INDONESIA

Third National Communication

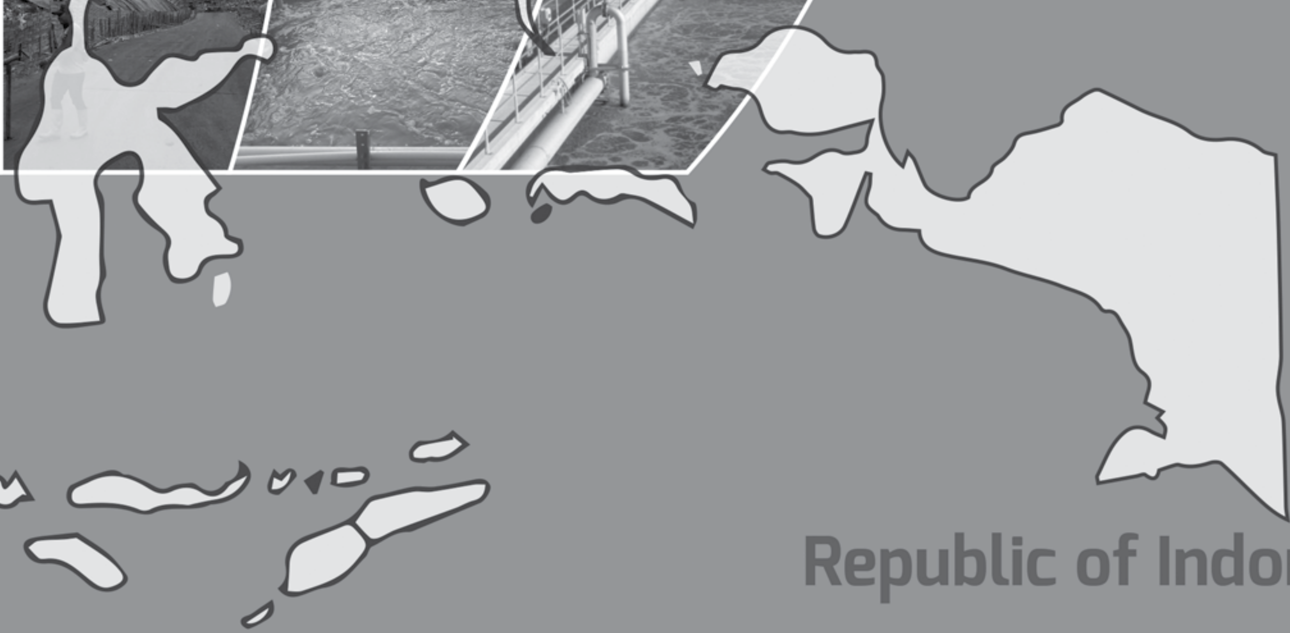
Under the United Nations Framework Convention on Climate Change

Republic of Indonesia
2017

INDONESIA

Third National Communication

Under the United Nations Framework Convention on Climate Change



Republic of Indonesia

2017

Adviser
Minister of Environment and Forestry

Editor in Chief
Nur Masripatin
Director General for Climate Change, Ministry of Environment and Forestry.

Coordinating Lead Authors
Emma Rachmawaty, Achmad Gunawan Widjaksono, Sri Tantri Arundhati, Joko Prihatno, Syaiful Anwar

Lead Authors
Rizaldi Boer, Retno Gumilang Dewi, Muhammad Ardiansyah, Ucok W. Siagian, Akhmad Faqih, Roland Barkey, I Wayan Suadnya, Ibnu Sofyan, Alan Koropitan, Perdinan, Agus Buono

Contributing Authors:
Agus Gunawan, Ai Dariah, Alex Yungan, Anna Tosiani, Ardina Purbo, Ari Suharto, Arif Dharmawan, Arif Wibowo, Astuti Widyarissanti, Belinda Arunarwati Margono, Beti Nurbaeti, Bintang Yuwono, Budiharto, Dadang Hilman, Darsilawati, Delon Marthinus, Dewi Istiyanie, Dida Migfar Ridha, Djarot Tri Wardhono Fenny Rahayu, Dodo Gunawan, Eko Prasondita, Emmy Suryandari, Endah Tri Kurniawaty, Endang Pratiwi, Farida Zed, Franky Zamzani, Gamma Nur Merrillia Sularso, Gatot Setiawan, Gito Immanuel, Hadi Prasojo, Hari Wibowo, Haris Sofyan, Hartiningsih, Haryo Pambudi, Hendra Nur Rofiq, Herawati, I Wayan Susi Dharmawan, Idham Cholik, Ilham, Iwan Hendrawan, Johny Santoso, Kardono, Koko Wijanarko, Kusno Hadi Utomo, Lia Kartikasari, Lilih Handayaningrum, Lintong Supandi Hutahaean, Maswar, Miranti, Monita Pasaribu, Muhammad Farid, Muhammad Ridwan, Novia Widyaningtyas, Nuraeni, Ova Candra Dewi, Prihasto Setyanto, Radian Bagiyono, Raka Whisnu Suryandaru, Ratna Patriana, Rias Parinderati, Ruandha Agung Sugardiman, Sabitah Irwani, Sigit Nugroho, Sudirman, Syahrina D. Anggraini, Teddy Rusolono, Tri Ligayanti, Tri Widayati, Wawan Gunawan, Wira Bayuwega, Wukir A. Rukmi, Yulia Suryanti

Acknowledgement :
Ministry of Environment and Forestry would like to thank to Ministry of Energy and Mineral Resources, Ministry of Agriculture, Ministry of Public Works and Housing, Ministry of Finance, Ministry of Transportation, Ministry of Industry, National Development Planning Agency, Ministry of Home Affairs, Ministry of Research and Technology, Ministry of Marine Affairs and Fisheries, Ministry of Health, Agency for the Assessment and Application Technology (BPPT), National Agency for Meteorology, Climatology and Geophysics (BMKG), Statistics Indonesia (BPS), National Agency for Disaster Management (BNPB), Geospatial Information Agency (BIG), National Institute of Aeronautics and Space (LAPAN), Agency for Peatland Restoration (BRG), Ministry of Research and Technology, CCROM SEAP-IPB, PPE-ITB and United Nations Development Programme (UNDP).

Layout and Cover:
Bintoro

ISBN: 978-602-74011-8-1

Foreword

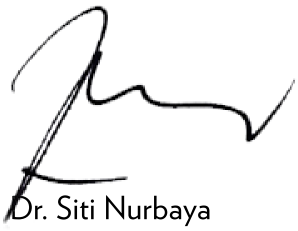
Indonesia, as an archipelagic country, is identified as one of the vulnerable countries. Analysis of Indonesia's future climate change projection has indicated that some areas in Indonesia are among the most vulnerable regions in Southeast Asia caused by sea level rise, drought, extreme weather and other climate-related events.

Responding to the challenge of climate change is a part of priority policies for Indonesia and that decisive actions are needed. Indonesia has carried out a number of measures and actions at the national level, consistent with our commitments under UNFCCC.

Following up the adoption of Paris Agreement, Indonesia has ratified the Paris Agreement through Act No.16/2016, and submitted the First Nationally Determined Contribution (NDC) in November 2016.

Consistent with the COP-UNFCCC mandate, Indonesia has completed its Third National Communication (TNC). Mechanism and institutional arrangement in the preparation of the Third National Communication could be adopted for implementation of NDC.

Finally, I would like to extend my appreciation to representatives of Ministries, subnational government, academic communities, private sectors and civil societies, international agencies, for their contribution in preparing the Third National Communication.



Dr. Siti Nurbaya
Minister for Environment and Forestry

Preface

As mandated by Decision 10/CP2 UNFCCC, each Party shall submit National Communication to the UNFCCC Secretariat. Indonesia has submitted its National Communication at least every 4 years.

The Third National Communication (TNC) of Indonesia was prepared by a team established through SK.25/PPI/SET/KUM.3/12/2016 regarding Establishment of Working Group for the Development of the Third National Communication to the UNFCCC, consisted of representatives from related ministries and institutions, scientists and experts specializing in different disciplines, and has been coordinated by the Ministry of Environment and Forestry.

The TNC describes national GHG inventories, a set of measures, actions and strategies that enable us to reduce greenhouse gases and to adapt to potential climate change impacts. The first part of the document portrays country-specific circumstances and climate change concerns. Moreover, the document also included wide-ranging practical examples, case studies, policy and strategy development.

During development process of the TNC, inputs were received from various stakeholders at the national and sub-national levels as well as from international and regional experts. Stakeholder consultations where also carried out to obtain public views.

We acknowledge contributions by relevant institutions and experts during preparation of this Third National Communication.

Dr. Nur Masripatin, M.For.Sc.
Director General of Climate Change/
National Focal Point for the UNFCCC

Table of Contents

Executive Summary

Indonesia as a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC), Indonesia fulfils one of its commitment to implement the Convention by presented its First National Communication in 1999, the Second National Communication (SNC) in 2010 and the First Biennial Up-Date Report in 2016. The Third National Communication (TNC) presents National Greenhouse Gases Emission Inventory, Adaptation and Mitigation to Climate Change. The TNC contains updates of national greenhouse gas inventory, adaptation and mitigation of climate change and needs and supports received compared to the Second National Communication.

The TNC was supported by the Global Environment Facility a through the United Nations Development Programme (UNDP), along with further funding from the Government of Indonesia. The Third National Communication was prepared together with related ministries and government agencies and universities. There were series of consultation processes that involved sub-national governments, representative of civil society and private sectors.

As requested, Indonesia's Third National Communication BUR was prepared in accordance with the UNFCCC reporting guidelines on National Communication.

1. Introduction

Indonesia is one of the largest archipelagic countries in the world and it lies along the Equator. Indonesia geological and geographical conditions increase its vulnerability to the adverse effects of climate change, such as severe floods and droughts, affecting the agriculture sector as well as other livelihood sectors. Awareness of these effects has encouraged Indonesia to participate in the global community efforts in combating and controlling global temperature rise.

Indonesia ratified the UNFCCC through Act No. 6 of 1994 concerning the Ratification of United Nations Framework Convention on Climate Change. As a non-Annex I party, despite not having obligation to reduce its GHG emission level, Indonesia is taking part in the effort to stabilise GHG concentration and reports the main sources of GHG emission and climate-change related activities to the UNFCCC.

Indonesia has also ratified the Kyoto Protocol through Act No. 17 of 2004 on the Ratification of Kyoto Protocol to the United Nations Framework Convention on Climate Change. Indonesia has adopted the Doha Amendment to the Kyoto Protocol on 6 August 2014 and submitted it to the UNFCCC Secretariat on 30 September 2014. On 24 October 2016, Indonesia ratified the Paris Agreement through Act No.16 of 2016 concerning the Ratification of Paris Agreement to the UNFCCC.

Indonesia has submitted the Intended Nationally Determined Contributions (INDC) to the Secretariat UNFCCC on September 24 of 2015. The INDC was then reformulated into the First of Nationally Determined Contribution (NDC) in 2 October 2016.

2. National Circumstances

Indonesia is located between 7o44'35.11" North latitude and 13o55'59.99" South latitude, and stretches from 91o38'25.55" West longitude to 144o24'00" East longitude. It lies between the Pacific and the Indian Oceans and bridges two continents: Asia and Australia. The country covers a total of approximately 820 million hectares (ha), with a total coastline length of about 95,181 km and land territory of about 200 million ha. It consists of approximately 13,466 islands of which only six thousands are inhabited, including the five main Islands of Sumatera, Java, Kalimantan, Sulawesi and Papua. Of the 200 million ha of land territory, the four largest land cover types are Lowland Forest with nearly 42 million ha (accounted for 22.58% of the National Land Cover) (Geospatial Information Agency of Indonesia, BIG, 2014), Upland Forest, Shrub, and Seasonal Crop on Dry Land. Administratively, since 2013, the Republic of Indonesia is divided into 34 provinces.

Monsoon dominates Indonesia's climate, which gives a degree of homogeneity across the region. Indonesia lies across the range of the Inter-Tropical Convergence Zone (ITCZ) where the northeast and southeast trade winds penetrate the doldrums. Strong ascending motion, overcast skies, strong squalls, heavy rainfall and severe local thunderstorms with variable intensities are characteristics of this zone.

Over the past four decades, Indonesia's population has been continuously increasing from 119.21 million in 1971, to 252.16 million in 2014. However, its annual growth rate appeared to be decreasing from 1.98% (1980-1990) to 1.38% (2010-2015). The population is projected to reach an estimation of 305 million by 2035. Life expectancy in Indonesia has improved significantly in the past four decades, from only 47.9 years in 1970 to 70.6 years in 2014. In education sector, as the result of sustained efforts, adult literacy has increased significantly from only 79% in 1970 to 95.9% in 2014. Indonesia has been showing a steadily increasing trend in alleviating poverty. In 2005, the number of people living in absolute poverty declined from 47.97 million people in 1999 to 35.10 million people, while people living in relative poverty declined from 23.43% in 1999 to 15.97% in 2005. The number of people living in poverty increased slightly in 2006 due to fuel price increased but since then the number continued to decline until 2014. Between the periods of 2006-2014, the number of people living in poverty dropped as much as 11.02 million, from 39.30 million in 2006 to 28.28 millions in March 2014. By the end of 2014, the number of poor people about 27.7 million (11% of the population).

Table 1 Summary of National GHG Emissions in year 2000 and 2014 (Gg CO_2e)

No	Sector	Three main gases		All Gases	
		2000	2014	2000	2014
1	Energy	298,412	602,458	298,412	602,458
2	IPPU	42,610	47,449	42,883	47,489
3	Agriculture	99,717	113,440	99,717	113,441
4	LULUCF (Inc. Peat fire)	505,368	979,422	505,368	979,422
5	Waste	61,351	101,560	61,351	101,560
Total without LULUCF		502,090	864,907	502,363	864,948
Total with LULUCF & peat fire		1,007,458	1,844,329	1,007,731	1,844,370

3. GHG Inventory

The Indonesia National Greenhouse Gases Inventory for the period 2000-2014 was estimated by methodologies that comply with IPCC Guideline (2006) for National GHG Inventories and IPCC GPG for LULUCF. GHG emission in each sector used different approach, in the energy sector was estimated following TIER 1 approach, IPPU mostly used TIER 1, while some industries used TIER 2 such as cement, ammonia, nitric acid and aluminum. The estimation for both forestry and agriculture were based on TIER 1 approach as well as the waste sector in generally still used TIER 1.

In 2014, the Indonesia's total GHG emission for the three main GHG emissions (CO_2, CH_4 and N2O), excluding LULUCF and peat fire sector estimated at approximately 864,907 Gg CO_2e (1,364,337 Gg CO_2e for all gases, including PFCs). With the inclusion of LULUCF and peat fire, the total three main GHG emissions becomes 1,844,329 Gg CO_2e (Table 1). The main contributing sector (three gases) were LULUCF including peat fire (53%), followed energy (33%), agriculture (6%), waste (5%) and IPPU (3%) (Figure 1). Carbon dioxide (CO_2) was the dominant GHG, which contributed 87%, followed CH_4 9.7% and N2O 3.3% (Table 2).

In the period of 2000 – 2014, national GHG emissions (all gases) increased with average rate of 4.4% per year with LULUCF, and 4% per year without LULUCF. This shows that land-based sector especially forestry have significant contribution to the national GHG emissions. Meanwhile, annual increase of emission by sector was energy (5.2%), IPPU (0.7%), agriculture (0.9%), forestry (12.8%) and waste (3.6%). Overall, GHG emission from all sector trend to increase (Figure 2).

Key category analysis to all emission (three gases) sources with LULUCF, 20 key source categories were identified. The first three main categories are (i) peat fires, (ii) peat decomposition, and (iii) energy industries with cumulative emissions of 1,063,431 Gg CO_2e (49.1%). Meanwhile, emission sources without LULUCF, there are 17 key source categories identified, contributing 808,098 Gg CO_2e emissions. The first three main categories are (i)

Table 2 Summary GHG Emissions in year 2000 and 2014 by gas (Gg CO_2e)

Sectors	Year	CO_2	CH_4	N_2O	CF_4	C_2F_6	CO	NOx	NMVOC	SOx	Total 3 Gases
1. Energy	2000	265,318	29,742	3,352							298,412
	2014	569,087	27,511	5,860							602,458
2. IPPU	2000	42,391	70	149	250	22					42,610
	2014	46,965	69	415	39	0					47,449
3. AFOLU											-
3.a. Agriculture	2000	4,772	54,258	40,687			2,724	70			99,717
	2014	6,756	56,028	50,656			2,724	70			113,440
3.b. FOLU (incl. Peat Fire)	2000	505,368	NE	NE							505,368
	2014	979,422	NE	NE							979,422
4. Waste	2000	2,216	56,917	2,218							61,351
	2014	2,653	95,896	3,011							101,560
Total (CO_2e)	2000	820,065	140,987	46,406	250	22	2,724	70			1,007,458
	2014	1,607,536	179,504	54,668	39	0	2,724	70			1,844,329
Percentage (%)	2000	81.4%	14.0%	4.6%	NE	NE					100%
	2014	87%	9.7%	3.3%	NE	NE					100%

NE = *Not Estimated*

energy industries, (ii) manufacturing industries and construction, and (iii) transportation, with cumulative emissions of 530,849 Gg CO_2e or 62% of total emissions.

Result of the uncertainty analysis showed that overall uncertainties of the Indonesian National GHG inventory with LULUCF for 2000 and 2014 were approximately 17.6% and 19.2% respectively. Without LULUCF the level of uncertainty were lower for both years, i.e: 10.3% and 13.1%, respectively.

4. Programme Containing Measures to Facilitate Adequate Adaptation to Climate Change

Due to its geographical location, topography and socioeconomic aspects, Indonesia is suffering the impacts of climate variability and climate change in food security and economic livelihood. The impacts of climate change on a wide range of economic sectors are also pose a serious challenge. Water resources, which are critical to support many economic activities, are directly influenced by the potential impacts of climate change that may cause erratic rainfall. This changing pattern and intensity of rainfall may potentially cause the changing occurrences of floods and drought such as those happened in Sumatra and Java. The linkage of the potential impacts of climate change on increasing the frequency of climate related disasters added more concerns

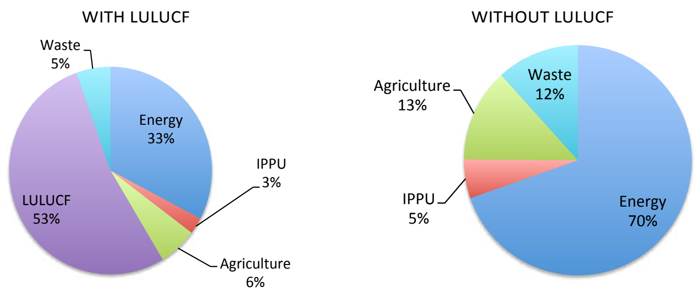


Figure 1 National GHG emissions (three gases) by sector in 2014

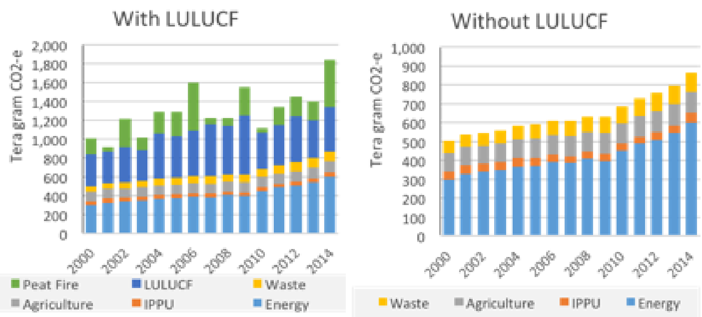


Figure 2 National GHG Emissions (three gases) Trend, 2000 – 2014

as disasters have been seen as a serious threat that can inhibit the achievement of development plan of a country. In Indonesia, it was reported that the frequency of floods and drought was increasing for the last four decades. The climate change will continue to have significant impacts on the natural and socio-economic systems in Indonesia. The Indonesian government has already taken and will further take effective policies and actions in adapting to climate change to enhance its adaptation capacity.

4.1. Historical and future climate of Indonesia

Historical climate and future climate scenarios have been updated to figure out climate variability and climate change in the future including its impact. The analysis combines the use of both dynamical and statistical downscaling approaches to provide regional climate information. The dynamical modeling is applied for both climate and ocean modeling, separately. The emission scenarios employed the next generation of climate scenarios: Representative Concentration Pathways (RCPs).

Analysis of long historical climate indicates that decadal variability affects mean temperature, but not as large as it is found in rainfall because long term trends still show different upward trends. Many regions experienced increasing temperature after 1950. Rate of temperature increase varied between 0.01°C and 0.06°C per year across location. Significant decreases and/or increases in annual rainfall have also detected in many part of Indonesian region, with inconsistent trends in every different period, indicating strong signal of decadal climate oscillation. For the last 30-year, in 1981-2010, the decadal rainfall trends dominantly show upward trends. This is suggested due to drier rainfall conditions in early 1980s and 1990s as the impact of strong and moderate El Nino events and wetter condition at the end of 2000s, where strong La Nina occurred in 2010. Drier rainfall condition in the beginning of that 30-year period and wetter condition in the end of that period is contributing to the upward trends found in almost all regions in Indonesia (Figure 3). Similar upward trends during the same periods are also found in the wet day frequency as shown in Figure 4, where wetter rainfall condition contributes to the increase of wet day frequency.

Spatially, the trend of extreme daily rainfall during the last few decades, which may contribute to climate related disasters such as floods and landslides, increase in some regions in Indonesia especially in Sulawesi, Kalimantan and Sumatra. Furthermore, there have been significant increasing trends of maximum length of wet spell in Sumatra, Java and Papua. In contrary, the trend of maximum length of dry spell is decreasing in these regions.

In general, the surface water that exits from Indonesian Seas to the Indian Ocean is getting weaker during DJF. The southward Makassar Strait surface current is weak. This caused by the

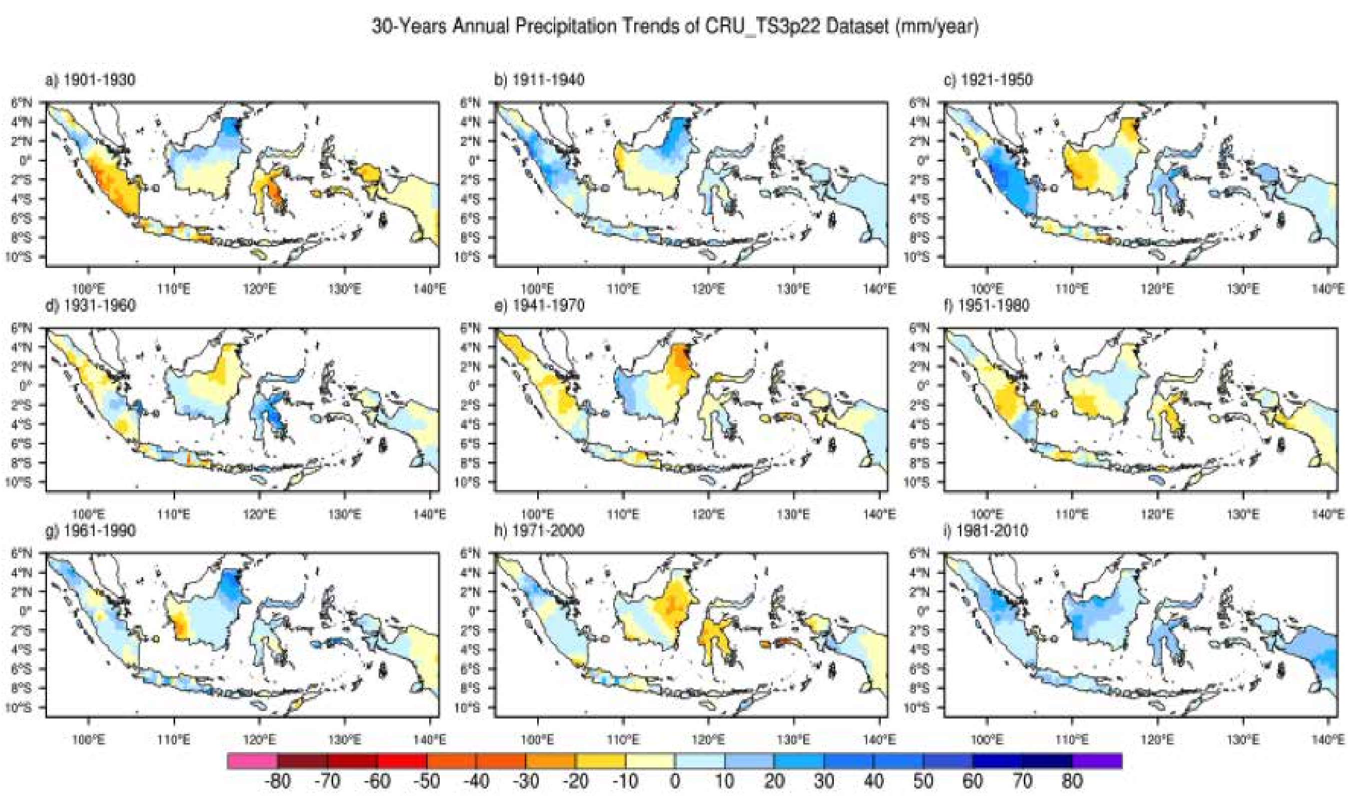


Figure 3 Decadal trends of annual rainfall (mm/year) in Indonesia based on CRU TS 3.22 dataset. The trends are calculated for every 30-year periods with every 10 year distance between the starting years

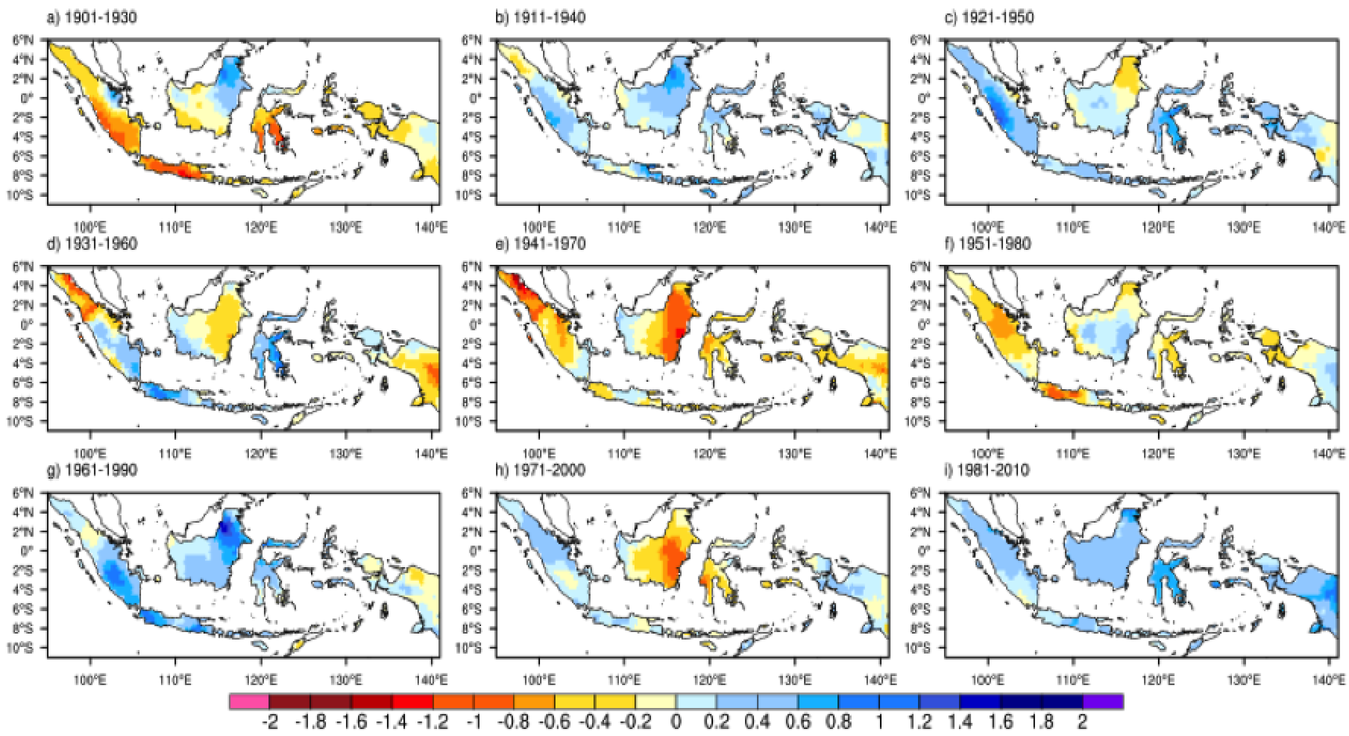


Figure 4 Decadal trends of annual wet day frequency in Indonesia based on CRU TS 3.22 dataset. The trends are calculated for every 30-year periods with every 10 year distance between the starting years

strong Java Sea eastward current that inhibits the southward Makassar Strait surface current, although the total of Makassar Strait water transport still going to the south. The surface water from the Java Sea and western Banda Sea exit to the Indian Ocean via the Lombok Strait.

In general, the wave height in Indonesian seas is influenced by the seasonal wind. During December to February (DJF), the mean wave height in Pacific is higher than the wave height in Indian Ocean. Conversely, during MAM the seasonal significant wave height in the Indian Ocean is getting higher, while in the east of Philippine is weakened. The significant wave height in the Karimata Strait, South China Sea, Sulawesi Sea and Banda Sea reach to the lowest during this period, as the weakening of monsoonal wind. During JJA, the wave height in Indian Ocean is higher than the wave height in Pacific Ocean.

Global warming is also very likely to increase sea levels. Historical data shows increasing frequent El Nino during 1980 to 1994 depresses the sea level in the Indonesian Seas. Conversely, the La Nina increase SST and sea level. During the strong La Nina 1999/2000, the sea level in the Indonesian Seas is 20 cm lifted up.

The surface temperature over Indonesia projected based on the ensemble of 24 CMIP5 GCMs seems continue to increase until 2100 (Figure 5). Compared to the projected global surface temperatures (IPCC, 2013), the surface temperatures increase over Indonesia is lower than the global, at all RCP scenarios. The temperatures increase at RCP2.6 is projected to be less than 1 ^{o}C in 2100, while the global value can reach 1 ^{o}C. The difference of temperature increase in 2100 as shown by RCP4.5 is nearly 0.5 ^{o}C lower for Indonesia, i.e. around 1.5 ^{o}C in Indonesia and almost 2 ^{o}C at global. The spatial pattern of future temperatures relative to the baseline periods by islands is presented in Figure 6.

The future annual rainfall is projected to be drier during dry season and wetter during rainy season and transition period (from wet to dry season). The mean annual rainfall tends to increase in the northern part of Indonesia, especially over most part of Sumatra, Kalimantan and Papua. The increase in mean annual rainfall is mostly more prominent in the eastern part of Indonesia, especially in Papua and Kalimantan (Figure 5). In contrast, the decreases are found mostly over the southern part of the country.

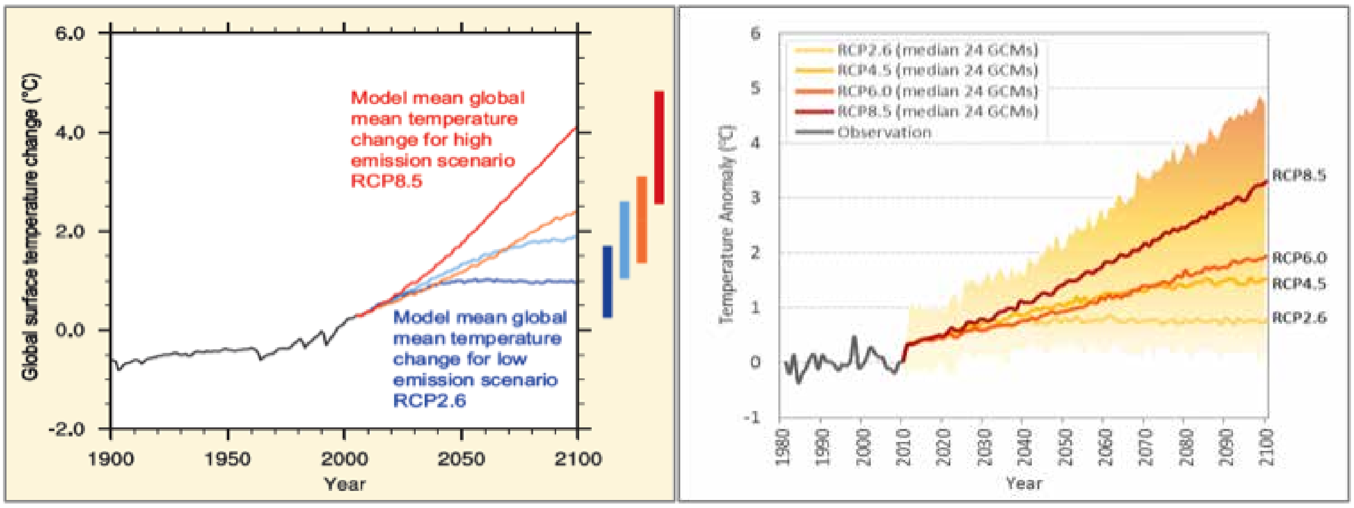


Figure 5 Trends of future temperatures from a) global mean surface temperatures as shown in the AR5 (IPCC, 2013), b) mean temperature anomalies in Indonesia as projected by 24 CMIP5 GCMs under four RCP scenarios. Light shaded colour shows range of uncertainties across all models and scenarios.

Figure 6. Annual mean temperatures differences in Indonesia from MME of 24 CMIP5 GCMs under all RCP scenarios (2026-2050, 2051-2075 and 2076-2100 periods), relative to observation (1981-2005 periods)

Seasonally, the pattern of rainfall changes quite varied between regions (Figure 7). In period of the Dec-Feb (DJF) seasonal rainfall will increase mostly over Java and Kalimantan, while the Mar-May (MAM) seasonal rainfall will also increase not only in Kalimantan, but also in Papua. In contrast, the June-August (JJA) seasonal rainfall will decrease, especially over Java, Sulawesi, and the southern part of Sumatera and Kalimantan. During the transition period in Sep-Nov (SON), some regions will have more rainfall, with the most prominent rainfall increases in Kalimantan. Consistent to the previous result, in more extreme scenario (RCP8.5), the change in seasonal rainfall is more significant.

However, the spatial changes of the annual and seasonal rainfall are not very significant over different areas between current and the future (Figures 6 & 7). Such similar patterns are mostly due to the coarse resolution data from GCM interpolated into higher resolutions.

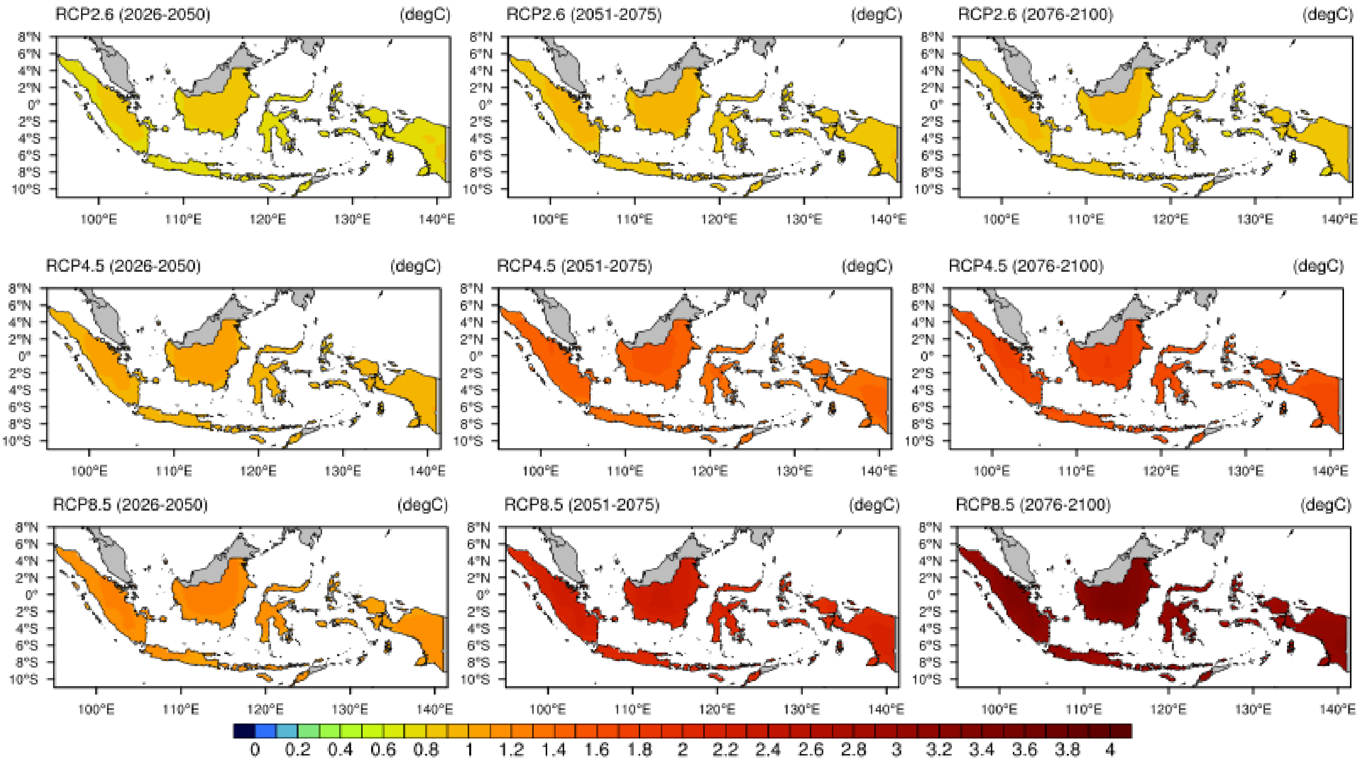
In the future, the extreme daily rainfall is projected to increase over most of land areas within Indonesia, except in Java. Over the surrounding waters or sea, the extreme daily rainfall will decrease in the western part and increase in the eastern part of Indonesia. The spatial change of extreme daily rainfall (RX5DAY) is shown in Figure 8.

Simulation results from 1961 to 2015 and RCP4.5 from 2006 to 2040 showed that regional averaged sea level, sea surface temperature and salinity over area of Indonesia are relatively matching (Figure 9). The sea surface height (sea level) will continue to increase to 2040. The sea level in 2040 will be 50 cm higher than the one in 2000. The sea surface temperature will also be increasing. By 2040, the sea surface temperature will be higher 1°C than that in 2000, or 2°C than that in 1961. Meanwhile, the surface salinity continues to decreases from 33.2psu in 2000 to 32.1psu in 2040. Furthermore, based on ENSO simulation it is shown that the strong El Nino and La Nina are likely to be occurred every 6 to 7 years.

In addition, the sea level rise is relatively homogeneous with variation in between 0.6cm/yr and 1.2cm/yr (Figure 10). The highest sea level rise is projected to occur at South China Sea, while it varies from 0.7cm/yr to 1.0cm/yr, at the other locations.

