are based on several targets as follows:

1. To achieve 3.6% reduction in energy use in non-kiln operations by 2030

Knowledge of energy efficiency technologies and their practical application in the Indonesian cement industry is very limited, creating a barrier for cement industry technical staff working cooperatively with "energy audit experts". On top of this most energy efficiency technology, equipment and services are imported implying that the local "promotional" activity for these technologies into the marketplace is currently limited.

Proposed programs are:

A. *Require the implementation of no-regrets activities from Energy Savings Plans*
B. *Capacity-build Energy Services Companies (ESCO)s for servicing the cement and other heavy manufacturing industries*

2. To displace 30% of the fossil fuel used in the kiln processes with waste materials reducing emissions by 8.2% by 2030

Regional demand for agricultural biomass waste, the missing economic incentive to find alternative uses for municipal solid waste and import levies on e.g. tires or other materials, which are assumed to be hazardous waste in Indonesia but not in other countries, create a limited supply of alternative fuels.

Proposed programs are:

C. *Review waste policy – increase landfill levies over time and make it viable to create new resource streams for municipal, agricultural and industrial waste*
D. *Review hazardous waste register and permit requirements for the cement industry*
E. *Provide a fair export and import levy for waste products*

3. To achieve 15% reduction in the clinker usage (or increase in blending) by 2030

It is noted that Indonesia has one of the highest average clinker/cement content in the world (95%) and this is largely due to the failed attempt in the mid-1990s to introduce a range of blended cements to the market, without proper quality controls, marketing and training.

Given that the majority of emission abatement opportunitie come from reducing the amount of clinker used in cement through blending, not over specifying concrete quality/characteristics for respective jobs could be a demand-led way of reducing cement industry emissions. This would need to be supported through an awareness raising initiative with the construction industry.

Proposed programs are:

F. *Review and set new cement performance standards - to avoid over specification of cement strength for use, and therefore reduce overall demand for clinker content*

G. *Eco-label cement products*

H. *Lead by example – government procures blended cement as appropriate to reduce overall demand for high clinker content cement*

I. *Review national building codes – require a minimum recycled concrete content for new cement*

J. Resource a national communications campaign to encourage the use of blended cements

K. *Increase government support for building local institutional capacity in policy development and program delivery for eco-efficiency, energy audits, energy services.*

Table 19 Activities of Long-Term Development Plan in Industry Sector

Category	2010-2014	2015-2019	2020-2024	2025-2029
Information and Knowledge Management	Measurement, reporting and verification of GHGe data at a plant level from the cement industry	Measurement, reporting and verification of GHGe data at a plant level from the cement industry	Measurement, reporting and verification of GHGe data at a plant level from the cement industry	Measurement, reporting and verification of GHGe data at a plant level from the cement industry
	Enhance technology research, development and deployment			
	Eco-label cement	Award System for specific savings in GHGe across the (target) industries		
	Study on the potential and supply of waste as alternative fuel for cement industry			
	Study on a supply network system of waste to be used as alternative fuel in cement industry			
	Study and issuance of a standard/ policy for supply and pre-treatment of raw material for cement blending			
	National communications campaign to encourage the use of blended cements	National communications campaign to encourage the use of blended cements	National communications campaign to encourage the use of blended cements	National communications campaign to encourage the use of blended cements
Planning and Policy, Regulation and Institutional Development	Climate Change Cooperative Agreements			
	Government support for building local institutional capacity in policy development and program delivery for eco-efficiency, energy audits, energy services			
	Capacity-build Energy Services Companies (ESCO)s for servicing the cement and other heavy manufacturing industries	No-regrets implementation of energy audits/savings plans	No-regrets implementation of energy audits/savings plans	
		BAT for new cement plants	BAT for new cement plants	BAT for new cement plants
	Review of waste policy – increase landfill levies over time and make it viable to create new resource streams for municipal, agricultural and industrial waste	Review of waste policy – increase landfill levies over time and make it viable to create new resource streams for municipal, agricultural and industrial waste	Review of waste policy – increase landfill levies over time and make it viable to create new resource streams for municipal, agricultural and industrial waste	Review of waste policy – increase landfill levies over time and make it viable to create new resource streams for municipal, agricultural and industrial waste

Category	2010-2014	2015-2019	2020-2024	2025-2029
		Review of hazardous waste register and permit requirements for the cement industry		
	Review and set new cement performance standards - to avoid over specification of cement strength for use	Procurement blended cement as appropriate to reduce overall demand for high clinker content cement		
	Review of National Building Codes	Review national building codes – require a minimum recycled concrete content for new cement		
	Increase government support for building local institutional capacity in policy development and program delivery for eco-efficiency, energy audits, energy services.			
Implementation and Control with Monitoring and Evaluation		Reward efforts to cut greenhouse emissions; removing subsidies for damaging activities		
	Provisions of fair export/import levy for waste products	Provision of fair export/import levy for waste products		
		Facilitation and investment on a supply network system of waste to be used as alternative fuel in cement industry	Monitor supply network system of waste to be used as alternative fuel in cement industry	

Note: Thicker shade represents stronger weight

12 Mitigation in Energy Sector

12.1 Emission Status

The GHG emissions from energy consumption in 2005 can be further categorized into 5 main sub sectors as illustrated in Figure 22 below. The contribution of those three fossil energy resources to GHG emissions is as tabulated in Figure 23 which shows that the coal share is steadily increasing over the period of projection. Thus, to reduce or at least to maintain this level, a special attention shall be focused on power sector as this sector will be the major consumer of coal, commencing in 2010 when new coal-fired power plants come online as part of the Accelerated 10,000 MW Power Program Phase I. Although the coming Accelerated 10,000 MW Power Program Phase II will accommodate more renewable energy, in particular geothermal power plants, the contribution of coal-fired power plants will be substantially high, which is at around 4,000 MW. Therefore, if there is no specific measure applied on the development of those coal-fired power plants, such as the usage of supercritical boiler and/or the introduction of carbon capture and storage (CCS), the level of CO_2 emission will definitely increase significantly in the coming years.

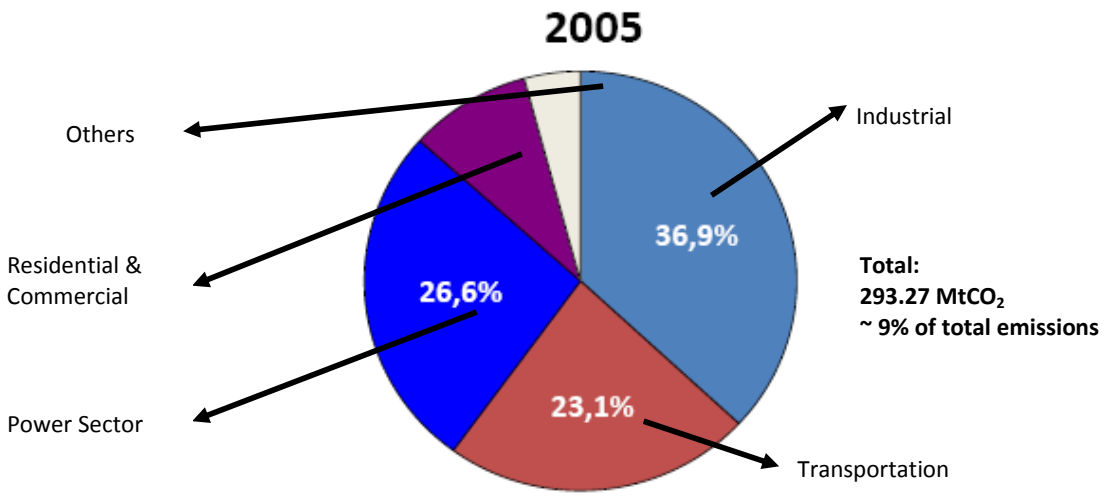

Figure 21 GHG Emissions by Sectors in Energy Sector
Source: Handbook of Energy and Economic Statistics of Indonesia 2006.

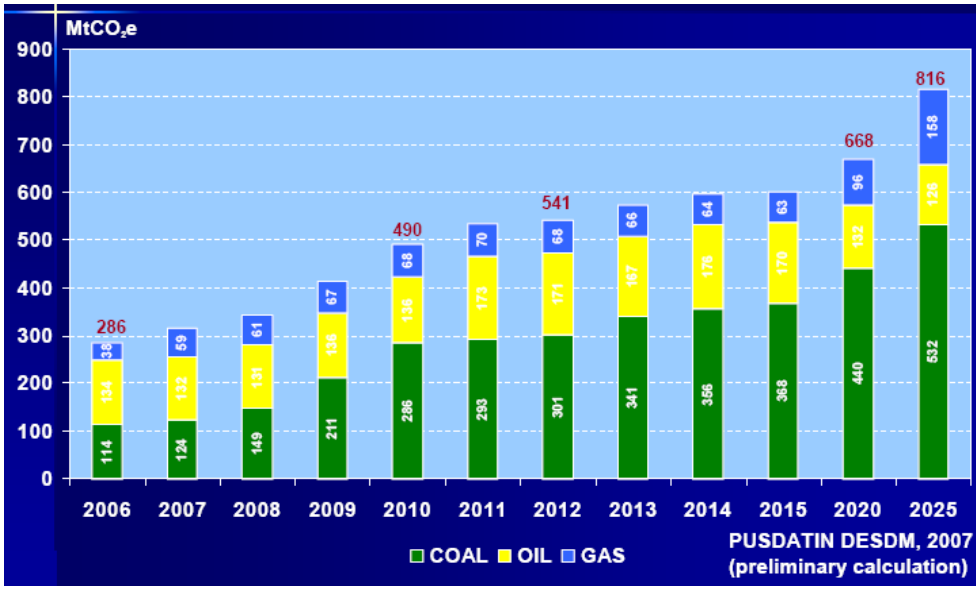

Figure 22 Estimated GHG Emissions from Fossil Fuels

12.2 Mitigation Potentials

In line with the above concerns and the national development planning priorities, the first batch of measures will focus on a set of priority sectors. These "priority sectors" are divided into mitigation and adaptation priorities, with the energy sector falling into the mitigation category. In mitigating climate change in the energy sector, Indonesia needs to properly address its heavy reliance on fossil-based fuels. The GHG emissions from the energy sector must be managed as this sector is crucial to the development of the Indonesian economy, both for earning export/foreign exchange (forex) revenue and for fulfilling the need for domestic energy.