4.2. Impact of Climate Change on Sector

The important sectors affected by climate change in Indonesia are the coastal (marine and fisheries), agriculture, water resources, forest, special areas (urban/rural), and health. The significant impact of climate change occurred in coastal areas and fisheries. In general, coral reefs can live well in temperature between 26°C and 30°C. However, an increase of SST between 1°C and 2°C from mean annual value can trigger coral bleaching. Meanwhile, the



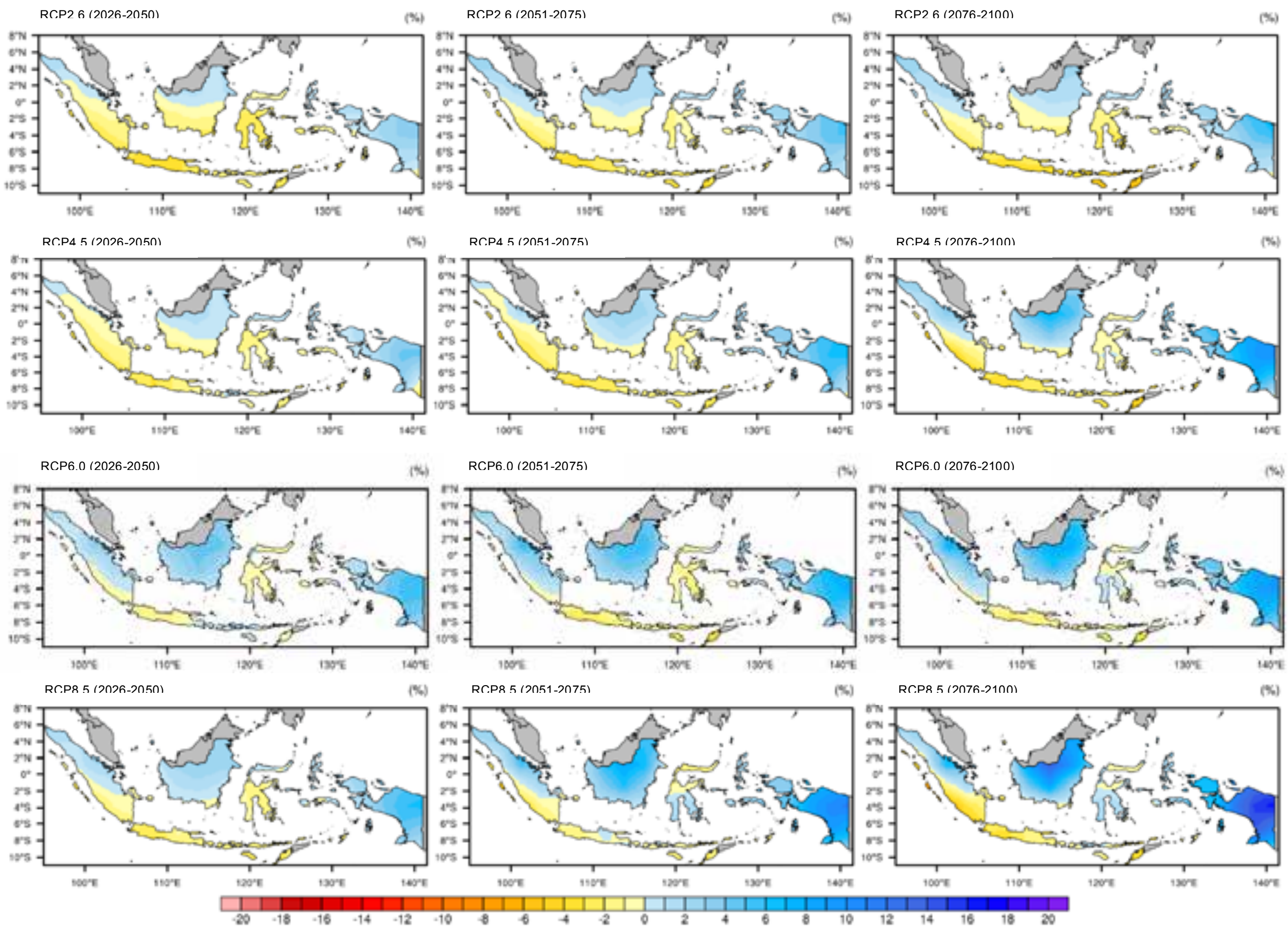


Figure 6 Changes (in %) of annual rainfall climatology calculated from MME mean of 24 CMIP5 GCMs separately calculated for each RCP scenarios at three different time periods (The changes are relative to the observed baseline (1981-2005 periods) using CHIRPS v2.0 dataset

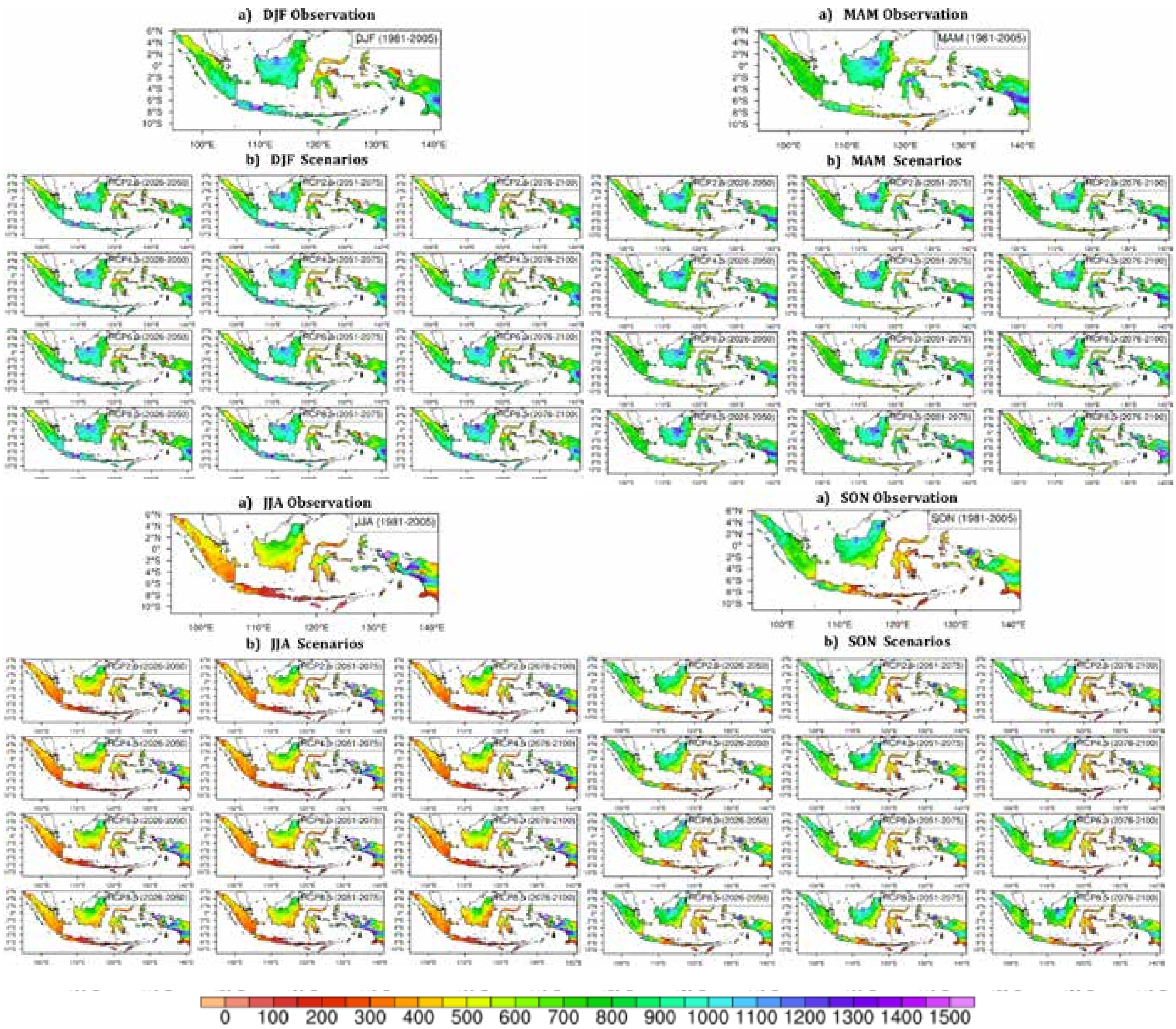


Figure 7 Seasonal rainfall climatology during 1981-2005 periods, and seasonal rainfall scenarios of the three different time periods calculated from MME median of 24 CMIP5 GCMs

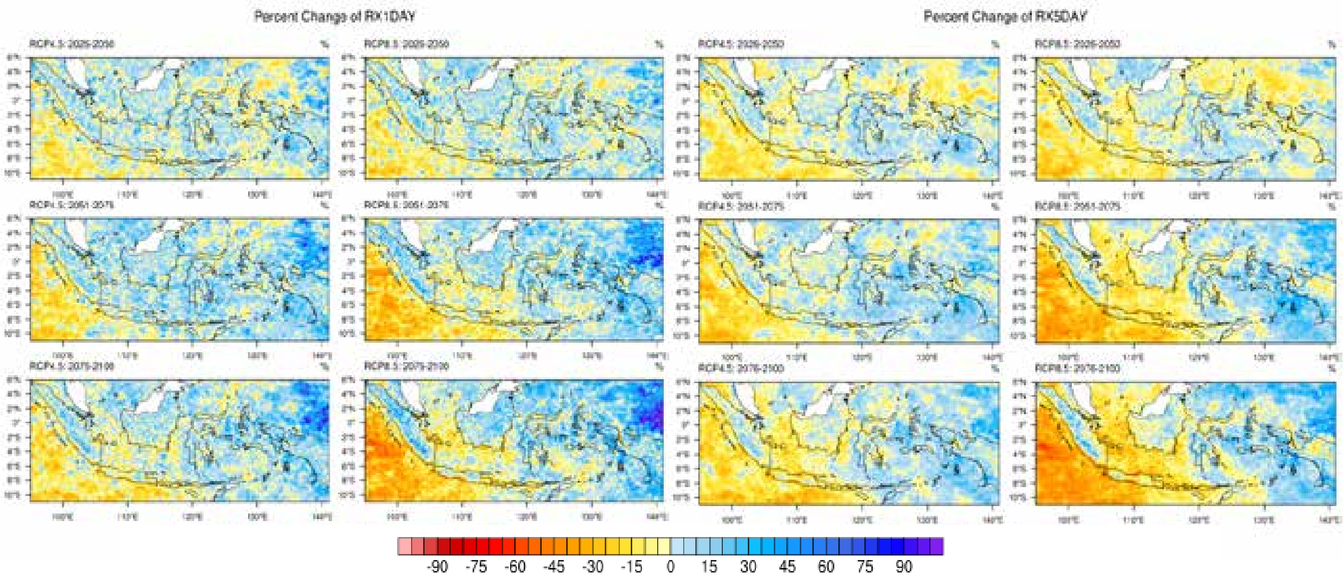


Figure 8 Projected percent changes (relative to the 1981–2005 reference period) in annual maximum one-day and five-days precipitation accumulation (RX1DAY and RX5DAY) projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs under RCP4.5 and RCP8.5

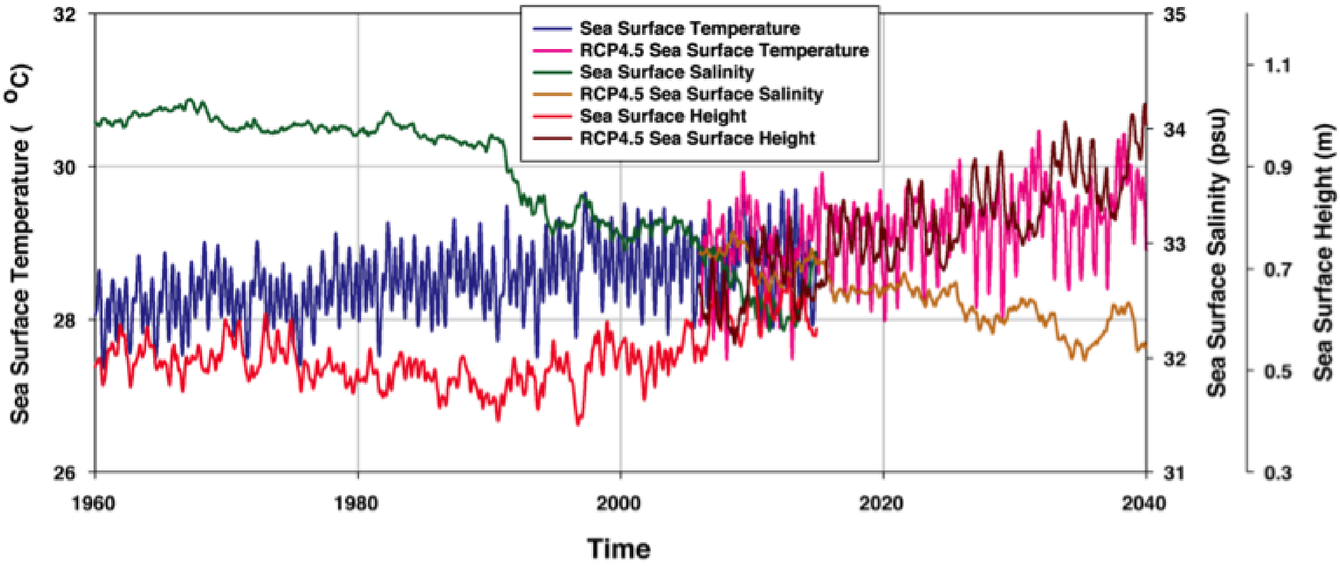


Figure 9 Time-series of monthly sea level, sea surface temperature (SST) and sea surface salinity (SSS) from 1961 to 2040

decline in SST needs a longer time to bleach the coral reef. Historical data showed that many coral in Indonesian water has been bleached as illustrated in Figure 11.

Referring to Figure 12, it is shown that the probability and occurrences of high sea surface temperature near the coast are relatively higher than the one over the open ocean. The median of SST is ranging from 24°C to 30°C, with regional mean of 28.7°C. The abrupt change of SST that indicated by 75 to 99 percentiles of data indicate that the Tomini Bay, western coast of Kalimantan, eastern coast of Sumatera and northern coast of Java Islands are suffered from the abrupt change of SST. It is estimated that coral reef area located in southern equator will be relatively more affected by the increasing of SST, and is suspected to suffer from massive bleaching, although there are reports of recovery processes in Kepulauan Seribu and Bali.

Impact of warming atmosphere on Indonesian climate as discussed above in general will increase the intensity and frequency of extreme climate events, and may ultimately reduce agricultural productivity. In most of center of agriculture areas

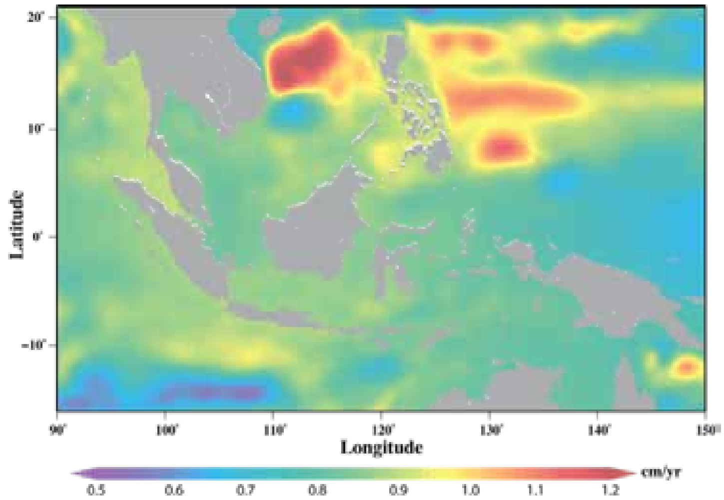


Figure 10 Rate of sea level rise in the period of 2006-2040 under the RCP4.5

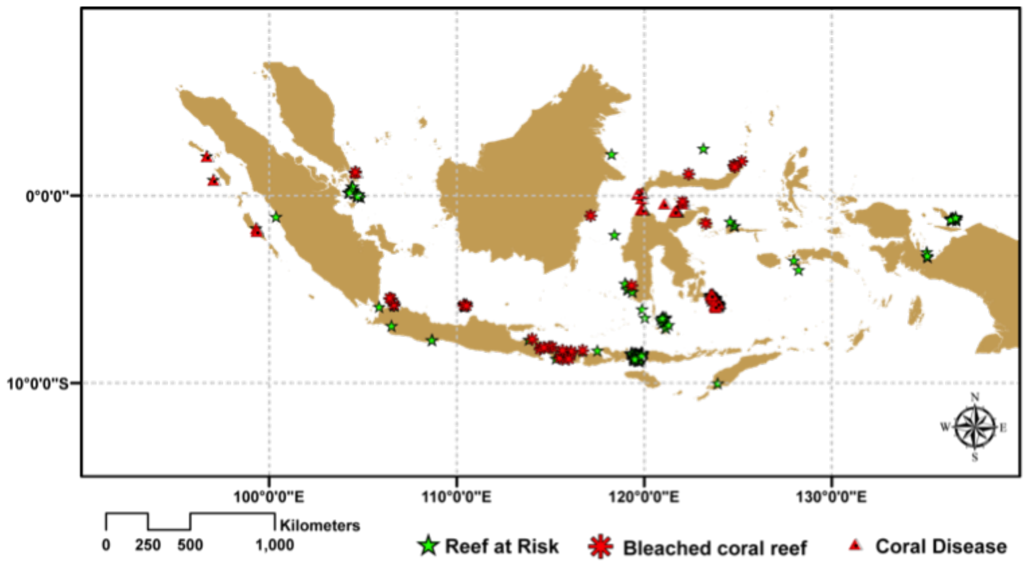


Figure 11 Map of coral reef damage and coral bleaching based on data from Basereef.org (ICCSR, 2010)

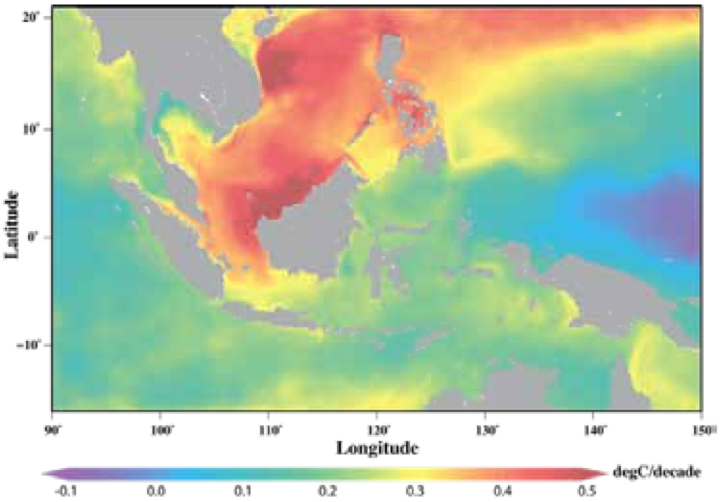


Figure 12 Rate of SST increase in the period 2006-2040 under RCP4.5

located in the southern part of equator such South Sumatra, Lampung, Java, Bali, West Nusa Tenggara, South Sulawesi often experienced longer dry season. In Java for example, by 2025 and 2050, the increase in temperature may cause significant decrease in rice production which is equivalent to about 1.8 and 3.6 million tons, respectively assuming the rice growing area in Java remain the same.

The dynamic interactions of crop pests and diseases on crops also appear to be related with change in rainfall pattern and temperature. Brown plant hopper tends to increase significantly when rainfall during the monsoon transitional period (MAM) increases. In West Java, during the La Nina years of 1998 for example, total area destroyed by brown plant hopper could increase up to 80 times the size of the area lost during normal years. There was also an indication that types of major crop pests and diseases have shifted recently.

Table 3 Vulnerability assessment by sector in specific locations in Indonesia

Sector	Locations	Vulnerability Assessment	Source
Agriculture	Bali island	Assessing vulnerability of rice farming system to climate change. Areas with high vulnerability is in the northeast of Bali	BMKG and JICA
	Malang-East Java and North Sumatra	Most of lowland rice areas are highly vulnerable to climate change. In 2030, the vulnerability will increase	Ruminta and Handoko (2012)
	Garut to Indramayu, West Java	Factors that have high influence in causing vulnerability of supply chain for the food crops (corn and rice) are family income sources and agricultural workers, and also ratio of rice and maize production per area planted and the ratio of food to the area of agricultural land area	Perdinan et al. (2015 & 2016) & Estiningtyas (2015)
Health	Bali, DKI Jakarta, East Java and Central Kalimantan	In the period of 2006-2012, the vulnerability of these areas to dengue and malaria has increased. Climate change in likely to have an impact on the changing patterns of dengue fever and malaria incidence	RCCUI and Ministry of Health (2013)
Watershed Sector	DAS Serayu in Cilacap and Banyumas of West Java	About 76% of the downstream watershed located in Cilacap and between 21% and 33% of the downstream of watershed located in Banyumas (subzone Klawing, Tajum, and Serayu Downstream) are very vulnerable to flood impact.	Jariyah and Budi (2013)
Coastal	Coastal city of Tegal	Most of kelurahan in Tegal city are vulnerable to impact of sea level rise (robs). Most of communities in the vulnerable areas are relatively poor and will be highly impacted by the climate change	Wulandari and sunarti (2013)
	Semarang City, Central Java	Kelurahan with high vulnerability situated near the coast with high rate of land subsidence. Vulnerability level of some village in 2030 will increase to high vulnerable such as Tanjung Emas, Bandarharjo and Kemijen. Large area of the kelurahan will be inundated and damaged infrastructure	Suhelmi (2013)
Vulnerable group (Children)	Surabaya, East Java	Areas with high vulnerability are mostly located in the north of the city of Surabaya. Factor causing the vulnerability are lack of disaster preparedness, limited common facility and low family welfare	Perdinan et al. (2016)
Lake Ecosystem	Solok, West Sumatra	Ecosystem of Singkarak Lake in West Sumatra are vulnerable to the impact of climate change. The change in rainfall pattern and temperature will reduce the water level in the lake, and this will affect population growth of fish particularly the endemic species such as 'ikan bilih' which is one of the main sources of community income surrounding the lake. Continuity of electricity production from the lake will also disturbed due to the increasing frequency of extreme rainfall. Floods will be more frequent in the downstream area of the Singkarak lake.	TNC Project (2016)

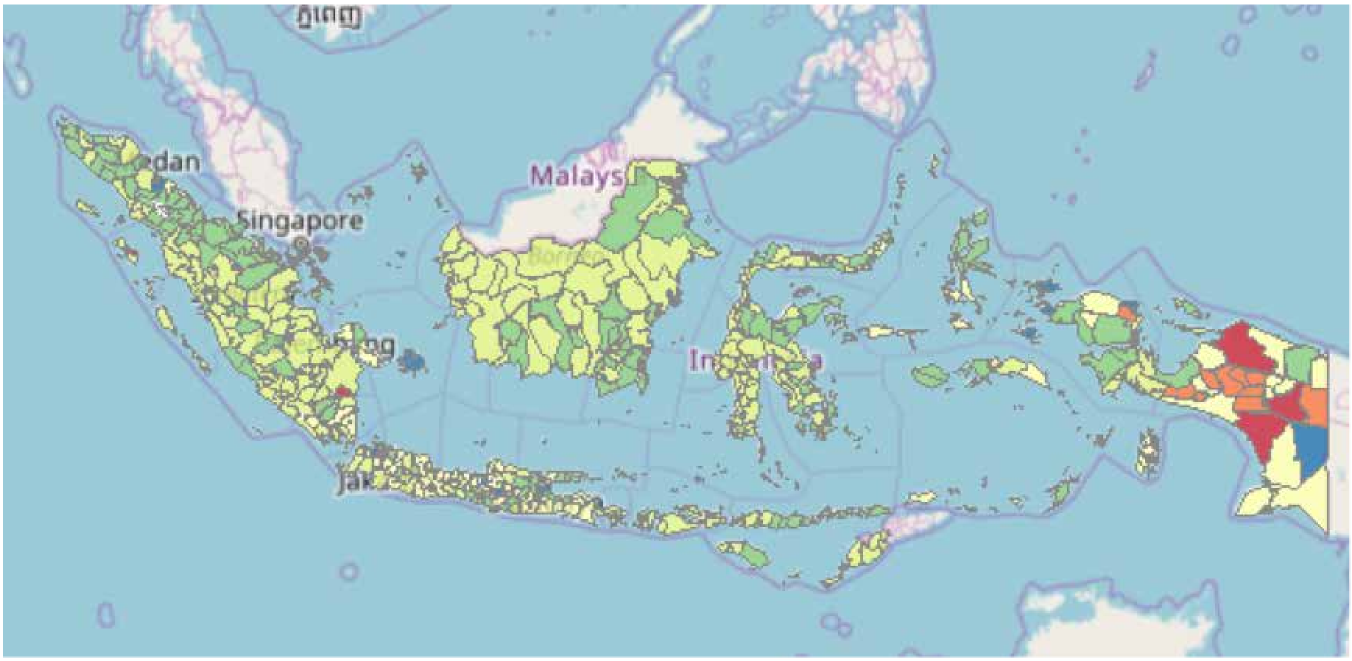


Figure 13 Vulnerabilities Districts based on 2014 data. Note: Level of vulnerability: Very high (red), High (orange), Medium (Yellow), Low (ligh green) and Very Low (Dark green)

4.3. Vulnerability Assessment

MoEF has developed tools for assessing the level of vulnerability at the village level called SIDIK (*Sistem Informasi Data Indeks Kerentanan* – Vulnerability Index Information System). The level of vulnerability is determined by the indicators that affect exposure, sensitivity and adaptive capacity of the village. The diversity of these factors, change over time in line with the implementation of development activities and adaptation efforts. The level of exposure, sensitivity and adaptive capacity levels is mirrored by the biophysical and environmental conditions, as well as socio-economic conditions. SIDIK has been used by local governments in developing adaptation action plans. Assessment of vulnerability at national level indicates that about half of the villages in Indonesia fall under the category of medium to very high vulnerabilities. Village with high to very high vulnerability levels are mostly located in Papua Province (Figure 13).

MoEF also established Climate Village Programme (Program Kampung Iklim, Proklim) that aims to increase community response and resilience to climate change. The program evaluates the community initiatives on combating climate change by recapitulating the community actions that contribute to GHG emission reduction and local climate change adaptation and mitigation

Vulnerability assessment on sectoral basis has also been done by many agencies focused in specific locations (Table 3). Most of studies indicated that most of sectors are vulnerable to the impact of climate changes due to unfavorable socio-economic and environmental conditions.

4.4. Adaptation Action Plans

Government of Indonesia has developed National Action Plan for Adaptation to Climate Change (RAN-API). This climate change adaptation (CCA) is directed to build economic resilience, to establish livelihood resilience, to maintain environmental service resilience, to strengthen special areas (*e.g.* urban, coastal and small islands) resilience, and to strengthen supporting systems (e.g. knowledge management, capacity building, planning and budgetting, monitoring and evaluation). As a guideline for preparing CCA the MoEF issued a legal basis for Devising Climate Change Adaptation through a ministerial decree No.P33/2016 as a guidance derived in accordance to the Act No.32/2009 on Environmental Management.

There are examples of mainstreaming CCA into development plan involved multistakeholders, such as the Asian Cities Climate Change Resilience Network (ACCCRN) programs and TA ADB and Ministry of Environment in mainstreaming climate change adaptation into RPJMD, RTRWD and RKP in several cities (i.e. Cities of Lampung, Semarang, Cirebon, Blitar, Probolinggo, Pekalongan, Bandung, and Tarakan) and also support from the TA ADB Project including from the development of the Third National Communication-TNC (Districts of Bandung, Indramayu, Kerawang, Purwakarta, Tanah Toraja, Ciamis, Bandung).

5. Programme Containing Measures to Mitigate Climate Change

Since Indonesia voluntarily pledged to reduce emissions by 26% on its own efforts, and up to 41% with international support, against the business as usual scenario by 2020, Indonesia has promulgated relevant legal and policy instruments, including the national action plan on GHG emissions reduction as stipulated in Presidential Regulation (PERPRES) No. 61/2011 and GHG inventory through Presidential Regulation (PERPRES) No. 71/2011.

Post 2020, Indonesia envisions a progression beyond its existing commitment to emission reductions and has set unconditional reduction target of 29% and conditional reduction target up to 41 % of the business as usual scenario by 2030.

5.1. Energy Sector

Baseline used to evaluate the achievement of GHG emission reduction from energy sector's mitigation action is an updated baseline with adjustments to the current conditions in the energy sector, i.e.:

1. Changes in base year of projected emissions calculation (SNC use base year of 2005 while TNC use base year of 2010).
2. Adjustment on the assumptions and parameters of socio-economic development (drivers of growth in energy demand). By comparison, SNC assumes the average GDP growth of 2005-2025 at 7.5% while TNC (2010-2030) uses a value of 5.5%.
3. Changes in the reference for calculation of electricity demand. In SNC, projection for electricity demand referred to General Plan of National Electricity (*Rencana Umum Ketenagalistrikan Nasional - RUKN*) referenced by the electric power supply plan (RUPTL) of 2009-2018 while TNC refers to RUKN referenced by RUPTL 2016-2025.

Sub-sectors whose energy demand is increasing in line with high growth rates are commercial industry (7.5%/year) and manufacturing industry (6.1%/year), followed by transportation (4.1%/year), and households (2.4%/year). Types of energy whose demand will grow at high speed are coal (8.3%/year) and electricity (7.9%/year), followed by natural gas (4.1%/year) and oil (4%/year). By 2030, the manufacturing industry will be the sub-sector with the highest share of energy demand (51%), followed by transportation (23%), household (21%) and commercial (6%). By type of energy, the largest share of energy demand in 2030 will be from fuel (32%), coal (27%), electricity (17%) and biomass (14%).

In RAN-GRK, mitigation activities in the energy sector are grouped by sub-sectors of energy supply and energy user, namely transportation sub-sector, manufacturing sub-sector, and buildings sub-sector (commercial and household). At the planning stage, RAN-GRK mitigation actions under the management of the Ministry of Energy and Mineral Resources (MEMR) are those related to energy supply and post-mining land reclamation activities. Those mitigation actions have the potential to reduce 72,500 Ggram CO_2-eq of emissions by 2020. In energy sector, the target for GHG emission reduction is 38,000 Ggram CO_2-eq by 2020 (53% of the emission reduction potential).

The energy sector mitigation actions are focused on increasing the utilisation of renewable energy, fuel-switching towards cleaner (lower emission) energy sources and efforts to improve energy efficiency and conservation.

Mitigation action in transportation sub-sector is under the responsibility of the Ministry of Transportation (MoT) and the Ministry of Public Works and Housing (MoPWH). MoT is responsible for activities related to traffic management and transportation, and the use of mass transportation, while MoPWH is responsible for the development and improvement of transportation infrastructure.

Mitigation actions in the manufacturing industry are under the responsibility of the Ministry of Industry, based on the sources of emissions related to energy use in industry.

5.2. NAMAs

Nationally Appropriate Mitigation Actions (NAMAs) implemented in Indonesia is NAMA SUTRI (Sustainable Urban Transport Programme Indonesia), which is a series of activities to demonstrate the capabilities of urban transport policies and action in mitigation action planning. The expected outcomes of the programme are:

1. Efficient and sustainable arrangement of urban transport;
2. Assist to the municipalities in developing mitigation action strategies that are suitable to local characteristics;
3. Development of a National Mitigation Action Plan for Transportation Sector in a roadmap related to climate change under the coordination of the Ministry of Transportation.

5.3. IPPU Sector

The institutions responsible for preparation of IPPU's GHG emission baseline are Ministry of Industry together with related industries and institutions, while the coordination for aggregation of IPPU baseline with other sector baselines is the responsibility of the Ministry of Environment and Forestry.

Based on type of gas, IPPU's mitigation actions are aimed at reducing emissions of CO_2, CH_4, N_2O, HFCs, PFCs (CF_4/C_2F_6), and SF_6 gases from industrial sector in Indonesia. National GHG Emission Inventory shows that the national GHG emissions from IPPU sector are dominated by CO_2 (98% of total GHG emissions from IPPU sector). Although CO_2 is the main GHG emission, the preparation of IPPU GHG emission baseline not only covers CO_2 emissions, since mitigation action in IPPU sector implemented in Indonesia not only covers CO_2 but also other GHG emissions, including N_2O (Acid Nitrate) and PFCs (CF_4/C_2F_6). Referring to data in First BUR and TNC, the industries that contribute significantly to the national GHG emissions from IPPU sector in Indonesia are the cement industry, ammonia-urea fertilisers, and iron-steel processing, whereas product use activities that contribute significantly to GHG emissions national are the use of carbonate, paraffin/wax, and lubricants. Mitigation action in IPPU is aimed at reducing GHG emissions from industrial processes and the product use that are significant contributors to the national GHG emissions. Among these industries, achievement of mitigation action in cement and ammonia-urea fertilisers can be reported, while achievement of mitigation actions in iron processing have not been reported due to data limitations.

Mitigation actions planned for the cement industry, ammonia-urea fertilisers, aluminium and nitric acid are mostly being implemented voluntarily by private sector or within the framework of CDM, which are not intended to meet national GHG emission reduction targets. However, there is mitigation action related to production process in cement industry, which the Ministry of Industry stipulates as a mitigation action aimed at meeting the target of RAN-GRK.

RAN-GRK in industrial sector will be implemented in three main action plan groups: (1) process modification and technology of biomass utilisation or other technology in cement industry as cement blended, (2) energy conservation and audit; and (3) elimination of ozone depleting substances (ODS). In this sector, emission on industrial mitigation actions in the field of industry only covers mitigation directly related to IPPU. In its implementation, only one action is directly related to GHG emission mitigation in IPPU, i.e. process modification and biomass utilisation and blended cement technology. The GHG emission reduction target from the action is estimated as much as 2.75 Million Tonnes of CO_2e to be achieved during 2010-2020.

Despite being implemented by private sector, non-RAN GHG emission mitigation action in IPPU industry is coordinated by MoI that it can be categorized as mitigation by party stakeholder.

5.4. AFOLU Sector

5.4.1. Forestry Sub-Sector

The projected baseline emissions of the AFOLU sector in 2010 are estimated to be 757,055 Gg CO_2e, then increased to 873,491 Gg CO_2e and 834,698 Gg CO_2e in 2020 and 2030, respectively. The projection came from use of actual deforestation data of 347,000 hectares in 2010, while deforestation rate for 2011 - 2020 use FREL projected rates for REDD

+, where it is assumed to follow the average historical deforestation rate over the period of 1990-2012 (MoE, 2016), i.e. 0.92 million ha/year. While in the period of 2021-2030 the rate of deforestation is projected at 0.82 million ha/year.

The RAN-GRK in forestry sector has 13 (thirteen) core mitigation action plans and 17 supporting mitigation action plans. The 13 core mitigation action plans contribute to 810,600 Gg CO_2e (0.811 Giga Ton CO_2e) emissions reduction by 2020. However, the target set for the forestry sector is 672,000 Gg CO_2e. Of the 13 core mitigation action plans, only 10 of it are managed by MoEF. Other two action plans are managed by MoA while another is managed by MoPWH.

In general, ten core mitigation action plans managed by the MoEF can be divided into two categories: actions aimed at avoiding carbon emissions (avoided deforestation and degradation), and actions aimed at increasing carbon sequestration (reforestation), with total emission reduction potential of 600,700 Gg CO_2e. Meanwhile, the three core mitigation action plans managed by the MoA and MoPWH have the potential to generate 209,950 Gg CO_2e emission reductions. The core mitigation action plans and its managing ministries are presented in Table below.

Referring to the rates of emission from deforestation during the 2011-2014 period, baseline emissions are higher than the actual emissions. This indicates generation of emission reductions from implementation of mitigation policies. Nevertheless, emissions from deforestation during the period showed increasing trend even though it decreased again in 2014. Cumulatively, the reduction of emissions during the period reached 365,569 GgCO_2e or equal to 91,392 GgCO_2 per year.

5.4.2. Agriculture Sub-Sector

The baseline emissions from agricultural sector are much smaller than the baseline in forestry/other land use sectors. The 2010 baseline emissions for the agricultural and forestry sectors are 110,510 Gg CO_2-eq and 646,545 Gg CO_2-eq, respectively, in 2020 it will be 115,925 Gg of CO_2-eq and 757,566 Gg of CO_2-eq, while in 2030 it will be 120,457 GgCO_2-eq and 714,241 Gg of CO_2-eq.

The RAN-GRK of the agricultural sector has 6 core mitigation action plans and 4 supporting action plans. The six core mitigation action plans have the potential to reduce around 130,730 Gg CO_2e (0.131 Giga Tons CO_2e) emissions by 2020. However, the target set for agriculture sector is only 8,000 Gg CO_2e.

Of the six core mitigation action plans of the agricultural sector, Kementan manages five core mitigation action plans, with an emission reduction potential of 130.570 Gg CO_2e. Meanwhile, KemenPU-PR manages 1 core mitigation action plan, with an emission reduction potential of 160 Gg CO_2e. The core action plan for mitigation of the agricultural sector at the relevant ministries is presented in Tabel below.

GHG Emission reductions in agriculture sector were generated from the implementation of three mitigation actions, (i) management of rice cultivation, (ii) utilization of livestock manure for biogas, and (iii) utilization of livestock manure for organic fertilizer. These actions will contribute to reduction of emissions in sub-categories of, among others, rice cultivation and manure management. The emission reductions from these actions were calculated under assumption that the actions have never been conducted before, thus emissions could not have estimated.

5.4.3. Waste Sector

In accordance with various changes related to the coverage and methodology for calculation of GHG emission level, the baseline used in TNC is an updated baseline, with the following changes:

1. Base year, where TNC base year is 2010 while SNC base year is 2005;
2. Methodology for calculation of emissions from solid waste disposal site (SWDS) is changed from the mass balance approach (based on revised 1996 IPCC) to First Order Decay (FOD) approach (based on 2006 IPCC);
3. Higher tier on activity data and emission factor in some categories of waste treatment, in accordance to changes in the methodology for GHG emission level calculations. In TNC, some categories have used higher Tier (Tier 2/3) whereas in SNC the entire waste sector used Tier 1.

In industrial wastewater treatment, lower baseline emissions in TNC were caused by revisions of activity data and related parameters on specific intensities of wastewater generated per industrial product (waste flow rate) and COD (chemical oxygen demand) value determining the organic content in industrial wastewater. In the SNC, GHG emissions from industrial wastewater were estimated using IPCC default numbers resulting in a relatively higher emission calculation when compared to using national and local (country-specific) data and parameters. In TNC, estimates of GHG emissions from industrial wastewater in several categories use the national and local specific data and parameters.

In the domestic solid waste sub-sector, baseline emissions in TNC are higher than SNC's due to change in methodology, i.e. from the mass balance approach to the FOD approach, which assumes that domestic solid waste stockpiled this year will still produce emissions in the coming years. The differences between TNC and SNC are also due to improved emission parameters. In SNC, all parameters used were default numbers of Revised 1996 IPCC, whereas in TNC GHG emissions are calculated based on local parameters, i.e. composition of domestic solid waste dumped in landfill and dry matter content for every component of domestic solid waste.

Based on the RAN-GRK, GHG emission reduction targets from the waste sector in 2020 is 0.078 Giga ton CO_2e. Mitigation action plans in this sector include (a) establishment of integrated wastewater infrastructure (*IPAL*) with offsite and on site systems and (b) development of SWDS and integrated waste management and 3R.

6. REDD+ Implementation

The development of REDD+ in Indonesia is in line with international guidance for REDD+ as per decisions resulted in COPs since COP 13 in Bali to COP 19 in Warsaw. Within this development process, policy interventions, regulations and actions related to REDD+ have been developed by the government of Indonesia. REDD+ activities in Indonesia has the potential to reduce emissions up to 70% of total planned emissions reduction in the land-based sector.

REDD+ development in Indonesia started in 2007 when Indonesian government through the Ministry of Forestry released a study report by IFCA (Indonesia Forest Climate Alliance), among others contain analysis on drivers of deforestation and forest degradation and how to address them. The progress of REDD+ programme then increased when REDD Task Force was established, continued by REDD+ Agency and then since 2015 all of REDD+ program run by REDD+ Agency and other relevant government institutions is coordinated and regulated by Ministry of Enviornment and Forestry c.q. Directorate General of Climate Change. Indonesia has made significant progress in the development of the four elements required for REDD+ implementation, as follows:

6.4.1. National REDD+ Strategy

Indonesian REDD+ National Strategy is formulated taking into account relevant policies, with an inclusive process based on wide-range participation of multistakeholders. The formulation of REDD+ National Strategy was conducted following four basic principles : inclusiveness, transparency, credibility, and institutionalization. There are 5 (five) pillars serving as fundamental strategy for REDD+ in Indonesia as mentioned in the REDD+ National Strategy document as well as the status its implementation : 1) institutions and proess; 2) laws and programs; 3) Strategic Programs; 4) Paradigm and Work Culture; 5) Stakeholder Involvement. As a follow up to the National Strategy, 11 (eleven) priority provinces have formulated REDD+ Provincial Strategy and Action Plan. SRAP REDD+ will be part of the local development plan thus ensure its implementation and enable evaluation on achievements of local development activities against REDD+ target.

6.4.2. National Forest Reference Emission Level (FREL)

Indonesian national FREL serves as baseline for reducing emission from deforestation and forest degradation under REDD+ mechanism (performance-based payment of REDD+). Indonesia has submitted FREL Indonesia in 2015 during the COP 21 in Paris, followed up by technical assessment by UNFCCC in 2016 (see Appendix VI-B). The updated FREL following the result of the technical assessment are accessible at the UNFCCC website.

6.4.3. National Forest Monitoring System/Measurement, Reporting and Verification (NFMS/MRV)

The Indonesia"s NFMS was not designed merely for implementing the REDD+, as the system is also important as source of national data and information for operational uses. The forest/land monitoring of NFMS is a system monitoring approach that was established in 2000 under the DG of Forest Planning. NFMS provide 23 land cover classes consist of four components/sub-system: (a) forest/land monitoring to provide land cover on regular basis and its changes from time to time; (b) forest inventory to provide forest biomass estimation; (c) mapping, to maintain spatial database and provide information based on spatial analysis, and (d) spatial data networking to maintain data communication, raw data-providers, data sharing, data exchange and spatial data clearing house. In general, only two sub-systems under the NFMS of Indonesia are known by users: (a) the forest monitoring sub-system that more often called NFMS and (b) national inventory data or NFI (National Forest Inventory).

With regard to the MRV preconditions, Indonesia sets the NFMS as one of the main pillars for implementing the domestic MRV. The pillars are in-line with what Indonesia has been developing at the National level, in term of NFMS as a comprehensive system, which consists of (i) forest/land monitoring or NFMS-Simontana (Indonesia FREL 2015, 2016, Margono et al 2016); (iii) NFI (Revilla Liang 1992, Indonesia FREL 2015, 2016); and GHG Inventory system, which is currently named National GHG Inventory System (*Sistem Inventarisasi Gas Rumah Kaca Nasional*/SIGN-SMART).

6.4.4. Safeguards Information System for REDD+ (SIS-REDD+)

Indonesia has developed a SIS for REDD+ aim to collect, manage and and provide/display information on the implementation of REDD+ by REDD+ activities in Indonesia. In 2011, Ministry of Forestry started a multi-stakeholder process to review existing policy, regulations and voluntary instruments, which are of relevance to REDD+ safeguards as defined by the COP 16 decision, as a preliminary basis for constructing a national REDD+ safeguards information system. The assessment and analysis process of the existing instruments, which resulted in the initial 7 Principles, 17 Criteria and 32 .Indicators (PCI) framework.

Indonesia also developed safeguards information system (http://sisredd.dephut.go.id/redd/) based on Indonesia's institutional structures and flow of information. The SIS-REDD+ Indonesia was designed using the following principles: simplicity, completeness, accessibility, and accountability. For operation of the system, the institutional structure of SIS-REDD+ consist of data and information management bodies (PSIS/*Pengelola* Sistem informasi Safeguards) from different level (from site, sub national, to national level). In SIS-REDD+, the provision of safeguards implementation information is designed to be delivered through the levels, from the project on site to the SIS management in districts, then to the provinces, and finally to the national level.

6.4.5. REDD+ Financing

REDD+ finance mechanism is a result-based payment mechanism, based on performance of verified emission reduction. Non-market based finance and alternative policy approaches are the approaches used by Indonesia now in REDD+ financing. In line with the REDD+ international guidance as well as Paris Agreement, several developed countries (Norway, Japan, Korea, and Germany) have committed to support Indonesia through bilateral mechanism. Beside public finance, private is also a potential source of finance for implementing REDD+. Some private sectors in Indonesia are potential to contribute in REDD+ implementation.

To provide an umbrella regulation for environment financing as mandated in Act No. 32/2009 on Environmental Protection and Management, the GoI has issued a Government Regulation on Economic Instruments for Environment, including funding instrument for REDD+. To address the mandate, this Government Regulation covers three main areas of development planning and economic activities, environmental financing, also incentive and disincentive systems. The regulation states that one of environmental financing management is the General Service Agency (*Badan Layanan Umum*/BLU), a national financing institution that will manage the funds, including REDD+ funds.

The progress of the four elements of the architecture of REDD+ is supported by a well-structured institutional arrangement and also lessons learned from the development of Demonstration Activities (DA)/pilots/projects related to REDD+. Until 2016, there have been around 37 DAs/pilots/projects/activities related to REDD+ developed in Indonesia, carried out with a variety of approaches, scale, scope, time period, extent and methods. In order to implement REDD+ in Indonesia, capacity building is one of important keys. Indonesia has conducted capacity building activities in some locations with supports from various parties namely government agencies, international organization, research institute, etc. Other important key of REDD+ implementation in Indonesia is to have a common understanding and awareness on REDD+, both in national and sub national level through several workshops, discussions, trainings, public consultation and publications.

In order to record the existence of the REDD+ related activities in Indonesia, a REDD+ Registry System was developed by MoEF, as part of the National Registry System. For the future of Indonesian REDD+, some plans for improvement have been prepared by the government of Indonesia and are on going. For example, the Indonesia's FREL need to be revisit and reviewed post 2020. Besides, in order to prepare the REDD+ performance-based payment (RBP), the MoEF has also initiated series of meetings aimed to develop guidelines forestablishing FREL sub-national. The guidance need to be established to maintain the appropriate use of the national FREL in sub-national implementation. The guidance on sub-national FREL is designed to be included in the regulation for REDD+ implementation, especially on the Measurement, Reporting, and Verification (MRV) of REDD+. In terms of REDD+ financing, accounting the finance demand for REDD+ in Indonesia is to be further discussed in near future. In addition, following up the progress on financing-related policy instruments being prepared, there is a need of capacity building for tracking the climate finance (especially for REDD+) and also capacity building for operationalization of the funding institution. In terms of SIS-REDD+, it is important to further maintain the system to be well-operationalized and to strengten the system through collaboration and synergy with other related system.

Furthermore, following the submission of Indonesia's First NDC, and with acknowledgement and strong political signal from Paris Agreement to REDD+ implementation, REDD+ will be an important part of the national emission's reduction target in the near future. With this regards, next important step to do is to determine the position of REDD+ activities in the Indonesian NDC. This step will enable REDD+ to play significant role in broader context of climate change in Indonesia, particularly to help the country in addressing the issue of deforestation and forest degradation.

7. Other Information

7.1. Transfer of Technology

In the past, much of technology transfer in mitigation activities was accomplished through the implementation of carbon projects such as the Clean Development Mechanism. It also takes place through multilateral and bilateral cooperation, for example through the ASEAN-Germany cooperation program: "Promoting Innovation and Technology-ASEAN" (PIT ASEAN) aiming at promoting the innovation and technology especially for small-medium enterprises (SMEs) and NGO works under SGP-GEF UNDP Programme mostly in Java area and predominantly in energy and waste sector.

7.1.1. Research and Systematic Observation

Research centres of various agencies/ institute and universities that carried out basic research on modelling of weather and climate are limited, mainly BMKG, LAPAN, IPB, and ITB. Some of the climate modelling research

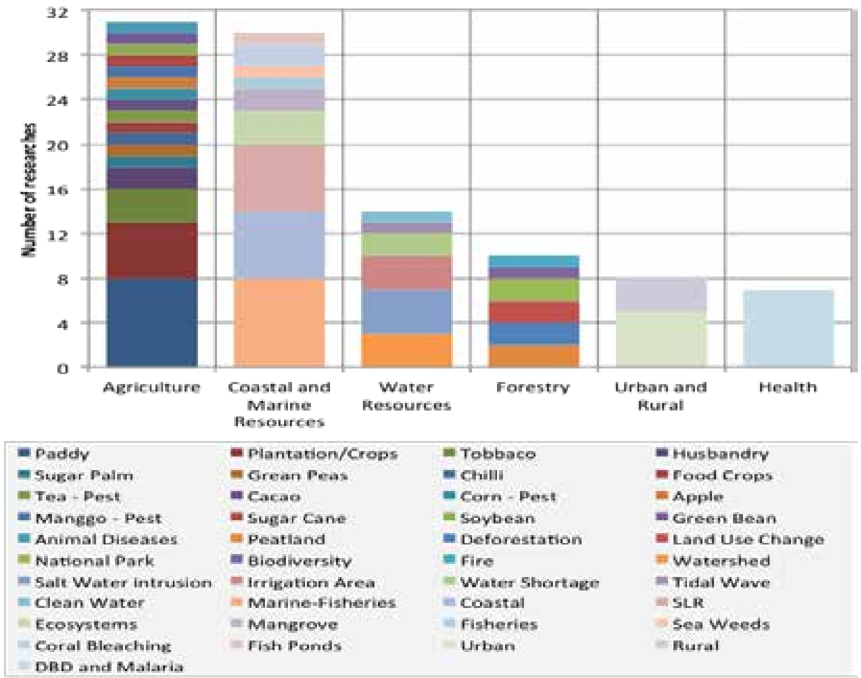


Figure 14 Number of climate change impacts research by sector in Indonesia in 2010-2016

activities conducted by BMKG, include an analysis of the spatial and temporal patterns of rainfall in western Indonesia using WRF-EMS (Weather Research and Forecasting Environmental Modelling System) such as the initiatives on SEACLID/Cordex-SEA (Southeast Asia Regional Climate Downscaling) that downscale a number of Global Climate Model (GCM) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) for Southeast Asia and SACA&D (Southeast Asia Climate Assessment and Dataset) as a part of the Digitisasi Data Historis (Didah) project, which is a two-year project (2010-2011) focusing on the digitization and use of high-resolution historical climate data from Indonesia over the period 1850-present. Climate Change Impact Research

Over the last six years, there have been at least 100 research activities undertaken by a wide range of sectors (Figure 14) mainly on agriculture, followed by coastal and marine, water resources, forestry, urban and rural, and human health. Most of the research in agricultural sector, focused on the assessments of climate change impacts on main food crop production, i.e. rice paddy. Climate research in urban/rural and human health are still limited, in which research on health impact of climate change still directed primarily to the occurrence of dengue and malaria.

The systematic observation of climate in Indonesia is coordinated by BMKG. Subsequent to independence, more rainfall stations were installed. Nevertheless, such efforts were still far from sufficient to have a representative number of stations across the country. At present, BMKG manages around 173 observation stations and around 5,000 rain gauges throughout the country as compared to t20,000 They are mainly located in Java, followed by Sumatra, Sulawesi, Maluku, Kalimantan and Papua. In addition to rain gauges stations, BMKG has also installed a number of automatic weather stations (AWS) and radar in several places, particularly in weather/climate hazards prone areas. In collaboration with WMO, BMKG has also established a Global Atmospheric Watch (GAW) in Bukittinggi, West Sumatra. With the presence of the GAW, Indonesia becomes a part of the global atmospheric observation under World Weather Watch.

The National Network of Agroclimatic Stations is installed in a number of agriculture research stations. The network is maintained by the National Agency for Agricultural Research and Development. There are about 59 agroclimatic stations, but only half are in good conditions (Surmaini et al., 2010). The distribution of the agroclimatic stations is presented below in Figure 15.

Data on daily rainfall and temperature are collected and provided by BMKG from 162 stations (Figure 16), portraying various record

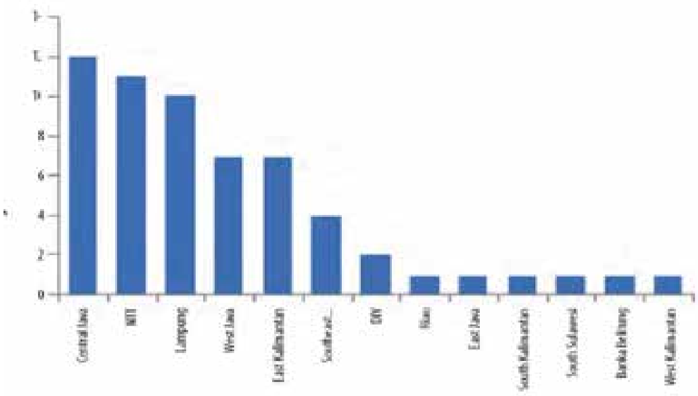


Figure 15 Number of agroclimatic stations by province (Surmaini et al., 2010)

lengths with the longest temporal coverage of 43 years (i.e. 1970–2012). All records are stored in an agroclimatic format comprising of weather variables including: surface temperature, rainfall, duration of solar irradiation, relative humidity and wind speed-direction. The longest observational data is from Jakarta Observation Station with a length of record of 134-years (daily) and 114-years (hourly) (Siswanto, 2015). BMKG provides online access for public uses through http://dataonline.bmkg.go.id/home.

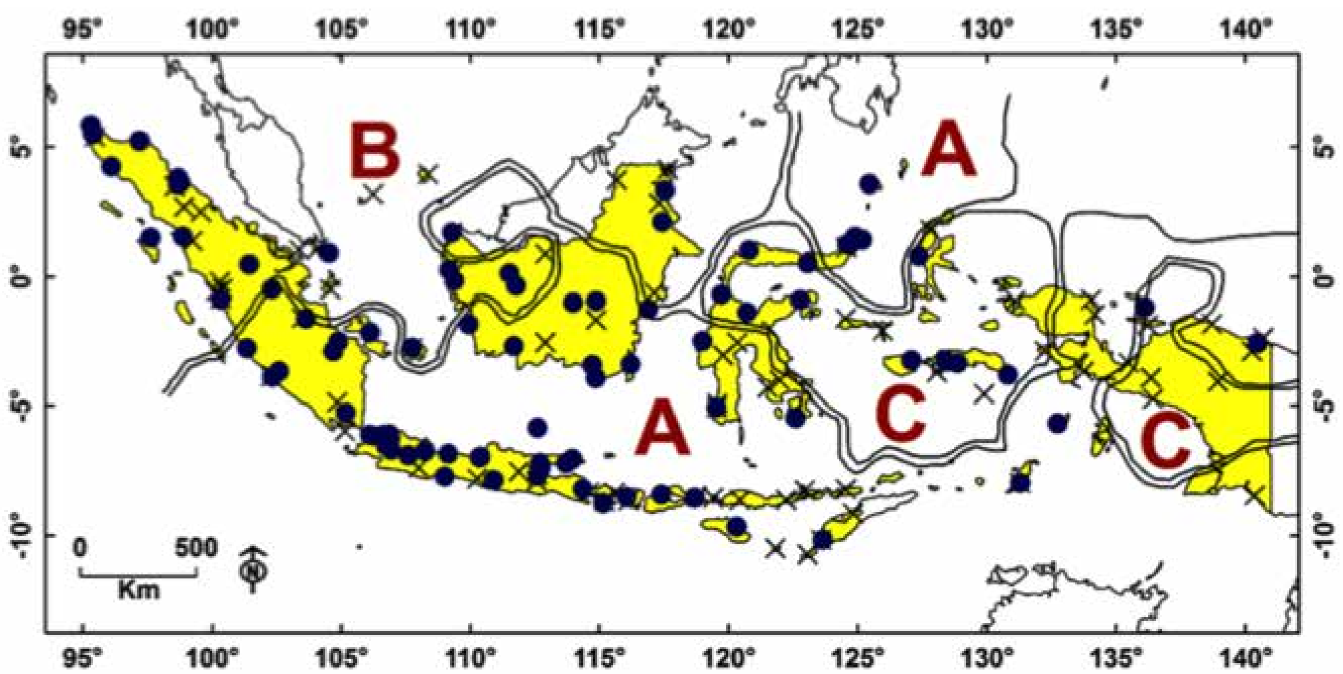
LAPAN also conducts climate observation and analysis using radar and satellite data. Some of their research activities include: Optimation of space weather data transfer system network, Development of space weather information services: Development of TEC observation system, and Ionosfer Real Time Sintilation and Utilization of radio FM for monitoring Irregularity of Ionosfer

Indonesia has also installed a number of instruments to monitor sea level. The existing Indonesia Sea Level Monitoring Network consists of 65 operational stations (Figure 17). More stations will be installed through an ongoing programme called the Indonesia Tsunami Early Warning System (IndTEWS) that will consist of 120 stations of which 80 will use real time data transmission and at least two quality sea level recordings.

7.1.2. Capacity Building, Education, Training and Public Awareness

Between 2000 and 2008, Indonesia has conducted about 91 trainings, public awareness programmes and capacity building activities, although this number might be underestimated, since many climate change capacity building activities have not been recorded by the related agencies. At present, there is no system in place to record and monitor the outcomes of the activities. However, the numbers presented in Figure 18 may reflect the level of participation in supporting capacity building programmes in Indonesia. Information on Figure 18 indicates that most capacity building activities were supported by Japan, Germany, ADB and the World Bank. It is to be noted that the number of activities does not necessarily reflect the amount of funding being provided.

Between the years 2011-2014, in total, there were 41 capacity building events on adaptation that were recorded, ranging from development of educational and training materials, to sectoral training such as for health, agriculture, and fisheries sectors. Events related to mitigation appeared more frequently as shown by the total number of 184 events, which were mostly related to forestry and energy sectors (Figure 19).



Note: For rainfall analysis, stations are grouped into the three sub-regions i.e., A,B and C (Aldrian and Susanto, 2003). Stations marked with X represent stations with poor quality with many missing observations (Supari, 2016)

Figure 16 Spatial distribution of 162 weather stations.

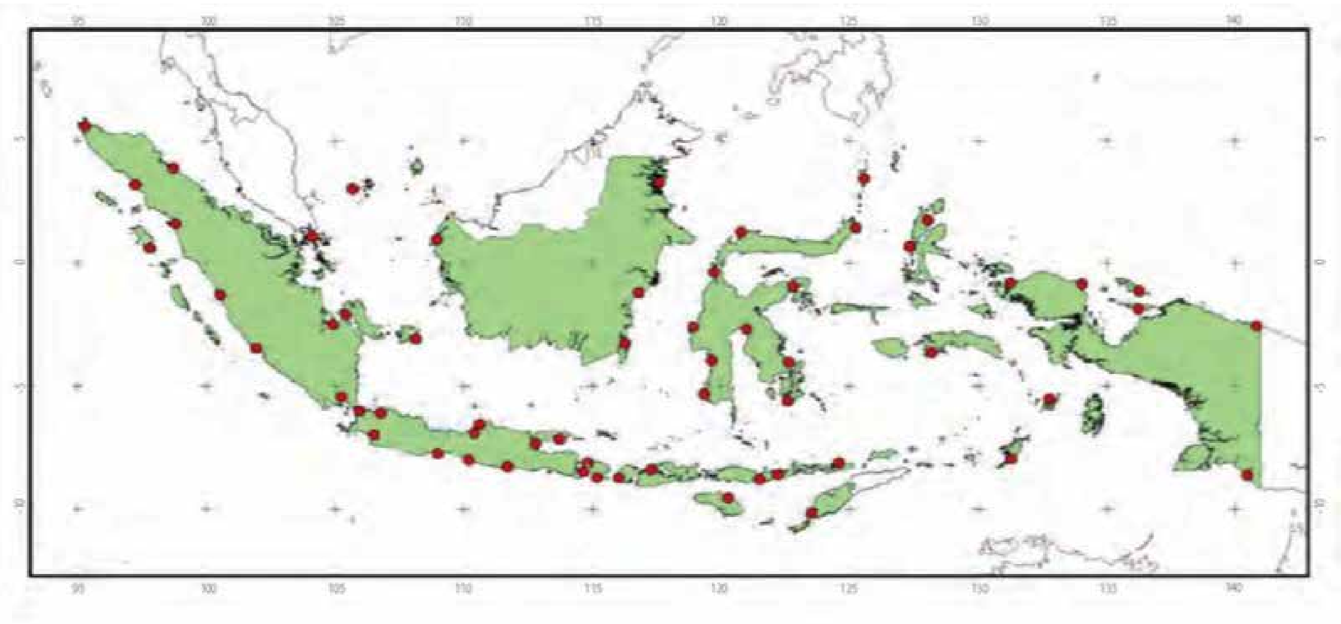


Figure 17 Existing operational Sea Level Monitoring Stations in Indonesia (MoE, 2008)

7.1.3. Networking and Information Sharing

To strengthen the research network among Indonesian scientists on climate change research, the MoEF has facilitated the formation of Indonesian Research Association on Climate Change and Forestry (APIKI). Other related ministries provide supports for research associations such as Agricultural Meteorology Society (PERHIMPI), Soil Scientist Association,

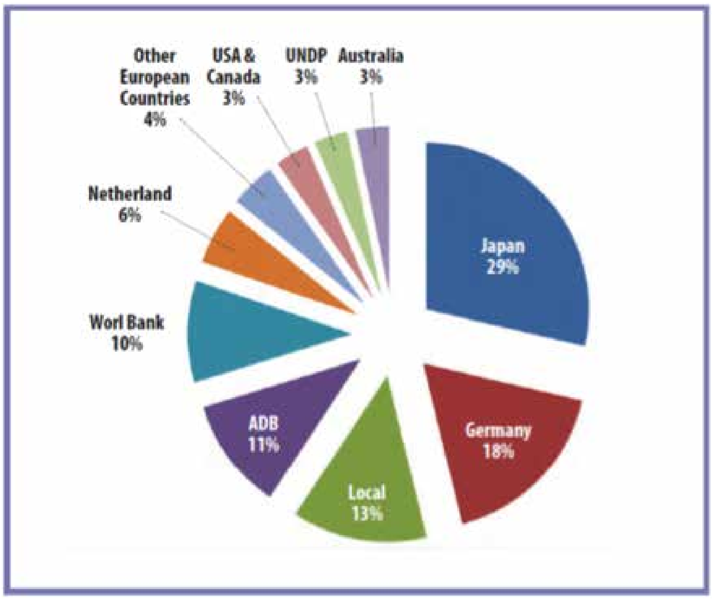


Figure 18 Donor countries/agencies who contribute to the implementation of climate change capacity building activities (based on data collected from the Ministry of Environment)

Indonesian Agronomy Association (PERAGI), Agriculture Socio-Economic Association (PERHEPI) etc., to conduct joint research related to climate change. In addition, many Indonesian scientists are also active in regional networkings such as LoCARNet (Low Carbon Asia Research Network).

At present, there are at least 10 portals on climate change, as shown in Figure 20 with some examples are as follow:

1. SIGN SMART (signsmart.menlhk.go.id), a portal that provides information on GHG emissions/sinks at national, sectoral and sub-national levels for 5 sectors.
2. SIDIK (http://sidik.menlhk.go.id), presents data and information on vulnerability index at provincial to village level data across Indonesia.
3. ProKlim (http://proklim.menlhk.go.id) provides public information on various actions implemented by the
4. RAN GRK/API (http://sekretariat-ranapi.org and http://www.sekretariat-rangrk.org) provides information on climate change adaptation and mitigation plans and programmes from sectors.
5. KATAM (http://katam.litbang.pertanian.go.id), that can be used by the local governments and communities in supporting planting decision that minimise climate risks. It is an integrated information system providing alternative farming decisions (e.g., planting dates, amount of seeds/varieties/fertilizer, and pest) based on rainfall forecast information.

6. Indonesian Ocean Forecasting System (http://maritim.bmkg.go.id) provides forecast information on sea surface temperature (SST) and surface currents (Current Ocean Circulation) that can be used by fishermen to determine proper fishing dates and fishing areas in Indonesia.
7. The Research and Development Centre for Marine and Coastal Resources (P3SDLP) of the MoMAF has developed a system to monitor fishing zone areas. For example, in estimating areas for Bigeye Tuna located within the Indian Ocean, hook rate is used as an indicator. In addition, the MoRF also have an android-based system to forecast tide.
8. http://ccis.klimat.bmkg.go.id) that manages climate data and standardised climate change information in Indonesia.
9. BPS established a system that provides information on the environmental condition and efforts to control environmental damage.
10. SADEWA (http://sadewa.sains.lapan.go.id) provides information on the formation and movement of cloud as well as monitoring the development of tropical cyclone.
11. SIMBA (*Sistem Informasi untuk Mitigasi Bencana*) has been developed by LAPAN to provide information on disaster management.
12. The National Disaster Management Agency (BNPB) developed information system that manages disasters data and presentation of disaster data analysis.

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

Some constraints related to climate finance have resulted from: (i) the decreased in the international and domestic climate finance in Indonesia after the fast-start finance period from 2010 through 2012 (Halimanjaya, 2016), (ii) the enabling conditions for an effective management of climate change, still need to be strengthened, including the institutional setting of climate change landscape, (iii). lack of capacity to access climate change fund; (iv) lack of coordination and oversight; (v) absence of country programme and consolidated project pipeline; (vi) lack of private sector involvement, (vii) less robust governance

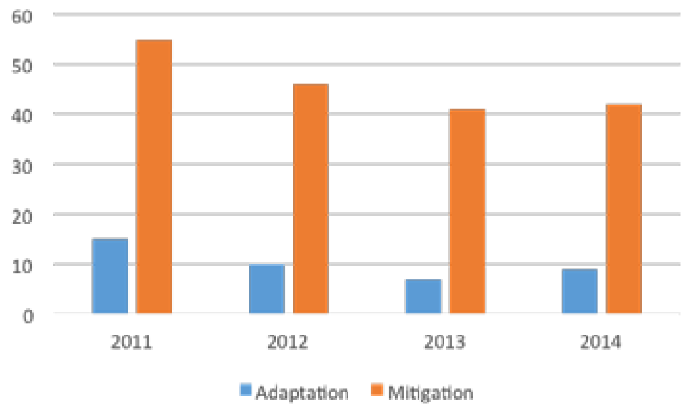
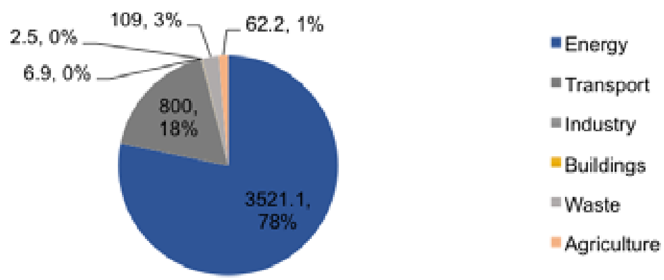


Figure 19 Number of capacity building events on climate change



Note: the amounts are the accumulated figures from 13 of 22 project proposals or concept notes. This has not fully reflected the need for land-based sectors

Figure 20 Identified financial needs based on proposed mitigation projects

and coherence of climate funds in Indonesia, and (viii) lack of capacity for data management to enhance the transparency of climate finance flows. Gaps related to international climate finance are mainly related to its volume and the availability of required matching fund, which is considered too demanding.

Related to climate change mitigation, the financial needs for national supports were identified for the implementation of 13 out of the 22 climate change mitigation projects totalling to USD 4.5 billion for the period of 2015 – 2020. Figure 20 and Annex 8.1 indicate that the existing energy and transportation projects are much more ready than agriculture, industry, and forestry and peatland projects. Most of these projects (around 78%) are classified under energy sector, with attached co-financing conditionality, and are faced with various stages challenges related to the financial supports tied to the conditionalities. The financial needs for the other eight mitigation actions listed in the Annex 8.1 have not been determined. Moreover, land based activities particularly forestry, which accounts for the largest emissions reduction target in the RAN-GRK, requires around USD 4 billion investment for the initial 5-Year Phase of REDD+ Related Investment Program in addition to its technical assistance component (IFCA, 2008). The estimation for forestry sector needs is not included in Figure 8.1.

The estimated funding needs for climate change adaptation activities reached up to IDR 840 trillion (eq. USD 64 billion), which was much higher than the needs for mitigation activities, which is stated in RAN-GRK at IDR 225 trillion (eq. USD 17 billion). Apart from small pilot projects, finance for adaptation activities is still sourced from government budget. Some international financing opportunities for adaptation such as the Adaptation Fund were still not fully utilised. Out of the total USD 10 million allocated to Indonesia by the Adaptation Fund, only around USD 4 million that was allocated, and this allocation was made for the Coastal Resilience Village project. Meanwhile, to access the other USD 6 million, the Directorate General for Climate Change of MoEF, acting as the Adaptation Fund's National Designated Agency and the accredited national implementing entity, Kemitraan, is creating an umbrella programme. In addition to the Adaptation Fund, other funding sources for adaptation include the Green Climate Fund as well as other bilateral supports.

Domestic financial resources to implement climate change activities particularly in relation to Presidential Regulations No. 61/2011 and No. 71/2011, are mainly provided by the State Budget (APBN. International funding sources are provided through multilateral climate finance and bilateral cooperation, based on the Government Regulation No. 10/2011 on procedure for obtaining loans and grants.

Figure 21. shows that Indonesia has significantly increased its expenses for mitigation

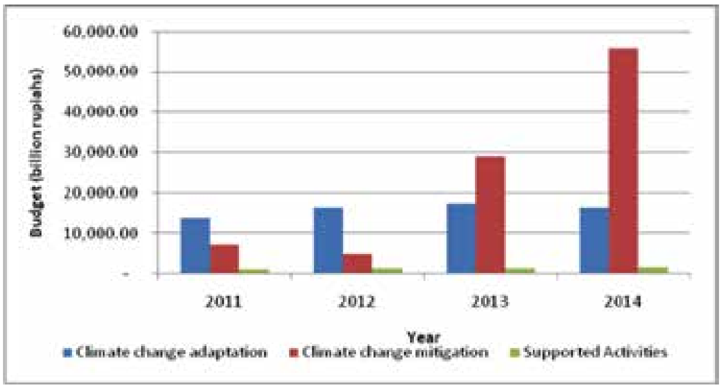


Figure 21 Budget realisation related to climate change in 2011-2014 (BAPPENAS, 2014a)

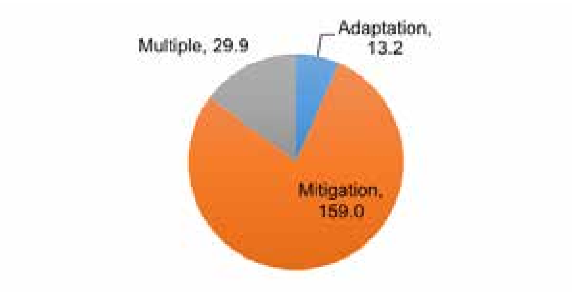
actions especially after 2012 from State Budget and international sources, of which some were channelled through Government Investment Agency (PIP), Indonesia Climate Change Trust Fund (ICCTF), and the Millennium Challenge Account Indonesia (MCAI).

In addition to APBN, mitigation actions at local level were implemented using the Local Government Budget (APBD) which also show increases after 2011 (Table 4). According to Bappenas (2014a), in 2012, most of the financial resources were used to fund forestry activities (Table 5). Ministry of Finance (2012) had estimated the amount of funding needed to achieve the voluntary emission reduction target in 2020, including possible contributions from private sectors, in forestry, peatland, energy and transportation sectors would reached a total of IDR 140 billion per annum.

Over the period of 2011 – 2014, the Government of Indonesia has spent IDR 8.7 billion (+ USD 655 million) for forestry projects, development of pre-conditions for REDD+, and carbon stock enhancement namely forest management unit development; development plan for the improvement of forest enterprises; development of environmental services, establishment of forest boundaries; development of social forestry, forest fire control; investigation and forest security; development of protected areas; ecosystems and capacity building; and improvement of forest plantations (MoEF, 2017). Through the MoEF, the Government of Indonesia has allocated approximately IDR 5.9 billion for the implementation of mitigation supporting activities in forestry for the period of 2018-2019.

Meanwhile, the volume of grants received during 2011-2014 from bilateral and multilateral public climate finances, was channelled through the arrangements recognised by UNFCCC and recorded by the country. The total grant was USD 202.1 million1 (Figure 22), although the figure is still far below the financial requirement.

[1] The amount may be underestimated, as not included in this report, are other climate finance such as loan, equity and grants provided by international NGOs that are directly channeled to beneficiaries without being reported to the Ministry of Finance.



Note: data only covers grants.

Source: Ministry of Environment and Forestry and Ministry of Finance.

Figure 22 Approved climate finance in Indonesia during 2011-2014 (in USD million)

8.1.1. Indonesia Climate Change Trust Fund

Since its establishment in 2009, ICCTF has managed USD 21.1 million: USD 11.4 million to conduct 6 large pilot projects and several small projects during its preparation phase (2010-2014) and EUR 4.5 million from GIZ in the form of technical assistance, USD 224,000 from DANIDA, USD 5.3 million from USAID, and USD 4.2 million pledge from the UK's International Climate Fund in the period of 2015-2016. To improve its governance and fiduciary standards, the ICCTF requires further capacity building to be able to channel funding from international climate funds such as Adaptation Fund and Green Climate Fund.

8.1.2. Global Environment Facility

Since 2011, the GoI has received USD 29 million from the GEF, of which USD 4.5 million is to support national communication to the UNFCCC over the period of 2013-2016. The GEF support for national communication has been valuable in improving Indonesia's capacity to conduct monitoring, reporting and verification of GHG emissions and conduct assessments related to climate change adaptation. The project has made achievements despite its limited resources and wide coverage of activities. In parallel with the USD 4.5 million GEF grant and a USD 61,000 UNDP grant, the GoI and the UNDP have both supported the activities in the form of in-kind contributions, jointly performed with some other bilateral grants from GIZ (USD 150,000) and JICA (USD 6.1 million).

Table 4 Number of Activities for GHG emissions Reduction and Budget Realization for RAD-GRK

Sector	2010		2011		2012		TOTAL	
Core Activities								
	Number of Activity	Budget (Billion IDR)	Number of Activity	Budget (Billion IDR)	Number of Activity	Budget (Billion) IDR	Number of Activity	Budget (Billion IDR)
Forestry	150	123	143	150	163	2,701	456	2,974
Agriculture	55	33	101	76	142	43	298	151
Energy	59	70	72	104	78	143	209	317
Transportation	37	62	32	60	37	240	106	362
Waste Management	37	128	209	216	276	589	522	934
TOTAL	338	417	557	606	696	3,716	1,591	4,738
Supporting Activities								
All Sectors	236	80	314	4	249	118	899	4,205

Source: Bappenas (2014a)

Table 5 Budget contribution for emission reduction and indicative costs

Sources of emission reduction	Emission reduction (tCO_2) in 2020	Indicative costs (billion IDR/year)		
		Public	Private	Total
Maintenance of RAN GRK expenditures based on the year 2012	116	16	0	16
Additional expenditure for RAN GRK according to GDP	31	4	0	4
Improvement of budget's effectiveness from the existing expenditures	78	1-2	0	1-2
Emissions from power plants 26% lower, including geothermal	104	15-45	15-45	40-70
Policy to limit deforestation up to 450,000 ha/year	260	1-2	20-30	21-32
Emission reduction needed from new initiative	121	6	11	17
RAN GRK target for forestry, peatland, energy and transportation	710	45-75	45-85	100-140
Emission reductions from agriculture, industry, and waste	57	Is not included in the report		
RAN GRK's total target	767			

Source: Ministry of Finance (2012)

8.1.3. Green Climate Fund

The Fiscal Policy Agency of the Ministry of Finance has been appointed as National Designated Authority (NDA) of Green Climate Fund since early 2016. From 2008 to 2014, a grant totalling to IDR 1.178 trillion was received. This amount is much less than the announced global level at USD249.79 million (eq. IDR3.04 trillion).

This discrepancy may be due to the global announcement by the donor prior to entering an agreement with the GoI. In addition, funding from donours might go directly to non-government organizations without being recorded by the GoI. Indonesia's the Second Technology Needs Assessment (TNA 2012) consisted of Mitigation and Adaptation Reports. Under the Mitigation Report, it was concluded that the Global TNA comprised of the three major contributing sectors, i.e. (1) forestry-including peat, (2) energy, and (3) waste. Following the mitigation TNA, technology prioritisation was listed from which the highest values of technology from each sector were then selected (see Table 6). The identified main constraints for the transfer of technology include the lengthy time that was required to procure components from abroad, and the existing limited monitoring capacity for low carbon technology.

Table 7 below shows examples of assistance received in meeting country-specific technology needs.

The sectoral ministries have identified at least 13 capacity building activities necessary for the implementation of NAMA with the total funding estimation about USD 25 millions (Table 9).