The energy sector consists of four major sub-sectors, namely transportation, industry, electric power and commercial & residential, yet the scope of this report will cover only the electric power sector, including its primary energy supplies. Therefore, the emphasis is on the identification of the preferable technology and policy portfolios for CO_2 mitigation options described, in combination with the primary energy supplied, technologies applied, carbon value and financing required for power plant within the Java – Bali System. An extensive modeling exercise was therefore undertaken to examine the impact of various policy measures on the introduction of future power plants in order to achieve significant CO_2 emissions reduction, is as shown in the figure below (Situmeang, 2009).

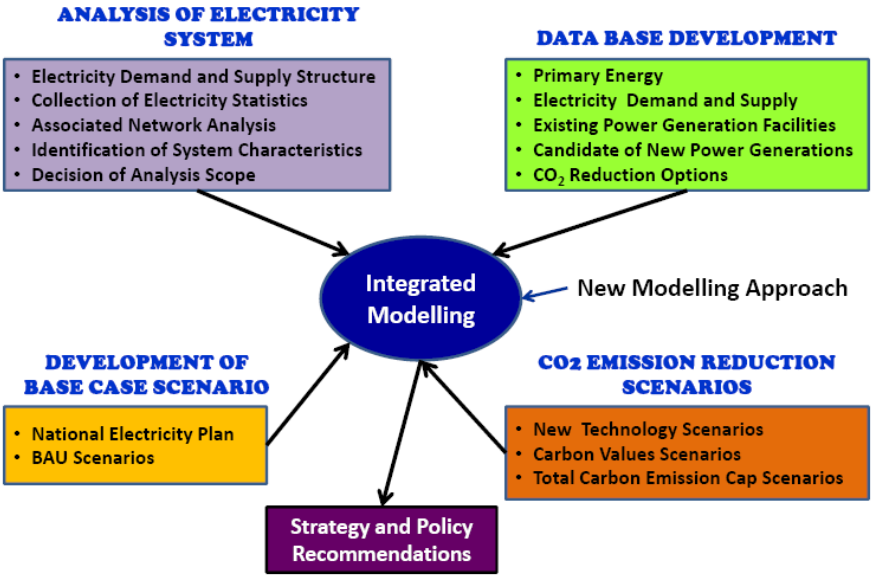

Figure 23 Integrated Modeling for Power Sector Scenarios
Source: Situmeang (2009)

Table 20 Proposed Scenarios for the Study

Description of Scenarios	
Base-case Scenario	This scenario is developed based on a projected level of future emissions against which reduction by project activities might be determined, or the emissions that would not occur without policy intervention as defined IPIECA or in UNFCCC Resource Guide for preparing the National Communications of Non-Annex I Parties). Thus it is prepared by using free optimization based on least cost principle.
RUPTL Scenario	Only technologies either current in 2009 or included in the Master Plan for Electricity Supply (RUPTL) 2009 - 2018 Plan were included. Current trend for renewables (mainly geothermal) introduction was reflected in the model. Constraint for some technologies were set according to the resource limit and geographical limit.
Total Carbon Emission Cap with New	Four likely and speculative new technologies using coal and gas were added to the Base-case scenario for application with in the life time considered in the mode. Retrofitting is also included in this scenario as well as CCS in these new technology variants.

Description of Scenarios	
Technologies and with/without NPP Scenario	**Yielded total carbon emission caps, such as 10, 20 and 30 percents compared to base-case scenario level were imposed on the RUPTL scenario with New Technology and with/without Nuclear Power Plant (NPP).** **Effect of total carbon emission caps was analyzed when higher generation limit was set on geothermal power plant.**
Carbon Value Scenario	**Various carbon values (USD 25 and 50/tCO_2) were imposed for both the Base-case scenario and the Total Carbon Emission Cap with New Technologies and with/without NPP Scenario.**

The proposed CO_2 reductions scenarios in the Power Sector are shown in Table 20 above. The results obtained are outlined along with recommendations for future activities that BAPPENAS might undertake to assist the Indonesian government in establishing a sustainable energy portfolio within the power generation sector. This is to be integrated and included in the Medium-term National Development Planning 2010 – 2014 document (Bappenas, 2009).

The simulation results of the integrated model with the proposed scenarios can be compared amongst the Base-case, RUPTL and Total Carbon Cap with New Technology and with/without NPP as follows:

1. Base-case scenario: CO_2 emissions increase by 185% in relation to 2009, going from 83 $MtCO_2$ to 236 $MtCO_2$.
2. RUPTL scenario: government intervention is counted through the introduction of geothermal and hydropower plants, withEmission reductions of 18 MtCO2 (7.6%).
3. New Technology scenario: the introduction of CCS proposed at PLTU Indramayu and PLTGU Muara Tawar, with CO_2 emissions reductions of **40.2 $MtCO_2$ (17%),** and abatement costs of USD 23.44/tCO_2.
4. New Technology + 4,000 MW PLTN with introduction of CCS: CO_2 emissions reductions of **62.4 $MtCO_2$ (26.4%)** and abatement costs of USD33.74/tCO_2.

When taking into account carbon values of USD 25/tCO_2 and USD 50/tCO_2, the following changes will be seen in the Carbon Value scenario's projection

1. On carbon value of USD 25/ton will reduce the emission by **88.4 $MtCO_2$ by 2020 (~ 37.4%)**, while on USD 50/ton will result in reduction by **129.7 $MtCO_2$ (~ 53.8%).**
2. Based on the rough estimate, for CO_2 emissions reductions of 1 $MtCO_2$, the required abatement cost is estimated at USD 72.93 million/tCO_2 and USD 76.68 million tCO_2 for carbon values of USD 25 and 50/tCO_2, respectively.

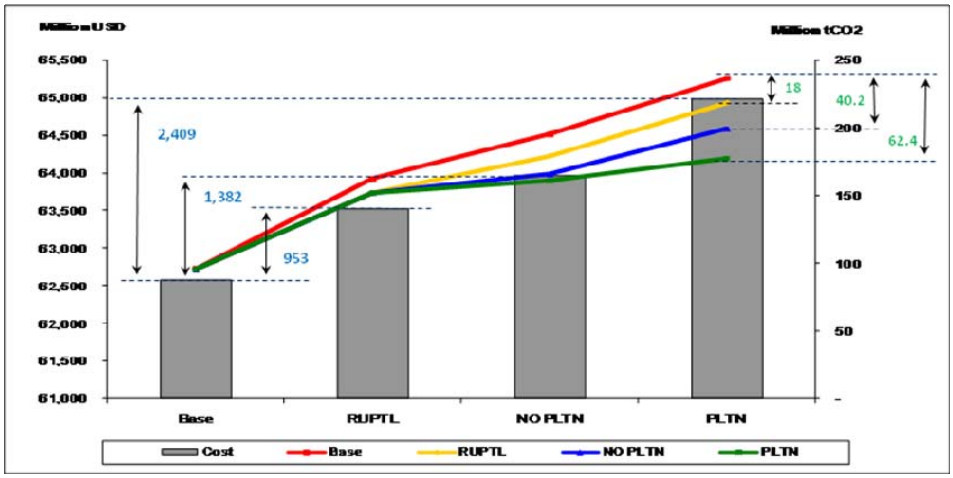

Figure 24 Comparison of Emission Reduction in Java – Bali Power System

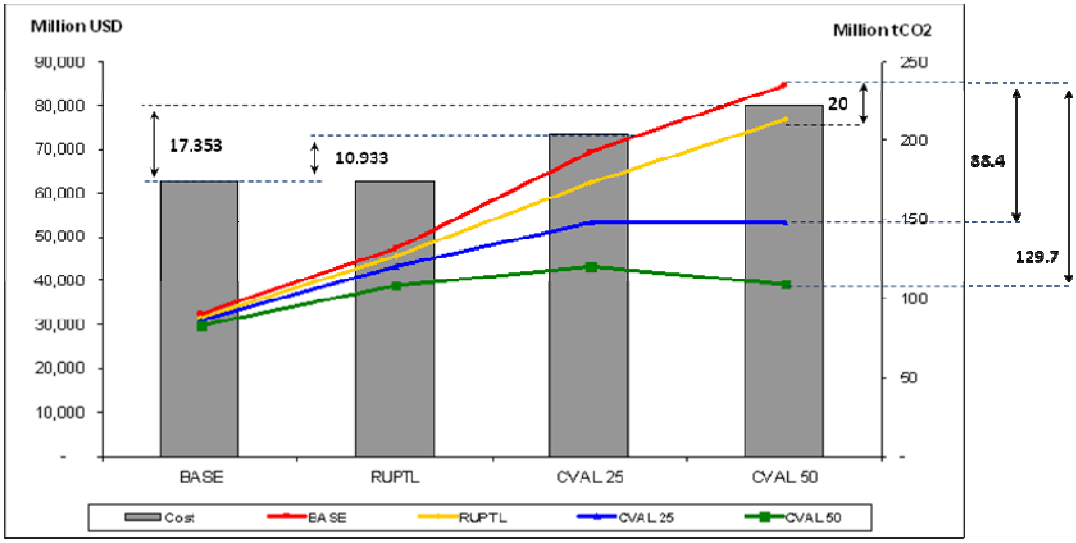

Figure 25 Comparison of Emission Reduction due to Introduction of Carbon Values in Java – Bali Power System

Table 21 Activities of Long-Term Development Plan in Energy Sector

Category	2010-2014	2015-2019	2020-2024	2025-2029
Information and Knowledge Management	Energy Conservation Partnership through energy audit services for industry and construction	Formulation of renewable energy technology information	Preparation of competence standard of Energy Manager	
	Clearing House as information center on energy conservation	Socialize policies on gas flaring to stakeholders	Promotion and preparation for energy saving labelling procedure for home appliances	
	Increasing public awareness through diffferent methods			
Planning and Policy, Regulation and Institutional Development	Education and training on energy efficiency and conservation			
	Produce Ministerial Decree on gas flaring utilization in Production Sharing Contract			
	Produce Ministerial Decree on gas flaring utilization as part of field's Plan of Development (POD)			
	Produce technical regulation on gas flaring.			
	Search funding and technical assistance to implement small-scale gas flaring projects			
Implementation and Control with Monitoring and Evaluation	Village electrification program based on renewable energy	Development of Energy Independent Village based on BBN and non BBN	Power plant facilitation program based on renewable energy	
	Development of biogas for domestic use	Development of geothermal	Development of biomass turbin for rural areas	
	Substituting fossil fuel (BBM) with natural gas (BBG) or nuclear energy (BBN)	Carry out several short listed gas flaring projects		
	Accelerate the development of natural gas infrastructure.			

Note: Thicker shade represents stronger weight

13 MITIGATION IN WASTE SECTOR

13.1 Emission Status

The population of Indonesia in 2005 was 218.8 million (BPS, 2006) and the level of solid waste production is 0.6 kg/capita/day for urban areas and 0.3 kg/capita/day for rural areas. Hence, solid waste from households amounts to 33.5 Mt/year. A portion of solid waste in urban areas (50%) is taken collectively by the Local Government Authorities. Based on research data (Damanhuri, 2009), the inorganic waste-recovery was around 3% and composting of organic waste was 1%., waste burning was 0.5%, open dumping (4.5%); and sanitary landfill and biogas capture (0.5%). While some portion of waste is managed by the communities themselves with the composition of the inorganic waste-recovery of 3%, composting 1%, waste burning of up to 5%, while 1% is discharged into the river channel and 40% is buried. Garbage in rural areas is only about 20% which is transported collectively by cleaning offices while 80% is managed by the communities. Therefore, it is calculated that in 2005, the total municipal solid waste generation was 33.5 Mt . However, the TNA report (2009) states that the total municipal solid waste generation in 2005 was higher, i.e. 48.8 Mt, due to the fact that it uses the same waste generation factor for urban and rural areas, i.e 0.61 kg/cap/day. In contrast, this study differentiates between the two, using 0.6 kg/cap/day as the urban factor and 0.3 kg/cap/day as the rural factor.

13.2 Mitigation Potentials

Based on the above condition, the BAU scenario was calculated with several components and assumptions as described in the table below.

Table 22 Assumptions Used for Business As Usual (BAU) Scenario

Waste Management Components	Assumptions Used
1)Transportation / transporting waste	• Transportation / transporting waste in 2005 has a 50% service level. • Level of services increased 2.5% per year so that by the year 2020 reached 71.2% and in 2030 to 90.1%.
2)Waste reduction	• There is no waste reduction. • Waste generated for urban waste increased from 0.6 kg/person/day in 2005 to 1.2 kg/person/day, while for rural increased from 0.3 kg/person/day in 2005 to 0.55 kg/person/day
3)Final Processing	• The amount of waste transported to the Open Dumping is around 45%.

Waste Management Components	Assumptions Used
	• There is no a conversion from Open Dumping to Controlled Sanitary Landfill and Landfill.
4)Other waste management activities	• There is no change in the percentage of waste management both for combustion, recycling plastic and paper, and composting.

To identify mitigation potentials, four scenarios were calculated and the results can be seen in the following tables. The four scenarios are:

- Law - Based (Act 18/2008) Scenario: Implementing Act 18 of 2008 on Solid Waste Management
- Optimistic Scenario: converting 30 sites of open dumping to sanitary landfill sites each year
- Moderate Scenario: converting less than 30 sites of open dumping to sanitary landfill sites each year
- Pessimistic Scenario: converting less than the moderate scenario

Table 23 Abatement under Different Scenarios

No.	Scenario	Total Mitigation (US$)	Reduction in 2030 (t CO_2)	Abatement Cost (US$/t$CO_2$)	Required Policy Measures and Instruments
1	Law-Based	2,038,013,852	70,318,990.62	42.89	OD converted to SL
2	Optimistic	1,689,642,765	68,242,112.25	37.61	
3	Moderate	1,597,928,481	60,328,556.69	48.35	OD converted to CL dan SL
4	Pessimistic	1,457,535,375	36,883,483.43	89.00	

Table 24 Emission Reduction under Different

No.	Year	BAU (thousand ton CO_2 eq)	Reduction (thousand ton CO_2 eq)			
			Law- Based	Optimistic	Moderate	Pessimistic
1	2010	34,987	18,709	19,259	12,088	5,570
2	2015	43,349	42,238	33,214	23,318	11,120
3	2020	52,381	49,841	44,571	34,372	17,436
4	2025	61,961	61,176	57,770	48,091	26,560
5	2030	75,992	70,319	68,242	60,329	36,883

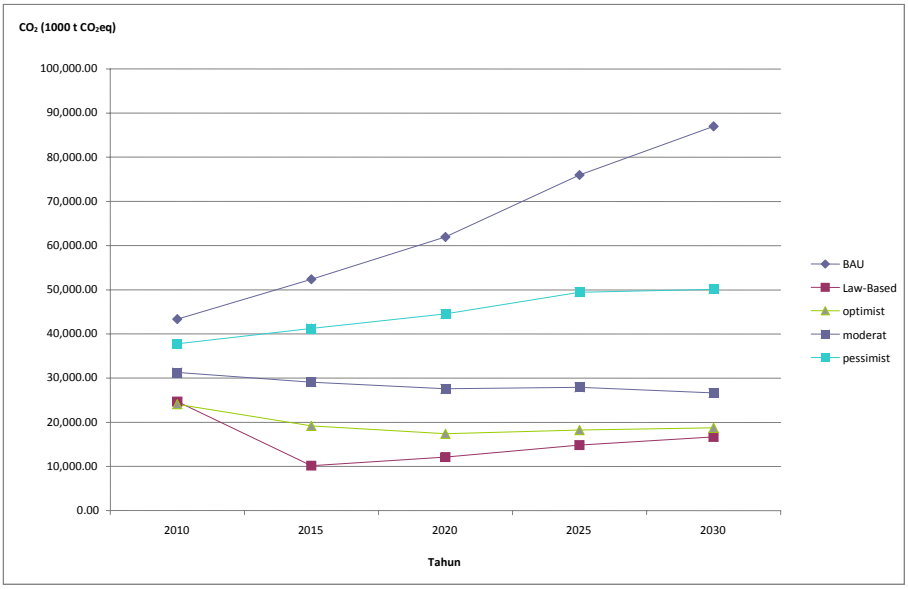

Figure 26 Emissions Reduction potentials based on four scenarios

Domestic solid waste in Indonesia can be mitigated through the following alternative strategies:

- Perform GHG inventory study of solid waste sector which is more complete and accurate, along with systematic GHG decrease plans
- Apply environmentally based infrastructure development policies in the waste sector supported by environmentally based technological development and research
- Develop application of environmental policies of 3R(reduce, reuse, recycle) principle in waste management
- Develop sustainable infrastructure development (by maintaining balance in 3 development pillars, which are economy, social and environment) by decreasing GHG emissions and increasing carbon absorption
- Provide infrastructure development in waste sector which focuses on capacity building, human resources and institutions. This includes improving competency and independence of regional government in environmentally based infrastructure development and encourage role of private sectors and society
- Develop waste management technology which is environmental friendly and anticipative to climate change
- Develop Extended Producer Responsibility implementation for B3 waste producers and importers

- Develop technology for landfill quality increase:
  - *Controlled Landfill* (CLF) for small and middle cities,
  - *Sanitary Landfill* (SLF) for big cities and metropolitans
  - Stop Open Dumping

The proposed programs of waste sector according to the three general strategies are depicted in the table below. The breakdown of the programs into the five-year period is available in the Roadmap report of waste sector.

Table 25 Activities of Long-Term Development Plan in Waste Sector

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
Data, Information and Knowledge Management		Inventory studies and decrease in Green House Gasses (GHG) from solid waste factor			
Planning and Policy, Regulation and Institutional Development		Strengthening of approach in environmental policies for waste management and standardization (stepwise approach).	Development in funding source and pattern in waste management	Law planning involving public private partnership in waste management	
		Creation of Norm, Standard, Procedure and Criteria(NSPK) and Norm, Standart, Guideline, Manual (NSPM) in waste sector	Waste regulator product development by regency/city government based on NSPK		
		Issue of waste development control by regency/city government based on NSPK	Funding sources development and investment pattern in waste management		
		Finalizing policies in waste sector	Waste management development by regency/city government based on NSPK		
		Providing waste surveillance guidelines			
		Provision of technological aid, technological guidence, and companionship (SSK) in waste management			

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
Implementation and Control with Monitoring and Evaluation			Funding sources monitoring and development and investment pattern in waste management	Waste development management product monitoring and evaluation by regency/city government based on NSPK	Waste development management product monitoring and evaluation by regency/city government based on NSPK
			Waste development management product monitoring by regency/city government based on NSPK	Designing law involving public private partnership in waste management	Law implementation evaluation involving public private partnership in waste management
	Waste infrastructure preparation/ maintenance/ development and Waste transportation facilities	Sumatera: 41 Regencies/Cities Java, Madura, Bali: 42 Regencies/Cities Kalimantan: 41 Regencies/Cities Sulawesi: 39 Regencies/Cities Nusa Tenggara: All Regencies/Cities Maluku: 11 Regencies/Cities Papua: 13 Regencies/Cities	Sumatera: 86 Regencies/Cities Java, Madura, Bali: 65 Regencies/Cities Kalimantan: 15 Regencies/Cities Sulawesi: 31 Regencies/Cities Nusa Tenggara: All Regencies/Cities Maluku: 7 Regencies/Cities Papua: 17 Regencies/Cities	Sumatera: 41 Regencies/Cities Java, Madura, Bali: 42 Regencies/Cities Kalimantan: 41 Regencies/Cities Sulawesi: 39 Regencies/Cities Nusa Tenggara: All Regencies/Cities Maluku: 11 Regencies/Cities Papua: 13 Regencies/Cities	Sumatera: 86 Regencies/Cities Java, Madura, Bali: 65 Regencies/Cities Kalimantan: 15 Regencies/Cities Sulawesi: 31 Regencies/Cities Nusa Tenggara: All Regencies/Cities Maluku: 7 Regencies/Cities Papua: 17 Regencies/Cities
	Final Disposal Area, CDM preparation	Sumatera: 6 Metropolitan Cities Java, Madura, Bali: 12 Metropolitan Regencies/Cities	Sumatera: 2 Metropolitan Cities Java, Madura, Bali: 5 Metropolitan Regencies/Cities	Sumatera: 3 Big Cities Java, Madura, Bali: 15 Metropolitan Regencies/Cities	Sumatera: 3 Big Cities Java, Madura, Bali: 4 Metropolitan Regencies/Cities
	Waste management facilities	Sumatera: 411 unit Java, Madura, Bali: 411 unit Kalimantan: 411 unit Sulawesi: 411 unit Nusa Tenggara: 411 unit Maluku: 411 unit Papua 411 unit	Sumatera: 453 unit Java, Madura, Bali: 453 unit Kalimantan: 453 unit Sulawesi: 453 unit Nusa Tenggara: 453 unit Maluku 453 unit Papua : 453 unit	Sumatera: 498 unit Java, Madura, Bali: 498 unit Kalimantan: 498 unit Sulawesi: 498 unit Nusa Tenggara: 498 unit Maluku: 498 unit Papua: 498 unit	Sumatera: 548 unit Java, Madura, Bali: 548 unit Kalimantan: 548 unit Sulawesi: 548 unit Nusa Tenggara: 548 unit Maluku: 548 unit Papua : 548 unit