Table 6 List of technology **prioritisation based on** mitigation **TNA**

Sector	Technology Needs
Forestry	1. Technology for measurement and monitoring of carbon sequestration and emission technology 2. Technology for peatland re-mapping 3. Technology for water management
Energy	1. Technology for photovoltaic 2. Technology for efficient electric motor 3. Technology for Mass Rapid Transit (MRT)
Waste (Municipal Solid Waste Treatment)	1. Technology for Mechanical-Biological Treatment 2. In-vessel composting technology and low-solid anaerobic digestion

Source: Republic of Indonesia (2012a)

Table 7 List of technology **prioritisation based on adaptation TNA**

No.	Sector	Technology Needs
1.	**Agriculture**	Crop insurance, food diversification, modification of planting media, crop replanting, development of tolerant varieties, simulation technology, utilisation of superior varieties, forecasting of planting and harvesting time (adjustment of growing season), increasing crop productivity, development of irrigation technology
2.	**Water Resources**	Sea water desalination, water use efficiency, building dams, building new water treatment plant, rehabilitation of damaged watershed, rainwater harvesting, building water storage system, water purchase, protection of water source, deepening wells, water allocation and supply, storage improvement
3.	**Forestry**	Agroforestry system, ecotourism development, environmentally agricultural technology, control of pests and diseases, plant type adjustment
4.	**Urban**	Mitigation disaster, water resources management, yard management, promotion of sustainable development, early warning system, media communication

Table 8 Examples of Technology Supports Received

No.	Country-specific technology needs	Assistance received from developed country parties	Time Frame	Institution
1	• Environmentally friendly: electric car • Renewable Energy Fuel: Bio-diesel • Low budget and environmentally friendly Carbon Capture Storage (CCS)	Asian Development Bank for CCS	2011-2012 2016-2016	Centre For Research and Technology Development of Oil and Gas, Ministry of Energy and Mineral Resources (PPPTMGB LEMIGAS, KESDM)
		World Bank for CCS	2014-2015	
		MHI and JCOAL Japan for CCS	2012-2011	
		UK Government	2013-present	
2	GHG mitigation technology on paddy field and paddy variety	USA; for research on paddy variety, testing of efficient nitrogen fertilizer for paddy field	2014-present	Environmental Research Center, The Ministry of Agriculture
3	Amelioration and fertilizer utilization to improve efficiency and GHG emission reduction	Japan; for research on emission reduction technology with intermittent irrigation method from NIAES.	2013-present	

Table 9 Number of capacity building activities and support needs

Types of capacity building	No. of Activities	Total funding (million USD)	Support required (million USD)
Development of mitigation strategies including supporting regulations	4	18.25	18.25
Application of mitigation technologies	1	2.54	NC
	4	NC	NC
Development and implementation of MRV system	2	4.25	4.25
	2	NC	NC
Total	13	25.04	22.50

Note: NC = Not communicated

List of Tables

List of Figures

Glossary of Abbreviations

ACE : Action for Climate Empowerment
ACM : Agriculture, Construction and Manufacturing
AE : Anode Effect
AFR : Alternative Fuel Resource
AFOLU : Agriculture, Forestry and Other Land Use
AOR : Ammonia Oxidation Reactor
APHI : Asosiasi Pengusaha Hutan Indonesia (Association of Indonesian Forest Concessionaires)
APIFA : Adaptasi Perubahan Iklim Fokus Anak (Climate Change Adaptation Children Focused)
AR : Assessment Report
APIK : Association of Indonesian Climate Change and Forestry Expert
ASM : Australian Summer Monsoon
ATHP : ASEAN Transboundary Haze Pollution
ATTC : Transfer Technology Network
APL : Areal Penggunaan Lain (Non Forest Area)
AWGCC : ASEAN Working Group on Climate Change
BAPPENAS : National Development Planning Agency
BATAMAS : Biogas Asal Ternak Masyarakat (Community Biogas from livestock)
BAU : Business as Usual
BBG : Bahan Bakar Gas (Gas Fuel)
BEF : Biomass Expansion Factor
BINTARI : Yayasan Bina Karya Lestari (Bina Karya Lestari Foundation)
BMKG : Badan Meteorologi Klimatologi dan Geofisika (Meteorological, Climatological and Geophysical Agency)
BOD : Biological Oxygen Demand
BPS : Badan Pusat Statistic (Central Statistics Agency)
BPP : Biaya Pokok Produksi (Cost of Basic Production)
BRT : Bus Rapid Transit
BSM : Boreal Summer Monsoon
BUMN : Badan Usaha Milik Negara (State Owned Company)
BUMD : Badan Usaha Milik Daerah (Provincial Owned Company)
BUR : Biennial Update Report
C4A : Child Centered Climate Change Adaptation
COP : Conference of the Parties
CDM : Clean Development Mechanism
CCT : Clean Coal Technology
CPO : Crude Palm Oil
CCVIA : Climate Change Vulnerability, Impacts, and Adaptation
CCA : Climate Change Adaptation
CCA : Canonical Correlation Analysis
CDD : Cooling Degree Day
CHIRPS : Climate Hazards Group Infra Red Precipitation with Station
CM : Climate Model
CMAP : CPC Merged Analysis of Precipitation
CMIP : Coupled Model Inter Comparison Project
COREMAP : Coral Reef Rehabilitation and Management Program
CRCD : Coordinated Regional Climate Downscaling
CRU : Climatic Research Unit
CSR : Corporate Social Responsibility
CTI : Coral Triangle Initiative
CTU : Clarity Transparency and Understanding
CWD : Consecutive Wet Days
DEN : Dewan Energi Nasional (National Energy Council)
DDPP : Deep Decarbonization Pathway Project
DIDAH : Digitisasi Data Historis (Historical Data Digitation)
DHF : Dengue Hemorrhagic Fever
DJF : December January February
DME : Desa Mandiri Energi (Self-Sufficient Village)
DOC : Degradable Organic Carbon
DRR : Disaster Risk Reduction

DTR : Diurnal Temperature Range
EBT : Energi Baru Terbarukan (Renewable Energy)
EF : Emission Factor
EEZ : Exclusive Economic Zone
ENSO : El Niño Southern Oscillation
ESCO : Energy Service Company
ESGF : Earth System Grid Federation
ETCCDI : Expert Team on Climate Change Detection and Indices
EWARS : Early Warning System
EWORS : Early Warning Outbreak Recognition System
FLENS : Forest Law Enforcement National Strategy
FREL : Forest Reference Emission Level
FOD : First Order Decay
FORM-KOMTEK : Engineering Communication Forum on Oil and Gas
GCF : Green Climate Fund
GEF : Global Environment Facility
GCM : General Circulation Model
GCMs : Global Climate Models
GDP : Gross Domestic Product
GHG : Green House Gas
Gg : Giga Gram
GOI : Government of Indonesia
GWP : Global Warming Potential
HEESI : Handbook of Energy and Economic Statistic of Indonesia
HD : Hutan Desa (Village Forest)
HK : Hutan Konservasi (Conservation Forest)
HKM : Hutan Kemasyarakatan (Community-based Forest)
HPHD : Hak Pengelolaan Hutan Desa (Village Forests Management Right)
HP : Hutan Produksi (Production Forest)
HPHH : Hak Pengusahaan Hasil Hutan (Forest Exploitation Right)
HPK : Hutan Produksi Konversi (Conversion Production Forest)
HPT : Hutan Produksi Terbatas (Limited Forest Production)
HL : Hutan Lindung (Protected Forest)
HTI : Hutan Tanaman Industri (Industrial Timber Plantation Forest)
HTR : Hutan Tanaman Rakyat (Community Based Plantation Forest)
ICCSR : Indonesia Climate Change Roadmap
ICCTF : Indonesia Climate Change Trust Fund
ICLEI : Local Government for Sustainability
IGES : Institute for Global Environmental Strategies
IIF : Indonesia Infrastructure Finance
IKE : Intensitas Konsumsi Energi (Intensity of Energy Consumption)
INDC : Intended Nationally Determined Contribution
IOD : Indian Ocean Dipole
IPAL : Instalasi Pengolahan Air Limbah (Waste Water Treatment Plant)
IPCC : Intergovernmental Panel on Cimate Change
IPLT : Instalasi Pengolahan Limbah Tinja (Septage Treatment Plant)
IPPU : Industrial Process and Product Use
ISVs : Intraseasonal Variabilities
ITCZ : Inter-Tropical Convergence Zone
ITS : Intelligent Transport System
IUP HKM : Izin Usaha Pengelolaan Hutan Kemasyarakatan (Forest Timber Utilization Permit for Community Forest)
IUPHHK HTI : Izin Usaha Pemanfaatan Hasil Hutan Kayu Hutan Tanaman Industri (Forest Timber Utilization Permit for Industrial Timber Plantation Forest)
IUPHHK HTR : Izin Usaha Pemanfaatan Hasil Hutan Kayu Hutan Tanaman Rakyat (Forest Timber Utilization Permit for Community-Based Plantation)
IUPHHK RE : Izin Usaha Pemanfaatan Hasil Hutan Kayu Restorasi Ekosistem (Ecosystem Restoration Forest Timber Utilization Permit)
JJA : June through August
JICA : Japan International Cooperation Agency
LAPAN : National Space Agency
LCD : Low Carbon Development
LCGC : Low Cost and Green Car
LCT : Low Carbon Technology
LPG : Liquid Petroleum Gas
LUCF : Lad Use Change and Forestry
MAI : Mean Annual Increment
MAM : March April May

MASKEEI	:	Efficiency Society or Masyarakat Konversi dan Efisiensi Energi Indonesia
MEMR	:	Ministry of Energy and Mineral Resources
MCF	:	Methane Correction Factor
METI	:	Masyarakat Energi Terbarukan Indonesia (Indonesian Renewable Energy Society)
MITI	:	Masyarakat Ilmuan dan Teknologi Indonesia (Indonesia's Science and Technology Community)
MJO	:	Madden-Julian Oscillation
MRI	:	Meteorological Research Institute
MoFOR	:	Ministry of Forestry
MoI	:	Ministry of Industry
MoT	:	Ministry of Transport
MoPW	:	Ministry of Public Works
MRT	:	Mass Rapid Transport
MRV	:	Measurement Reporting, and Verification
MSW	:	Municipal Solid Waste
NAMAs	:	Nationally Appropriate Mitigation Actions
NAMAs SSLI	:	NAMAs Smart Street Lighting Initiative
NAMAs Sutri	:	NAMAs Sustainable Urban Transport Program Indonesia
NAP-CCA	:	National Action Plan on Climate Change Adaptation
NCCC	:	National Council on Climate Change
NDA	:	National Designated Authority
NDC	:	Nationally Determined Contribution
NFP	:	National Focal Point
NGOs	:	Non Governmental Organizations
NTP	:	Nilai Tukar Petani (Farmer Exchange Rate)
OSEC	:	Ocean South Equatorial Current
OTIS	:	Ocean Tidal Inverse Solution
PA	:	Paris Agreement
PDO	:	Pacific Decadal Oscillation
PERHIMPI	:	Perhimpunan Meteorologi Pertanian Indonesia (Association of Indonesia Agriculture Meteorology)
PIT ASEAN	:	Promoting Innovation and Technology-ASEAN
PKS	:	Perkebunan Kelapa Sawit (Palm Oil Plantation)
PKO	:	Palm Kernel Oil
PLN	:	Perusahaan Listrik Negara (State Electricity Company)
PLTA	:	Pembangkit Listrik Tenaga Air (Hydro Power Plant)
PLTMH	:	Pembangkit Listrik Tenaga Mikro Hidro (Mycro Hydro Power Plant)
PLTS	:	Pembangkit Listrik Tenaga Surya (Solar Power Plant)
PLTP	:	Pembangkit Listrik Tenaga Panas Bumi (Geothermal Power Plant)
PLTU	:	Pembangkit Listrik Tenaga Uap (Steam Power Plant)
PMA	:	Penanaman Modal Asing (Foreign Investment)
PMDN	:	Penanaman Modal Dalam Negeri (Domestic Investment)
POME	:	Palm oil mill effluent
PROKLIM	:	Program Kampung Iklim (Climate Village)
RAN-PI	:	Rencana Aksi Nasional Perubahan Ikli (National Action Plan on Climate Change)
RCP	:	Representative Concentration Pathways
REDD+	:	Reducing Emissions from Deforestation and forest Degradation
RIBASIM	:	River Basin Simulation Model
RSO	:	Research and Systematic Observation
ROMS	:	Regional Ocean Modeling Systems
RPJMN	:	Mid-Term Development Plan
RUPTL	:	Rencana Usaha Penyediaan Tenaga Listrik (Electricity Supply Business Plan)
RUKN	:	Rencana Umum Ketenagalistrikan Nasional (National Electricity General Plan)
SACA&D	:	Southeast Asia Climate Assessment and Dataset
SBNP	:	Sarana Bantu Navigasi Pelayaran (Sailing Navigation Supporting Facilities)
SEACLID	:	Southeast Regional Climate Downscaling
SDSN	:	Sustainable Development Solution Network
SFF	:	Study and Specialist Fund
SLI	:	Sekolah Lapang Iklim (Climate Field School)

SLPTT	:	Sekolah Lapangan Pengelolaan Lapangan Terpadu (Field School of Integrated Field Management)
SST	:	Sea Surface Temperature
SMI	:	Sarana Multi Infrastruktur
SNC	:	Second National Communication
SNI	:	Standard Nasional Indonesia (Indonesia National Standard)
SRI	:	System of Rice Indonesia
SSS	:	Sea Surface Salinity
SON	:	September through November
SWD	:	Surface Water Dominated
TGHK	:	Tata Guna Hutan Kesepakatan (Forest Land Use by Consensus)
TIC	:	Traffic Impact Control
TNA	:	Technology Needs Assessment
TNC	:	Third National Communication
TOE	:	Ton of Oil Equivalent
TOT	:	Training of Trainer
TSU	:	Technical Support Unit
TPA	:	Tempat Pemrosesan Akhir (Field Processing Site)
UASB	:	Unaerobic Sludge Blanket
UEA CRU	:	University of East Anglia Climate Research Unit
UNEP	:	United Nations Environment Programme
UNFCCC	:	United Nations Framework on Climate Change Convention
UNFPA	:	United Nations Population Fund
UNICEF	:	United Nations Children's Fund
UNGEGN	:	United Nations Groups of Experts on Geographical Names
UPPO	:	Unclaimed Property Profesionals Organization
WBSCD	:	World Business Council for Sustainable Development
WCRP	:	World Climate Research Programme
WHO	:	World Health Organization
WKP	:	Wilayah Kerja Pertambangan (Mining Work Area)

Source/Location: Directorate of Mitigation MOEF/Protected Forest at Desa Merek, Kab. Tanah Karo, Province of North Sumatera

Chapter 1

INTRODUCTION

1.1 Indonesia as a Part of Global Climate Change Society

Indonesia is one of the largest archipelagic countries in the world and it lies along the Equator. Indonesia geological and geographical conditions increase its vulnerability to the adverse effects of climate change, such as severe floods and droughts, affecting the agriculture sector as well as other livelihood sectors. Awareness of these effects has encouraged Indonesia to participate in the global community efforts in combating and controlling global temperature rise.

Indonesia ratified the United Nations Framework Convention on Climate Change (UNFCCC) through Act No. 6 of 1994 concerning the Ratification of United Nations Framework Convention on Climate Change. Upon ratifying the Convention, Indonesia is a party to the Convention and is bound to all the responsibilities attached and is entitle to the opportunity of receiving supports to achieve the objectives of the Convention. As a non-Annex I party, despite not having obligation to reduce its GHG emission level, Indonesia is taking part in the effort to stabilise GHG concentration and reports the main sources of GHG emission and climate-change related activities to the UNFCCC.

Indonesia has also ratified the Kyoto Protocol through Act No. 17 of 2004 on the Ratification of Kyoto Protocol to the United Nations Framework Convention on Climate Change. Indonesia has adopted the Doha Amendment to the Kyoto Protocol on 6 August 2014 and submitted it to the UNFCCC Secretariat on 30 September 2014.

The Indonesian Minister of Environment and Forestry signed the Paris Agreement during the High Level Signature Ceremony of Paris Agreement in New York on 22 April 2016. On October 24 2016, Indonesia ratified the Paris Agreement through Act No.16 of 2016 concerning the Ratification of Paris Agreement to the UNFCCC.

1.2 Policy Framework

Prior to the COP 13 in Bali, the Ministry of Environment in December 2007 had issued the National Action Plan on Climate Change (RAN-PI), describing the climate change policies and short-medium-long term climate change programmes. This document was further refined by the National Development and Planning Agency (Bappenas) and produced into the "National Development Planning: Indonesia responses to climate change", also known as the 'Yellow Book'. In 2010, Bappenas developed a policy framework for climate change, i.e., Indonesia Climate Change Roadmap (ICCSR), which laid down the principles, approaches and priorities to mainstream climate change adaptation and mitigation into development planning. This was to bridge the National Action Plan on Climate Change into a 5 year Mid-Term Development Plan (RPJMN) for 2010-2014, and to provide inputs for the subsequent RPJMN until 2030.

With regard to climate change mitigation, Government of Indonesia (GoI) has formulated the target to reduce GHG emissions voluntarily and enhanced its capacity towards sustainable development, starting with the President's statement during the G-20 Summit in September 2009 and later reiterated at the COP-15 December 2009, that by 2020 Indonesia will reduce its GHG emissions by 26 percent unilaterally and up to 41 percent with international support, as compared to Business as Usual baseline. Following this statement, GoI has issued Presidential Decree No. 61/2011 on National Action Plan for GHG Emission Reduction (RAN-GRK), which provides the work plan for the implementation of direct and indirect activities related to GHG emission reduction. RAN-GRK serves as a (i) guidance to line ministries in planning, implementing, monitoring, and evaluating the national action plan on GHG emission reduction; (ii) guidance to provincial governments in formulating egional action plan for reducing GHG emission (RAD GRK), and (iii) reference to community and private sector in planning and implementing GHG emission reduction.

To achieve the emission reduction target, GoI will prioritize the efforts to reduce the emissions from land use change and forestry (LUCF) and peatland. As this sectorswill play a pivotal role in reducing GHG emissions, a national strategy for reducing emissions from deforestation and degradation and the role of forest conservation, sustainable forest management and sink enhancement (REDD+) has also been developed.

Prior to the UNFCCC COP-21/CMP-11 in Paris, Indonesia has submitted the Intended Nationally Determined Contributions (INDC) to the Secretariat UNFCCC on September 24 of 2015. The INDC was then reformulated into the First of Nationally Determined Contribution (NDC) in October 2, 2016 along with the ratification of the Paris Agreement.

Alongside a historic milestone of adopting the Paris Agreement, Member States of the United Nations defined their visions for the post-2015 development agenda, called the 2030 Agenda for Sustainable Development, by agreeing upon a set of Sustainable Development Goals (SDGs). One of the goals is targeted to "take urgent action to combat climate change and its impacts". Indonesia has certainly recognized the essential relationship between the two instruments, i.e., must be mutually supportive, interrelated and complementary in the implementation.

Source/Location: Directorate of Mitigation MOEF/Electronic Industry, Batam, Kep. Riau

Chapter 2

NATIONAL CIRCUMSTANCES AND INSTITUTIONAL ARRANGEMENT

2.1 National Circumstances

2.1.1 Geography

Indonesia is located between 7°44'35.11" North latitude and 13°55'59.99" South latitude, and stretches from 91°38'25.55"West longitude to 144°24'00" East longitude. It lies between the Pacific and the Indian Oceans and bridges two continents: Asia and Australia (Geospatial Information Agency of Indonesia, BIG, 2015). The country covers a total of approximately 820 million hectares (ha), with a total coastline length of about 95,181 km (Statistics Indonesia, BPS, 2014) and land territory of about 200 million ha. It consists of approximately 13,466 islands[1],of which only six thousands are inhabited, including the five main Islands of Sumatera, Java, Kalimantan, Sulawesi and Papua. Of the 200 million ha of land territory, the four largest land cover types are Lowland Forest with nearly 42 million ha (accounted for 22.58% of the National Land Cover) (Geospatial Information Agency of Indonesia, BIG, 2014), Upland Forest, Shrub, and Seasonal Crop on Dry Land. Administratively, since 2013, the Republic of Indonesia is divided into 34 provinces as shown in Figure 2.1.

[1] Based on Inventory of the National Team for Standardization Topographic Name. This number has been registered at the United Nations through the United Nations Groups of Experts on Geographical Names (UNGEGN) in 2012.Indonesia is planning to revise and update the data in 2017, based on the latest inventory (source: BIG, 2017).

2.1.2 Climate

Monsoon dominates Indonesia's climate, which give a degree of homogeneity across the region. Indonesia lies across the range of the Inter-Tropical Convergence Zone (ITCZ) where the northeast and southeast trade winds penetrate the doldrums. Strong ascending motion, overcast skies, strong squalls, heavy rainfall and severe local thunderstorms with variable intensities are characteristics of this zone.

Source: Geospatial Information Agency of Indonesia, BIG, 2014)

Figure 2.1 Map of Indonesia

There are three types of rainfall pattern in Indonesia (Boerema, 1938; Aldrian and Sutanto, 2003; Tjasjono, 2004; Figure 2.2), i.e.:

1. Monsoon rainfall with a monthly rainfall peak in December;
2. Equatorial rainfall characterized by two monthly rainfall peaks, in March and October; and
3. Localized rainfall pattern in the eastern equatorial part of the country with a monthly rainfall peak in July-August.

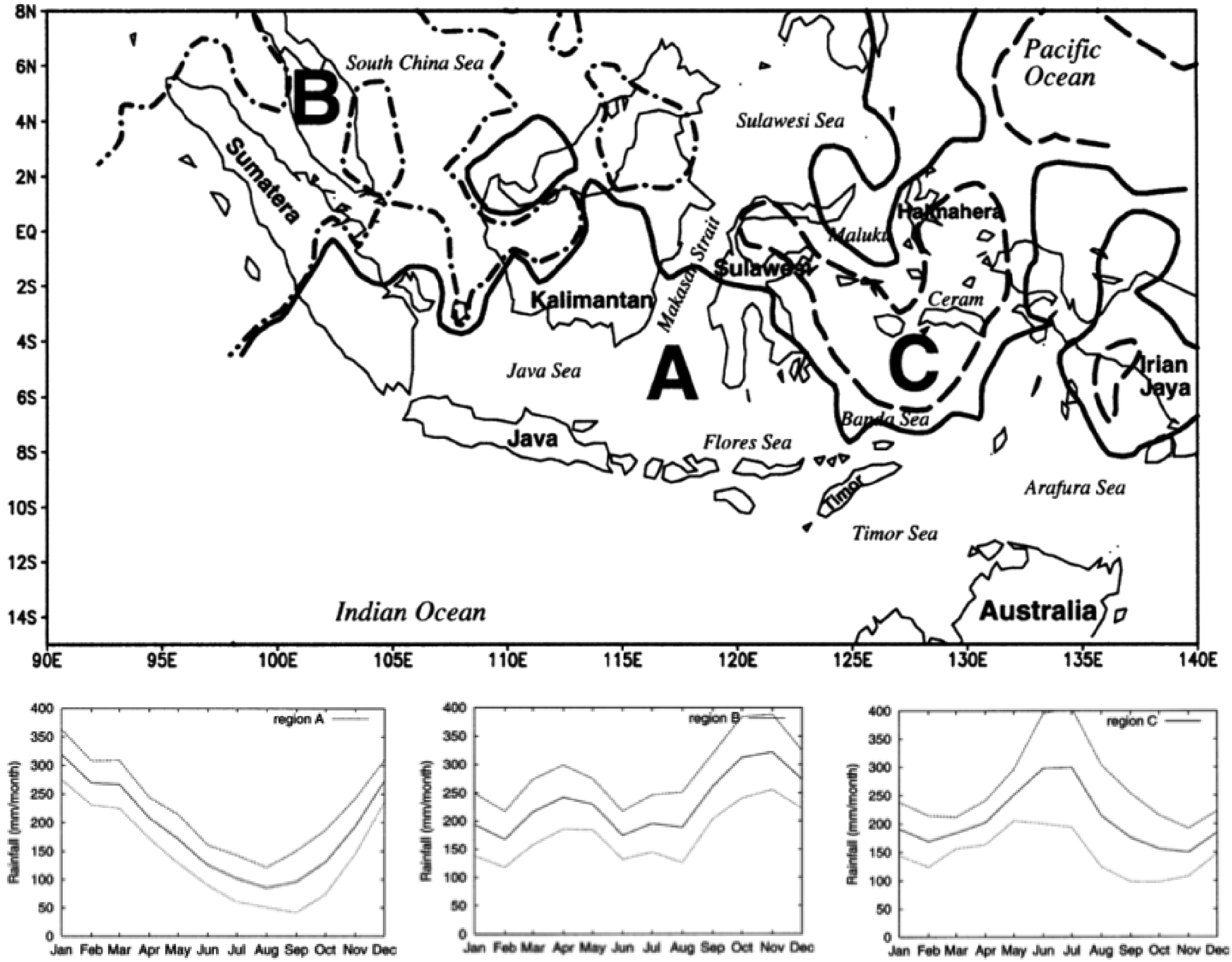
Overall, these three types of rainfall have resulted in a wet season that varies in length from as long as 280 to 300 days to as short as 10 to 110 days, with rainfall varying from 4,115 mm to as low as 640 mm.

Rainfall variability in Indonesia is influenced by many large-scale climate phenomena, one of them is El Niño Southern Oscillation (ENSO). Various studies on the influence of ENSO on inter-annual rainfall variability in Indonesia[2] reveal the following seasonal patterns:

1. The end of the dry season occurs later than normal during El Niño and earlier during La Niña years,
2. The onset of the wet season is delayed during El Niño and advanced during La Niña years,
3. A significant reduction of dry season rainfall could be expected during El Niño and a significant increase during La Niña years,
4. Long dry spells occur in the monsoon period, particularly in Eastern Indonesia.

ENSO is one of the natural phenomena that resulted in devastating consequences on climate and often evoking disasters. In Indonesia, El Nino is often associated to drought and La Nina to floods. Of the total 43 drought events occurred over the period of 1844-1998, only six events were not associated with El Nino (Quinn

[2] e.g. Yoshino *et al*., 2000; Kirono and Partridge, 2002; Aldrian and Susanto, 2003



Source: Aldrian and Sutanto (2003).

Figure 2.2 **Three main rainfall regions of Indonesia (A in solid line, B in short dashed line and C in long dashed line) and the annual cycles of rainfall (solid lines; dashed lines indicates one standard deviation above and below average)**

et al., 1978; ADB and BAPPENAS, 1999; Boer and Subbiah, 2005).

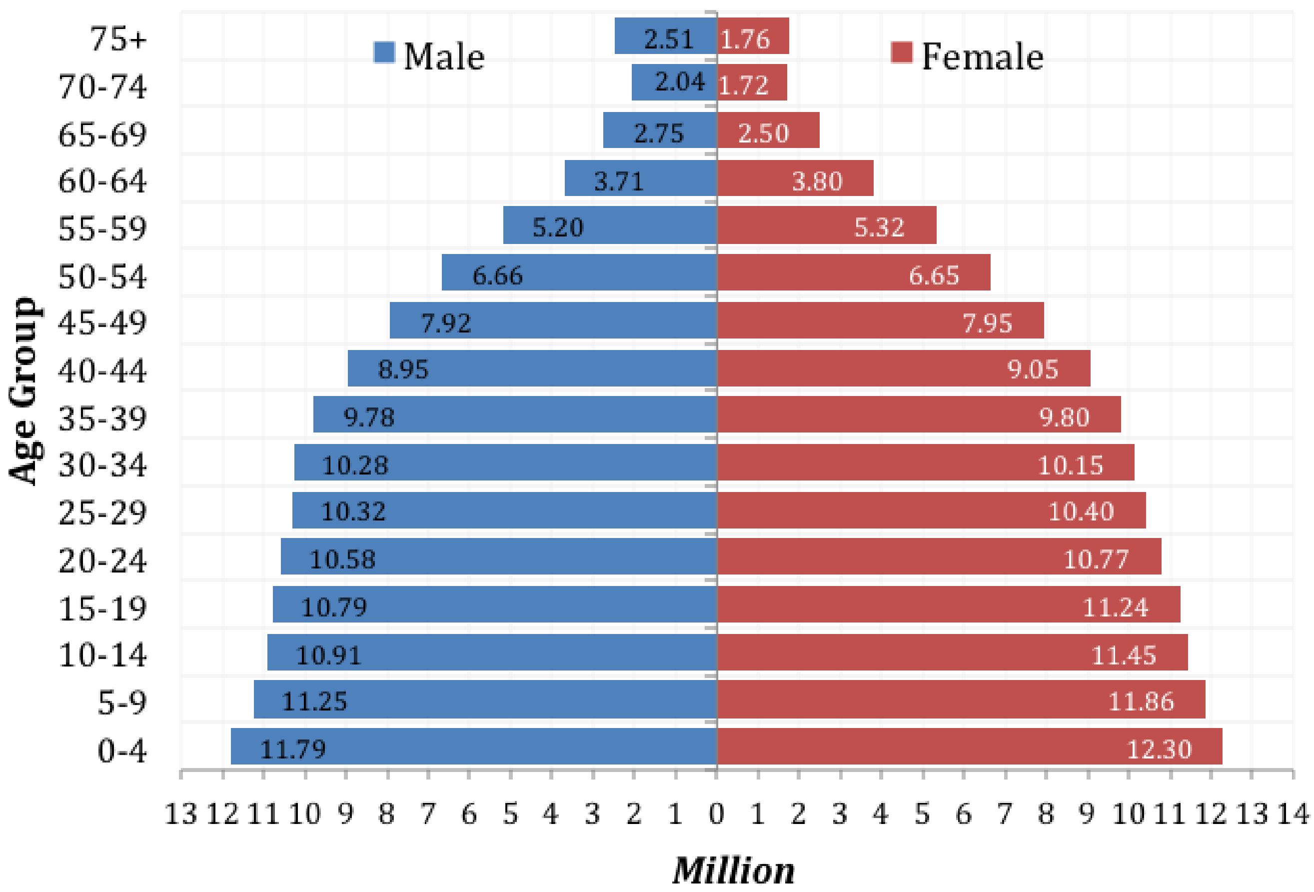
Moreover, El Nino is considered as one of the overriding control factors in major forest/land fire and haze occurrence and frequency. Outbreaks of crop pests and diseases as well as human vector-borne diseases are often reportedly connected with these phenomena (Gagnon et al., 2001 Hopp and Foley, 2003). Economic losses due to climate hazards tend to increase (Boer and Perdinan, 2008). In 2016, the economic loss due to floods and land/forest fires reached USD 2.5 billion. Based on the estimation of National Agency for Disaster Management (BNPB), the cost required for the rehabilitation of infrastructural damages due to floods occurred in 2016, reached USD 275 million.

2.1.3 Population

Over the past four decades, Indonesia's population has been continuously increasing from 119.21 million in 1971, to 252.16 million in 2014 (Statistics Indonesia, 2015: 76). However, its annual growth rate appeared to be decreasing from 1.98% (1980-1990) to 1.38% (2010-2015) (BPS, Bappenas and UNFPA, 2014). The population is projected to reach an estimation of 305 million by 2035 (BPS, Bappenas and UNFPA, 2013: 24).

There is a tendency that distribution of the population follows the trend in the distribution of the country's economic activity that is concentrated in the western part of Indonesia, i.e. on the Islands of Java and Sumatera. In 2014, around 56.93% (more than 140 million) of the population were living in the Island of Java, of which half inhabited the urban areas. Provinces with more than 50% of their inhabitants living in urban areas are DKI Jakarta (100%), Kepulauan Riau (83%), Banten, Yogyakarta, West Java, and Bali (more than 60%).

Based on age composition, population below the age of 45 dominates (Figure 2.3) (BPS, Bappenas and UNFPA, 2013).



Source: BPS, Bappenas and UNFPA, 2014

Figure 2.3 Indonesian Population Pyramid 2014

2.1.4 Economic and Social Development

Life expectancy in Indonesia has improved significantly in the past four decades, from only 47.9 years in 1970 to 70.6 years in 2014 (BPS, 2015). In education sector, as the result of sustained efforts, adult literacy has increased significantly from only 79% in 1970 to 95.9% in 2014 (BPS, 2015: 2).

Following the successful recovery after experiencing social and economical crisis in 1998-1999, Indonesia has been showing a steadily increasing trend in alleviating poverty. In 2005, the number of people living in absolute poverty declined from 47.97 million people in 1999 to 35.10 million people (BPS, 2015:175), while people living in relative poverty declined from 23.43% in 1999 to 15.97% in 2005. The number of people living in poverty increased slightly in 2006 due to fuel price increased but since then the number continued to decline until 2014 (Table 2.1). Between the periods of 2006-2014, the number of people living in poverty dropped as much as 11.02 million, from 39.30 million in 2006 to 28.28 million in March 2014. By the end of 2014, the number of poor people totalled to about 27.7 million (11% of the population) (BPS, 2015).

The employment rate of Indonesian workforce has been improving for the past 8 years. Though the unemployment rate is still relatively high, it has been decreasing from about 10% in 2004 to be around 5.9% in 2014 (BPS, 2015).

During the period of 2010 – 2014, population structural shift from Agriculture, Forestry, and Fishery sectors to other economic sectors, has become apparent and reflected in the share of each sector to GDP. In 2014, Manufacturing sector has become the major contributor to GDP, followed by Wholesale and Retail Trade sector; Repair of Motor Vehicles and Motorcycle sector, Agriculture, Forestry, and Fishery sectors, Construction, and Mining and Quarrying Industry (Table 2.2), while other sectors accounted for less than 5 percent (BPS, 2016).

In 2013, Indonesia's GDP was IDR 9,084 trillion (±USD 745 billion), which was much higher than the 2004 value at IDR 2,300 trillion (±USD 248 billion). In terms of per capita, the GDP grew from IDR 10.5 million in 2004 (USD 1,132) to IDR 36.5 million (USD 2,994) in 2013. Table 2.3 shows the development of Indonesia's GDP in current price as well as constant price in 2000. For the past ten years, the national

Table 2.1 Indonesian poverty and inequality statistics during March 2004-2014

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Relative Poverty (% of population) [1]	16.7	16.0	17.8	16.6	15.4	14.2	13.3	12.5	12.0	11.4	11.2
Absolute Poverty (in millions) [1]	36.2	35.1	39.3	37.2	35.0	32.5	31.0	30.0	29.1	28.1	28.3
Gini Coefficient (Gini Ratio)	-	0.363	-	0.364	0.350	0.370	0.380	0.410	0.410	0.410	0.410

Source: BPS, 2015

Table 2.2 Development of Indonesian GDP and Exchange Rate

	2006	2007	2008	2009	2010	2011	2012	2013	2014
GDP in trillion IDR (current price)	3.339	3.951	4.949	5.606	6.864	7.832	8.616	9.546	10.566
GDP/cap in million IDR (current price)	15,0	17,4	21,4	23,9	28,8	32,4	35,1	38,4	41,9
GDP (constant price 2010), in trillion IDR (constant price 2010)					6.864	7.288	7.727	8.156	8.566
GDP/cap in million IDR (constant price 2010)					28,8	30,1	31,5	32,8	34,0
GDP Growth (%)	5,5	6,3	6,0	4,6	6,2	6,2	6,0	5,6	5,0
Exchange rate, (000 IDR/USD)									

Source: BPS, 2016

Table 2.3 Share of GDP by Sector, 2010-2014 (in percent)

No.	Sector	2010	2011	2012	2013	2014
1	Agriculture, Forestry and Fishery	13.93	13.51	13.37	13.36	13.34
2	Mining and Quarrying	10.46	11.81	11.61	11.01	9.87
3	Manufacturing	22.04	21.76	21.45	21.03	21.01
4	Electricity and Gas	1.06	1.17	1.11	1.03	1.08
5	Water Supply, Sewerage, Waste Management and Remediation Activities	0.09	0.08	0.08	0.08	0.07
6	Construction	9.13	9.09	9.35	9.49	9.86
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	13.46	13.61	13.21	13.21	13.44
8	Transportation and Storage	3.57	3.53	3.63	3.93	4.42
9	Accommodation and Food Service Activities	2.92	2.86	2.93	3.03	3.04
10	Information and Communication	3.73	3.6	3.61	3.57	3.50
11	Financial and Insurance Activities	3.49	3.46	3.72	3.88	3.87
12	Real Estate Activities	2.89	2.79	2.76	2.77	2.79
13	Business Activities	1.44	1.46	1.48	1.51	1.57
14	Public Administration and Defence; Compulsory Social Security	3.78	3.89	3.95	3.90	3.83
15	Education	2.94	2.97	3.14	3.22	3.24
16	Human Health and Social Work Activities	0.97	0.98	1.00	1.01	1.03
17	Other Service	1.47	1.44	1.42	1.47	1.55
	Gross value added at basic price	**97,37**	**98.01**	**97.84**	**97.51**	**97.51**
	Taxes less subsidies on products	**2,63**	**1.99**	**2.16**	**2.49**	**2.49**
	Gross domestic products	**100**	**100**	**100**	**100**	**100**

Source: BPS, 2016

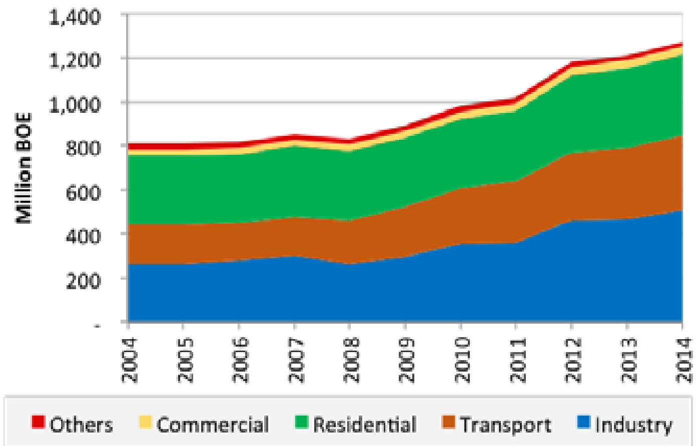
economy has been growing with varying annual growth rates from 4.6% to 6.5%. The RPJMN 2015-2019 has set the annual economic growth target of 6% - 8% within the next five years.

2.2 Sectoral Conditions

2.2.1 Energy Sector

Indonesia's energy supply comes from the exploitation of its wide range of energy resource endowments (Table 2.4) and from fuel imports, especially oil. Energy resource exploitation also generates government revenues from sales, to domestic and export markets through royalties and taxes (Ministry of Energy and Mineral Resources of Indonesia, MEMR, 2016).

The final energy consumption has been growing in line with the economic and population growth. Between 2004 and 2014, the total final energy demand grew by an average of 4.6% annually, from 813 million to 1,273 million BOE. Industrial, residential and transport sectors dominate the final energy consumption (Figure 2.4). High consumption growth also occurred in industry (6.8%), transport (6.5% per year) and commercial (4.1% per year) sectors, which was much higher than that of residential sector (1.6% per year).



Source: MEMR, 2015

Figure 2.4 Development of final energy demand (including biomass) by sector

By fuel type (Figure 2.5), crude oil still dominates the energy demand (accounted to about 30.8% of the total consumption), followed by biomass (20.7%), coal (17.3%), natural gas (13.5%) and electricity (9.6%). Most of the biomass consumptions occurred

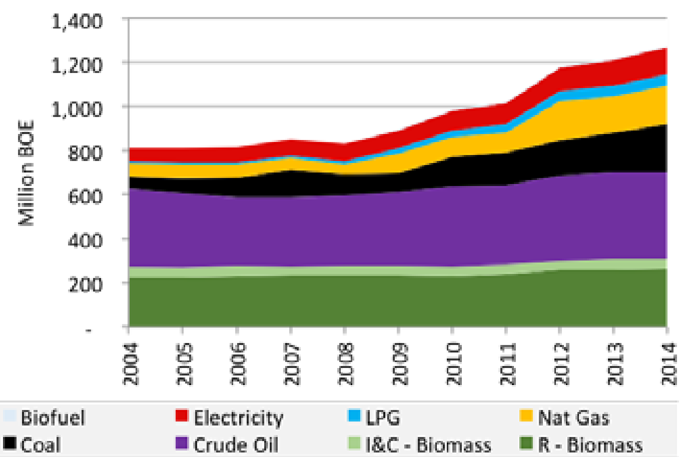
Table 2.4 Indonesia's Energy Resources in 2014

Energy Resource	Reserve	Resource
Oil, billion barrels	7.4	
Natural gas, TSCF*	149	
Coal, billion tons	32	125
Coal Bed Methane, TSCF*		457
Shale gas, TSCF*		574
Potential power		
Hydro	75 GW	
Geothermal	29 GW	
Micro-hydro	750 MW	
Biomass	32.6 GW	
Solar	4.80 kWh/m²/day	
Ocean Energy**	47.8 GW	
Wind	970 MW	

Source: MEMR, 2016; Directorate General for New Renewable Energy and Energy Conservation, MEMR 2014; 2013

particularly in rural residential sector over other users, which include agro industry, small and medium industries, and commercial sectors (restaurants). LPG (18.9% per year), coal (14.8% per year), natural gas (11.0%) and electricity (7.1% per year) have also shown high growths of final energy demand.

The high growth in LPG demand was due to the government policy that replaces the subsidy for kerosene to LPG, for residential sector. Coal consumption as a final energy, was used solely in industrial sector. The high growth in coal consumption was due to the removal of industrial diesel subsidy, forcing the industries to switch from diesel to coal.



R-Biomass: Residential biomass; I&C-Biomass: Industrial & Commercial Biomass
Source: *MEMR, 2015*

Figure 2.5 **Development of final energy demand by fuel type**

From 2004 to 2014, the primary energy supply grew at an average rate of 4.4% per annum, from 1,144 million to 1,767 million BOE. As shown in Figure 2.6, oil dominates the primary energy supply, followed by coal and natural gas. From the time of the declining domestic oil production capacity, for energy security reasons, the government has been attempting to move away from oil by promoting energy that are abundantly available in the country i.e. coal, natural gas and renewable energy. These attempts have resulted in high growth of coal supply (12.6% per year), much higher than growth of oil (2.4% per year) and natural gas (3.8% per year). These growths have resulted in decreased oil share in supply mix, from 43.5% in 2004 to 35.6% in 2014, and increased coal share, from 13.2% in 2004 to 28.2% in 2014.

About 10% of the final energy consumption was in the form of electricity. Between the years of 2004 and 2014, the electricity demands grew at an average rate of 7.1%, from 117 TWh in 2004 to 228 TWh in 2014. The electricity consumption was supplied by 53 GW power plant in 2014, an increase from 23 GW in 2001, which translated to average annual growth of around 7% per annum. Indonesia's electricity is generated using fossil fuels (coal, natural gas, crude oil) and renewable energy sources (hydropower, geothermal, and other R.E: solar PV, wind).

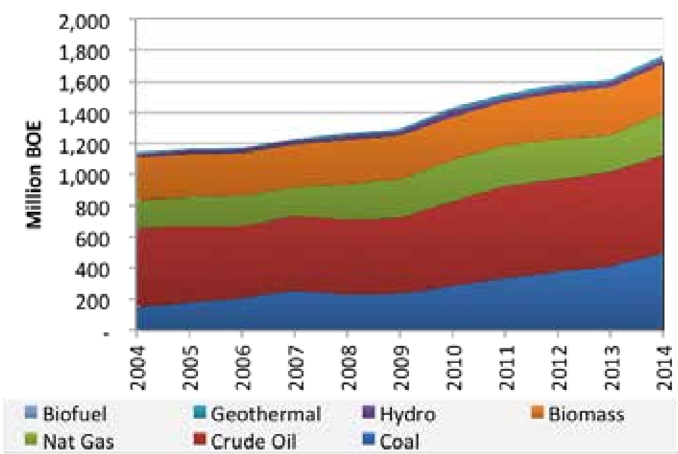
Figure 2.7 shows the development of power generation by types of energy sources. In the past decade, the electricity generation that have experienced high annual growths were geothermal (12.3%) and coal (9.6%). The high growth rate of coal plant had pushed the share of coal in the power generation mix to increase from 41.3% in 2004 to 52.7% in 2014. Despite the high growth, the share of geothermal in power mix was still small, i.e. 4.4% in 2014. Overall, renewable fuel accounted to about 11% of the total electricity generation in 2014.

2.2.2 Industrial Sector

As previously mentioned, industrial sector in particular manufacturing industry, has been shown to play an important role in Indonesian economy. Since the past decades, this sector has contributed to around 40% - 46% of the GDP formation. The most important industrial sub-sectors are mining and non-oil and gas manufacturing, which together account for about 31% of Indonesia's GDP (BPS, 2016: 592-594; 2015: 579-581). Table 2.5 shows the development of industrial manufacturing production of non-oil and gas in 2000-2014.

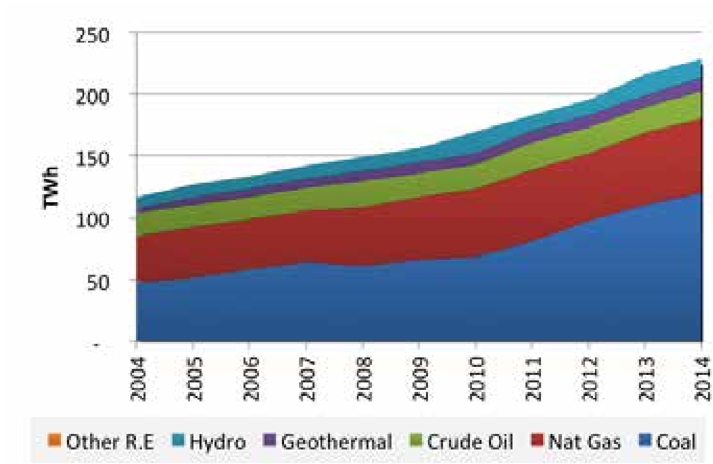
2.2.3 Forestry Sector

Indonesia lies along the Equator and blessed with rich and extensive tropical forests. The forests are also rich in biodiversity, with more than 1,077 species of algae, 91,251 species of plants and more than 19,000 of spermatophyte. As for fauna, Indonesia is home for 3,982 species of vertebrates, more than 150,000 species of insects that contribute to



Source: *MEMR, 2015*

Figure 2.6 Development of primary energy supply



Source: *MEMR, 2015*

Figure 2.7 Development of power generation mix

Table 2.5 Non-oil & gas manufacturing industry growth per sector 2010 – 2014 (in Percent)

No.	Manufacturing Industry Sector	2010	2011	2012	2013	2014
1	Food, Beverages, and Tobacco	2.78	9.14	7.57	3.34	8.80
2	Textile, Leather Products, and Footwear	1.77	7.52	4.27	6.06	3.54
3	Wood and Other Products	-3.47	0.35	-3.14	6.18	7.27
4	Paper and Printing Products	1.67	1.40	-4.75	4.45	5.12
5	Fertilizer, Chemical, and Rubber Products	4.70	3.95	10.50	2.21	1.05
6	Cement and Non-Metallic Quarry Products	2.18	7.19	7.80	3.00	1.20
7	Iron and Steel Basic Metal	2.38	13.06	5.86	6.93	3.13
8	Transport Equipment, Machinery and Apparatus	10.38	6.81	7.03	10.54	4.70
9	Other Manufacturing Products	3.00	1.82	-1.13	-0.70	10.77
	Non Oil & Gas Manufacturing Industry	**5.12**	**6.74**	**6.42**	**6.10**	**5.30**
	National GDP	**6.22**	**6.49**	**6.26**	**5.78**	**5.11**

Source: *BPS, 2015*

11% of the world's insects, and 30,000 species of hymenoptera that account for 20% of the world species. Such conditions have made Indonesia as one of the mega-biodiversity countries in the world (Bappenas, Ministry of Environment and Forestry-MoEF and Indonesian Institute of Science, 2016).

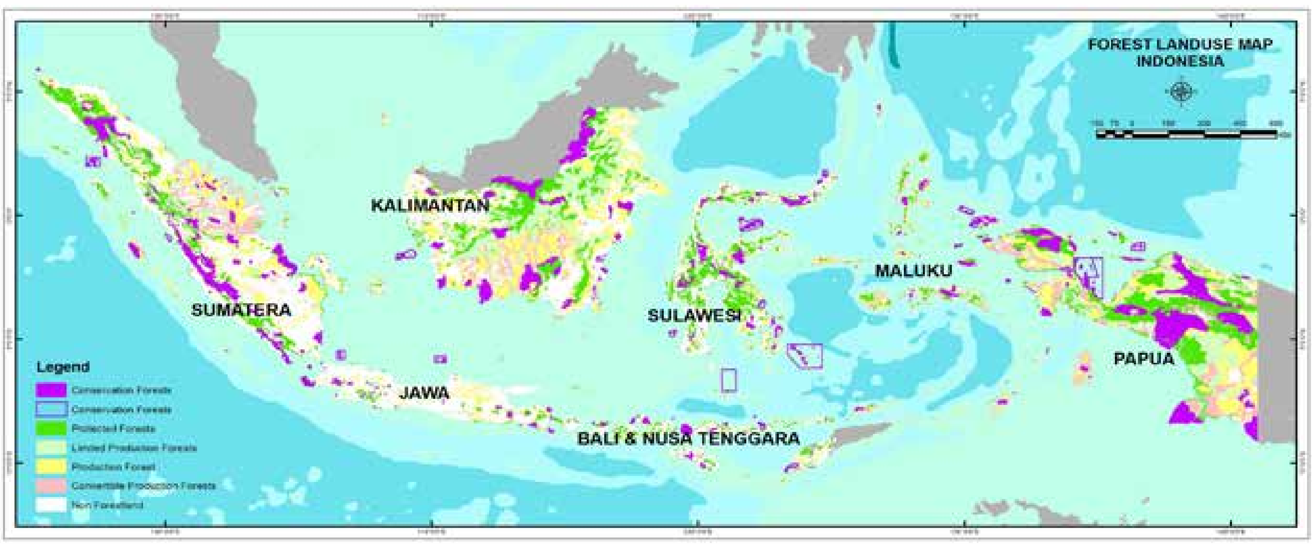
Forest resources are central to life supports for the country's environment and socio-economy. Forest resources support the life of 48.8 million people (Ministry of Forestry, 2010), of which 60% were directly dependent on shifting cultivation, fishing, hunting, gathering, logging and selling wood and non-wood forest products (Nandika 2005).

In general, Indonesia recognises two status for its land territory, forest and non-forest areas (also known as other land uses or *Area Penggunaan Lain – APL*). With the purpose of administering the use of forest resources, in 1980s, the Ministry of Forestry-MoFor, developed a national forest area based on forest functions (conservation, protection and production), termed as TGHK (*Tata Guna Hutan Kesepakatan*) or Consensus Forest Land Use Plan. There are three main classifications of forest based on forest functions, i.e.: Conservation Forest (*Hutan Konservasi* - HK), Protection Forest (*Hutan Lindung* - HL) and Production Forest (*Hutan Produksi* - HP). Conservation forests (HK) are forested areas with certain characteristics that have the principal function of preserving flora, fauna and the ecosystem. Production forests (HP, HPT, HPK) are forest areas with the principal function to produce forest products, which refer to all kinds of materials obtained from the forest for commercial uses such as timber cutting, paper and animal feed (wood and non wood). Protection forests (HL) are forest areas with a basic protective function for the life support system in regulating water, preventing floods, controling erosion, preventing seawater intrusion and maintaining soil fertility. Production forest is further classified as Permanent Production Forest (HP), Limited Production Forest (HPT) and Convertible Production Forest (HPK).

The total forest area in Indonesia in 2014 was 120,770,300 hectares (Figure 2.8), of which 21,902,400 hectares are classified as Conservation Forest (HK)[3], 29,637,600 hectares as Protection Forest (HL), 29,265,400 hectares as Production Forest (HP), 26,844,201 hectares as Limited Production Forest (HPT), and 13,120,714 hectares as Convertible Production Forest (MoEF, 2015).

The status as forestland does not guarantee that an area is covered with forest. Data on forest land cover area shows that 88,136,100 hectares are forested, while on the APL area, a total of 7,603,00 hectares are forested (see Table 2.6; Figure 2.9).

[3] HK area that encompasses territorial water is 27.43 million ha.



Source: Ministry of Forestry, 2014a

Figure 2.8 **Forest function designation map based on Minister of Forestry Decree**

Source: Ministry of Forestry, 2014

Figure 2.9 Land cover map of Indonesia in 2014

The main drivers of deforestation and forest degradation vary among islands. In the early 1980s, the main driver of deforestation in Sumatra Island was the establishment of settlement through transmigration programme, while in Kalimantan Island, deforestation was mainly due to excessive timber harvesting (Ministry of Environment, 2003). It is presumed that logging alone was not responsible for deforestation of Indonesia's tropical forests. However, development of road network systems during timber harvesting, have given access of capital to the forest area.

The attractiveness of timber products, high agriculture income and open access market, have increased the vulnerability of the forest. High logging extractions coupled with capital investment for agroindustrial production have resulted in high rates of forest degradation and deforestation.

In the efforts to reduce deforestation and forest degradation rate, the Government of Indonesia have established five priority policies, namely (i) combating illegal logging and forest fire, (ii) restructuring of forestry sector industries including enhancing plantation development, (iii) rehabilitation and conservation forest, (iv) promoting sustainable forest area, and (v) strengthening of local economies. Forest Management Units (KPH) was particularly developed, in an effort to improve the weak state of open access areas. Open access areas refer to forest areas not given to concessionaires and have no management status. These open access areas are highly risky of illegal activities; hence, to improve their management, the GoI has established Forest Management Unit (*Kesatuan Pengelolaan Hutan* – KPH) in each province.

As per December2014, there were170 units of KPHs in Indonesia with a total area of 26.75 millions hectare. These units consisted of 40 units of KPHL (Protection KPH) model managing around 3.5 millions hectare of land and 80 units of KPHP (Production KPH) model managing 12.89 millions hectare of land. In addition, there were around 50 units of KPHK (Conservation KPH)that were established, consisted of 38 National Parks (Taman Nasional, or TN) and 12 Non-TN (10.2 millions hectare) (MoEF, 2015).

2.2.4 Agriculture Sector

There are four primary types of lands under agriculture sector in Indonesia, namely Paddy Field (*Sawah,* consisted of irrigated and non-irrigated paddy fields), Dry Field/Garden (*Tegal/Kebun),* Shifting Cultivation (*Ladang/ Huma),* and Temporarily Increased Land. Between the periods of 2010-2014, there was a 7.8% decreased of agriculture land area, from 39.9 million ha in 2010 to 36.8 million ha in 2014 (Ministry of Agriculture, 2015: 4). Figure 2.10 illustrates the decreasing trend of agricultural lands in Indonesia.

Table 2.6 Forest land cover of Indonesia in 2014 (Thousand Ha)

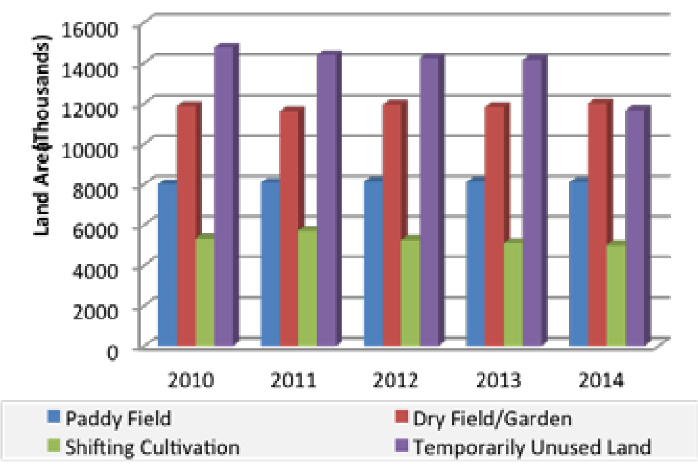
NO	LAND COVER	FOREST FUNCTION							APL	TOTAL
		Permanent Forest					HPK	Sub Total		
		HK	HL	HPT	HP	Sub Total				
1	2	3	4	5	6	7	8	9	10	11
A. Forest										
1	Primary Forest	10,827.7	12,973.6	7,763.3	3,742.2	35,306.8	1,755.8	37,062.6	991.9	38,054.4
2	Secondary Forest	3,382.9	8,259.9	11,182.4	8,159.1	30,984.3	3,292.7	34,277.0	4,121.6	38,398.6
3	Primary Swamp Forest	1,116.0	1,036.3	1,687.7	690.1	4,530.1	609.9	5,140.0	171.4	5,311.4
4	Secondary Swamp Forest	1,473.0	619.2	592.9	2,090.6	4,775.6	658.4	5,434.0	855.1	6,289.1
5	Primary Mangrove Forest	435.0	562.5	73.6	131.8	1,202.9	171.6	1,374.5	136.1	1,510.7
6	Secondary Mangrove Forest	150.7	296.4	178.0	240.5	865.6	158.9	1,024.5	382.8	1,407.3
7	Plantation Forest *	146.5	294.7	330.9	3,011.1	3,783.2	40.3	3,823.5	971.4	4,794.9
Area of Forest		17,531.7	24,042.8	21,808.8	18,065.3	81,448.6	6,687.5	88,136.1	7,630.3	95,766.4
B. Non Forest										
8	Shrubs	747.8	1,657.7	1,564.8	2,980.0	6,950.3	1,347.8	8,298.1	6,402.3	14,700.4
9	Swamp Shrubs	1,251.5	509.0	547.0	1,876.3	4,183.9	1,118.8	5,302.7	3,045.3	8,347.9
10	Savannah	544.5	368.4	140.8	259.5	1,313.1	460.5	1,773.7	1,112.6	2,886.3
11	Plantation	83.9	76.6	283.9	1,008.8	1,453.3	1,002.2	2,455.5	9,105.0	11,560.4
12	Dryland Farming	155.5	442.2	259.2	596.3	1,453.2	302.8	1,756.0	8,221.4	9,977.4
13	Mixed Dry Land Agriculture Bush	770.1	1,987.7	1,793.9	2,675.1	7,226.8	1,425.9	8,652.7	18,748.3	27,401.0
14	Transmigration Area	0.7	0.4	0.3	9.9	11.3	7.3	18.6	249.6	268.1
15	Field Rice	33.7	60.8	43.2	131.0	268.6	97.8	366.4	7,293.1	7,659.5
16	Fishpond	35.2	112.1	12.4	159.0	318.8	2.9	321.8	531.1	852.8
17	Bare Land	378.3	280.0	229.9	997.1	1,885.4	290.3	2,175.6	1,406.0	3,581.7
18	Mining Area	6.4	21.2	13.1	152.1	192.8	45.2	238.0	342.7	580.7
19	Settlement	6.4	13.9	9.1	26.9	56.3	24.9	81.1	2,532.5	2,613.6
20	Swamp	356.7	64.5	137.6	328.2	887.0	306.7	1,193.6	343.4	1,537.0
21	Harbour/ Airport	0.0	0.1	0.1	0.1	0.3	0.2	0.5	18.1	18.6
Non Forested Area		4,370.7	5,594.8	5,035.4	11,200.1	26,201.0	6,433.2	32,634.2	59,351.3	91,985.5
Total Forested Area + Non Forest		21,902.4	29,637.6	26,844.2	29,265.4	107,649.6	13,120.7	120,770.3	66,981.6	187,751.9

Source: (*Source:MoEF, 2015*)

Nevertheless, there was a quite significant increased in the overall harvested area and paddy production. Between the years 2010-2013, there was an annual increase of rice harvested area and production at a rate of 2% and 4% respectively (Figure 2.11). In 2014, paddy production and harvested area experienced a decrease of 0.6% and 0.027% from the area and production value in 2013.

Concerning the estate crops area, the growth of palm oil plantation has increased exponentially over the last four years (Figure 2.12). Between 2011 and 2014, the average increased was 6% annually from about 8.9 million ha to 10.9 million ha. Areas of rubber and coconut plantations have also increased, although not as drastically as oil palm.

Development of livestock population saw an increase in the number of population



Source: Ministry of Agriculture, 2015

Figure 2.10 Agricultural lands area by utilization in 2010-2014 between the periods of 2011-2014. Figure 2.13 indicates that poultry, in particular broiler, was the primary contributor of livestock population, followed by goat, beef cattle, and sheep.

2.2.5 Water Sector

As an archipelagic country, Indonesia constitutes of 6% of the world's freshwater reserve or approximately 21% in the whole Asia-Pacific region (Ministry of Public Works, 2007). In 2011, the annual per capita water availability was 16,800 m^3, much higher than the average world's availability of 8,000 m^3 per capita (Ministry of Environment 2011).

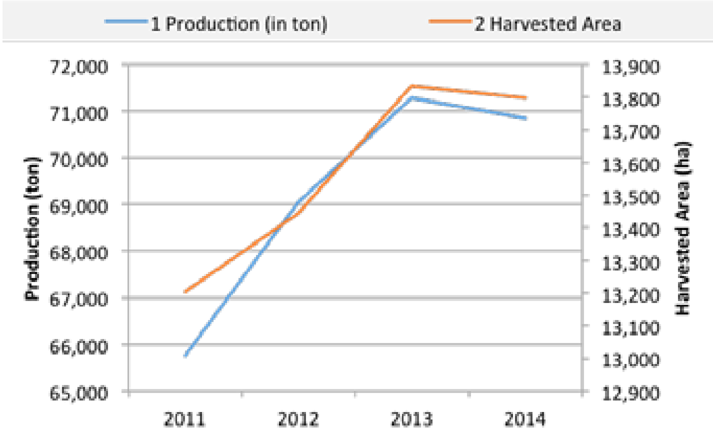
However, there is an uneven distribution of water availability, in spatial and temporal sense throughout the country, due to the uneven distribution of population, which is mainly concentrated in the Island of Java. For example, Kalimantan has abundant water resources with a small fraction of the population, while Java has a large proportion of population but very limited water resources. Consequently, Indonesia often faces water availability problems (Ministry of Public Works 2012).

The water resources potentials of each island are the accumulation of the interaction between rainwater, groundwater, and surface water (Ministry of Environment 2012). The chart on Figure 2.14 illustrates the surface water availability of the main islands in Indonesia in 2012, of which the surface water in Papua and Kalimantan Islands account for 50% of the national surface water availability.

2.2.6 Coastal and Marine Sector

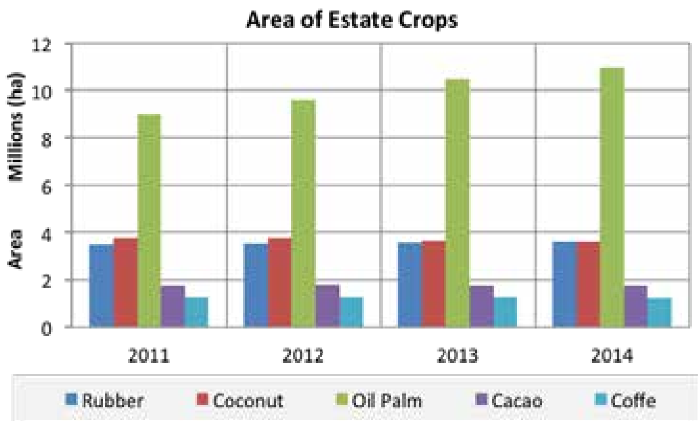
Indonesia has approximately 3.25 million km^2 of ocean, where coastal areas, small islands, marine life and fisheries play important roles in supplying food energy, supporting natural cycles, and regulating global climate. Its fishery resources equal to around 6.03 million tonnes per year consisted of 3.32 million tonnes in territorial and around 2.7million tonnes in the Executive Economic Zone (MoMAF, 2014). About 175 million people or almost 70% of the total population, spread across 42 cities and 182 districts, were living within 50 km of the shoreline.

Indonesia marine ecosystem is also home to a rich diversity of coral reefs. Each coral reef area contains at least 2,500 species of corals,



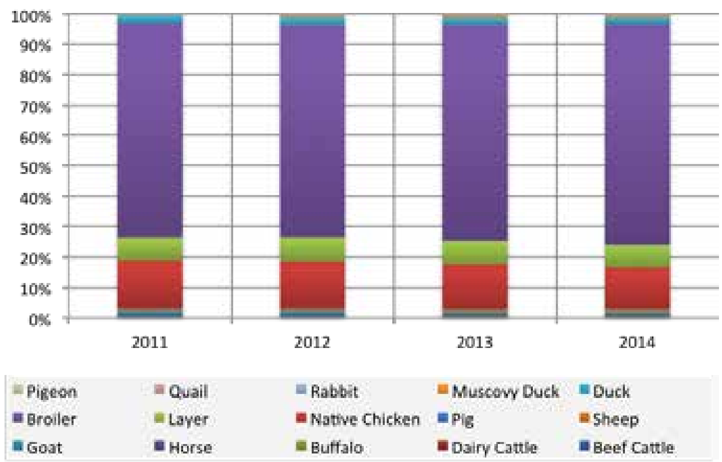
Source: *Ministry of Agriculture, 2015*

Figure 2.11 Development of paddy cultivation from 2011 to 2014



Source: *Ministry of Agriculture, 2015*

Figure 2.12 Development of estate crops area in 2011-2014

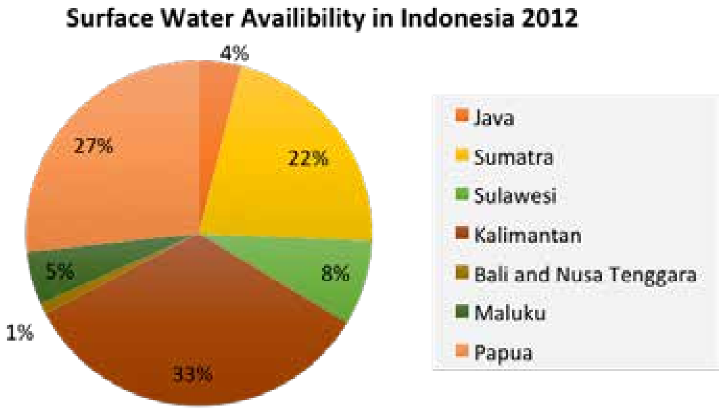


Source: *Ministry of Agriculture, 2015*

Figure 2.13 Development of livestock population in 2011-2014

with approximately 69.9% in good condition in 2014. Using the 2007 data as comparison, these findings indicate the significant reduction of damages due to non-environmental friendly practices such as unsustainable fishing practices, over-fishing, sedimentation and land-based pollution, as well as coral mining.

Similar conditions were also shown for mangrove ecosystems. In 2005, the total area of mangrove forest was around 1.5 million ha, and by 2014 it has increased to around 2.89 million ha (MoEF, 2015).



Source: *W. Hatmoko et al. 2012*

Figure 2.14 Surface water availability in 2012

A significant improvement in marine ecosystem has been achieved since 2007 through the continuous collaborations among related government institutions, as well as existing initiatives carried out by various parties including the government, environmental non-governmental organizations and communities related to coastal and marine management. One of the many initiatives is Coral Reef Rehabilitation and Management Programme (COREMAP) with the main activity comprised of priority area mapping for rehabilitation and utilisation of marine and coastal areas and mangrove rehabilitation management. Other example is the Coral Triangle Initiative aimed at conserving marine regions in Indonesia, Malaysia, New Guinea, the Philippines, the Solomon Islands and Timor Leste. These areas have at least 569 species of reef-building corals, having the potentials in generating incomes and food security to more than 175 million people living in the areas (MoMAF, 2017).

2.3 Institutional Arrangement

Ministry of Environment had coordinated the development and submission of Initial and Second National Communication in 1995 and 2011 respectively. Article 7 Paragraph (2) of the Presidential Regulation No. 71 of 2011 on the Implementation of National Greenhouse Gas Inventory has strengthened the role of the Minister of Environment in coordinating the development of National Communication on Climate Change. Currently, this responsibility has been taken over by the newly established structure under the Ministry of Environment and Forestry based on the Presidential Regulation No. 16/2015 regarding Ministry of Environment and Forestry

Presidential Regulation No. 16/2016 stipulates that the mandate for coordination of climate change governance and implementation of the Climate Change Convention at national level is assigned to the Directorate General of Climate Change, Ministry of Environment and Forestry. Moreover, through the Minister of Environment and Forestry Decree No. Ref. S. 210 /MenLHK-II/2015 dated 18 May 2015, the Minister of Environment and Forestry has designated the Director General of Climate Change as the National Focal Point (NFP) for the UNFCCC. Simultaneously, the Decree also appointed Director General of Climate Change as the NFP to the Kyoto Protocol and the Paris Agreement to the United Nations Framework Convention on Climate Change.

The Second National Communication was updated on January 19^{th}, 2012 and included information on institutional arrangement for the preparation of the Third National Communication. During this period, Indonesia started the process of preparing the First BUR, while its development had started since March 2014 and has been submitted in 2016. With regard to the institutional arrangement for the development of Third National Communication, an ad-hoc working group has been established as stipulated in the Director General Decree of DGCC No. SK.25/PPI/SET/Kum.3/12/2016 (Table 2.7)

In order to sustain the development of National Communication, Indonesia would establish more structured institutional arrangement as an integral part for implementation of the First NDC. Each ministry that is assigned the responsibility to achieve the sectoral emission reduction target and adaptation action, would assign a dedicated unit to coordinate, monitor and evaluate the implementation of NDC. Embedded in this function, is the coordination for National Implementation of GHG Inventory based on existing mechanism, as described in Chapter

Table 2.7 Institutional arrangement for the Third National Communication

Working Group	I	II	III	IV
Responsibility:	National GHG Inventories	GHG Mitigation Policies and Measures to Address Climate Change	Assessment of the Impacts, Vulnerability and Adaptation Policies	· Introduction · National · Circumstances and Institutional Arrangement · Constraints and Gaps and Related Financial, Technical and Capacity Building Needs
Coordinator:	Director of GHG Inventory and MRV, MoEF	Director of Mitigation of Climate Change, MoEF	Director of Adaptation of Climate Change, MoEF	Director of Sectoral and Regional Resources Mobilization, MoEF
Relevant Ministries/Agencies:	• MoEF • Ministry of Agriculture • MEMR • Ministry of Industry • Ministry of Transportation • Ministry of Public Works and Housing • BPS • BIG • LAPAN • Research Institutes (ITB, IPB, CIFOR)	• MoEF • BAPPENAS • Ministry of Energy and Mineral Resources • Ministry of Transportation • Ministry of Agriculture • Ministry of Industry • Ministry of Public Works and Housing • Ministry of Agraria Affairs and Spatial Planning / National Land Agency • National Peatland Restoration Agency • Research Institutes (ITB, IPB)	• MoEF • Ministry of Agrarian Affairs and Spatial Planning / National Land Agency • Ministry of Marine Affairs and Fisheries • Ministry of Health • Ministry of Agriculture • Ministry of Public Works and Housing • Relevant units in MoEF • Meteorology, Climatology, and Geophysics Agency (BMKG) • National Disaster Management Authority (BNPB) • Statistics Indonesia (BPS) • Geospatial Information Agency (BIG) • Food Security Agency	• MoEF • BAPPENAS • Ministry of Agriculture • MEMR • Ministry of Industry • Ministry of Transportation • Ministry of Public Works and Housing • MoMEF • Ministry of Higher Education and Research and Technology • Coordinating Ministry of Economy • Agency of the Assessment and Application of the Technology (BPPT) • BMKG • National Disaster Management Authority (BNPB) • BPS • BIG • LAPAN

Source: *MoEF, 2015*

III. General institutional arrangement of the development of national communications is depicted in Figure 2.15. DGCC as the National Focal Point to the UNFCCC will coordinate the whole implementation process of NDC including the development of National Communication.

2.4 National Registry System

The National Registry System on Climate Change (NRS) that was launched in November 2016, is a web-based management and provision system intended to:

1. collect data on actions and resources for the implementation of climate change adaptation and mitigation; and
2. support the implementation of the Convention and Paris Agreement, following the rules of clarity, transparency and understanding (CTU)

The establishment of NRS is specifically aim to achieve the following objectives:

1. Document action and resources on Adaptation and Mitigation of climate change
2. Provide Government recognition to the contributions from various stakeholders, ranging from relevant ministries/ government institutions, local government, business community and civil society organization on efforts to control climate change (adaptation, mitigation, finance, technology, capacity building)
3. Provide public data and information on the actions and resources on Adaptation and Mitigation and their achievements.

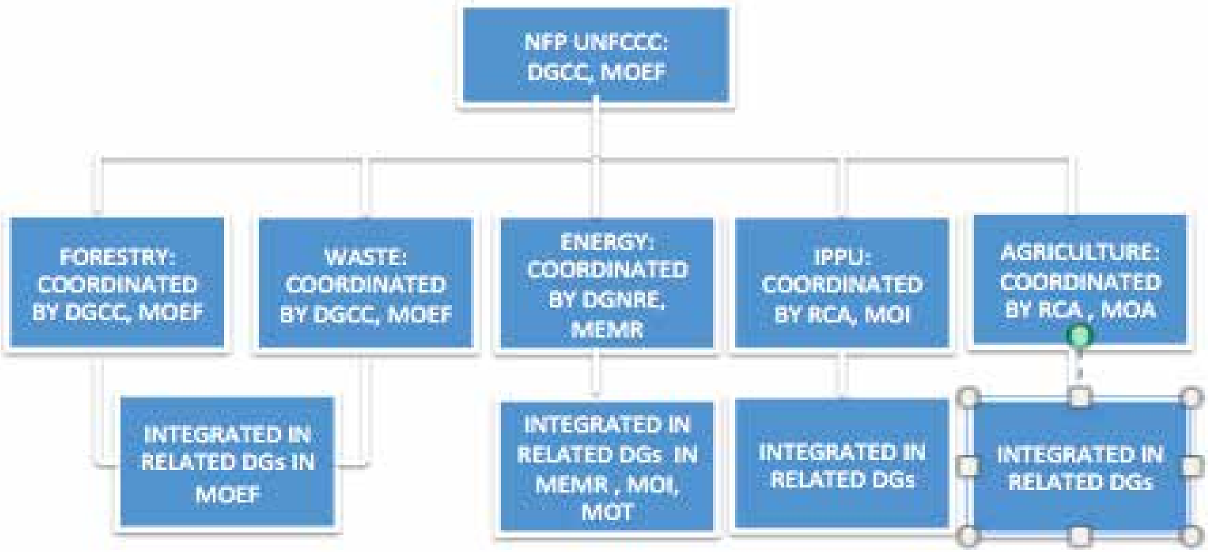
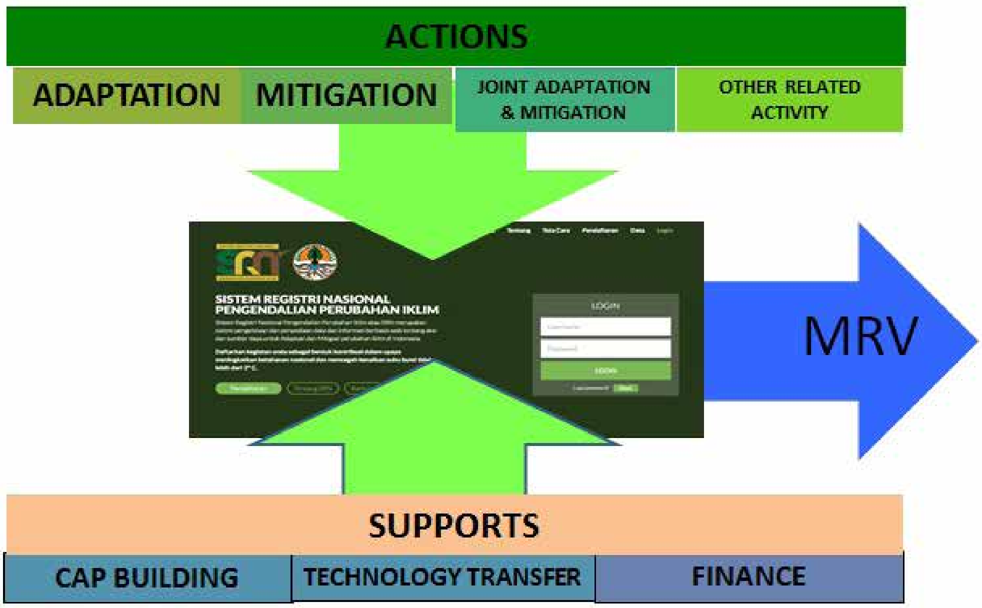


Figure 2.15 **Institutional arrangement in the development of national communication**

4. Avoid double counting on action and resources on Adaptation and Mitigation as part of the implementation of the principles of clarity, transparency and understanding (CTU).

The NRS will serve as a platform to register data and information on the implementation of adaptation, mitigation, joint adaptation and mitigation, and other related activities. Furthermore, information on related supports, either in the form of capacity building, transfer of technology and financing will also be registered and provided. Data and information to be registered consist of general information, technical data, results of mitigation (GHG emission reduction) and adaptation actions, and *Program Kampung Iklim* (PROKLIM) or Climate Village[4]. Figure 2.16 illustrates the general descriptions of NRS flow of process.

[4] The Climate Village program is a joint adaptation and mitigation initiatives at local level, emphasizing on exploring and utilising the local potentials and resources



Source: MoEF, 2016

Figure 2.16 **General descriptions of NRS Flow**

Source/Location: Directorate of Mitigation MOEF/Rice field, Kab. Buleleng, Province of Bali

Chapter 3

NATIONAL GREENHOUSE GAS INVENTORY

3.1 Introduction

The national greenhouse gas inventory covers GHG emission and/or removal sources from energy, IPPU, waste, and AFOLU sectors for the period of 2000-2014. Type of gases reported are four out of the six major GHG category of IPCC 2006, i.e. carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons or PFCs (CF_4 and C_2F_6), and other gases (CO, NOx, NMVOC, and SOx). Other major GHG emissions (HFCs and SF_6) are not reported in the TNC because these gases are not estimated.

3.2 Institutional Arrangements

The Presidential Regulation no. 71/2011 mandates development of annual GHG inventory report to be published periodically in accordance to the needs for reporting in national and international level, such as the national communications. Results of the GHG inventory will also be considered as inputs for evaluation on the achievement of mitigation actions and further development of policies. Institutional arrangement for the development of GHG Inventory is illustrated in Figure 3.1.

Each ministry/agency involved has been assigned a specific unit in their institution to implement the national GHG Inventory. List of the units is presented in Table 3.1.

The Presidential Regulation No. 71/2011 also mandates the active participation of sub-national level in the development of GHG Inventory. However, due to insufficient data availability at sub-national level, hence, only institutions at national level that are currently involved in the development of National GHG Inventory.

To assist in the development of the annual GHG inventory, the MoEF has developed and manages a simple, easy, accurate and transparent National GHG Inventory called *Sistem Inventarisasi GRK Nasional* (SIGN) SMART. This system assists in facilitating the

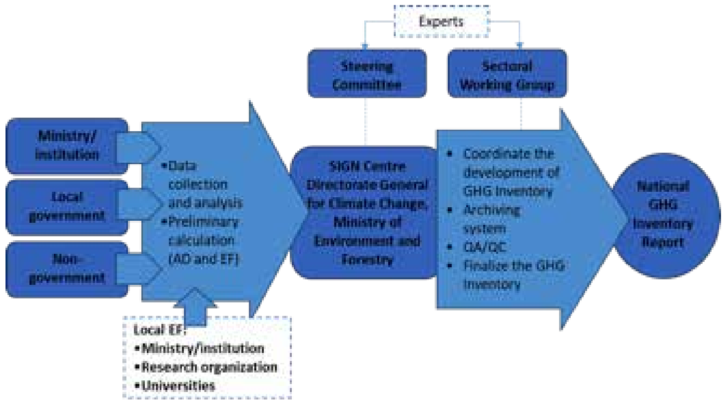


Figure 3.1 Institutional mechanism for the National GHG Inventory System (Sistem Inventarisasi GRK Nasional – SIGN)

coordination of the relevant ministries and agencies, Through this web-based system, data on the activities of relevant agencies, including from sub-national level, can be delivered to the MoEF. This system also provides practices for relevant institutions, particularly at sub-national level, in managing activity data related to the development of GHG Inventory.

For the time being, relevant ministries are responsible for data collection which will then be compiled by the MoEF to determine the emissions estimation. In the future, each respective ministerial sector, through its working group, must conduct the estimation and the result will be validated by the MoEF.

3.3 Overview of Sources and Sinks Category Emission Estimates for 2014

3.3.1 Methodology

Estimation of National GHG Inventory for the period of 2000-2014 was conducted based on the Tier 1 and Tier 2 approaches of the 2006 IPCC Guideline, which were similar approaches used in the Second National Communication.

The values of Global Warming Potential (GWP) used in the Third National Communication are described in the IPCC's Second Assessment Report (see Table 3.2 below).

Table 3.1 List of agencies and institutions involved in development of the national greenhouse gas inventory

Sector	Related institution(s)	Person in charge
Coordinator of the National GHG Inventory: Directorate for GHG Inventory and MRV (Monitoring, Reporting, and Verification), Ministry of Environment and Forestry (MoEF)		
A. GHG Emissions from Energy		
Reference Approach	Ministry of Energy and Mineral Resources (MEMR)	Centre for Data and Information Technology
Electricity generation	Ministry of Energy and Mineral Resources (MEMR)	Centre for Data and Information Technology
	State Electricity Company (*Perusahaan Listrik Negara – PLN*), Independent Power Producer (IPP), Private Power Utility (PPU), Excess Power, and IO	Centre for Data and Information Technology
Oil and gas *(Fuel + Fugitive)*	Ministry of Energy and Mineral Resources (MEMR)	Centre for Data and Information Technology
	Oil and gas companies	Centre for Data and Information Technology
Coal mining (*Fuel + Fugitive*)	Ministry of Energy and Mineral Resources (MEMR)	Centre for Data and Information Technology
	Coal companies	Centre for Data and Information Technology
Transportation	Ministry of Energy and Mineral Resources	Centre for Data and Information Technology
	Ministry of Transportation (MoT)	Centre for Sustainable Transportation Management
Energy industry	Ministry of Energy and Mineral Resources	Centre for Data and Information Technology
	Ministry of Industry (MoI)	Centre for Research and Development of Green Industry and Environment, Centre for Data and Information
	Statistics Indonesia (*BPS*)	Directorate for Industrial Statistics
	Major companies/industries	-
Energy in commercial areas	Ministry of Energy and Mineral Resources	Centre for Data and Information Technology
Energy in residential areas	Ministry of Energy and Mineral Resources	Centre for Data and Information Technology
B. GHG Emissions from Industrial Processes and Products Use (IPPU)		
Industrial processes	Ministry of Industry	Centre for Research and Development of Green Industry and Environment, Centre for Data and Information
	Statistics Indonesia (BPS)	Directorate for Industrial Statistics
	Major companies/industries	-
Products use	Ministry of Energy and Mineral Resources	Centre for Data and Information Technology
	Ministry of Industry	Centre for Research and Development of Green Industry and Environment, Centre for Data and Information
C. GHG Emissions from Waste Management		
Municipal Solid Waste (MSW)	Ministry of Environment and Forestry	Directorate for Waste Management
	Ministry of Public Works and Housing	Directorate for Development of Environmental Sanitation and Housing
Domestic wastewater	Ministry of Environment and Forestry	Directorate for Water Pollution Control
	Ministry of Public Works and Housing (MPWH)	Directorate for Development of Environmental Sanitation and Housing
		Centre for Research and Development of Housing and Settlement
Industrial solid waste (including pharmaceutical waste)	Ministry of Environment and Forestry	Directorate for Management of Hazardous Waste
	Ministry of Industry	Centre for Research and Development of Green Industry and Environment, Centre for Data and Information
Wastewater	Ministry of Environment and Forestry	Secretariat for the Directorate General Control of Pollution and Environmental Damage
		Directorate for Performance Appraisal of Hazardous Waste Management
	Ministry of Industry	Centre for Research and Development of Green Industry and Environment
		Centre for Data and Information
		Directorate for Beverage, Tobacco, and Refreshment Industry
		Directorate for Food, Marine and Fishery Products Industry
	Statistics Indonesia (BPS)	Directorate for Industrial Statistics
D. AFOLU *(*Agriculture, Forestry and Other Land Use)		
Livestock	Ministry of Agriculture	Directorate General for Animal Husbandry and Health
		Centre for Data and Information
		Planning Bureau
		Centre for Livestock Research and Development
		Agency for Research in Agriculture Environment
	Statistics Indonesia (BPS)	Directorate for Animal Husbandry, Fisheries, and Forestry
Aggregate Sources and Non CO_2 Emissions	Ministry of Agriculture	Directorate General for Crops
		Directorate General for Agricultural Infrastructure and Facilities
		Directorate General for Horticulture
		Directorate General for Estate
		Centre for Data and Information

Sector	Related institution(s)	Person in charge
		Planning Bureau
		Centre for Agricultural Land Resources
		Agency for Research in Agriculture Environment
	Statistics Indonesia (BPS)	Directorate for Statistics on Crops, Horticulture and Estate
	Associations	Indonesia Fertiliser Producer Association
Forestry and Other Land Uses	Ministry of Environment and Forestry (MoEF)	Directorate General for Sustainable Production Forest Management
		Centre for Data and Information
		Directorate for Forest Resources Inventory and Monitoring
		Centre for Research and Development on Social Economy Policy and Climate Change
		Centre for Forestry Research and Development
		Directorate for Peat Damage Control
	Ministry of Agriculture	Centre for Agricultural Land Resources
	Geospatial Information Agency	Deputy for Thematic Geospatial Information
	National Institute of Aeronautics and Space (*LAPAN*)	Remote Sensing Application Centre, Deputy for Remote Sensing

Table 3.2 Global Warming Potential values adopted in the Third National Communication*)

No.	Gas	GWP (CO_2e)
1	CO_2	1
2	Methane (CH_4)	21
3	Nitrous Oxide (N_2O)	310
4	PFC-14 (CF_4)	6,500
5	PFC-116 (C_2F_6)	9,200
6	Sulphur hexafluoride (SF_6)	23,900

*) *Second assessment report (SAR) for 100 years time horizon*

3.3.2 National Emissions

In 2014, the total GHG emissions from three main gases (CO_2, CH_4 and N_2O) without LULUCF and peat fire was 864,907 Gg CO_2e, while with LULUCF and peat fire the emission level was 1,844,329 Gg CO_2e. The emissions were dominated by CO_2 (87.3%), followed by CH_4 (9.7%), and N_2O (3.3%) (see Table 3.3). The main contributor sectors were LULUCF and peat fire (53.1%), followed by energy, agriculture, waste, and IPPU. Without LULUCF and peat fire, energy was the main contributor, accounted for 69.7% of the total emissions (see Figure 3.2). Further detail on the 2014 national GHG emissions is presented in Table 3.4.