Category	Activities	2010-2014	2015-2019	2020-2024	2025-2029
	Integrated Waste Disposal Area, 3R development	Sumatera: All Regencies/Cities Java, Madura, Bali: All Regencies/Cities Kalimantan: All Regencies/Cities Sulawesi: All Regencies/Cities Nusa Tenggara: All Regencies/Cities Papua: All Regencies/Cities	Sumatera: All Regencies/Cities Java, Madura, Bali: All Regencies/Cities Kalimantan: All Regencies/Cities Sulawesi: All Regencies/Cities Nusa Tenggara: All Regencies/Cities Maluku: All Regencies/Cities Papua: All Regencies/Cities		

Note: Thicker shade represents stronger weight

14 MITIGATION MATRIX

In order to have a synoptic view on the mitigation scenarios, costs, policies and actions, table 26 below depicts these in a mitigation matrix. The selection of the priority scenarios of each sector which entered the table was done on the basis of overall GHG emission reductions potential, cost of mitigation and alignment with sectoral development objectives. The figures are given as to reflect the mitigation potential and costs in the year 2020 (target year for the 26 % reduction goal).

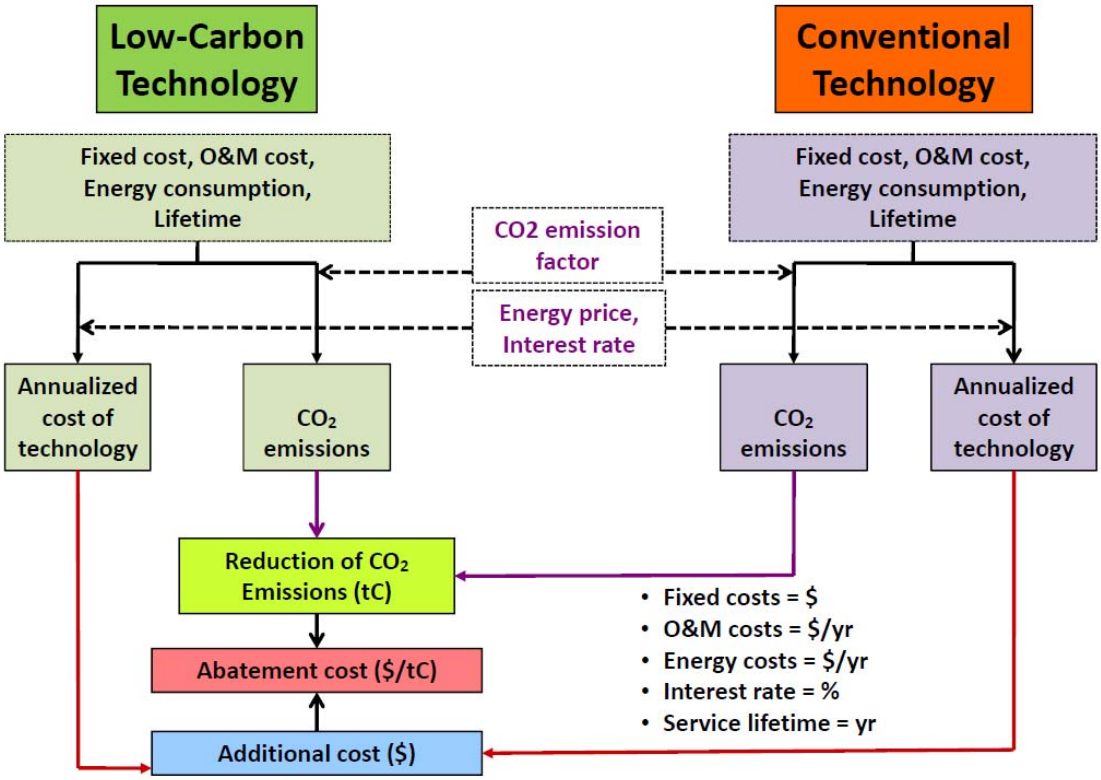

Figure 27 Method applied to calculate the abatement costs (Situmeang, 2009)

The amount of GHG emissions reductions are given in cumulative figures to show the complete mitigation potential. Costs of actions differ significantly across the sectors, so that a ranking becomes necessary in order to weigh impacts on the economy against achievements in terms of GHG emissions reductions.

The table 26 depicts the mitigation options according to these two main criteria, overall amount of GHG emissions reduced and abatement costs (reference year 2020).

Table 26 Matrix of sectoral mitigation actions without peatland

Sector / scenario	Cumulative BAU ($MtCO_2$)	Cumulative Emission Reduction ($MtCO_2$)	Total Mitigation Cost [billion USD]	Abatement Cost [USD/tCO_2]	% of Emission Reduction each sector	Required Policy Measures and Instruments
Energy (Sumatra)/ RUPTL	206.93	45.97	#	#	22.22%	Presidential Decree No 5/2006 Optimizing Energy Mix Scenario the government intervention is counted through the introduction of geothermal and hydropower plants
Energy (Java-Bali)/ RUPTL	1713	106.21	#	#	6.20%	
Industry/Cement	562.95	43.15	0.47	10.89	7.66%	Reducing the clinker content in produced cement Review and set new cement performance standards Eco-label cement products Lead by example – government procures blended cement Review national building codes National communications campaign to encourage the use of blended cements Increase government support for building local institutional capacity in policy development and program delivery for eco-efficiency, energy audits, energy services.
Transport/ Modal Shifting	1104	127.14	17.66	138.90	11.52%	Holistically improving public transport quality in urban area Promote non-motorised transport in urban area Improving the carbon efficiency of transport facilities and operations
Waste/Optimist	577.8	356.44	2.48	6.96	61.69%	Converting 30 sites of open dumping to sanitary landfill sites each year Development and enforcement of environmentally based infrastructure policies for the waste sector Capacity development for human resources and institutions on local governemnt level Partnerships with and involvement of the private sector and civil society on LG level
Forestry (LULUCF)	8000	3040	6.28	2.07	38.00%	SC3 Increasing the sink and creating conditions for preventing further deforestation (KPH – HTI scenario) Mitigation efforts in SC3 are based on mix of activities: 1) industrial plantations development on dry land, where KPH has been developed; 2) emission reduction enhancement comes from better management of production, conservation and protection forests under the KPHs (11.4 tCo2/ha/year), 3) some modest REDD activities during the first period. In SC3 4 million ha of HTI/HTR are planted on 24 million ha of KPH. Mitigation comes also from better management of natural forest, less illegal logging and fire.
Total	**12164.7**	**3718.91**	**26.89***	**7.23***	**30.57%**	

Table 27 Matrix of sectoral mitigation actions with peatland

Sector / scenario	Cumulative BAU ($MtCO_2$)	Cumulative Emission Reduction ($MtCO_2$)	Total Mitigation Cost [billion USD]	Abatement Cost [USD/tCO_2]	% of Emission Reduction each sector	Required Policy Measures and Instruments
Energy (Sumatra)/ RUPTL	206.93	45.97	#	#	22.22%	Presidential Decree No 5/2006 Optimizing Energy Mix Scenario the government intervention is counted through the introduction of geothermal and hydropower plants
Energy (Java-Bali)/ RUPTL	1713	106.21	#	#	6.20%	
Industry/Cement	562.95	43.15	0.47	10.89	7.66%	Reducing the clinker content in produced cement Review and set new cement performance standards Eco-label cement products Lead by example – government procures blended cement Review national building codes National communications campaign to encourage the use of blended cements Increase government support for building local institutional capacity in policy development and program delivery for eco-efficiency, energy audits, energy services.
Transport/ Modal Shifting	1104	127.14	17.66	138.90	11.52%	Holistically improving public transport quality in urban area Promote non-motorised transport in urban area Improving the carbon efficiency of transport facilities and operations
Waste/Optimist	577.8	356.44	2.48	6.96	61.69%	Converting 30 sites of open dumping to sanitary landfill sites each year Development and enforcement of environmentally based infrastructure policies for the waste sector Capacity development for human resources and institutions on local governemnt level Partnerships with and involvement of the private sector and civil society on LG level
Forestry (LULUCF)	8000	3040	6.28	2.07	38.00%	SC3 Increasing the sink and creating conditions for preventing further deforestation (KPH – HTI scenario) Mitigation efforts in SC3 are based on mix of activities: 1) industrial plantations development on dry land, where KPH has been developed; 2) emission reduction enhancement comes from better management of production, conservation and protection forests under the KPHs (11.4 tCo2/ha/year), 3) some modest REDD activities during the first period. In SC3 4 million ha of HTI/HTR are planted on 24 million ha of KPH. Mitigation comes also from better management of natural forest, less illegal logging and fire.
Peatland	17000	4700	9.729	2.07	27.65%	*Improvement of Peat Land Management Practices* to reduce emissions in peat land currently under forestry and agricultural land use. This policy might be directed at enforcing existing legal requirements and establishing new standards for best practices in 'low carbon' peat land management. Three main mitigation actions are

Sector / scenario	Cumulative BAU ($MtCO_2$)	Cumulative Emission Reduction ($MtCO_2$)	Total Mitigation Cost [billion USD]	Abatement Cost [USD/tCO_2]	% of Emission Reduction each sector	Required Policy Measures and Instruments
						defined: • Enforce strict compliance by existing forest and plantation concessions with regulations forbidding the cultivation of peat more than three metres thick. • Provide incentives, sanctions and enforce (a) the zero burning policy for land clearance by companies and (b) best practices for water management to reduce subsidence and carbon emissions from oxidation in peat land under cultivation.
Total	**29164.7**	**8418.91**	**36.619***	**4.35***	**28.87%**	

Note: # in progress; * without energy

A general ranking of the mitigation actions according to costs and absolute cumulative emissions reductions is given in 28 below.