3.4 Sectoral Emissions

The following sections will discuss summaries of the national GHG inventory

Table 3.3 Summary of National GHG Emissions in year 2000 and 2014 (Gg CO_2e)

Sectors	Year	CO_2	CH_4	N_2O	CF_4	C_2F_6	CO	NOx	NMVOC	SOx	Total 3 Gases
1. Energy	2000	265,318	29,742	3,352							298,412
	2014	569,087	27,511	5,860							602,458
2. IPPU	2000	42,391	70	149	250	22					42,610
	2014	46,965	69	415	39	0					47,449
3. AFOLU											-
3.a. Agriculture	2000	4,772	54,258	40,687			2,724	70			99,717
	2014	6,756	56,028	50,656			2,724	70			113,440
3.b. FOLU (incl. Peat Fire)	2000	505,368	NE	NE							505,368
	2014	979,422	NE	NE							979,422
4. Waste	2000	2,216	56,917	2,218							61,351
	2014	2,653	95,896	3,011							101,560
Total (CO_2e)	2000	820,065	140,987	46,406	250	22	2,724	70			1,007,458
	2014	1,607,536	179,504	54,668	39	0	2,724	70			1,844,329
Percentage (%)	2000	81.4%	14.0%	4.6%	NE	NE					100%
	2014	87%	9.7%	3.3%	NE	NE					100%

NE = *Not Estimated*

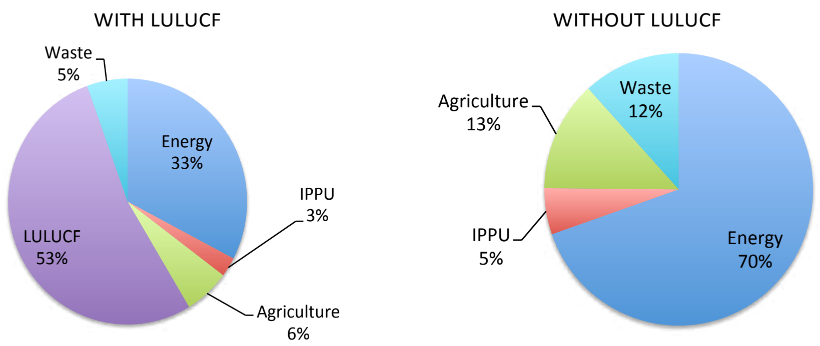


Figure 3.2 National GHG Emissions by Sector in 2014

conducted in 2014 and the trend between the years 2000-2014, including details of the anthropogenic emissions by sources/sinks, covering (a) energy, (b) IPPU, (c) AFOLU, and (d) waste sectors.

3.4.1 Energy

3.4.1.1 Source Categories for GHG Emissions in Energy Sector

Under the 2006 IPCC Guidelines, the sources of emissions in energy sector were classified into three categories, i.e. (a) fuel combustion, (b) fugitive emissions from fuels productions, and (c) activities of transporting, injecting, and storing of CO_2 (related to CCS or carbon capture storage). Since CCS has not been implemented in Indonesia, this report will only cover the first two sources. Coverage for GHG emission sources from energy sector is presented in Figure 3.3.

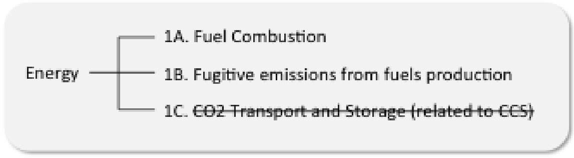


Figure 3.3 The coverage of GHG emissions sources from energy sector

1. Fuel Combustions

GHG emissions from fuel combustion is generated in fuel use for electricity, manufacture, industry (exclude construction), transportation, and other sources such as residential, commercial, and ACM (Agriculture, Construction, and Mining). Fuel use for construction activities is covered under the sub-category ACM. However, emissions from this sub-category (ACM) are presented in aggregate form due to the detail data limitation concerning the use of fuel in each of the components of agriculture, construction and mining.

Table 3.4 Summary of National GHG Emissions in 2014 (Gg CO_2e)

Categories	Total 3 Gas	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
	CO_2 equivalents (Gg)								(Gg)				
Total National Emissions and Removals	**1,844,329**	**1,604,883**	**179,504**	**59,942**	NE	NE	NE	NE	NE				
1 ENERGY	602,458	569,087	27,511	5,860									
1A Fuel Combustion Activities	579,940	562,897	11,195	5,848									
1A1 Energy Industries	223,213	222,307	69	836									
1A2 Manufacturing Industries and Construction	171,593	170,145	463	985									
1A3 Transport	141,246	138,397	792	2,056									
1A4a Commercial/Institutional	2,899	2,826	57	15									
1A4b Residential	32,303	20,581	9,788	1,934									
1A5 Non-Specified	8,687	8,640	25	22									
1B Fugitive Emissions from Fuels	22,518	6,190	16,316	12									
1B1 Solid Fuels	2,221	NE	2,221	NE									
1B2 Oil and Natural Gas	20,296	6,190	14,095	12									

Categories	Total 3 Gas	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
	CO_2 equivalents (Gg)				(Gg)								
1B3 Other Emissions from Energy Production	NE	NE	NE	NE									
1C Carbon Dioxide Transport and Storage	NE	NE											
1C1 Transport of CO_2	NE	NE											
1C2 Injection and Storage	NE	NE											
2 INDUSTRIAL PROCESSES AND PRODUCT USE	**47,449**	**46,965**	**69**	**415**	NE	39	NE	NE	NE				
2A Mineral Industry	27,752	27,752	NE	NE									
2A1 Cement Production	25,534	25,534	NE										
2A2 Lime Production	153	153	NE										
2A3 Glass Production	38	38	NE										
2A4 Other Process Uses of Carbonates	2,027	2,027	NE										
2A5 Other (please specify)	NE	NE	NE	NE									
2B Chemical Industry	10,846	10,363	67	415									
2B1 Ammonia Production	7,947	7,947	NE	NE									
2B2 Nitric Acid Production	415	NE	NE	415									
2B3 Adipic Acid Production	NO	NO	NO	NO									
2B4 Caprolactam, Glyoxal and Glyoxylic Acid Production	NO	NO	NO	NO									
2B5 Carbide Production	29	29	NO	NE									
2B6 Titanium Dioxide Production	NO	NO	NO	NO									
2B7 Soda Ash Production	NO	NO	NO	NO									
2B8 Petrochemical and Carbon Black Production	2,011	1,944	67	NE									
2B9 Fluorochemical Production					NO	NO	NO	NO	NO				
2B10 Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE	NE				
2C Metal Industry	6,701	6,699	2	NE		39							
2C1 Iron and Steel Production	6,259	6,256	2	NE									
2C2 Ferroalloys Production	NO	NO	NO	NO									
2C3 Aluminum Production	320	320				39							
2C4 Magnesium Production	NO	NO											
2C5 Lead Production	113	113											
2C6 Zinc Production	10	10											
2C7 Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE	NE				
2D Non-Energy Products from Fuels and Solvent Use	2,491	2,491	NE	NE									
2D1 Lubricant Use	206	206											
2D2 Paraffin Wax Use	2,284	2,284	NE	NE									
2D3 Solvent Use													
2D4 Other (please specify)	NE	NE	NE	NE									
2E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE				
2E1 Integrated Circuit or Semiconductor	NE	NE		NE	NE	NE	NE	NE	NE				
2E2 TFT Flat Panel Display					NO	NO	NO	NO	NO				
2E3 Photovoltaics					NO	NO	NO	NO	NO				
2E4 Heat Transfer Fluid								NO	NO				
2E5 Other (please specify)													
2F Product Uses as Substitutes for Ozone Depleting Substances	NE	NE	NE	NE	NE	NE		NE	NE				
2F1 Refrigeration and Air Conditioning	NE	NE			NE	NE		NE	NE				
2F2 Foam Blowing Agents	NE	NE			NE	NE		NE	NE				
2F3 Fire Protection	NE	NE			NE	NE		NE	NE				
2F4 Aerosols	NE				NE	NE		NE	NE				
2F5 Solvents	NE				NE	NE		NE	NE				
2F6 Other Applications	NE	NE	NE	NE	NE	NE		NE	NE				
2G Other Product Manufacture and Use	NE	NE	NE	NE	NE	NE	NE	NE	NE				

Categories	Total 3 Gas	Net CO_2 (1) (2)	CH_4	N_2O	HFCs	PFCs	SF_6	Other halogenated gases with CO_2 equivalent conversion factors (3)	Other halogenated gases without CO_2 equivalent conversion factors (4)	NOx	CO	NMVOCs	SO_2
	CO_2 equivalents (Gg)								(Gg)				
2G1 Electrical Equipment						NE	NE						
2G2 SF6 and PFCs from Other Product Uses						NE	NE						
2G3 N_2O from Product Uses	NE			NE									
2G4 Other (please specify)	NE	NE	NE		NE			NE	NE				
2H Other (please specify)	104	104	NE	NE									
2H1 Pulp and Paper Industry	99	99											
2H2 Food and Beverages Industry	5	5	NE										
2H3 Other (please specify)	NE	NE	NE	NE									
3 AGRICULTURE, FORESTRY AND OTHER LAND USE	1,092,863	986,178	56,028	50,656									
3A Livestock	25,741		18,115	7,625									
3A1 Enteric Fermentation	16,084		16,084										
3A2 Manure Management	9,656		2,031	7,625									
3B Land	979,422	979,422	NE	NE									
3B1 Forest Land	-131,375	-131,375	NE	NE									
3B2 Cropland	107,752	107,752	NE	NE									
3B3 Grassland	17,118	17,118	NE	NE									
3B4 Wetlands	NE	NE	NE	NE									
3B5 Settlements	10,257	10,257	NE	NE									
3B6 Other Land	134,546	134,546	NE	NE									
Peat Decomposition	341,735	341,735	NE	NE									
Peat Fire	499,389	499,389	NE	NE									
3C Aggregate Sources and Non-CO_2 Emissions Sources on Land	87,701	6,756	37,913	43,031									
3C1 Biomass Burning	2,654	NE	1,919	734						70.03	2,724		
3C2 Liming	1,920	1,920											
3C3 Urea Application	4,836	4,836											
3C4 Direct N_2O Emissions from Managed Soils	32,575			32,575									
3C5 Indirect N_2O Emissions from Managed Soils	8,520			8,520									
3C6 Indirect N_2O Emissions from Manure Management	1,202			1,202									
3C7 Rice Cultivations	35,994		35,994	NE									
3C8 Other (please specify)	NE	NE	NE	NE									
3D Other	NE	NE	NE	NE									
3D1 Harvested Wood Products	NE	NE											
3D2 Other (please specify)	NE	NE	NE	NE									
4 WASTE	101,560	2,653	95,896	3,011									
4A Unmanaged Solid Waste Disposal	33,467		33,467	NE									
4B Biological Treatment of Solid Waste	49		1	48									
4C Incineration and Open Burning of Waste	4,644	2,653	1,687	305									
4D Wastewater Treatment and Discharge	63,400		60,741	2,659									
4D1 Domestic Wastewater Treatment and Discharge	17,417		14,758	2,659									
4D2 Industrial Wastewater Treatment and Discharge	45,982		45,982	NE									
4E Other (untreated waste)	NE	NE	NE	NE									
5 OTHER	NE	NE	NE	NE	NE	NE	NE	NE	NE				
5A Indirect N_2O Emissions from the Atmospheric Deposition of Nitrogen in NOx and NH3	NE			NE									
5B Other (please specify)	NE	NE	NE	NE	NE	NE	NE	NE	NE				

Note: NE = *not estimated*, NO = *not occurred, shaded = do not require entries*

a. Fuel Combustion in Energy Industry

GHG emissions on this sub-category include GHG emissions generated during the production of electricity and heat, petroleum industries, and manufacturing of solid fuels. The electricity production includes those generated by the PLN (state owned electricity company), independent power producers (IPP), and captive power from private power utility (PPU). GHG emissions generated in heat production as well as combined heat and electricity production as often occurred in industry, were covered in GHG emissions from fuel combustions in manufacturing industries. The petroleum industry sub-category includes upstream oil and gas, oil refining, as well as production of LNG and LPG.

Data presented in the document is an update on the activity data presented in the first BUR document.

b. Fuel Combustion in Manufacturing Industry

Manufacturing industry comprises of all types of industry known to apply fuel combustion to generate its energy. Practically, almost all industries fall within this category. In Indonesia, data on fuel consumptions of these industries were collected from aggregated fuel sales data of these industries, from which the GHG emissions from fuel combustions in manufacturing industries were calculated. However, fuel consumptions of several industries such as cement, urea fertiliser and nitric acid production, as well as pulp and paper, were identified and used in this report. It should be noted that the GHG emissions from fuel combustions in non-fuel mining and quarry fall under the manufacturing industries category. However, GHG from fuel combustions in fuel mining activities is covered in the ACM in the later discussion.

c. Fuel Combustion in Transportation

According to the 2006 IPCC GL, emissions from transportation sector include emissions generated from fuel combustion in civil aviation, land transportation, railway, water borne transportation, and other means of transportation (pipeline and off road). Emissions reported in this document used aggregate fuel consumption data where data were grouped based on fuel types. For example, avgas and avtur were only used in civil aviation thus GHG emissions from the civil aviation was estimated from avtur and avgas consumption data. However, since the data was aggregated, the estimation could not differentiate between domestic and international use. Transportation of materials through pipelines such as oil, gas and industrial materials transfer within industries, are included in the corresponding industries.

d. Fuel Combustion in Other Sectors

GHG emissions from this category include fuel combustion in residential, commercial, and ACM sectors. Emissions from residential and commercial areas were generated from combustions of LPG, gas, and kerosene. Gasoline, ADO, and kerosene were used in motorized equipments used in agriculture activities including fisheries. Marine Fuel Oil (MFO) was used in fisheries activities, while ADO and IDO were used in mining and construction sub-sectors.

2. Fugitive Emission from Fuel Production

Fugitive emission from fuel production only includes CH_4 generated from upstream oil and gas production facility, refining and process, storage, and distribution. On this category, GHG emission is estimated in aggregate, based on the physical form of the fuel, i.e: solid, liquid, and gas. Most Indonesian coal minings are either open or surface mining, therefore fugitive emission from coal mining only includes emissions generated during mining process.

3.4.1.2 Methodology

GHG emissions in the energy sector were estimated following Tier 1 approach of the 2006 IPCC GL with default value emission factor and activity data in energy unit (boe, barrel oil equivalent) collected from the Energy Balance Table in the Handbook of Energy and Economic Statistics of Indonesia, published by the MEMR. At the moment, the MEMR is preparing Indonesian fuel characteristics, particularly the calorific values and emission factors. However, these values are not yet officially published by the MEMR, thus this inventory still apply default values from the 2006 IPCC GL.

All data and information related to GHG emissions inventory of energy sector were collected from the Energy Balance Table. However, data presented in the Table could not directly be used due to the difference in structure and unit. Therefore, re-classification of data on the Table was performed to alleviate its use in GHG emission estimation (see Table 3.5).

Table 3.5 Classification of category between IPCC GL 2006 and the Energy Balance Table

2006 IPCC Category		Energy Balance Table Category	
1A1a	Main activity electricity and heat production	2e	Power plant
			PLN
			Non-PLN
1A1b	Petroleum refining	2a	Refinery
		2b	LPG Plant
		2c	LNG Plant
		3a	During Transformation
		3b	Energy use / own use
1A1c	Manufacture of solid fuels and other energy industries		Coal Processing Plant
1A2	Manufacturing Industries	6a	Industry
1A3	Transport	6b	Transportation
1A4a	Commercial/institutional	6d	Commercial
1A4b	Residential	6c	Household
1A4c	Other Sector	6e	Other sector
1B1	Solid Fuel	1a	Production/Coal
1B2a	Oil	1a	Production/Crude Oil
		4	Final Energy Supply / LPG
1B2b	Natural Gas	1a	Production/Natural Gas
		4	Final Energy Supply / LPG

As described in the 2006 IPCC GL, the total GHG emission in energy sector was calculated using two approaches, i.e.: reference approach and sectoral approach. However, the two approaches showed different results. The reference approach adopted top-down approach where emissions were estimated using aggregate data of national primary energy supply, while the sectoral approach used bottom-up approach where estimation was calculated using final energy consumption data, energy transformation, and fugitive-related data. The difference in emission estimates between the approaches should not exceed 5%, and the difference was mostly caused by fugitive emissions and stock change in users.

3.4.1.3 Time Frame

GHG Inventory reported covered GHG emissions generated from the year 2000 until 2014. The year 2000-2012 GHG Inventory data were taken from data published in the First BUR, while data on years 2013 and 2014 were current data published by the MEMR in 2015.

3.4.1.4 Type of Gases

According to 2006 IPCC GL, the types of GHG emissions estimated in energy sector were from CO_2, CH_4 and N_2O gases.

3.4.1.5 Data Sources

All data and information on GHG inventory in energy sector were gathered from one source, i.e.: the Energy Balance Table (2007 – 2014) in the Handbook of Energy and Economic Statistics of Indonesia year 2008 – 2015 published by the MEMR.

Data from the Energy Balance Table is fuel consumption data in a category, product generated from the category, and energy transformation data. The energy unit for the activity data in the Energy Table is BOE and thus must be converted into kiloliter or ton to estimate the GHG emissions. The conversion factors were available in the Handbook of Energy and Economic Statistics of Indonesia 2015.

3.4.1.6 GHG Emissions Calculation

1. ***Reference Approach***

In reference approach, emissions were estimated following national fuel supply data. The energy supply composition for the five past years, was dominated by coal, followed by natural gas and oil, and this development has caused significant increase on GHG emissions in energy sector as shown in Figure 3.4.

2. ***Sectoral Approach*: GHG Emission Level by Activity Sector**

In sectoral approach, emissions were estimated from the amount of fuels used in the activity sectors where the emissions were generated, i.e.: energy industries, transportation, manufactures, and others as presented in Figure 3.5 Trend of the emissions shows an increase especially in the category of energy industries. CO_2 remains the highest greenhouse gas contributor in energy sector, with an average of 93% during the period of 2000-2014 (Figure 3.6).

In 2014, GHG emissions in energy sector reached 602,458 Gg CO_2 (Table 3.6). 96% of it came from fuel combustion and the remaining were from fugitive emissions. The emissions level experienced 10.26% (or 56,060 Gg CO_2e) increase from the 2013 level. Average annual increase of GHG emissions within the period of 2000 – 2014 is 3.71% (304,045 Gg CO_2e).

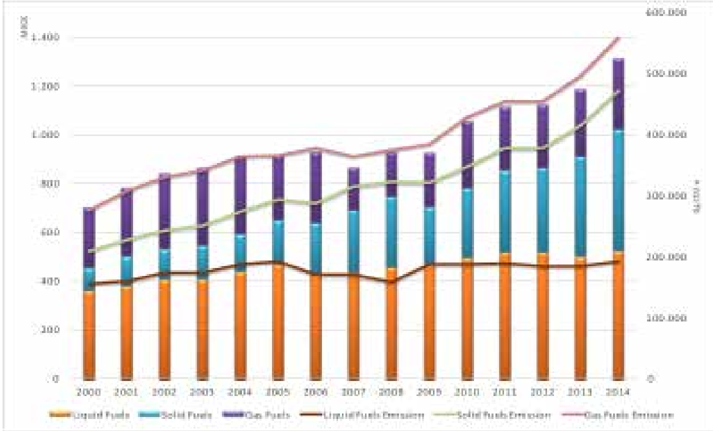


Figure 3.4 Fuel consumption and GHG emissions in energy sector by fuel type on years 2000-2014

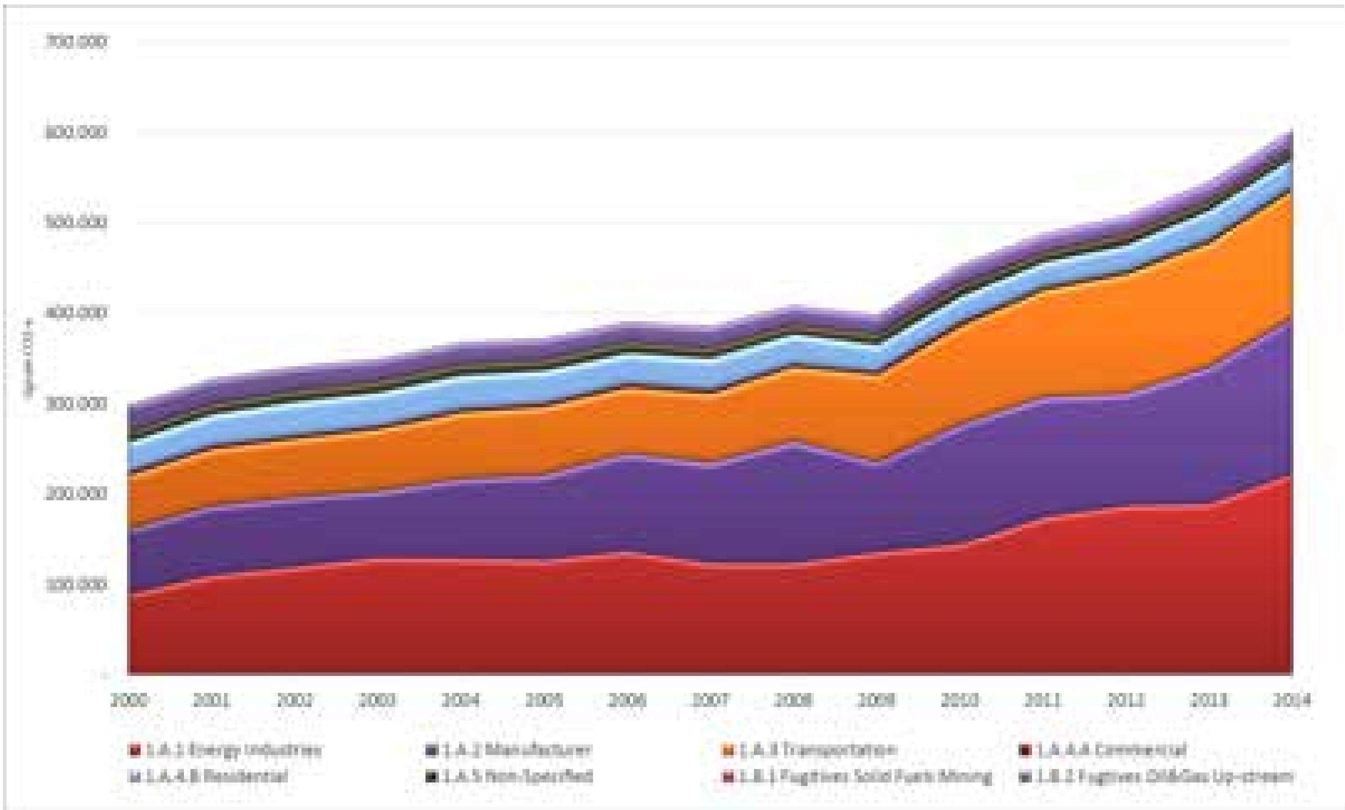


Figure 3.5 GHG emissions in energy sector by sub-category, 2000 – 2014

The use of fuel in manufacturing and construction industries in 2014 had generated 171,593 Gg CO_2e, about 30% of the energy sector's emissions. On this category, total fuel consumption of 2,309,559 TJ/year was identified in three industries, i.e: urea fertiliser (4,939 Gg CO_2e), pulp and paper (29,112 Gg CO_2e), and cement (12,818 Gg CO_2e).

3. Reference versus Sectoral Approaches for Estimation of CO_2 Emissions Level

The result of the emissions estimation using the reference approach resulted in a 3.9%

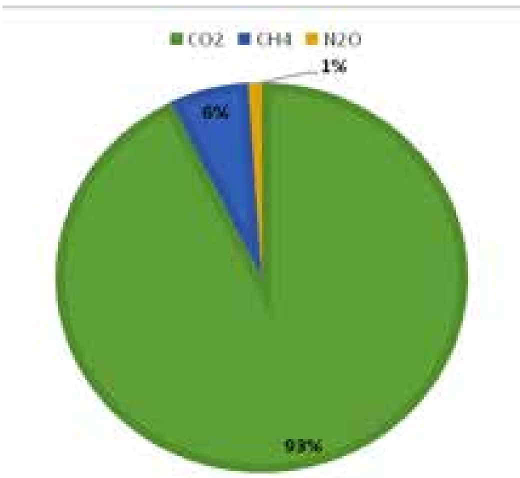


Figure 3.6 Annual average of GHG emission in energy sector by type of gas, 2000 – 2014

Table 3.6 Summary of GHG Emissions in Energy Sector in 2014

Code	Categories	2014			
		CO_2	CH_4	N_2O	Total
		$GgCO_2$	$GgCH_4$	GgN_2O	$Gg\ CO_2e$
Sectoral Approach					
Energy	**Energy**	**569,087**	**1,310**	**19**	**602,458**
1.A	**Fuel Combustion**	562,897	533	19	579,940
1.A.1	**Energy Industries**	222,307	3	3	223,213
1.A.1.a	Main activity electricity and heat production	207,780	3	3	208,671
1.A.1.b	Petroleum refining	14,489	0	0	14,503
1.A.1.c	Coal Processing	39	0	0	39
1.A.2	**Manufacturing Industries and Construction**	170,145	22	3	171,593
1.A.3	**Transport**	138,397	38	7	141,246
1.A.4	**Other Sectors**	23,408	469	6	35,201
1.A.4.a	Commercial/Institutional	2,826	3	0	2,899
1.A.4.b	Residential	20,581	466	6	32,303
1.A.5	Other	8,640	1	0	8,687
1.B	**Fugitive emissions**	6,190	777	0	22,518
1.B.1	**Solid Fuels**	-	106	-	2,221
1.B.1.a	Underground coal mining				-
1.B.1.b	Surface coal mining	-	106		2,221
1.B.2	**Oil and Natural Gas**	6,190	671	0	20,296
1.B.2.a	Oil	2,090	515	0	12,909
1.B.2.b	Natural gas	4,100	156	0	7,388

higher figure than the estimation using sectoral approach as shown in Table 3.7 and Figure 3.7.

Result of the Key Category Analysis (KCA) shows that GHG emissions in energy sector were mainly from the sub-categories of fuel combustion in electricity and heat production, manufacturing and construction industries, transportation, residential, and fugitives from oil and gas (Table 3.8).

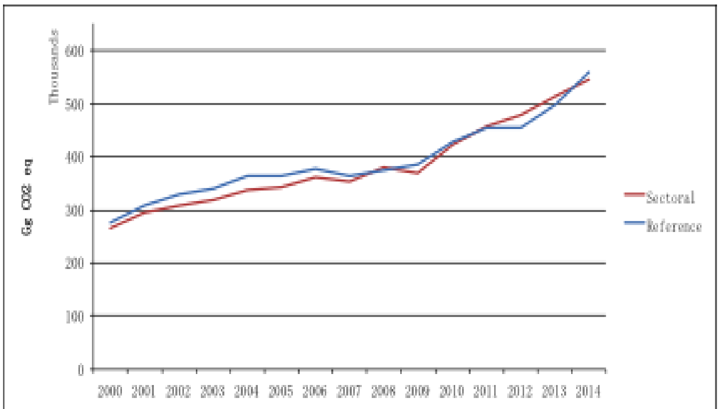


Figure 3.7 Estimated emissions based on Reference and Sectoral Approaches in energy sector

3.4.2 Industrial Processes and Product Use (IPPU)

3.4.2.1 Source Category of GHG Emissions from IPPU

GHG emissions from IPPU include CO_2, CH_4, N_2O and perfluorocarbon (PFC) in the form of CF_4 dan C_2F_6. According to 2006 IPCC GL, the industries are categorized into mineral, chemical, metal, non-energy products from fuels and solvent, electronic industry, and others. In this document, GHG inventory only covers emissions from (i) mineral production, such as cement, lime, glass, and other process utilizing carbonates (ceramics and soda ash); (ii) chemical production, such as in ammonia production, nitric acid, carbide, and petrochemicals; (iii) metal production, such as on iron and steel, aluminium, lead, and zinc; (iv) non-energy products from fuels and solvent (lubricant and paraffin wax); and (v) other industry such as the use of carbonate for pulp and paper industry as well as food and beverages industry.

Table 3.7 Estimation of energy sector's emissions using reference and sectoral approaches (in Gg CO_2e)

Source of GHG Emissions	GHG Emission (Gg CO_2e)														
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
By Type of Fuel															
1. Liquid Fuels	155,515	159,934	174,080	173,785	188,172	191,501	170,507	170,041	158,206	188,034	187,820	189,793	183,924	183,762	191,432
2. Solid Fuels	52,998	67,474	69,393	77,206	85,518	101,838	117,410	145,686	163,786	133,421	158,793	188,555	194,682	231,681	280,909
3. Gas Fuels	67,748	79,664	86,497	89,883	89,971	72,003	90,821	49,182	52,524	63,433	82,855	76,427	76,019	81,586	87,190
Total by type of fuel	**276,262**	**307,071**	**329,971**	**340,874**	**363,661**	**365,341**	**378,738**	**364,910**	**374,516**	**384,889**	**429,467**	**454,775**	**454,625**	**497,029**	**559,531**
By Sector/Sources															
1.A.1. Energy Industries	**89,716**	**110,764**	**119,793**	**130,188**	**129,518**	**127,816**	**137,094**	**124,026**	**124,485**	**136,599**	**144,526**	**173,803**	**187,631**	**189,860**	**223,213**
1.A.1.a Electricity Generation	62,030	76,614	80,964	90,946	93,516	101,948	108,930	121,696	121,940	136,058	130,886	160,771	174,873	177,294	208,671
1.A.1.b Oil and Gas	27,686	34,151	38,829	39,242	36,002	25,867	28,049	2,211	2,442	395	13,449	12,988	12,672	12,529	14,503
1.A.1.c Coal Processing	-	-	-	-	-	-	115	119	103	146	192	44	86	37	39
1.A.2 Manufacturer	72,300	77,379	77,393	74,019	88,365	94,005	108,118	111,441	134,824	99,255	132,306	133,226	123,738	151,256	171,593
1.A.3 Transportation	58,916	62,158	64,636	67,601	72,841	74,947	73,120	76,219	81,367	96,352	108,745	117,518	131,458	136,646	141,246
1.A.4.a Commercial	3,489	3,483	3,572	3,632	3,819	3,271	3,979	3,946	3,732	3,668	3,798	3,438	3,541	3,259	2,899
1.A.4.b Residential	33,167	34,381	35,836	36,930	36,930	36,449	34,340	34,699	32,397	29,379	28,299	27,842	28,865	32,303	32,303
1.A.5 Non-Specified	11,421	11,742	11,996	12,120	12,286	12,276	11,372	10,828	10,787	11,423	12,496	10,743	11,301	10,045	8,687
1.A Fuel Combustion	**269,009**	**299,907**	**313,227**	**324,491**	**343,759**	**348,764**	**368,023**	**361,158**	**387,591**	**376,676**	**430,171**	**466,571**	**486,534**	**523,369**	**579,940**
1.B Fugitives	**29,404**	**28,031**	**27,096**	**25,753**	**24,749**	**24,127**	**23,401**	**25,435**	**22,145**	**21,963**	**23,007**	**22,365**	**21,586**	**23,028**	**22,518**
1.B.1 Fugitives Solid Fuels Mining	374	449	501	554	642	738	940	1,054	1,110	1,242	1,334	1,713	1,871	2,178	2,221
1.B.2 Fugitives Oil/Gas	29,030	27,582	26,595	25,199	24,107	23,389	22,461	24,381	21,034	20,721	21,673	20,652	19,714	20,851	20,296
Total Sectoral	**298,412**	**327,938**	**340,323**	**350,244**	**368,508**	**372,891**	**391,424**	**386,593**	**409,736**	**398,639**	**453,178**	**488,936**	**508,120**	**546,398**	**602,458**

Table 3.8 Key Category Analysis for energy sector in 2014

Code	Category	Total GHG Emissions	Level/Rank	Cumulative
1.A.1.a	Main activity electricity	208,671	34.64%	34.64%
1.A.2	Manufacturing and construction industries	171,593	28.48%	63.12%
1.A.3	Transport	141,246	23.44%	86.56%
1.A.4.b	Residential	32,303	5.36%	91.93%
1.B.2	Fugitives from Oil/Natural Gas	20,296	3.37%	95.29%
1.A.1.b	Petroleum refining	14,503	2.41%	97.70%
1.A.5	Other	8,687	1.44%	99.14%
1.A.4.a	Commercial/Institutional	2,899	0.48%	99.62%
1.B.1	Fugitive from solid fuels	2,221	0.37%	99.99%
1.A.1.c	Coal processing	39	0.01%	100.00%
Total		**602,458**		

GHG emissions from chemical production such as on the productions of adipic acid, caprolactam, glyoxal, titanium dioxide, and soda ash industry are excluded in this GHG inventory since they were not available in Indonesia. In addition, GHG emission sources from ferroalloy, electronic, and other manufacturing industries (solvent and other product use) are also excluded due to difficulty in data collection.

In this document, emissions from electronic industry is also excluded since the related data were only available in aggregate from industries generating GHG emissions and industries not generating GHG emissions such as the assembly industry. Data on Ozone Depleting Substances (ODS) substitute was also not available, therefore its GHG emission was difficult to estimate. For the time being, the

Government of Indonesia is using the data of the import of ODS substitute as the basis to estimate the GHG emissions.

1. **Mineral Industry**

Emissions from mineral production include emissions related to chemical processes activities in cement (clinker production), lime, glass production activities and industries that use carbonates in their processes. Use of carbonat in non-metallurgical magnesia production and other industries are not available in Indonesia, thus are excluded in the GHG Inventory.

2. **Chemical Industry**

According to 2006 IPCC GL, production process in chemical industry includes the production of ammonia, nitric acid, carbide, adipic acid, caprolactam, glyoxal, glyoxilic acid, titanium dioxide, natural soda ash production, and petrochemical (methanol, ethylene, ethylene dichloride, and black carbon). However, emissions related to adipic acid, caprolactam, glyoxal, glyoxylic acid, titanium dioxide, and soda ash are excluded since they are not available in Indonesia.

3. **Metal Industry**

Considering data availability, the GHG emissions estimation of metal industry in this document will only cover iron and steel production, aluminium, lead, and zinc.

4. **Non-Energy Products and Solvent**

Products included in this category are lubricant, paraffin wax, and solvent.

5. **Other Industry**

GHG emissions for this category include emissions related to the use of carbonate in the production of pulp and paper industry as well as food and beverages industry. In pulp/paper industry, the carbonate used as chemical make-up during recausticizing process. Although the amount of carbonate form is not significant, the process will still release GHG emissions.

3.4.2.2 Methodology

GHG emissions from IPPU were mostly estimated based on Tier 1 approach where activity data were multiplied with IPCC default emission factors. Tier 2 approach was applied in industries such as cement, ammonia, nitric acid, and aluminium due to their participations in CDM projects.

3.4.2.3 Time Frame

GHG Inventory reported on this document covers emissions generated in the period of 2000-2014. The 2000-2005 inventory was taken from the Second National Communication document with some revision, among others updated activity data and emission factor (especially from cement industry). For the 2006-2012 inventory, data was taken from the first BUR, while for 2013-2014, new data were used.

3.4.2.4 Type of Gases

GHGs from IPPU include CO_2, CH_4, N_2O, HFC, perfluorocarbons (PFCs), and SF_6.

3.4.2.5 Data Sources

Related data and information for GHG Inventory in IPPU sector (Table 3.9) and list of activity data and emission factor for each of the IPPU category (Table 3.10) were synthesized from the following sources:

1. Activity data were obtained from the documents on Statistics of Large and Medium Scale Manufacturing Industry published by BPS (2000-2014), industry associations such as from the Indonesian Cement Association, and the Centre for Research and Development of Green Industry and Environment – MoI. These data have undergone consolidation and verification process through series of discussions coordinated by the MoEF.
2. Standard/default emission factors and other parameters were taken from the 2006 IPCC GL and the Centre for Research and Development of Green Industry and Environment – MoI.

Data sourced from the BPS' Statistics of the Manufacturing Industry were traced using the code of Industrial Standard International Classification (ISIC). Further detail on the source of activity data and emission factors used in the estimation on IPPU sector is presented in the following Table 3.9.