Table 28 Mitigation Rank

Rank	Abatement costs	GHG emissions
1	Forestry	Forestry
2	Waste	Waste
3	Industry	Transport
4	Transport	Energy
5	-	Industry

Key recommendations for mitigation

- Taken all sectors and key programs and scenarios together, Indonesia has the potential to reduce GHG emissions significantly at an order of magnitude of **3718.91**Mt CO2-e until the year 2020 (without peatland), respectively. Costs of actions differ significantly across the sectors, so that a ranking becomes necessary in order to weigh impacts on the economy against achievements in terms of GHG emissions reductions.
- For all sectors, the establishment of a national GHG inventory and monitoring system is precondition
- The forest sector represents the largest potential to reduce GHG emissions at rather low costs, however to tap that potential, activities have to be applied in the right mix in order to effectively deviate from the business as usual scenario
- In order to deviate successfully from the business as usual scenario, sector specific development of institutional and human capacities is indispensable.
- Cross sectoral issues, as identified by the forest sector, need to be addressed adequately in order to safeguard effectiveness of mitigation actions.
- While it is important to come to a sound understanding of abatement costs across sectors, it will be equally important to carefully assess barriers to policy implementation in different areas. Only on this basis, an adequate mix of policy measures can be developed.

15 CROSS-CUTTING ISSUES OF NATIONAL IMPORTANCE

A number of cross-cutting issues arise from the impact of climate change on Indonesia. These will be highlighted in this chapter.

15.1 Food Security

The Roadmap chapter on agriculture reports that several studies show that global warming and climate change in tropical zones are predicted to lessen the productivity of food production if no adaptation strategies are implemented (IPCC, 2007), thus having severe implications on global food security (Torriani et al, 2007). It is predicted that agricultural productivity in Indonesia will decrease 15 – 20% by 2080 as a result of global warming (Cline, 2007). According to Tschirley (2007), the lessening of agricultural production may reach 20% if temperature increases more than 4°C. Peng et al (2004) specifies that a decrease in rice production of up to 10% may be experienced for every 1°C of temperature increase.

The impacts of temperature rise on rice plantation are threefold (Handoko et al, 2008), namely: i. *Evapotranspiration* will reduce water levels in the irrigation systems, thus reducing the number of rice fields that can be served, ii. Hastened maturation will shorten plant life; and iii. Increased plant respiration will decrease productivity. The area occupied by rice plantations will shrink 3.3% in Java and 4.1% on other islands by 2050 due to temperature increase. The decrease in rice production due to hastened maturation is predicted to reach between 18.6 – 31.4% in Java and 20.5% on other islands. Meanwhile, the decrease in rice production due to increased plant respiration is predicted to reach between 10.5 – 19.94% in Java and Bali, and 11.7% in other islands.

In addition to the direct impacts of global warming, agricultural production may be indirectly affected by an increase in pests due to extreme events. Wiyono (2009) identified the increasing occurrences of flooding resulting in the increase of golden snail populations, which threaten rice plantation. Moreover, rice fields that are flooded during rainy seasons are subsequently more prone to brown bug outbreaks, as happened after La Nina in 1998.

The Roadmap chapter on water resources identifies several risks associated with climate change impacts as discussed above. The region of Java and Bali, which is the main producer of rice for the nation, is a region with extremely high risks of water shortage, flooding and drought. As projected by the scientific-based report, the occurrence of extreme climate events will increase in frequency and intensity, which could cause more severe and frequent flooding and drought. This will make rice fields more prone to hazards, especially if it is topped with the outbreak of pests.

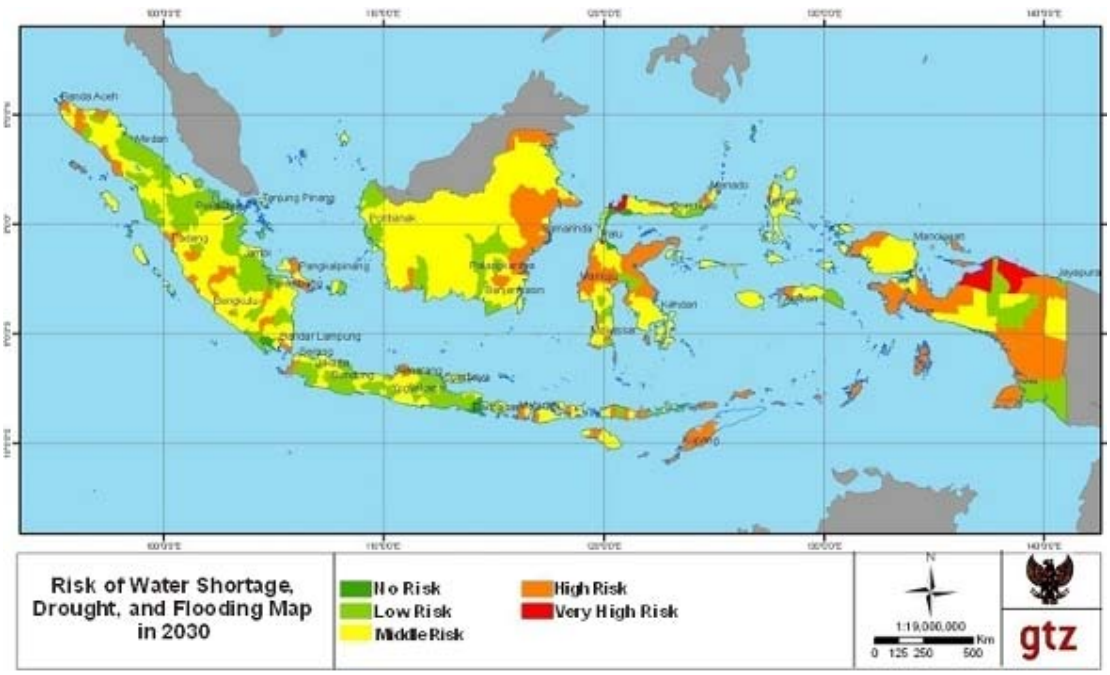

Figure 28 Risks of Water Shortage, Drought and Flooding

Before taking into consideration the impacts of climate change, current land conversion practices (from rice fields to non-agricultural use) will lead to an annual decrease 0.77% in rice plantations areas by 2025; the rice production in each district in Indonesia will decrease between 42,500 – 162,500 tons (Boer, 2008). If sea level rise due to climate change is taken into consideration, as has been identified and reported by the Roadmap marine and fisheries chapter, it is predicted that Java will loose approximately 113,000 – 146,000 hectares of rice fields, 16,600 – 32,000 hectares of horticultural land and 7,000 – 9,000 hectares of hard crop land in 2050 (Handoko et al, 2008). Currently strong waves from the ocean have caused *rob* flood in some coastal areas, such as the northern coast of Java, which threatens the production of rice in some farming areas. The activities in coastal fish and shrimp farming areas will also be affected by sea level rise and rob flood.

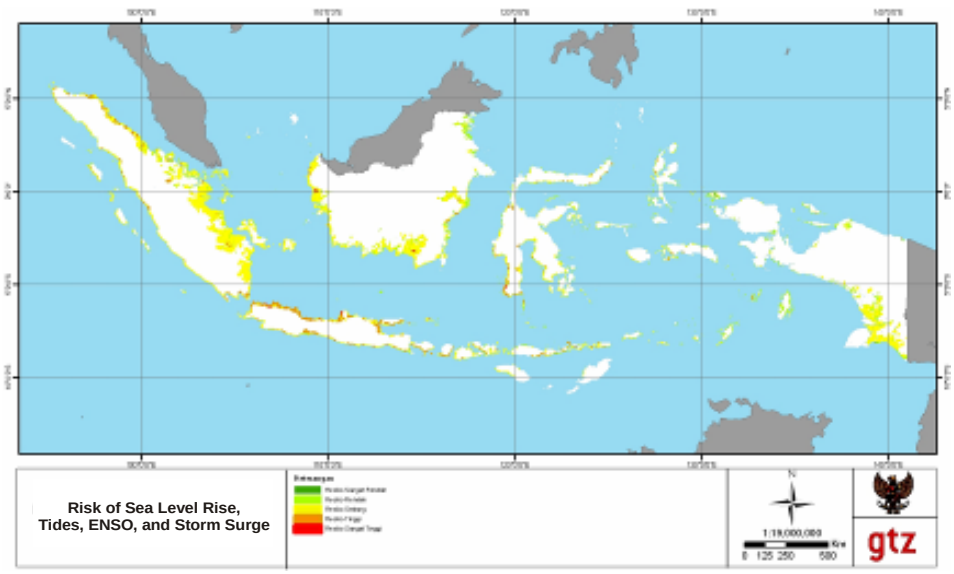

Figure 29 Risks of Sea Level Rise, Tides, ENSO, and Storm Surge

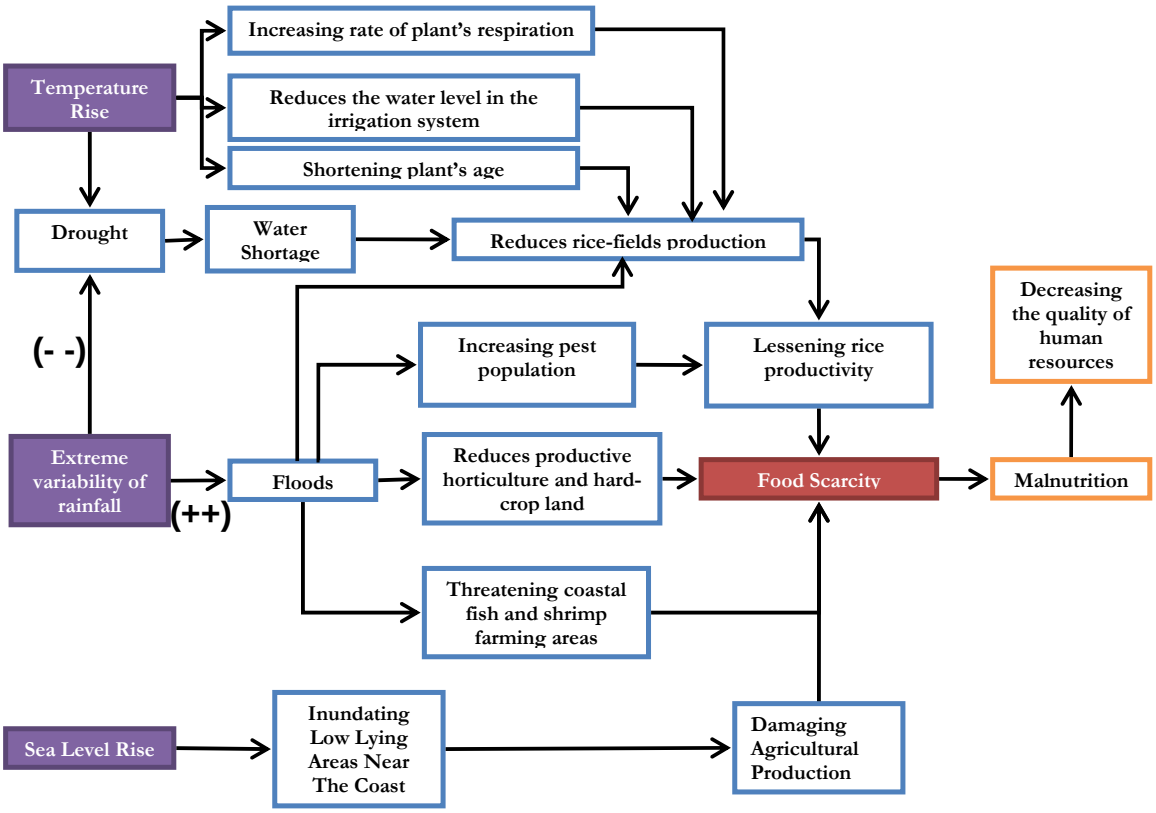

Figure 30 Inter-connecting Impacts of Climate Change Resulting in Food Scarcity

As a result of climatic actors and decreasing rice fields due to land conversion, Indonesia will face a major problem of food scarcity in the future as illustrated in the chart above. Without climate change adaptation measures, it is estimated that in 2050 the national production of rice will decrease between 20.3 – 27.1%, corn will decrease by 13.6% and soy will decrease by 12.4%, compared to 2006 production Handoko et al, 2008). If this happens as predicted, Indonesia may become a net importer of rice and other staple foods forever, which is detrimental for its balance of trade and will weaken its economy. It is also considered a threat to national security, thus making it important that recommended programs in each sector are included in the national development plans.

15.2 Natural and Built Environmental Degradation

Other than food security issue, an issue of environmental degradation that has occurred in either the natural ecosystem or the built environment might get worse when the climate change impacts do happen as predicted. For the environmental degradation in a natural ecosystem, we can recall the events of forest fires that hit Indonesia in 1997 and 1998. Although it was conceived that the major factors causing the fires were human activities such as vegetation clearing by burning (Schweithelm, 1998), the unusual drought that was carried over by El Nino made it difficult to extinguish the fires since rain was not coming to relieve while human efforts could not handle hundred thousand, even million hectares of fires at the same time.

The effects of the forest fires in 1997 and 1998 have been documented in the Integrated Forest Fire Management report (IFFM, 1998). Besides burnt forests and the loss of biodiversity, the haze resulted from the fires has been associated with several transportation accidents due to poor visibility. This included a ship collision in the Malacca Strait which killed 29 people and a commercial airline crash in north Sumatra which costs 222 people. Respiratory problem was considered the most problem that many people suffered during the forest fires. This was not only perceived by people in Borneo or Sumatra where the fires took place, but also in neighboring countries, such as Malaysia, Singapore and Brunei. This health alert is so important because the exposure to acute air pollution increases the probability of premature death in vulnerable groups such as asthmatics, people with chronic lung or heart disease, and young and old pneumonia patients (Schweithelm, 1998).

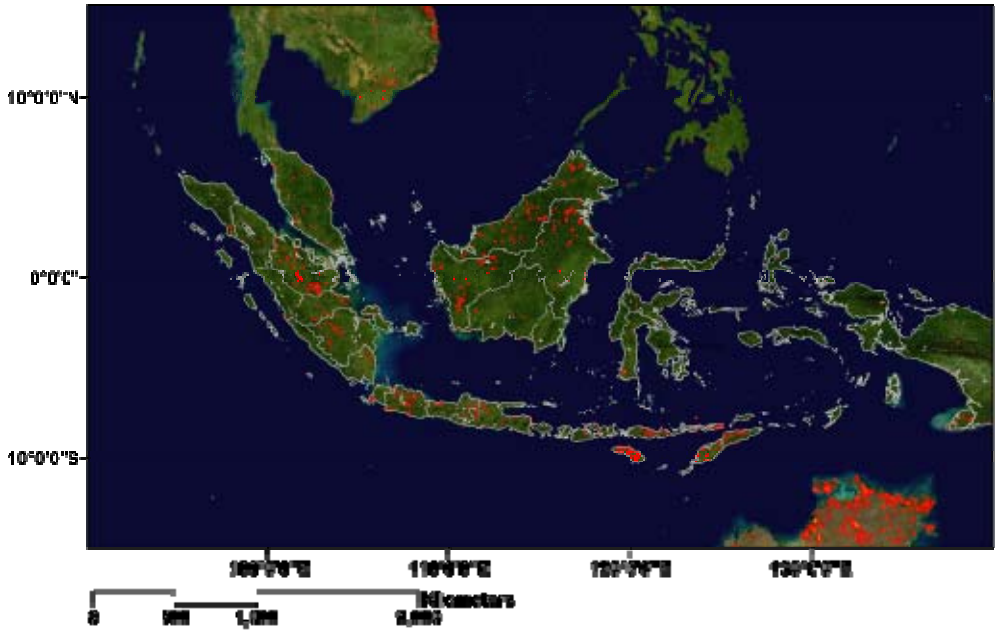

Figure 31 Location of Hotspots during 1997-1998 Forest Fires

More than that, schools, businesses and airports had to be closed which in turn damaged the local economy. Almost all economic activities were paused, including tourism, which caused double hit to people which had already suffered from the Asian monetary crisis around the same time. Even the plantation firms have to cease the operation and prove that they were not guilty unless their licenses were revoked. The cost of haze was estimated to be approximately US$1.4 billion, divided into the three countries. Indonesia paid the highest, US$1 billion, where 90% of it went to short-term health costs borne by people made ill by the haze and to run government clinics and hospitals which treated them. Malaysia lost US$300 million or more due to industrial production losses and lost tourism revenues, while Singapore lost US$60 million from tourism revenues as well.

Besides the cost of haze, the cost of fires damage itself was estimated to be over US$3 billion. This includes: US$493 million in timber; US$470.4 million agriculture (plantations and smallholdings); US$705 million in direct forest benefits (non-timber products such as food and raw materials); US$ 1.077 billion in indirect forest benefits related to hydrology and soil conservation; US$30 million in capturable biodiversity; US$ 272.1 million for carbon release (gases that contribute to climate change); and US$13.4 million for fire fighting costs (IFFM, 1998). Thus, Indonesia could not afford to face another forest fire in the future, since there are too many negative interrelated impacts caused by such incident. The predicted long El

Nino that might occur more often between 2010 and 2030 poses major risks to the forests if similar activities that triggered the hotspots as in 1997 and 1998 fires are still practiced on the ground. Therefore programs in order to ensure that land clearing by burning for plantation, logging or farming would not be practiced anymore are necessary.

Threats to our environment as the result of climate change do not only happen to the natural ecosystem such as forest but also to our built environments. Recently many regions in Indonesia experienced the worst flooding after many years and more often than usual. This has been caused by the precipitation level which is higher than normal. The floods cause losses to our rural areas and, even more, to urban areas. If in rural areas the floods mainly cause the damage to agricultural production such as rice fields or other crops, in urban areas the floods cause damage to properties and to lives as well. The rapid urban development due to population pressures has been the major force behind land conversion from non built up to built up areas in our cities, which makes the capacity of the open space to absorb run off water during rain substantially reduced.

Coupled with narrowing rivers and channels due to squatter development as well as deficiency in the drainage system, our cities are already very vulnerable during rainy season. Take Jakarta for example, the worst flood in February 2007 inundated 75% of the area, causing 80 deaths, damaged thousands of houses and hundred thousands of refugees (Nurbianto, 2007). What happen in Jakarta will be worsened when the increase of precipitation level as the impact of climate change as predicted do actually happen. If it happened it might happen in other cities in Indonesia, especially the cities and towns on the northern coast of Java, the urban concentration of our population. Floods become inevitable in those areas during rainy season and it would cause lives and damage to properties either buildings or other belongings. Floods will also cause damage to urban infrastructures, especially the road network. Moreover, as discussed in the Roadmap for health sector, major outbreaks of water-borne diseases might easily occur during or after the floods, such as diarrhea, leptosclerosis or dengue fever. With the prediction of sea level rise in some parts of northern coast of Java as well as eastern coast of Sumatera, major urban disasters associated with prolonged inundation during rainy season would eventually happen in our major coastal cities before the end of the 21st century. Therefore some strategic measures to anticipate the worst scenario of flooding and inundation, especially in urban areas, must be outlined in the Roadmap.

Figure 32 Flood in Jakarta's Golden Triangle in 2008 (source: Cipbox, 2008)

Climate change may also affect our coastal, not only the inland areas. As reported in the Roadmap of marine and fishery sector, the climate change phenomena such as the sea level rise or the increase of sea surface temperature are predicted to cause hazards to the coastal and marine ecosystems. While the increase of sea surface temperature would cause coral bleaching, the sea level rise would inundate certain low-lying areas near the coastline in northern part of Java as well as eastern part of Sumatera as discussed earlier. Another impact of sea level rise would be the inundation of small islands, in which if located on the outer part of our sea border would make those islands disappeared. This would be a national security issue for Indonesia. Indonesia had lost small islands such as Sipadan and Ligitan Islands to Malaysia due to border dispute few years ago. Thus it is a great concern for Indonesia if it has to loose other small islands on the border with neighboring countries due to sea level rise. Therefore some strategic measures to avoid the lost of other small islands are needed. The inter-connecting impacts of climate change that will further deteriorate natural and built environment are illustrated in the chart below.