Table 3.9 List of activity data and emission factors used in the estimation of GHG emissions in IPPU sector

Category		Data	Year	Source
2A. Mineral Industry				
2A1: Cement Production	AD	Total clinker produced domestically Cementitious	2000 – 2008 2009 - 2014	Indonesian Cement Association (*Asosiasi Semen Indonesia - ASI*) Ministry of Industry
	EF	EF Default 0.52 t CO_2/clinker EF Local: 0.47 t CO_2/ton cementitious EF Local: 0.473 t CO_2/ton cementitious EF Local: 0.452 t CO_2/ton cementitious EF Local: 0.439 t CO_2/ton cementitious EF Local: 0.431 t CO_2/ton cementitious EF Local: 0.434 t CO_2/ton cementitious EF Local: 0.424 t CO_2/ton cementitious	 2000 – 2008 2009 2010 2011 2012 2013 2014	Documents on CDM and NAMAs in Cement Industry
2A2: Lime Production	AD	Lime Production	2000-2014	Statistics of the Manufacturing Industry – BPS
	EF	Default High Calcium Lime: 0.75 t CO_2/ t Lime		2006 IPCC GL
2A3: Glass Production	AD	Carbonate consumption for glass production	2000-2014	Statistics of the Manufacturing Industry – BPS
	EF	Limestone ($CaCO_3$): 0.43971 t CO_2/t carbonate		2006 IPCC GL
		Dolomite $CaMg(CO_3)_2$: 0.47732 t CO_2/t carbonate		
		Natrium Carbonate/Soda ash (Na_2CO_3): 0.41492 t CO_2/t carbonate		
2A4a: Ceramics	AD	Carbonate consumption for ceramics production	2000-2014	Statistics of the Manufacturing Industry – BPS
	EF	Limestone $CaCO_3$: 0.43971 t CO_2/t carbonate		2006 IPCC GL
		Dolomite $CaMg(CO_3)_2$: 0.47732 t CO_2/t carbonate		
		Natrium Carbonate/Soda ash (Na_2CO_3): 0.41492 t CO_2/t carbonate		
2A4b: Other Uses of Soda Ash	AD	Carbonate consumption for production except for glass, ceramics, pulp and paper, and food and beverages	2000-2014	Annual Statistics of Manufacturing Industry – BPS, 2015
	EF	Limestone $CaCO_3$: 0.43971 t CO_2/t carbonate		2006 IPCC GL
		Dolomite $CaMg(CO_3)_2$: 0.47732 t CO_2/t carbonate		
		Natrium Carbonate/Soda ash (Na_2CO_3): 0.41492 t CO_2/t carbonate		
2B. Chemical Industry				
2B1: Ammonia	AD	Actual production capacity of ammonia plant (including urea production)	2000-2014	Ministry of Industry (Agregate data from five urea plants)
	EF	Conventional reforming - natural gas: 1.694 t CO_2/t NH_3		2006 IPCC GL
2B2: Nitric Acid	AD	Actual production of nitric acid	2000-2014	SNC/BUR and Ministry of Industry
	EF	High pressure plants: 9 Kg N_2O/t nitric acid		2006 IPCC GL
2B5: Carbide	AD	Production data of Calcium Carbide (CaC_2)	2000-2011	Statistics of the Manufacturing Industry – BPS
			2012-2014	Ministry of Industry

	EF	▪ Calcium Carbide: 1,09 t CO_2/t raw material
		▪ Silicon Carbide:
		  ▪ 2.62 t CO_2/t raw material
		  ▪ 11.6 kg CH_4/t raw material
				2006 IPCC GL

2B8a: Methanol	AD	Domestic methanol production	2000-2014	Ministry of Industry
	EF	Lurgi conventional process: ▪ 0.39 t CO_2/t methanol ▪ 2.3 kg CH_4/t methanol		2006 IPCC GL

Category		Data	Year	Source
2B8b: Ethylene	AD	Ethylene production	2000-2014	Ministry of Industry
	EF	Naphta: ▪ 1.73 t CO_2/t ethylene ▪ 3 kg CH_4/t ethylene		2006 IPCC GL
2B8c: Ethylene Dichloride (EDC) and VCM	AD	EDC and VCM production	EDC: 2000-2014 VCM: 2006-2014	Ministry of Industry
	EF	▪ 0.196 t CO_2/t EDC ▪ 0.0226 kg CH_4/t EDC		2006 IPCC GL
2B8f: Carbon Black	AD	Carbon Black production	2000 - 2009 2010 - 2014	BPS Ministry of Industry
	EF	▪ Furnace Black Process (default): ▪ 2.62 t CO_2/t carbon black ▪ Thermal treatment: ▪ 0.06 kg CH_4/t carbon black		2006 IPCC GL
2C. Metal Industry				
2C1: Iron and Steel	AD	DRI, EAF, BOF, and Iron production (Blast Furnace)	DRI: 2000-2014 BOF: 2000-2014 Pig Iron: 2000-2014	Ministry of Industry
	EF	▪ BOF: 1.46 t CO_2/t product ▪ DRI: 0.7 t CO_2/t product ▪ Pig Iron: 1.35 t CO_2/t product ▪ Sinter: 0.2 t CO_2/t product		2006 IPCC GL
2C3: Aluminium	AD	Aluminium production	2000-2014	Ministry of Industry
	EF	▪ Year 2000-2009: 1.122 t CO_2e/t Al ▪ Year 2010-2012: 0.216 t CO_2e/t Al		CDM Document of PT. INALUM
2C5: Lead	AD	Lead production	2000-2013	Statistics of the Manufacturing Industry – BPS
			2014	Ministry of Industry
	EF	Default Emission Factor: 0.52 t CO_2/t production		2006 IPCC GL
2C6: Zinc	AD	Zinc production	2000-2012	Statistics of the Manufacturing Industry – BPS
			2013 - 2014	Ministry of Industry
	EF	Default factor: 1.72 t CO_2/t product		2006 IPCC GL
2D Non-Energy Products from Fuel and Solvent Use				
2D1: Lubricant Use	AD	Domestic use of lubricant (production minus export)	2000-2014	Handbook of Energy, MEMR
	EF	Default: 0.2		2006 IPCC GL
2D2: Paraffin Wax Use	AD	Domestic use of paraffin wax	2000-2014	Handbook of Energy, MEMR (category other products)
	EF	Default: 0.2		2006 IPCC GL
2H Other Industry				
2H1: Pulp and Paper	AD	Soda Ash consumption (Na_2CO_3) (assumed 3% of the total pulp production)	2000-2007	Statistics of the Manufacturing Industry – BPS
		Data on pulp production	2007-2014	Indonesian Pulp and Paper Association (*Asosiasi Pulp dan Kertas Indonesia – APKI*)
	EF	Natrium Carbonate/Soda ash (Na_2CO_3): 0.41492 t CO_2/t carbonate		2006 IPCC GL
2H2: Food and beverages	AD	Soda Ash consumption (Na_2CO_3)	2000-2014	Statistics of the Manufacturing Industry – BPS
	EF	Natrium Carbonate/Soda ash (Na_2CO_3): 0.41492 t CO_2/t carbonate		2006 IPCC GL

3.4.2.6 GHG Emission Estimates

GHG emissions in IPPU sector is dominated by CO_2 and the rest are CF_4, N_2O, CH_4, CF_4 and C_2F_6. As shown in Table 3.10 and Figure 3.8, the GHG emissions in 2014 was 47,488 Gg CO_2e, a 17.5% higher than the 2013's emission of 39,164 Gg CO_2e. Within the period of 2000-2014, the emissions in IPPU sector experienced an average of 0.7% increase annually.

Table 3.10 Summary on GHG emissions from IPPU sector by gas (in Gg CO_2e), 2000-2014

Year	CO_2	CH_4	N_2O	CF_4	C_2F_6	Total	Total 3 Gases
2000	42,391	70	149	250	22	42,882	42,610
2001	47,778	71	149	250	22	48,270	47,998
2002	41,202	65	149	250	22	41,688	41,416
2003	40,913	69	149	250	22	41,403	41,131
2004	42,657	68	149	250	22	43,146	42,874
2005	41,803	72	149	250	22	42,296	42,024
2006	38,145	64	149	260	22	38,640	38,358
2007	35,431	66	149	251	22	35,919	35,646
2008	36,003	72	149	252	22	36,498	36,224
2009	37,062	62	149	250	22	37,545	37,273
2010	35,708	83	90	130	22	36,033	35,881
2011	35,699	76	89	47	-	35,911	35,864
2012	39,623	81	327	47	-	40,078	40,031
2013	38,647	85	382	50	-	39,164	39,114
2014	46,965	69	415	39	-	47,488	47,449

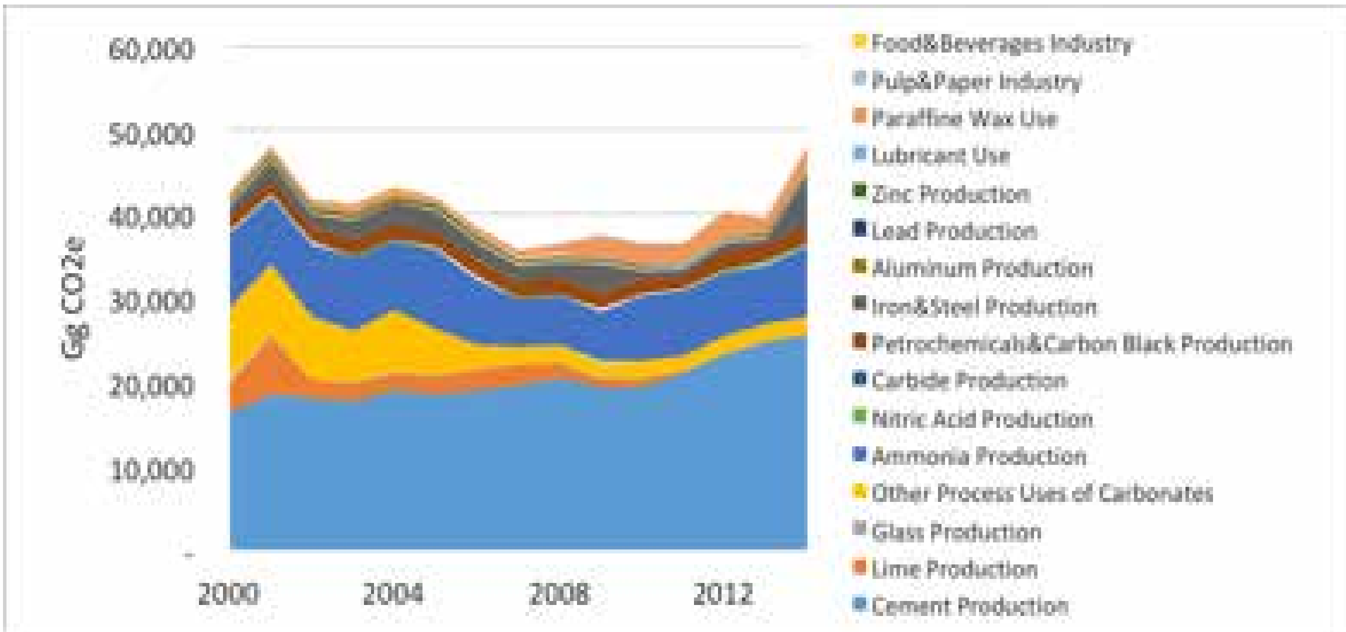


Figure 3.8 GHG Emissions from IPPU Sector by Source Category

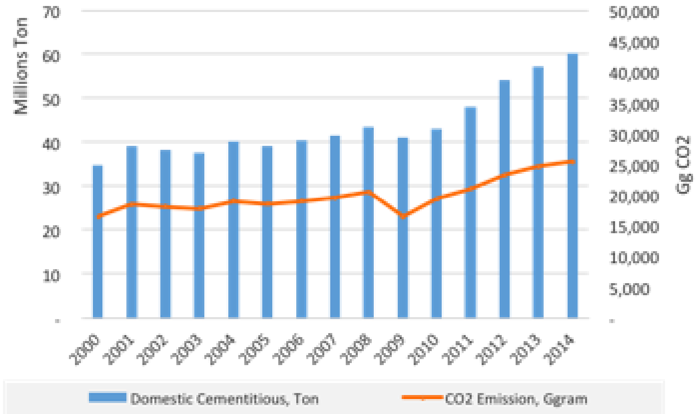


Figure 3.9 Cementitious data and estimated GHG emissions rom 2.A.1 – Cement production process

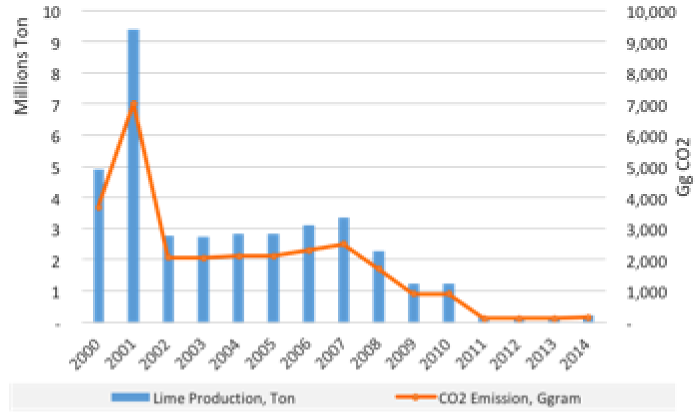


Figure 3.10 Lime production and GHG emissions from 2.A.2 – Lime production process

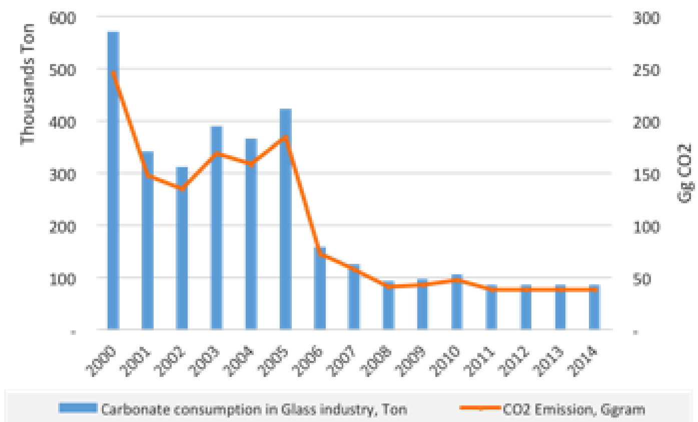


Figure 3.11 Carbonate consumption and GHG emissions from 2.A.3 – glass production process

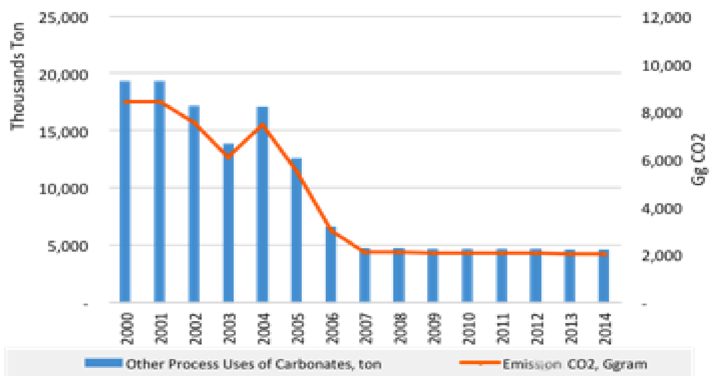


Figure 3.12 Other Process Uses of Carbonates and GHG emissions

In 2014, the largest contributor to IPPU sector's emission came from cement industry with 25,534 Gg CO_2. The estimation was based on data from national clinker production using national cementitious production data. For the period 2000 – 2008, cementitious data were estimated based on known ratio between cementitious and clinker, which is 0.866. Figure 3.9 shows cementitious data and estimated CO_2 emissions generated. Local emission factors were available for years 2009-2014, ranging from 0.424 – 0.474 ton CO_2/ton cementitious.

GHG emissions generated from lime, glass, and ceramics productions as well as other uses of carbonates, in average, were experiencing declines due to the decrease in production value of the respective industries (Figure 3.10 – Figure 3.12).

The development of GHG emissions in IPPU sector from chemical production is shown in Figure 3.13 to Figure 3.16 Emissions from ammonia production tend to be constant along with its production level. Estimation of emissions from this sub-category was conducted following the Tier 2 approach where data on fuel consumption for ammonia production and data on CO_2 recovery in urea production were used.

GHG emissions from production of nitric acid in the period of 2000 – 2014 were constant in the first nine years then experienced decline in 2010 – 2011. The emissions were later increased in 2012 – 2014. The changes in last year's were due to the addition of national production capacity with the establishment of new production plant.

IPPU emissions from production of carbide and petrochemical industry were fluctuating following the production level of each respective industry (Figure 3.15 and Figure 3.16).

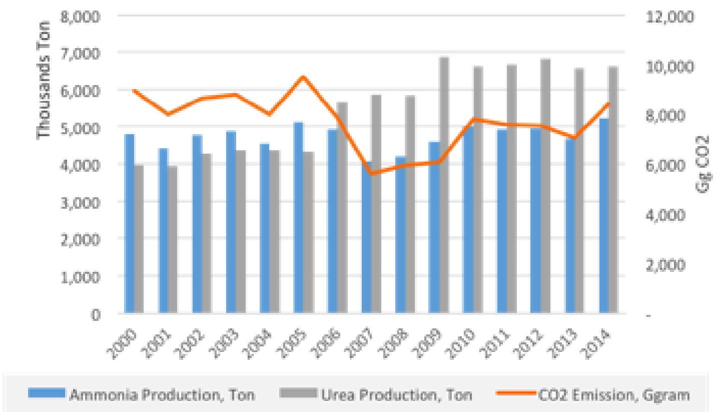


Figure 3.13 GHG emissions from 2.B.1 – Ammonia production

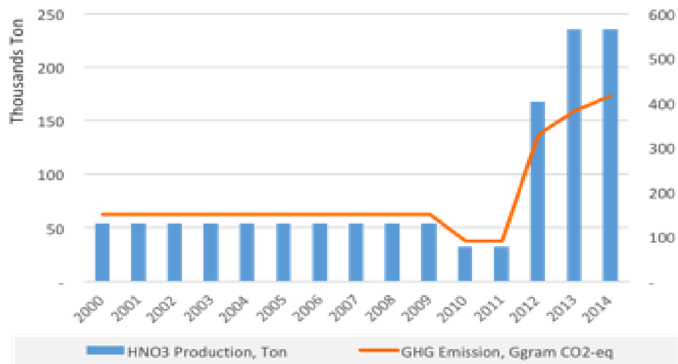


Figure 3.14 GHG emissions from 2.B.2 – Nitric acid production

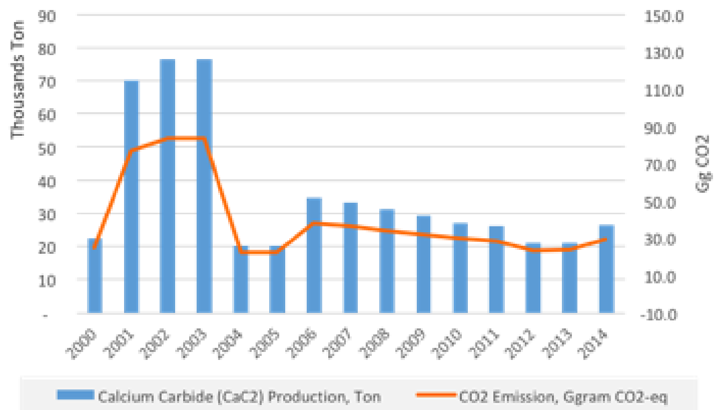


Figure 3.15 GHG emissions from 2.B.5 – Carbide production

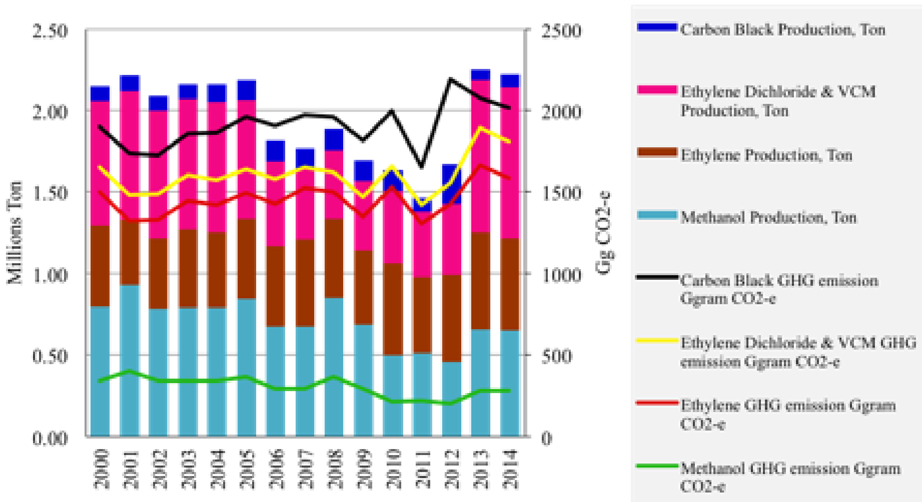


Figure 3.16 GHG emissions from 2.B.8 – Petrochemical industry

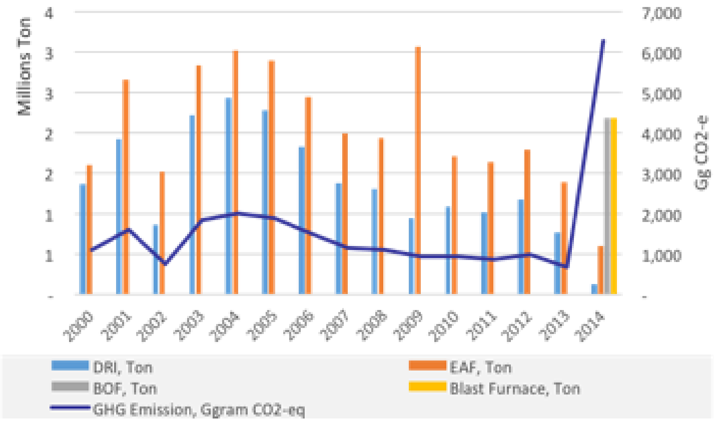


Figure 3.17 GHG emissions from 2.C.1 – Iron and steel production

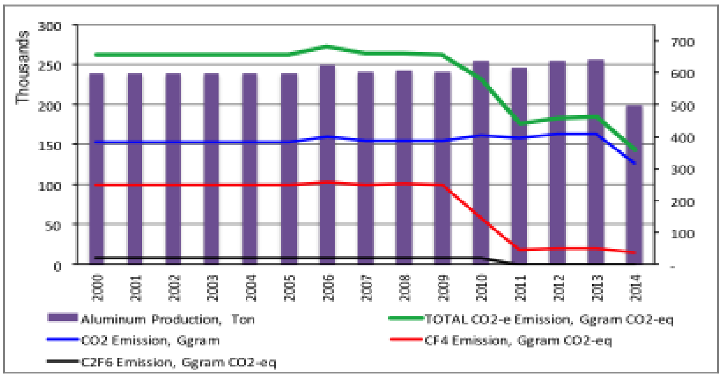


Figure 3.18 GHG emissions from 2.C.3 – Aluminium production

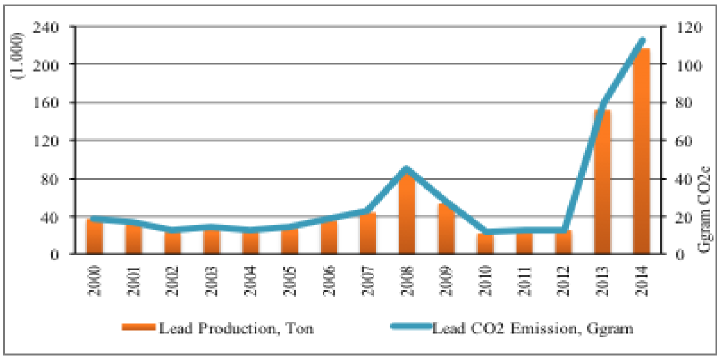


Figure 3.19 GHG emissions from 2.C.5 – Lead production

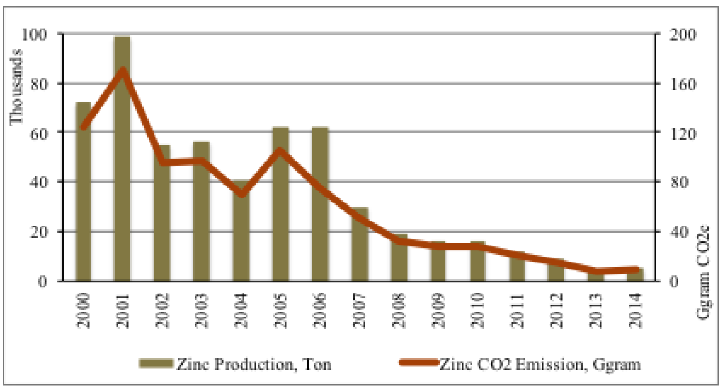


Figure 3.20 GHG emissions from 2.C.6 – Zinc production

The process in iron and steel production included in the GHG inventory for years 2000 – 2012 covers the production activities of Direct Reduced Iron (DRI) and Electric Arch Furnace (EAF). However, a correction to the data was made for this TNC document where iron and steel industry in the period of 2000 – 2014 implemented DRI and EAF production, but the DRI production was only implemented until March 2014. Afterward, the industry implemented other types of production, i.e: BOF and Blast Furnace. Thus there was and increase in GHG emissions level in 2014 (Figure 3.17).

There is only one aluminium smelter in Indonesia, PT. INALUM in North Sumatera, which applies Centre-Worked Prebake technology. The anode effect of aluminium production process in this company generates PFC emissions that are being monitored due to the company's participation in CDM project. The monitoring process provides data on aluminium production and the following emission factors: 1.6 ton CO_2e/ton Al production; 0.4 ton CF_4/t Al (year 2000-2010); 0.03 ton CF_4/t Al (year 2011-2014); 0.04 ton C_2F_6/ton Al (year 2000-2010) and 0 ton C_2F_6 / ton Al for year 2011-2014. The zero emissions of C_2F_6 after 2010 was caused by installation of new technology in the factory's aluminium production process (Figure 3.18).

Lead production showed an increasing trend while on the contrary, zinc production experienced a decline. For lead industry, the production level and GHG emissions were increasing in the periods of 2000 – 2008 and 2013 – 2014, but had a decrease in the period of 2010 – 2012. In 2014, the production value of lead was 217,588 ton and GHG emission level was 113 Gg CO_2e (Figure 3.19).

Zinc industry showed adeclining trend in production. In 2014, the production value of the industry was 5,769 ton and its GHG emission level was 10 Gg CO_2e (Figure 3.20).

Lubricant was mostly used in industry and transportation. It was produced through the separation of crude oil or at petrochemical facilities. The classification of paraffin wax here includes jelly oil, paraffin wax, and other waxes including ozokerite (a mixture of saturated hydrocarbon, solid at room temperature). Emissions from use of paraffin are mostly generated when it and its derivatives are burned, and when wax is burned with or without heat recovery or in wastewater treatment (for surfactant).

In general, use of lubricant was stable in the period of 2000 – 2014, with the exception of a decline in 2002 and 2010. Profile of lubricant and paraffin use and its respective CO_2 emissions is presented in Figure 3.21.

For pulp and paper industry, soda ash consumption was estimated based on Na_2CO_3 needs in pulp production, which is 3% of the total annual production. For food and beverages industry, data on soda ash consumption was obtained from the Statistics of the Manufacturing Industry – BPS. Consumption value of soda ash in the two industries, and its CO_2 emissions are presented in Figure 3.22 and Figure 3.23.

In 2014, IPPU emissions from the three main gases (CO_2, CH_4, and N_2O) were 47,449 Gg CO_2e (Table 3.11).

Result of Key Category Analysis (KCA) for IPPU sector is presented in Table 3.12 From 20 emission sources, the six main contributors are: cement industry, ammonia production, iron and steel, paraffin wax use, ethylene, and nitric acid production.

3.4.3 AFOLU (Agriculture Forestry and Other Land Use)

According to the 2006 IPCC GL, AFOLU sector is classified into four categories: (A) livestock, (B) land, (C) aggregate sources and non-CO_2 emissions sources on land, and (D) others. In Indonesia, livestock is included under agriculture sector thus categories 3A and 3C are covered by the agriculture sector while category 3B is covered by the forestry sector.

a. GHG Inventory on Agriculture Sector

b. Livestock

3.4.3.1 GHG Emission Category

The sources of GHG emissions of livestock sector include GHG emissions from enteric fermentation and manure management. The estimation for both sub-categories were based on Tier 1 approach using livestock population data. However, for the estimation of sub-category direct and indirect N_2O emissions, an assumption based on national condition was applied to assist in the determination of the types of treatment for cattle manure.

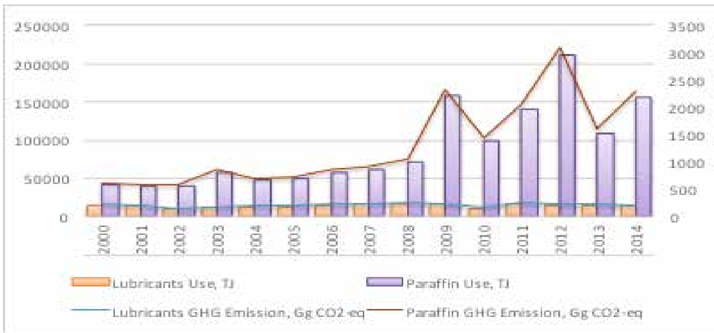


Figure 3.21 GHG emissions from 2.D.1 – Lubricant Use and 2.D.2 – Paraffin Wax use

Figure 3.22 GHG Emissions from 2.H.1 – Carbonate use in pulp and paper industry

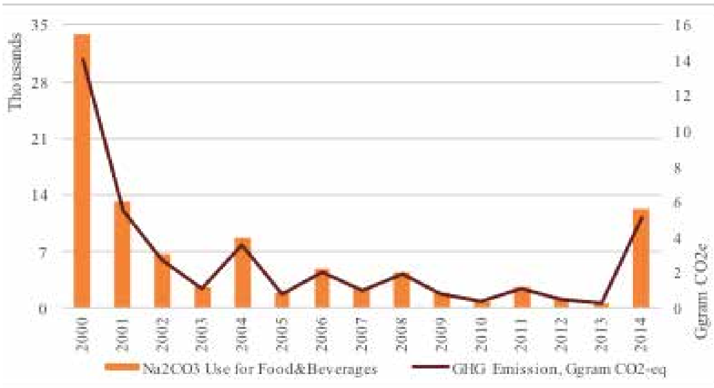


Figure 3.23 GHG emissions from 2.H.2 – Carbonate consumption in food and beverages industry

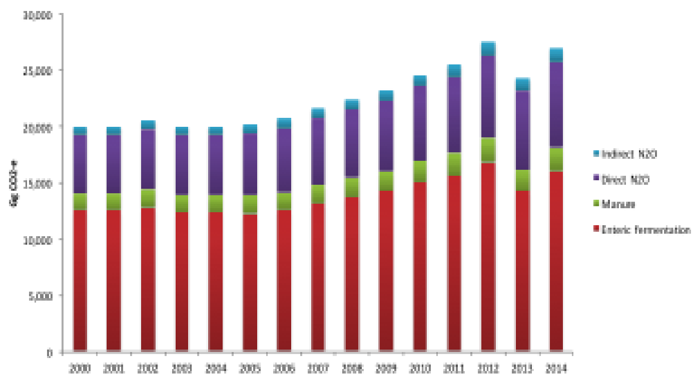


Figure 3.24 Trend in CO_2e Emission from Livestock, 2000-2014

Table 3.11 GHG Emissions in IPPU Sector in 2014 (in Gg CO_2e)

Kategori		CO_2	CH_4	N_2O	Total for 3 Gases
		(Gg)	(Gg)	(Gg)	(Gg CO_2e)
2A1	Cement Production	25,534			25,534
2A2	Lime Production	153			153
2A3	Glass Production	38			38
2A4a	Ceramics Production	6			6
2A4b	Other Carbonate Use	2,021			2,021
2B1	Ammonia Production	7,947			7,947
2B2	Nitric Acid Production			1.34	415
2B5	Carbide Production	29			29
2B8	Petrochemical and Carbon Black				
	2B8a Methanol	251	1.5		282
	2B8b Ethylene	1,262	1.68		1,297
	2Bbc Ethylene dichloride &VCM	229			229
	2B8f Carbon black	203	-		203
2C1	Iron and Steel Production	6,256	0.1		6,259
2C3	Aluminium Production	319			319
2C5	Lead Production	113			113
2C6	Zinc Production	10			10
2D1	Lubricant Use	206			206
2D2	Paraffin Wax Use	2,284			2,284
2H1	Soda Ash Use in Pulp and Paper Industry	99			99
2H2	Soda Ash Use in Food and Beverages Industry	5.10			5.10
	Total	**46,965**	**3.3**	**1.34**	**47,449**

Table 3.12 Key Category Analysis

Code	Category	Total GHG Emissions, Ggram CO_2e (2014)	Level/ Rank	Cumulative
2A1	Cement production	25,534	53.77%	53.77%
2B1	Ammonia production	7,947	16.73%	70.50%
2C1	Iron & steel production	6,259	13.18%	83.68%
2D2	Paraffin wax use	2,284	4.81%	88.49%
2A4b	Other Carbonate Use	2,021	4.26%	92.75%
2B8b	Ethylene	1,297	2.73%	95.48%
2B2	Nitric acid production	415	0.87%	96.35%
2C3	Aluminium production	358	0.75%	97.11%
2B8a	Methanol	282	0.59%	97.70%
2Bbc	Ethylene dichloride and VCM	229	0.48%	98.18%
2D1	Lubricants use	206	0.43%	98.62%
2B8f	Carbon black	203	0.43%	99.05%
2A2	Lime production	153	0.32%	99.37%
2C5	Lead production	113	0.24%	99.61%
2H1	Soda Ash Use in pulp & paper industry	99	0.21%	99.81%
2A3	Glass production	38	0.08%	99.89%
2B5	Carbide production	29	0.06%	99.96%
2C6	Zinc production	10	0.02%	99.98%
2A4a	Ceramic production	6	0.01%	99.99%
2H2	Soda Ash Use in food & beverages industry	5.1	0.01%	100.%
	Total	**47,488**		

3.4.3.2 Time Frame

The GHG inventory reported in this document covers GHG emissions generated for the year 2000 until 2014. GHG Inventory for the period of 2000 – 2012 is available from the Indonesia First BUR document, with updated activity data.

3.4.3.3 Data Sources

Livestock data and relevant information to GHG Inventory were gathered from a single source, i.e., the Statistics of Agriculture year 2000 – 2014 (BPS, 2016).

3.4.3.4 GHG Emissions Estimates

Livestock population in Indonesia has increased in years, with the largest population being broiler chicken and the lowest dairy cattle. In 2014, the total GHG emissions from livestock were 26,943 Gg CO_2e, higher than the 2013's emissions of 24,254 Gg CO_2e (Figure 3.24). This was caused by significant increased in population, especially from beef cattle.

The largest source of emissions for livestock sub-category in 2014 was CH_4 derived from enteric fermentation (60% of total livestock emission), followed by direct N_2O emissions from manure management (28%), CH_4 emissions from manure management, and indirect N_2O emissions from manure management (4%).

1. Methane Emission from Livestock

Enteric fermentation is the main source of methane (Figure 3.25). In Indonesia it was mostly generated by beef cattle (65.1%), goats (12.2%), sheep (10.5%), and buffalo (6.9%). The 2014 emission level from this sub-category was 16,084 Gg CO_2e.

Meanwhile, the total methane emissions from manure management in 2014 was 2,031 Gg CO_2e and mostly contributed by swine (56%), followed by dairy cattle (12%) and beef cattle (11%). Emissions from other types of livestock contributed to around 21% of the total emissions from this sub-category (Figure 3.26).

2. N_2O Emission from Manure Management

Direct N_2O emission is the main source of N_2O from manure management. In 2014, direct N_2O emission was 7,625 Gg CO_2e, while indirect N_2O emission was 1,117 Gg CO_2e.

Goats, sheep, beef cattle, and dairy cattle were the most contributing livestock species to the N_2O emissions from manure management. In 2014, the total N_2O emissions from manure management was 8,827 Gg CO_2e (Figure 3.27).

a. **Aggregate Sources and Non-CO_2 Emission Sources on Land**

3.4.3.5 Source Category

Under this category, the sources of GHG emissions can be classified into seven sub-categories, (a) biomass burning, (b) liming, (c) urea application, (d) direct N_2O emission from managed soil, (e) indirect N_2O emission from managed soil, (f) indirect N_2O emission from manure management, and (g) rice cultivation. In this report, emissions from biomass burning in forest land and other land were excluded due to unavailability of activity data on burnt area. Only emission from biomass burning in cropland and grassland were included.

3.4.3.6 Time Frame

The GHG inventory reported in this document covers GHG emissions generated in the year 2000 until 2014. GHG Inventory for the period of 2000 – 2005 was taken from SNC document, with updated activity data.

3.4.3.7 Data Sources

Activity data used in the estimation of GHG emissions from this category were obtained from various publications. Activity data for biomass burning and lime application were provided by the Center for Data and Information – MoA, who also provided data on urea application, direct N_2O from managed soil and indirect N_2O from manure management, with additional information from the Indonesia Fertiliser Producer Association (*Asosiasi Produsen Pupuk Indonesia – APPI*). Meanwhile, activity data to estimate methane emission from rice cultivation were provided by the Centre for Data and Information – MoA and BPS.

3.4.3.8 GHG Emission Estimates

In estimating the emissions for Aggregate Sources and Non-CO_2 Emission Sources on Land, some of the calculations were based on the aggregate of emissions in provincial level. In rice cultivation and biomass burning (in cropland and grassland), data collection was conducted

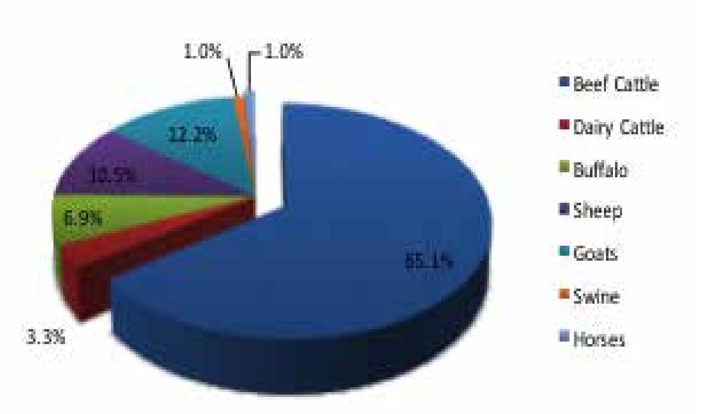


Figure 3.25 Contribution to CH_4 emissions from enteric fermentation by livestock species

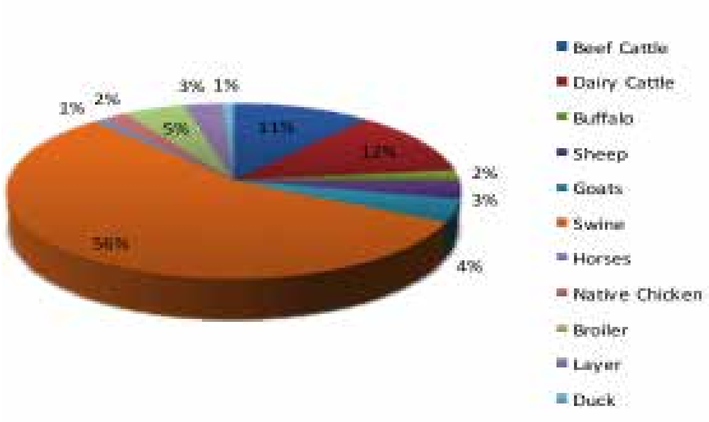


Figure 3.26 Contribution to CH4 emissions from manure management by livestock species

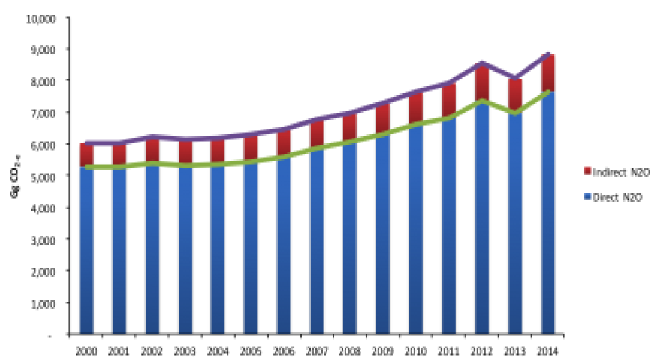


Figure 3.27 Trend of N_2O emission from manure management for the 2000-2014 period

for provincial level, while for N_2O from managed soil, and urea and lime application data collection was conducted for national level. Therefore, biophysical condition between provinces was part of the consideration in determining the emission factor.

1. **Emissions from Biomass Burning**

a. **Biomass Burning in Grassland and Biomass Burning in Cropland**

Biomass burning emissions from grassland was calculated based on harvested upland rice area for the period of 2000 – 2014, while emissions from biomass burning in cropland was calculated based on harvested rice area and rice production. Data on harvested upland rice area was used under the assumption that the data can be used to represent the shifting cultivation area where biomass burning might have occurred.

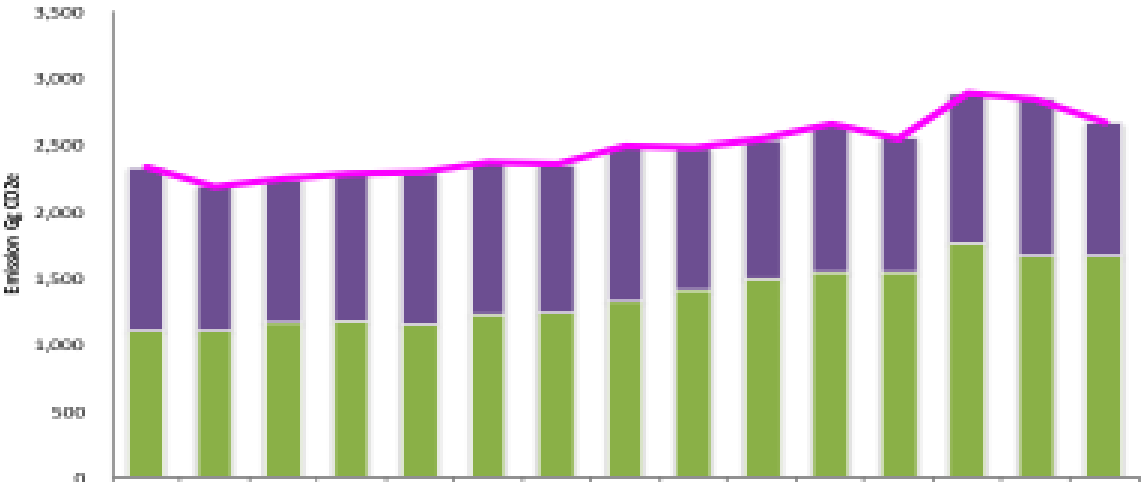
Results of the calculation show a decreasing trend of biomass burning emissions from grassland over an increasing trend of biomass burning emissions from cropland (Figure 3.28). The total emissions from biomass burning in 2000 reached 2,322 Gg CO_2e, followed by an increase to 2,654 Gg CO_2e in 2014.

2. Emission from Liming

CO_2 emissions from lime application was calculated based on the number of lime applied (according to the recommended dose) in palm oil, cocoa, and rubber plantations in sulphuric acid and organic soils. Lime are rarely applied for crops thus it wasn't calculated. Along with the increasing trend on lime application in Indonesia, so did the GHG emission within this same period (Figure 3.29). The increasing lime consumption was consistent with the expansion of palm oil plantation on peatland after the year 2000. CO_2 emission level from this sub-category in 2000 reached 872 Gg CO_2, and increased by more than 100% to 1,920 Gg CO_2 in 2014.