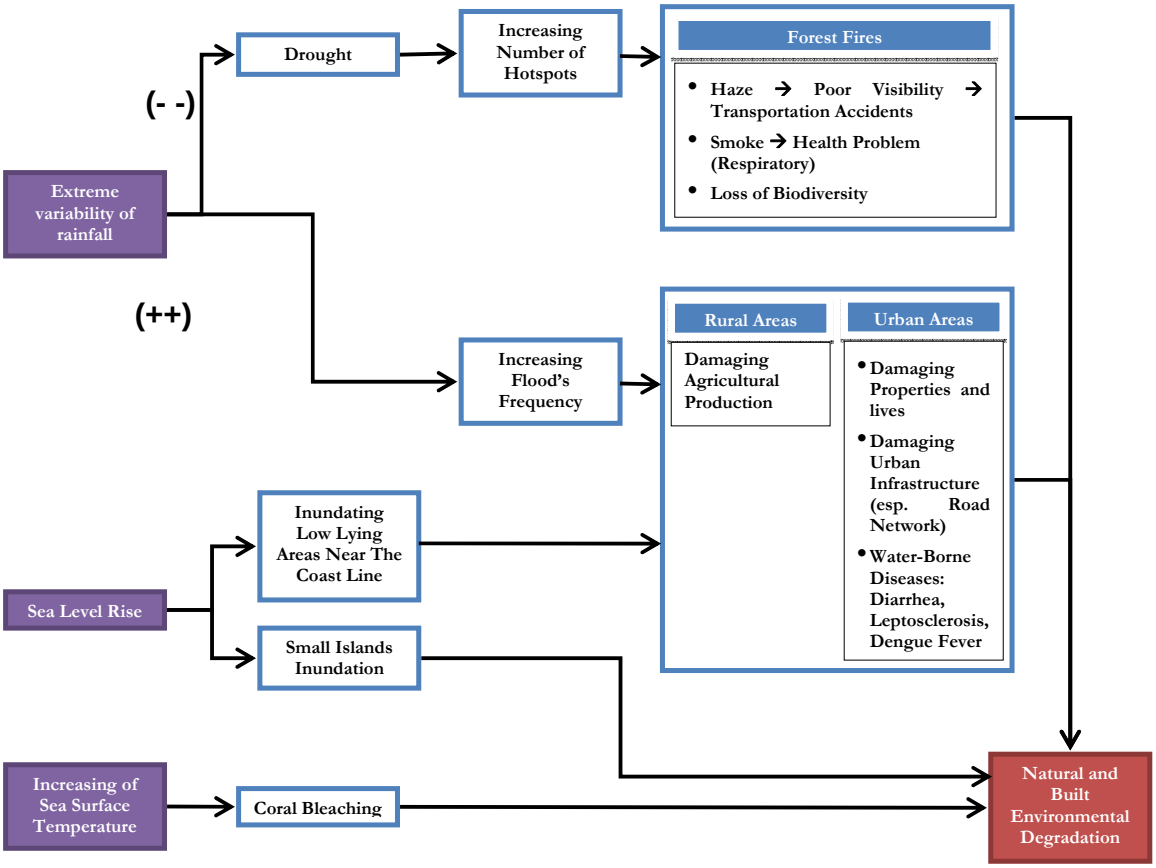

Figure 33 Interconnecting Impacts of Climate Change Resulting in Natural and Built Environmental Degradation

15.3 Cross sectoral in issues with the forest sector

The roadmap identified three sectors with major influences on mitigation efforts in the forestry sector, i.e., agriculture, energy and mining[4]. Without addressing these cross sectoral issues properly, mitigation efforts as described in the three scenarios above are at risk.

Table 29 Cross sectoral issues with an influence on climate change mitigation in the forest sector

Sector	Effect on mitigation
Agriculture	Policy synchronization needed with a view to expansion of agricultural land and palm oil plantation as well as other sources of bio fuel for enhancement of sinks and reducing emissions from deforestation
Mining	Open mining in the forest area
Energy	Forest conversion to increase alternative energy supply (geothermal) in forest areas

[4] Other sectors have influences as well, and are listed in more detail in the forest sector roadmap document.

In the light of climate change mitigation efforts and to overcome these cross sectoral issues, the existing regulations[5] can indeed serve to synchronize the activities so it can achieve more efficient and effective program implementation. For several development purposes of strategic importance which have to use some of the forest area, then this has to be compensated with other areas by renting and releasing forest area. In case of non compliance this can cause a further significant increase of emissions from the forestry sector. Since the current set of regulations both in the forestry as well adjacent sectors have been made without consideration of climate change issues, more analysis of regulations and policies and respective implementation might be appropriate.

[5] Law No. 5 year 1967 (basic forestry regulation), Law No. 5 Year 1990 (natural resources and ecosystem conservation), regulation on land use planning (RTRW/*Rencana Tata Ruang Wilayah*)

16 Conclusion and recommendations

Indonesia has been playing an active role in international negotiations on Climate Change, including as the host for Conference of the Parties 13 in Bali, which resulted in the Bali Action Plan. Since adaptation and mitigation for climate change impacts have to be integrated into national development plans, Indonesia needs to mainstream climate change into development planning processes. Therefore this Roadmap is essential as the guideline for all development sectors to plan for future programs.

The Indonesia Climate Change Sectoral Roadmap for mainstreaming climate change into national development planning is arguably among the first of its kind in the world. It has some breakthroughs in terms of approach, scope, and time dimension. The Roadmap is started with scientific reports on the projection of climate change phenomena that might be occurring in Indonesia until the end of the 21st century. This projection is then used by development sectors, i.e. water, marine and fisheries, agriculture, and health, to create risks analyses that are used to plan a Roadmap for adaptation. Meanwhile, the projection of CO_2 emission status by other sectors, i.e. energy, transportation, industry, forestry, and waste, is used to develop scenarios for mitigation. Through bottom-up processes such as focus group discussions with stakeholders in each sector, the Roadmap for each sector is generated, with a time-frame between now and 20 years later.

16.1 Conclusions and recommendations to address vulnerability and adaptation

A scientific basis for the Roadmap has been provided through a rapid scientific study based on literature review on climate change in Indonesia and analysis of global observational data and global climate model (GCM) output. Results of observational data analysis indicate that a certain degree of climate change has occurred in Indonesia in terms of temperature increase, and changing precipitation pattern. Projections of near and farther future climate condition show some potential climate change hazards in terms of increasing temperature and increasing or decreasing rainfall with larger variability. Sea level rise is also a serious climate hazard for Indonesia that has been identified and projected to occur in the Indonesian seas with ramification due to more frequent extreme climatic events.

Results of this scientific study are, however, still quite rudimentary in terms of completeness of data and methodology. Among other things, climate projection using the global model

output for climate projection over Indonesia may not be sufficient and quantitative formulation of uncertainties has not been carried out. Therefore, more serious concerting efforts are needed to develop a comprehensive report on climate change in Indonesia based on the best available expertise. This recommendation envisages the publication of a report that may look like "Future Climate Change in Indonesia: The Physical Science Basis". The existence of scientifically sound source of climate information seems to be crucial to develop "climate literacy" among people of various competences, especially those who are involved in the decision making processes.

In order to have a clear destination as we proceed for the next 20 years, there are several targets set for each five-year period in this Roadmap as follows:

1. In 2015 we hope that advanced research on the impact climate change and the mapping of local vulnerability will be available to support the establishment of the information system for adaptation. Meanwhile we also expect that inventory of CO_2 emission status is refined so that the clear target of emission reduction can be recalculated.
2. Since the institutional capacity of national ministries and agencies to anticipate climate change impacts will be strengthened by year 2015, we expect that climate-proof policy-making process and regulation shall be achieved in 2020. Meanwhile, we are also determined that our emission of greenhouse gas will decrease to 26% from the projected "business as usual" emission in 2020.
3. In 2025 we expect that all national development processes will be shaped by the climate change adaptation and mitigation efforts. Meanwhile, we are also determined to increase the use of renewable sources for alternative energies as well as to reduce the use non-renewable sources such as oil and coal consumption for energy in 2025.
4. Then in 2030 we hope that risks from climate change impacts on all sectors of development will be significantly reduced, through concerted efforts of public awareness, strengthened capacity, improved knowledge management, and the application of adaptive technology as indicators of adaptation-proof development. In the meantime, we also expect that all sectors that contribute to greenhouse gas emission will operate using low-carbon development concept.

As a nationally concerted effort to cope with climate change, the Roadmap sets up three categories of activities each development sector, asfollows:

- Category 1. Data, Information and Knowledge Management (KNOW-MANAGE)
- Category 2. Planning and Policy, Regulation and Institutional Development (PLAN-PRIDE)
- Category 3. Plans and Programs Implementation and Control with Monitoring and Evaluation (ICON-MONEV)

In order to allocate national resources efficiently and effectively to achieve several objectives for the next 20 years, each category has different weight for each five-year period.

From the various risk/vulnerability assessments to climate change, including the ones which were conducted for the Indonesia Climate Change Sectoral Roadmap (ICCSR), it has become clearer that formulation of adaptation strategies and action plans should be based on risk assessment. This is to prevent over-adaptation, mal-adaptation and under-adaptation (Australian Government, 2005). In terms of level of accuracy and level of plan to be formulated, risk assessment can hierarchically be divided into macro, meso and micro.

Macro level of assessment as done for ICCSR is intended for formulation of strategies and programs at national level. As seen from risk maps on water shortage in section 5 above, extreme and high risk areas in all over Indonesia were identified. Therefore, priority programs for adapting to water shortage can be focused on those areas. However, to identify more precise action such as whether a dam is a best option to be built in an area to deal with the risk of water shortage, a further detail assessment at local level should be made.

By procedure, risk assessment is preceded by hazards assessment. In the context of climate change, hazards assessment is to project future change of temperatures, rainfall, sea level rise and extreme climatic events. For projecting such changes, bottom up analysis (trend from observational data) and top down analysis (down scaling from global model) are applied. For either approaches, Indonesia is still facing the challenges on providing time series observational data (bottom up) and discovering the most suitable global climate model representing Indonesia's climate condition to be down scaled to national and local level.

Therefore it can be concluded that for adaptation programs in the Medium-term Development Plan (RPJM) 2010-2014 need to be focused on strengthening the capacity of data, information, climate modeling and risk assessment. In addition, in this period, serious attention should be dedicated to capacity development such as adjustment of regulation and enhancement of human resources capability. However, programs on adaptation implementation should also begin from the planning term of 2010-2014, although the proportion of resources allocation will be still smaller. Once the capacity of information system and research on climate change is established by 2015, then the percentage of the resources for adaptation action will be getting bigger from the RPJM 2015-2019 so on.

From the macro level of risk assessment on water sector, marine and fisheries sector, agriculture sector and health sector, it shows that the Northern Coast (Pantura) of Java may be considered as the most vulnerable region to climate change impacts. Similarly, Suroso and Sofian (2009) also concluded that many key infrastructures, densely populated areas, paddy fields, fishponds, industrial sites, tourism sites would be exposed to multiple stressors from climate change. Such findings lead to the need to urgently respond with appropriate adaptation actions. For an example, fisherman villages along the northern coast of Jakarta have routinely experienced disaster from high tide waves. The disturbance has also been experienced by harbors located along the Northern Coast of Java. For an example, the distribution of goods and services to and from the Tanjung Mas Port, Semarang experienced trouble in May 2009 due to seawater inundation which was complicated by land subsidence. It means that even though appropriate adaptation action has to be preceded with risk assessment at micro level, we should not be prevented to begin with adaptation action from now on.

We realized that the climate change phenomena may pose some threats to our nation, such as on food security, natural and built environmental degradation, and as an archipelagic nation: the national security, if we loose our remote, small islands on the border. Therefore it is important that the concerted efforts to adapt and mitigate the climate change impacts as proposed in the Roadmap to be implemented. In order to have effective implementation of the Roadmap other efforts may be required and have not been specifically mentioned in the Roadmap, i.e.:

- We need to seriously think about the management of our land use and population in order to avoid more land use conversion to built-up areas that will be threatening our farms and forests, as well as overpopulation in our coastal cities.
- In order to do that we will need to make some revisions on our spatial plans, either the national spatial plan, the major islands spatial plans, the provincial spatial plans, or the local spatial plans.
- Moreover, we will need to think seriously about the protection of national strategic areas, such as the capital city, special economic zones, small and remote islands, etc.

All of these efforts must be done so that we can optimize our natural resource management but at the same time we can prevent hazardous effects of the climate change on the people, the natural and built ecosystems, including important infrastructures, by reducing the risks from climate change impacts.

As we developed this Roadmap we encountered some challenges that should be take into consideration as we progress, namely:

- Due to data availability and the variety of process in each sector, we have different quality of Roadmap of each sector.
- Institutional coordination between ministries and agencies is not easy to be done, thus the integration of sectoral programs into national multi-sectoral programs have not been clearly defined.

Finally, we also envisage another challenge that we may encounter in diffusing the national roadmap into the local level in the context of decentralization, as some functions and authorities of most development sector have been devolved to local governments. Partnership between central, provincial and local governments will be required to ensure that the nationally concerted efforts for climate change adaptation and mitigation will be owned by all level of governments.

16.2 Conclusions and recommendations to address mitigation

- Taken the sectors and scenarios of the roadmap together, Indonesia has the potential to reduce GHG emissions significantly at an order of magnitude of **3718.91** Mt CO2-e until the year 2020 (without peatland).

- The scenarios in the mitigation matrix were selected based on abatement costs and cumulative GHG emissions reductions. They represent a suite of possible mitigation actions that can achieve a 30 % cut in GHG emissions, compared to the BAU scenario. It seems important to note that this BAU scenario of the climate change roadmap does not correspond to the entire national BAU, since the focus was laid on the most important mitigation sectors and activities[6].
- Analyzing the matrix of mitigation actions, it can be understood that the forest sector (excluding peat) features by far the biggest potential in terms of GHG emissions reduction and associated costs. In this sector, at a given budget and cost level it depends crucially on the right mix of activities for mitigation in the forest sector, namely Forest management units (including management of natural forests and forest rehabilitation) and industrial plantations. To tap the large potential to reduce GHG emissions and to effectively deviate from the business as usual scenario, activities have to be applied in the right mix.
- Subsequently, the waste sector offers considerable potential to reduce GHG emissions (above all if the mitigation costs are concerned), followed by the industry (cement), power sector (Sumatra, Java-Bali systems) and transport, which features the highest mitigation costs, but significant potential in terms of GHG emissions.
- For more ambitious emissions cuts, further scenarios and actions can be realized, when chosing for example the Carbon value scenario at 50 USD t CO_2 (Sumatra power sector) or the combination of energy efficiency, alternative fuel and blended cement in the cement sector over the respective sector scenarios in the mitigation matrix above.
- To illustrate, the Carbon value scenario at 50 USD t CO_2 (Sumatra power sector) would lead to a cumulative emission reduction of 81,4 Mio t CO_2 (i.e., an additional 35,43 Mio t CO_2) and the combined cement sector scenario to a reduction of 43 Mio t CO_2, which supersedes the reductions achieved in the blended cement scenario by 24 Mio t CO_2.
- For all sectors, the establishment of a national GHG inventory and monitoring system is precondition measure the success of mitigation actions towards achieving the emission reduction target of - 26 % as declared by the Indonesian president.
- In order to deviate successfully from the business as usual scenario, sector specific development of institutional and human capacities in order to safeguard implementation and overcome the barriers is indispensable.

[6] For example the power sector excludes all regions besides Jawa-Bali and Sumatra, and agriculture (paddy cultivation, livestock) were not considered, among others.

- Cross sectoral issues, as identified by the forest sector, need to be addressed adequately by policy makers in order to safeguard effectiveness of the mitigation actions as listed in the mitigation matrix.
- While it is important to come to a sound understanding of abatement costs across sectors, it will be equally important to carefully assess *barriers* to policy implementation in different areas. Only on this basis, an adequate mix of policy measures can be developed.

REFERENCES

Australian Government, Department of the Environment and Heritage Australian Greenhouse Office, 2005. *Climate Change Risk and Vulnerability*. (http://www.greenhouse.gov.au/)

BAPPENAS. 2007. National Long-Term Development Plan (RPJPN) 2005-2025

BAPPENAS. 2008. National Development Planning: Indonesia Responses to Climate Change.

BAPPENAS. 2009. Medium-Term National Development Planning 2010-2014.

Boer, R. 2008. *Pengembangan Sistim Prediksi Perubahan Iklim untuk Ketahanan Pangan*. Laporan Akhir Konsorsium Penelitian dan Pengembangan Perubahan Iklim Sektor Pertanian, Balai Besar Litbang Sumberdaya Pertanian. Jakarta: Badan Litbang Pertanian.

Boer, R. 2009. *Impacts of Climate Change in Agriculture*. Country case study submitted to International Food Policy Research Institute, Washington, DC. (Un-published report).

Badan Pengkajian dan Penerapan Teknologi. 2009. *Technology Need Assessment (TNA)*. Badan Pengkajian dan Penerapan Teknologi. Jakarta.

Cipbox. 2008. *Jakarta Banjir 2008*. http://media.photobucket.com/image/banjir.jakartathamrin/chipbox_2008/jlnthamrinjkt010208.gif

Damanhuri, Enri. 27th-29th October 2009. *Some Principal Issues on Municipal Solid Waste Management in Indonesia*. 1st Expert Meeting on Waste Management in Asia-Pacific Islands. Tokyo.

Departemen Kelautan dan Perikanan. 2005. Strategis Pembangunan Kelautan dan Perikanan tahun 2005-2009. http://www.dkp.go.id

Handoko, I., Y. Sugiarto, dan Y. Syaukat. 2008. *Keterkaitan Perubahan Iklim dan Produksi Pangan Strategis: Telaah kebijakan independen dalam bidang perdagangan dan pembangunan*.. Bogor, Indonesia: SEAMEO BIOTROP.

Integrated Forest Fire Management. 1998 *IFFM/GTZ Interim Report*. http://www.iffm.or.id.

IPCC. 2007. *Climate Change 2007 - The Physical Science Basis:* Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Cambridge: Cambridge University Press.

Kim HY, Horie T, Nakagawa H and Wada K (1996). *Effects of Elevated CO_2 Concentration and High Temperature on Growth and Yield of Rice*. II. The Effect on Yield and Its Components of Akihikari Rice. Japanese Journal of Crop Science 65, 644-651.

Minister for Agriculture Regulation No. 26/2007 on Guidelines of Plantation License.

Minister for Agriculture Regulation No. 47/2006 on Guidelines for Agriculture Cultivation in Highlands.

Ministry of Forestry. 2007. *Road Map Revitalisasi Industri Kehutanan Indonesia*. Ministry of Forestry. Jakarta.

Nurbianto, B. 2007 "Floods biggest challenge for Fauzi" *The Jakarta Post*, December 15, 2007.

Peng, S. et al. 2004. *Rice yields decline with higher night temperature from global warming*. Proceeding of National Academy of Sciences of the United States of America.

Peraturan Menteri Pertanian No. 14/PL.110/2/2009 tentang Pedoman Pemanfaatan Lahan Gambut untuk Budidaya Kelapa Sawit.

Sakamoto, K in ADB. 2009. (forthcoming) *Innovative financing of low-carbon and energy efficient transport*.

Saunders, M. A. and Lea, A. S. 2008. *Large Contribution of Sea Surface Warming to Recent Increase in Atlantic Hurricane Activity*. Nature Vol.45 doi: 10.1038/nature06422.

Schweithelm, J. 1998. *The Fire This Time: An overview of Indonesia's Forest Fires in 1997/1998*. Discussion Paper. WWF Indonesia.

Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). 2009.

Situmeang, Hardiv. 2009. *NAMAs and Its Linkages at National Level*, presented at FGD Perubahan Iklim Sektor Energi, Industri dan Limbah, Jakarta, 28 August 2009.

Sofian, I. 2009. *Kajian Dasar Akademis (Scientific Basis) : Analisis dan Proyeksi Perubahan Iklim di Indonesia*. Tim Roadmap Bappenas-GTZ. Jakarta.

Suroso, Djoko S. A. and Sofian, Ibnu. 2009. *Vulnerability of the Northern Coast of Java, Indonesia to Climate Change and the Need of Planning Response*. Proceeding Positioning Planning in the Global Crises, International Conference on Urban and Regional Planning. Bandung: 12-13 November 2009.

Technology Need Assessment. Indonesia, MoE and BPPT, 2009.

Timmermann, A., M. Latif, A. Bacher, J. Oberhuber, E. Roeckner, 1999, Increased El-Niño, *Nature*, 398, 694-696.

Torrence, C. and G. P. Compo., 1999, A Practical Guide to Wavelet Analysis, *Bulletin of the American Meteorological Society*, 79, 1:61–78.

Tschirley, J. 2007. *Climate Change Adaptation*: Planning and Practices. Powerpoint keynote presentation of FAO Environment, Climate Change, Bioenergy Division. Rome: 10-12

September, 2007.

Wiyono, S., 2009. *Organisme Pengganggu Tanaman dan Perubahan Iklim*. Makalah FGD Sektor Pertanian, Jakarta, 24 April 2009.

www.usaid.gov/our_work/cross-utting_programs/water/docs/coastal_adaptation/chapters_1-3.pdf