3. Emissions from Urea Application

Activity data from urea application for the 2000-2014 period was calculated from the domestic consumption of fertiliser gathered from the APPI. Moreover, urea application was also estimated from palm oil plantations by multiplying the recommended dose with plantation area. CO_2 emissions from this sub-category is shown in Figure 3.30 where the 2000's and 2014's emission levels was at 3,900 Gg CO_2 and 4,836 Gg CO_2, respectively. Increased of emission from urea application followed the increased in crop productions especially rice, which was consistent with the increasing of rice field area.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Biomass Burning GL	1,224	1,084	1,084	1,112	1,140	1,153	1,109	1,162	1,072	1,043	1,106	1,002	1,112	1,172	989
Biomass Burning CL	1,098	1,100	1,152	1,166	1,146	1,213	1,235	1,318	1,397	1,488	1,532	1,537	1,761	1,657	1,664
Total	2,322	2,184	2,235	2,278	2,286	2,366	2,344	2,480	2,469	2,531	2,638	2,539	2,873	2,830	2,654

Figure 3.28 Emissions from biomass burning for the 2000 – 2014 period

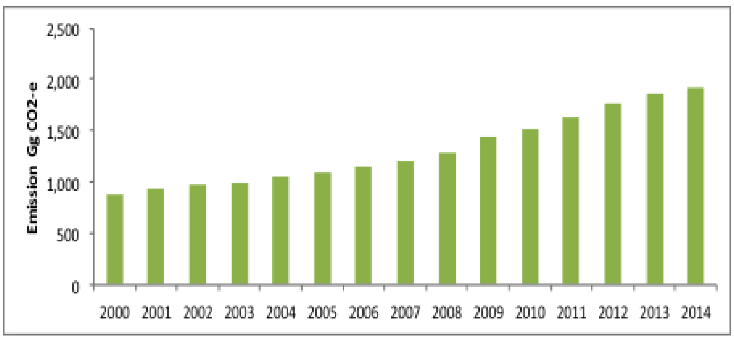


Figure 3.29 CO_2 emission from liming

4. N_2O Emission from Managed Soil

a. *Direct N_2O emission*

Urea, ammonium sulphate (AS), and NPK (nitrogen, phosphorus, and potassium) are the most common inorganic nitrogen (N) fertiliser used for cultivation in Indonesia. Urea and AS are the most applied nitrogen-based inorganic fertiliser in large plantations (APPI, 2008). Moreover, the fertilisers are also applied for fruits, vegetables, and other annual crops with high economic values. Nitrogen concentration in urea, AS, and NPK are 46%, 21%, and 15%, respectively (Petrokimia Gresik, 2008).

Direct N_2O from managed soil was calculated from the consumption of N and manure fertiliser. Direct N_2O emission on inundated rice fields was calculated based on data of harvested rice field area and data on managed soils area for crops, horticulture, vegetables, fruits, and plantations. Fluctuations of direct N_2O emissions from managed soil in the period of 2000 – 2014 is attributed to the consumption of urea, NPK, and AS for cultivation. In the year 2000, emissions from this sub-category totalled to 26,775 Gg CO_2e, and was increased to 32,575 Gg CO_2e in 2014 (Figure 3.31).

b. Indirect N_2O Emission from Managed Soil

Indirect N_2O emission from managed soil was calculated based on the consumption of N fertiliser (urea, AS, NPK, and manure) for agricultural area. As shown in Figure 3.32, the overall emissions showed an increasing trend in the period of 2000 – 2014, although subsequently declined in 2014 (8,520 Gg CO_2e) as compared to the 2013's emission level (8,691 Gg CO_2e).

5. Emissions from Rice Cultivation

Activity data used to calculate emissions from rice cultivation was based on data for the 2000 – 2014 period on rice field area and planting intensity published by the MoA and BPS. Scale factor for soil was weighted based on the proportion of soil type in the province. Weighting was also used to define the national scale factor for paddy variety, taking into account the proportion of all paddy varieties used at the provincial level. The scale factor value was then applied for all years of inventory.

Methane emissions from rice cultivation in Indonesia in 2000 and 2014 were 38,587 CO_2e and 35,994 CO_2e respectively (Figure 3.33). The emissions reduction that occurred in 2014 was attributable to the mitigation measures especially on the application of low emission paddy variety, SRI (System of Rice Intensification) program and SLPTT (*Sekolah Lapang Pengelolaan Tanaman Terpadu* – Field School on Integrated Crop Management) program initiated in 2008 by the Ministry of Agriculture.

3.4.3.9 Summary of Emissions from Agriculture Sector

In 2000, the total GHG emissions in agriculture sector from the three main gases (CO_2, CH_4 and N_2O) was 99,717 Gg CO_2e, and it was significantly increased to 113,441 Gg CO_2e in 2014.

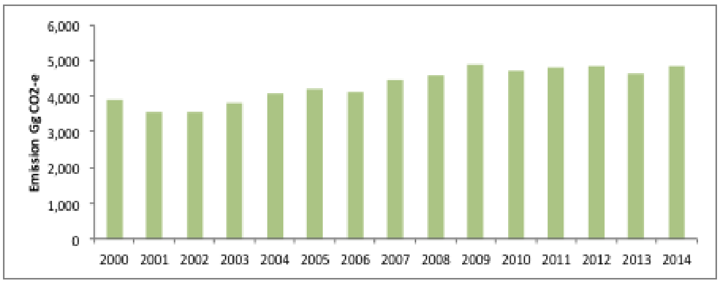


Figure 3.30 CO_2 emissions from urea application for the 2000-2014 period

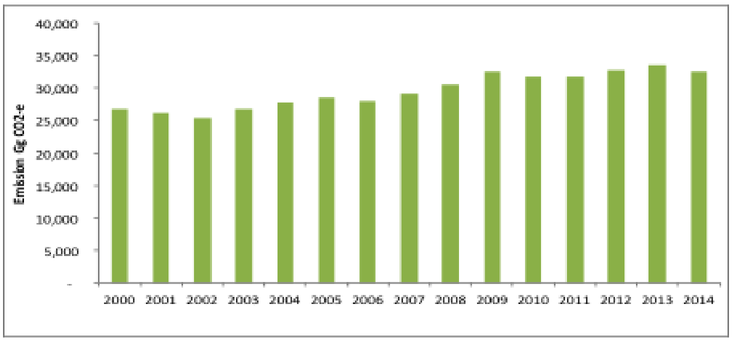


Figure 3.31 Direct N_2O emission from managed soil for the 2000-2014 period

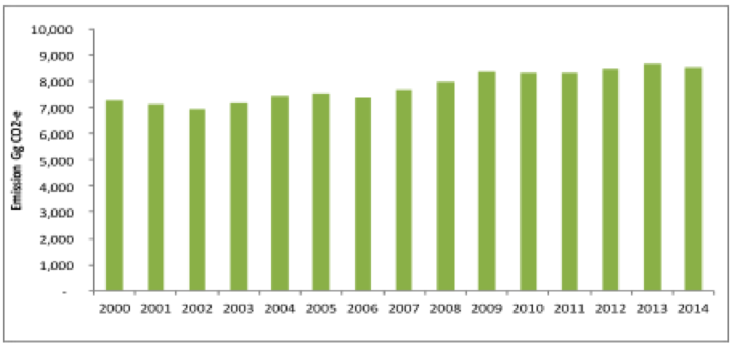


Figure 3.32 Indirect N_2O emissions from managed soil for the 2000-2014 period

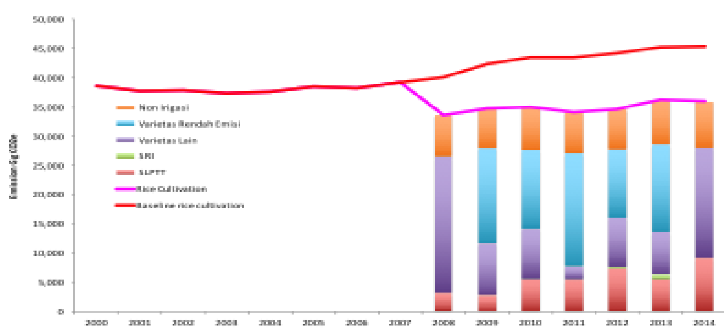


Figure 3.33 Methane emissions from rice cultivation for the 2000-2014 period

Figure 3.34 indicates that by source category, the 2014 GHG emission from agriculture sector originated from rice cultivation (32%), direct N_2O from managed soil (29%), and enteric fermentation from manure (14%). The abovementioned three sources contributed to 75% of the total GHG emissions from agriculture sector.

GHG Inventory from Forestry and Other Land Use

3.4.3.10 Source Category of GHG Emissions from Forestry and Other Land Use

On this sector, GHG emission/removal was classified into the six IPCC land use categories, in which land is categorized to, lands remaining in a land use category and lands converted. The emission/removal from LUCF is therefore classified into 12 categories, i.e. (1) forest land remained as forest, (2) land converted to forest land, (3) cropland remained crop land, (4) land converted to cropland, (5) grassland remained grassland, (6) land converted to grassland, (7) wetlands remained wetlands, (8) land converted to wetlands, (9) settlements remained settlements, (10) land converted to settlements, (11) other land remained other land, (12) land converted to other land.

The total CO_2 emissions/removals from C stock changes for each land use category is the sum of those from these all subcategories by considering the five carbon pools: (i) above ground biomass, (ii) below ground biomass, (iii) dead wood, (iv) litter, and (v) soil.

3.4.3.11 Type of Gases

According to the 2006 IPCC GL, GHGs that fall under the category of land use change and forestry (LUCF) are CO_2, CH_4 and N_2O. However, this document will only cover the estimated CO_2 emissions.

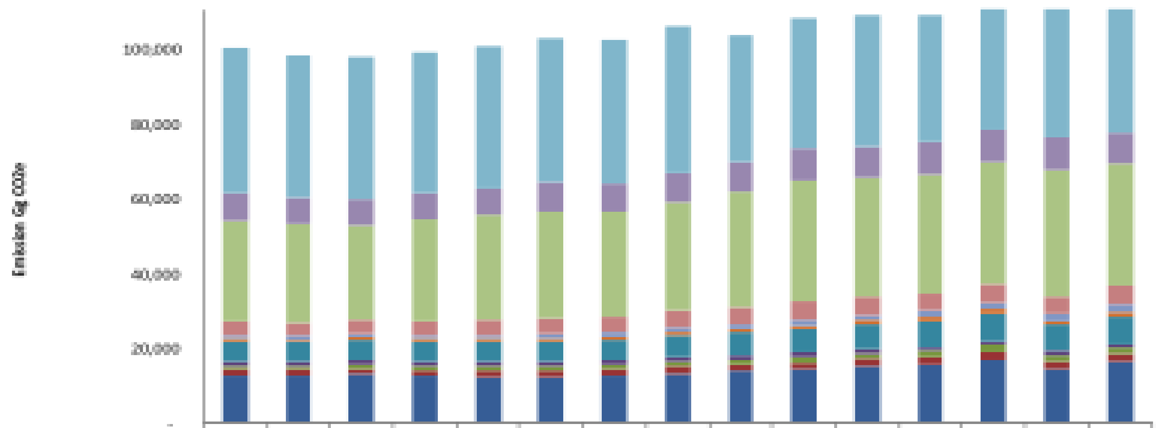
3.4.3.12 Time Frame

The GHG emissions inventory reported in this document provides the GHG emissions for the period of 2000 to 2014.

3.4.3.13 Data Sources

Land cover map produced by the Ministry of Forestry was used as the basis for generating activity data to estimate GHG emissions under this category of emission source. The dataset used for the inventory were data on years 2000, 2003, 2006, 2009, 2011, 2012, 2013 and 2014.

Since land categories in the 2006 IPCC GL consisted of 6 main land use categories, land cover categories by the Ministry of Environment and Forestry were grouped according to the 2006



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Rice Cultivation (3C7)	38,587	37,720	37,813	37,374	37,679	38,510	38,283	39,272	33,679	34,776	34,990	34,134	34,641	36,230	35,994
Indirect N2O Soils (3C5)	7,254	7,108	6,951	7,167	7,405	7,514	7,383	7,651	7,953	8,372	8,333	8,331	8,479	8,691	8,520
Direct N2O Soils (3C4)	26,775	26,237	25,366	26,839	27,758	28,546	27,876	29,102	30,641	32,454	31,731	31,780	32,646	33,624	32,575
Urea Fertilization (3C3)	3,900	3,562	3,547	3,809	4,056	4,210	4,124	4,440	4,581	4,865	4,709	4,813	4,853	4,619	4,836
Liming (3C2)	872	933	976	1,001	1,057	1,091	1,146	1,200	1,275	1,441	1,515	1,631	1,771	1,858	1,920
Indirect N2O Manure Management (3C6)	751	773	850	824	826	836	861	915	931	978	1,007	1,084	1,162	1,117	1,202
Direct N2O Manure Management (3A2b)	5,265	5,259	5,378	5,331	5,348	5,448	5,611	5,876	6,046	6,292	6,630	6,821	7,371	6,953	7,625
Biomass Burning Grassland (3C1c)	1,224	1,084	1,084	1,112	1,140	1,153	1,109	1,162	1,072	1,043	1,106	1,002	1,112	1,172	989
Biomass Burning Cropland (3C1b)	1,098	1,100	1,152	1,166	1,146	1,213	1,235	1,318	1,397	1,488	1,532	1,537	1,761	1,657	1,664
Manure Management (3A2a)	1,422	1,429	1,549	1,575	1,545	1,659	1,595	1,693	1,758	1,811	1,910	1,995	2,103	1,937	2,031
Enteric fermentation (3A1)	12,570	12,585	12,813	12,351	12,339	12,239	12,597	13,129	13,697	14,212	15,024	15,590	16,828	14,247	16,084

Figure 3.34 GHG emissions from agriculture sector by category for the 2000-2014 period

IPCC GL as shown in Table 3.13. To ensure that variations among regions in the calculation of emissions from LUCF were considered, land cover types were stratified into seven major island groups, i.e. Sumatera, Java, Kalimantan, Sulawesi, Bali and Nusa Tenggara, Maluku and Papua, and two soil types, i.e. mineral soil and peat soil.

3.4.3.14 Summary of GHG Inventory on Forestry and Other Land Use

Summary of GHG emissions from forestry and other land use in 2000 – 2014 were presented in Table 3.14 and Figure 3.35, with annual average of 658,878 Gg CO_2e. As reported in the 1st BUR, emissions from this category in 2000 and 2012 were 505,368 Gg CO_2e and 694,978 Gg CO_2e. In 2014, the emissions increased to 979,422 Gg CO_2e. Fluctuation of emissions in the period of 2000 – 2014 was influenced by emissions from peat fires, as one source of emission.

As seen in Table 3.14, the main sources of emissions from LUCF are peat fires, peat decomposition, and land use change from non-cropland to cropland with contributions in 2014 of 499,389 Gg CO_2e, 341,735 Gg CO_2e and 141,481 Gg CO_2e, respectively. For source of removal, the main source in 2014 was the sub category of forest remaining forest, contributing to 127,701 Gg CO_2e (marked negative in Table 3.15).

Table 3.13 Adjustment of land cover category produced by the Ministry of Environment and Forestry to the 2006 IPCC GL categories

No	Land-cover class	2006 IPCC GL	Abbreviation	Note
	Forest			
1.	*Primary dryland forest*	*Forest*	*FL*	Natural forest
2.	*Secondary dryland forest*	*Forest*	*FL*	Natural forest
3.	*Primary mangrove forest*	*Forest*	*FL*	Natural forest
4.	*Secondary mangrove forest*	*Forest*	*FL*	Natural forest
5.	*Primary swamp forest*	*Forest*	*FL*	Natural forest
6.	*Secondary swamp forest*	*Forest*	*FL*	Natural forest
7.	*Plantation forest*	*Forest*	*FL*	Plantation forest
	Other Land Use			
8.	*Estate crop*	*Crop land*	*CL*	Non-forest
9.	*Pure dry agriculture*	*Crop land*	*CL*	Non-forest
10.	*Mixed dry agriculture*	*Crop land*	*CL*	Non-forest
11.	*Dry shrub*	*Grassland*	*GL*	Non-forest
12.	*Wet shrub*	*Grassland*	*GL*	Non-forest
13.	*Savannah and Grasses*	*Grassland*	*GL*	Non-forest
14.	*Paddy Field*	*Crop land*	*CL*	Non-forest
15.	*Open swamp*	*Wetland*	*WL*	Non-forest
16.	*Fish pond/aquaculture*	*Wetland*	*WL*	Non-forest
17.	*Transmigration areas*	*Settlement*	*ST*	Non-forest
18.	*Settlement areas*	*Settlement*	*ST*	Non-forest
19.	*Port and harbour*	*Other land*	*OL*	Non-forest
20.	*Mining areas*	*Other land*	*OL*	Non-forest
21.	*Bare ground*	*Other land*	*OL*	Non-forest
22.	*Open water*	*Wetland*	*WL*	Non-forest
23.	*Clouds and no-data*	*No data*	-	Non-forest

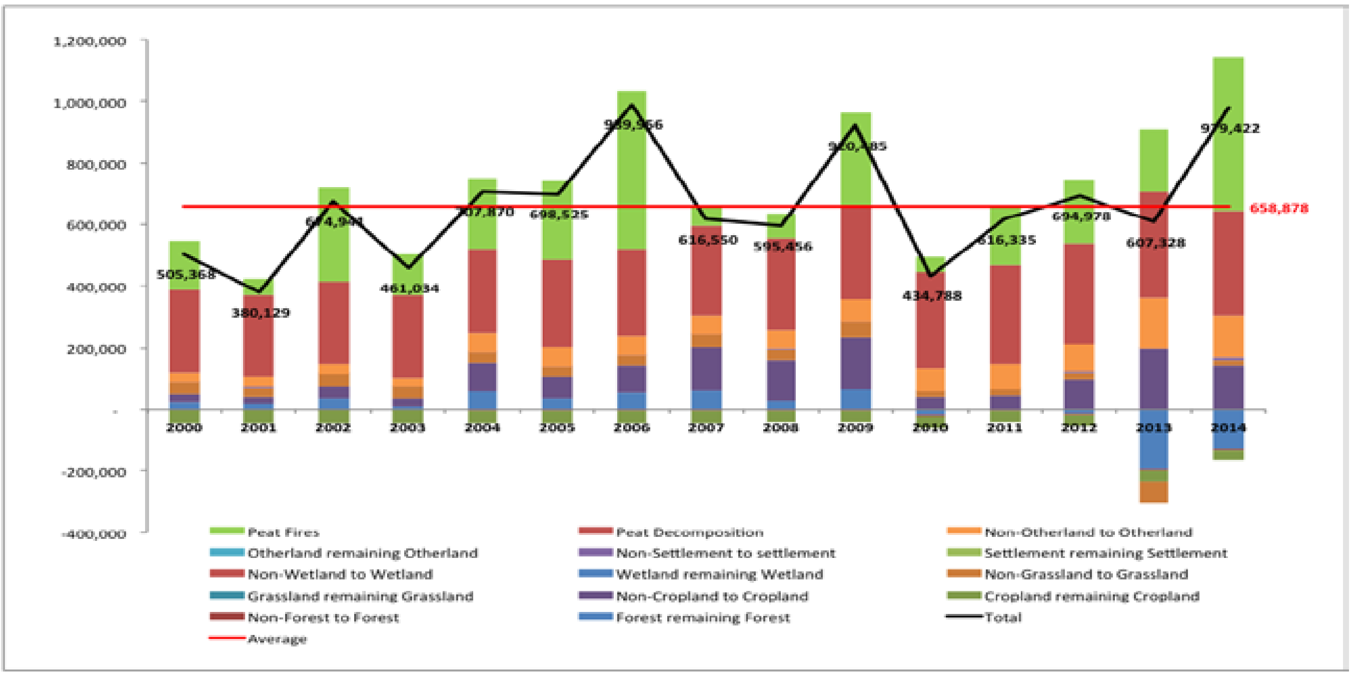


Figure 3.35 Emissions from Forestry and Other Land Use (Gg CO_2e) for the 2000-2014 period

Table 3.14 Emissions from Forestry and Other Land Use (in Gg CO_2e) for the 2000-2014 period

Code	Source Category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
3B1a	Forest remaining Forest	20,678	17,537	37,002	7,495	56,129	35,824	51,523	61,158	27,650	66,632	-17,655	77	-11,839	-192,135	-127,701
3B1b	Non-Forest to Forest	-1,260	-1,274	-1,320	-1,187	-2,647	-2,805	-2,603	-2,152	-2,225	-2,734	-5,183	-4,819	-4,095	-4,909	-3,675
3B2a	Cropland remaining Cropland	-41,587	-41,626	-41,541	-41,595	-41,450	-41,219	-40,778	-39,835	-38,855	-37,671	-37,464	-36,985	-36,758	-35,886	-33,729
3B2b	Non-Cropland to Cropland	29,609	22,931	36,709	29,186	93,413	71,680	90,222	140,197	131,466	167,580	38,641	45,658	95,266	197,494	141,481
3B3a	Grassland remaining Grassland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B3b	Non-Grassland to Grassland	36,335	32,319	40,338	36,348	34,802	30,338	34,659	40,477	36,592	47,774	18,164	21,088	25,342	-69,383	17,118
3B4a	Wetland remaining Wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B4b	Non-Wetland to Wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B5a	Settlement remaining Settlement	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B5b	Non-Settlement to settlement	1,863	2,199	1,775	1,614	1,482	971	1,348	1,240	931	1,390	1,370	1,677	1,753	1,975	10,257
3B6a	Other land remaining Other land	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3B6b	Non-Other land to Other land	29,585	29,626	31,679	27,448	59,692	64,031	58,587	59,892	60,804	74,028	72,564	78,020	89,692	163,653	134,546
	Other :															
Peat Decomposition		268,575	267,531	268,545	269,650	274,431	280,818	286,289	292,825	297,349	303,567	312,968	322,595	328,567	341,443	341,735
Peat Fires		161,571	50,885	301,753	132,075	232,018	258,887	510,710	62,747	81,744	299,920	51,383	189,026	207,050	205,076	499,389
Total		**505,368**	**380,129**	**674,941**	**461,034**	**707,870**	**698,525**	**989,956**	**616,550**	**595,456**	**920,485**	**434,788**	**616,335**	**694,978**	**607,328**	**979,422**

3.4.4 Waste Sector

3.4.4.1 Source Category

Under the 2006 IPCC GL, the sources of emissions from waste sector are classified into the following four categories: (a) municipal solid waste (MSW) treatments in solid waste disposal site (SWDS) or landfill, biological treatment/composting unit, open burning site, and incinerator, (b) domestic liquid waste treatment (collected and treated in centralized domestic wastewater treatment – WWT as well as un-collected such as septic tank, latrine, etc.), (c) industrial wastewater treatment, and (d) industrial solid waste treatment.

Due to the difficulties in data collection and identification, not all GHG emissions from these waste treatment activities could be reported in this document, i.e. industrial solid waste (including sludge from wastewater treatment plant), clinical waste, hazardous waste, etc. However, compared to the SNC, the coverage of GHG emissions of the waste sector reported in this document is broader, i.e. by including several types of industries that were not covered in the SNC.

3.4.4.2 Type of Gases

Based on the 2006 IPCC GL, the types of GHG from waste sector includes CO_2, CH_4, and N_2O. CO_2. These gases were released from incineration and open burning of waste. CH_4 was mainly released from anaerobic digestion processes, i.e. at solid waste disposal site or SWDS (landfill) and decay of organic matter at wastewater treatment plant. N_2O was mainly released from biological process in composting activity and municipal wastewater treatment facilities.

3.4.4.3 Methodology

GHG emissions level of waste sector was dependent on the amount of waste to be treated and characteristics of the wastes and the treatment processes. The GHG emission calculated also dependent on its calculation method. On this document, improvement has been made to the estimation of emission from municipal solid waste treatment using the First Order Decay (FOD) method, instead of mass balance method as applied in SNC.

Improvement has also been made in the estimation of GHG emissions from industrial wastewater treatment. Instead of using the default values of IPCC 2006 GLs, the GHG emissions level was estimated using parameters collected from industries, i.e. wastewater flow rate, wastewater COD level and also types of wastewater treatment facilities.

3.4.4.4 Time Frame

The GHG inventory reported in this document covered the GHG emissions generated in the year 2000 to 2014, and updated from the First BUR for period of 2000 – 2012. GHG emissions level reported in the SNC for 2000 – 2005 have been revised due to changes in methodology and revision of activity data and related parameters.

3.4.4.5 Activity Data and Parameters for Estimating GHG Emissions Level

Activity data and other relevant parameters used in estimating GHG emissions level were classified based on the source category of the 2006 IPCC GL, i.e. MSW treatment, domestic liquid waste treatments, and industrial wastewater treatment.

1. Municipal Solid Waste (MSW) Management

MSW managed in solid waste disposal sites are generated from residential areas, markets, garden, commercial areas, etc. In urban area, the MSW is mostly treated in SWDS but in rural area, it is mostly treated through open burning or open burning method.

The amount of annual MSW generation was collected from ADIPURA documents that were submitted by all cities in Indonesia. The document provided information on the average fraction of waste brought to landfill (SWDS). Based on this information, the fraction of MSW

Table 3.15 Waste sector activity data and its source(s)

IPCC Category	Type of Data		Year	Source
4A SWDS, 4B Composting, 4C Open burning	AD	Waste generation	2000-2014: actual data 1990-1999: back-casting	ADIPURA
		Bulk Density: 0.347 ton/m^3		Survey on waste composition conducted in North Sumatera, South Sumatera, Riau, DKI Jakarta, and East Java
		Waste Composition		
		Dry Matter Content		
		Waste stream (by fraction): a. SWDS: 69% b. Open burning: 21% c. Composting 2% d. 3R: 2.5% e. Other (untreated)		ADIPURA & IPCC GL 2006
	EF	MCF: 0.8 (open dumping SWDS) DOC: default		IPCC GL 2006
4D1 Domestic Wastewater	AD	Population	2000-2014	BPS
		BOD: 35 g/person/day		IPCC GL 2006
		Protein consumption/capita/year	2000-2014	BPS
	EF	Default		IPCC GL 2006
4D2 Industrial Wastewater	AD	Total production value	2000-2014	• Statistics of the Manufacturing Industry, BPS; • Ministry of Agriculture; • Indonesia Pulp and Paper Association; • Ministry of Industry
		Wastewater flow rate		PROPER, Industries, MoEF regulation, and Associations
		COD Inlet		
	EF	Default		IPCC GL 2006

dumped to SWDS was on average 69%. This figure was used in estimating GHG emissions level of MSW treatment in SWDS.

Local parameters such as waste composition and dry matter contents were adopted from the study by the MoEF located originally in North and South Sumatera Provinces, and later on expanded to cover East Java, DKI Jakarta, and Riau Provinces. The following Table 3.16 shows the comparisons between waste composition values in the study locations and those of the 2006 IPCC GL's.

In the meantime, the dry matter content values have adopted the values generated in North and South Sumatera studies since the values from other provinces still require further research (Table 3.17).

Based on collection of activity data for MSW, it was found that waste generated in 2000 – 2014 period had experienced an increase due to population growth. In 2014, the total waste generated was 62,177 Ggram, which itself has generated 38,160 Gg CO_2e of emissions (Figure 3.36).

The main contributor to GHG emissions from MSW management is the SWDS. The number of wastes being composted increased to 2.71% of the total wastes generated in 2014.

Table 3.16 SWDS Waste Composition Values

No.	Component	Waste Composition (% wet weight)						
		North Sumatera	South Sumatera	Riau	DKI Jakarta	East Java	Average*)	IPCC GL 2006 (SE Asia)
1	Food waste	54.62%	56.62%	47.23%	49.72%	53.30%	**49.86%**	43.50%
2	Paper	11.39%	10.01%	11.34%	10.79%	3.63%	**10.82%**	12.90%
3	Nappies	6.06%	5.35%	7.50%	5.93%	6.26%	**6.04%**	-
4	Garden waste	8.02%	5.90%	4.12%	7.70%	9.02%	**7.39%**	-
5	Wood	0.01%	0.44%	3.50%	0.78%	0.60%	**0.95%**	9.90%
6	Textile	3.28%	2.43%	3.56%	4.10%	2.30%	**3.97%**	2.90%
7	Rubber & leather	0.84%	0.59%	1.79%	0.37%	0.07%	**0.51%**	0.60%
8	Plastic	13.15%	16.15%	16.74%	19.26%	23.42%	**18.80%**	6.30%
9	Metal	0.37%	0.50%	0.84%	0.30%	0.21%	**0.35%**	1.30%
10	Glass	1.59%	1.11%	1.46%	0.59%	0.75%	**0.71%**	2.20%
11	Other (inert)	0.68%	0.90%	1.94%	0.47%	0.44%	**0.60%**	5.40%

Source: *Ministry of Environment and Forestry, 2016*

*) calculated using weighted average

Table 3.17 Dry matter content for waste in SWDS

Component	Dry matter content (% wet weight)			
	South Sumatera	North Sumatera	Average	IPCC 2006 GL (SE Asia)
a. Food waste	23%	59%	46%	40%
b. Paper + cardboard + nappies	51%	44%	48%	90%
c. Wood and garden waste	50%	57%	55%	85%
d. Textile	56%	73%	64%	80%
e. Rubber & leather	84%	89%	90%	84%
f. Plastic	76%	57%	68%	100%
g. Metal	100%	97%	97%	100%
h. Glass	92%	66%	79%	100%
i. Other (inert)	85%	95%	92%	N/A

Source: *Ministry of Environment, 2012*

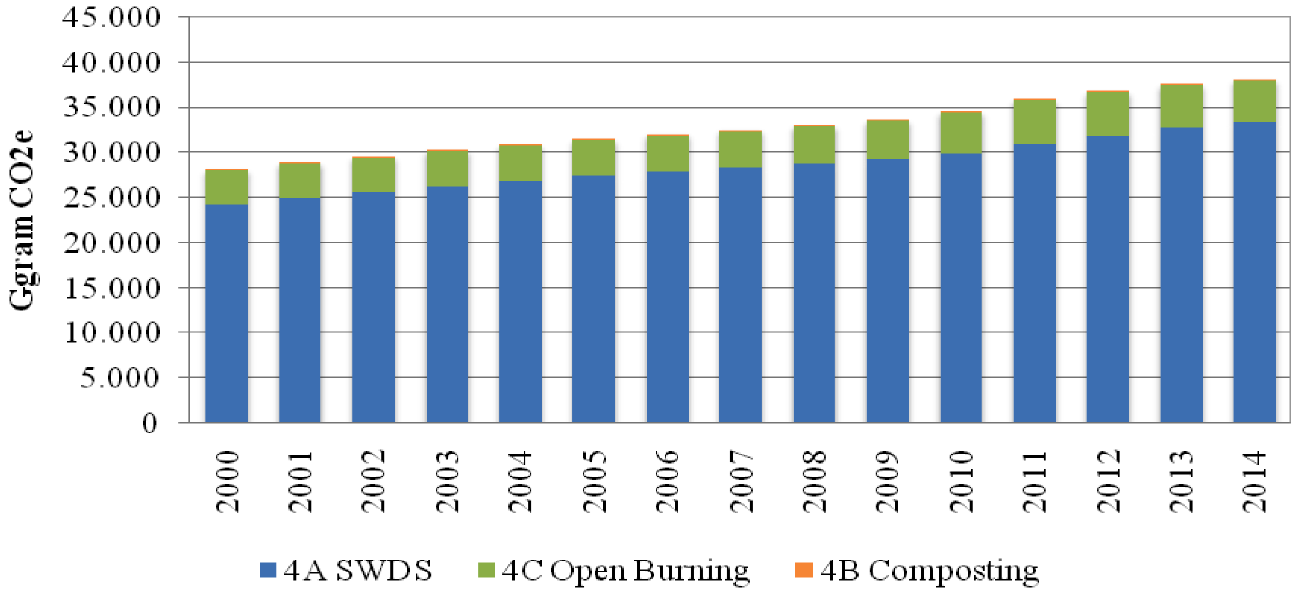


Figure 3.36 GHG Emissions from MSW

2. Domestic Wastewater

Domestic wastewater are usually managed on-site, channelled to wastewater treatment centre, or discharged without prior treatment to river. Activity data for this category are TOW (Total Organics in Wastewater) estimated based on the population multiplied by the value of kg BOD/capita. BOD parameter and CH_4 emission factor used in estimating the emissions, were adopted from the 2006 IPCC GL for Asia, Middle East and Africa. For the purpose of estimating the N_2O emission, the value for protein consumption, used the national value generated annually by BPS. Table 3.18 shows parameters and emission factors used in estimating the emissions from this category.

Domestic wastewater treatment differs for rural and urban areas. As much as 52% of the population in rural area use septic tank and 48% use non septic tank. Meanwhile, for urban population, 79% use septic tank and 21% use non septic tank.

Table 3.19 shows the characteristics of domestic wastewater treatment while Table 3.20 shows the population and estimated TOW, as well as emissions generated from domestic wastewater.

Table 3.18 Parameters and emission factors for estimation of domestic wastewater emissions

Parameter	Characteristics	
BOD	35 gram/capita/day; 12.8 kg/capita/year	
Max CH_4 production capacity	0.6 kg CH_4/kgBOD	
Protein consumption per capita per year*	Year	Protein consumption, Kg/cap/year
	2000	17.76
	2001	17.76
	2002	19.87
	2003	20.21
	2004	19.95
	2005	20.17
	2006	19.58
	2007	21.05
	2008	20.98
	2009	19.84
	2010	20.08
	2011	19.96
	2012	19.58
	2013	19.37
	2014	19.68
Fraction of N in protein	0.16 kg N/kg protein	
F non-consumption protein	1.10	
F industrial and commercial co-discharged protein	1.25	
N removed with sludge (default is zero)	0 kg	
Emission factor	0.01 kg N_2O-N/kg N	
Conversion factor of kg N_2O-N into kg N_2O, 44/28	1.57	
Emissions from Wastewater plants (default = zero)	- kg N_2O-N/kg N	

Source: default values IPCC GL 2006, *BPS

Table 3.19 Characteristics of domestic wastewater treatment

Treatment		Fraction	Degrees of Utilisation	EF (MCF*EF)
Rural	Septic tank	0.50	0.52	0.30
	Non Septic tank	0.50	0.48	0.03
Urban	Septic tank	0.50	0.79	0.30
	Non Septic tank	0.50	0.21	0.03

Source: Ministry of Health

3. GHG Emissions Estimate

GHG emissions from domestic wastewater in 2000 – 2014 have experienced an increase due to population growth. In 2014, the GHG emissions level was 17,417 Ggram CO_2e, where about 14,758 Ggram CO_2e originated from CH_4 emissions and 2,659 Ggram CO_2e from N_2O emissions. Trend for emissions from domestic wastewater is given in Figure 3.37.

Table 3.20 Population and estimated TOW and emissions generated from domestic wastewater (Ggram)

Year	Population*	TOW	CH_4		Nitrogen in effluent	N_2O		Ggram CO_2e
	(BPS Data)	(Kg BOD/year)	Ggram	Ggram CO_2e	(kg N/year)	Ggram	Ggram CO_2e	
2000	206,264,595	2,635,030,201	575	12,072	806,123,496	6.33	1,963	14,036
2001	209,283,255	2,673,593,581	583	12,249	817,921,026	6.43	1,992	14,241
2002	212,346,093	2,712,721,333	592	12,428	928,448,253	7.29	2,261	14,689
2003	215,453,755	2,752,421,714	600	12,610	957,952,853	7.53	2,333	14,943
2004	218,606,897	2,792,703,107	609	12,794	959,333,413	7.54	2,337	15,131
2005	221,806,185	2,833,574,013	618	12,982	984,415,996	7.73	2,398	15,379
2006	225,052,294	2,875,043,060	627	13,172	969,546,664	7.62	2,362	15,533
2007	228,345,910	2,917,119,003	636	13,364	1,057,263,942	8.31	2,575	15,940
2008	231,687,728	2,959,810,722	646	13,560	1,069,574,116	8.40	2,605	16,165
2009	235,078,452	3,003,127,230	655	13,758	1,025,954,065	8.06	2,499	16,257
2010	238,518,800	3,047,077,670	665	13,960	1,053,609,811	8.28	2,566	16,526
2011	241,990,700	3,091,431,193	674	14,163	1,062,728,052	8.35	2,589	16,751
2012	245,425,200	3,135,306,930	684	14,364	1,057,118,001	8.31	2,575	16,939
2013	248,818,100	3,178,651,228	693	14,563	1,060,543,359	8.33	2,583	17,146
2014	252,164,800	3,221,405,320	703	14,758	1,091,614,611	8.58	2,659	17,417

Source: Source: Projection of Indonesia Population 2010-2035, BPS, 2013

*Population Census, 2000

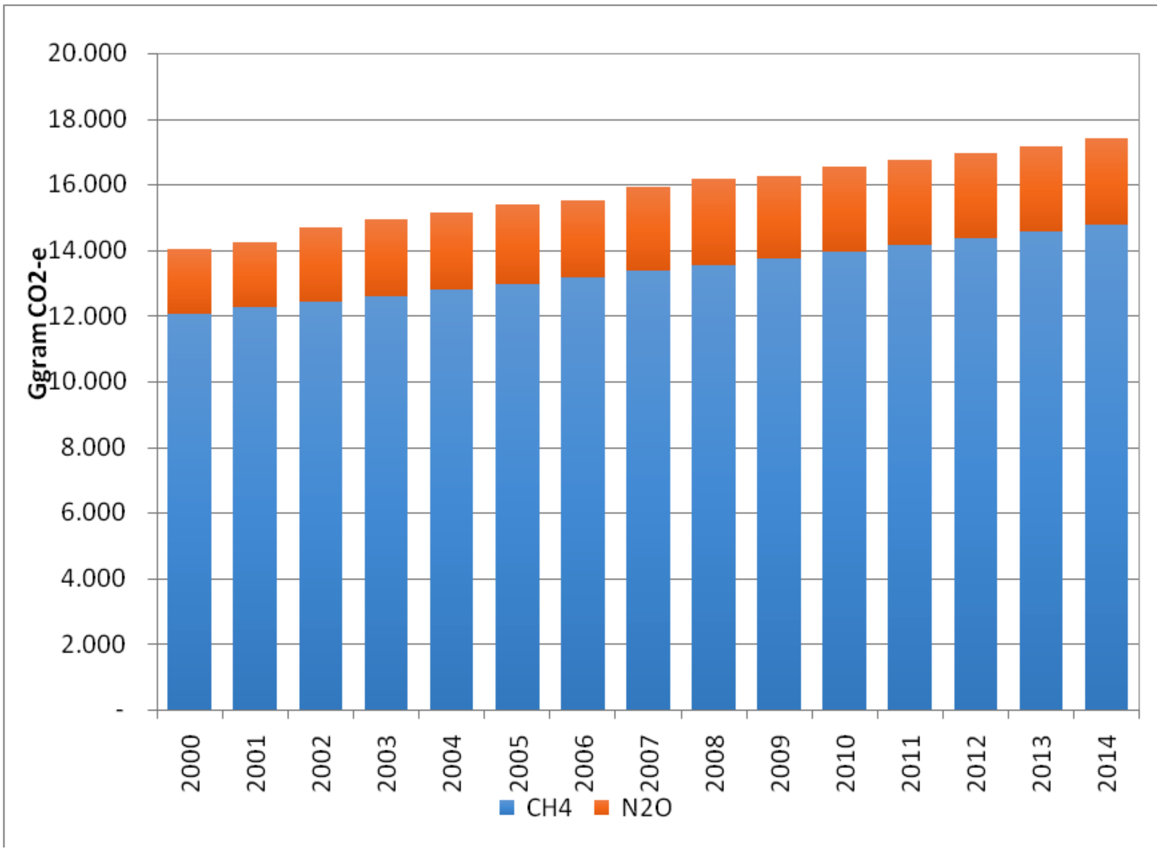


Figure 3.37 GHG emissions from domestic wastewater for the 2000-2014 period

4. Industrial Wastewater

GHG emissions from industrial wastewater were estimated based on the quantity of waste treated, waste characteristics, and wastewater treatment. Parameters such as COD/m^3 and wastewater flow rate were used to estimate TOW (annual total organics degradable material in wastewater for each industry sector, kg COD/yr) and were collected from PROPER data, research studies (BPPT and universities), ministerial regulations, and industry associations. For source categories that lack research, the 2006 IPCC default values were applied. Emission factor values were also using the 2006 IPCC default values. Industries covered on this document include oil palm, sugar cane, crumb rubber. These industries were not covered in SNC.

Activity data on wastewater generated, was estimated from the total production of each respective industry (Table 3.21). Wastewater characteristics and the type of treatment are presented in Table 3.22.

Table 3.21 Production value of each type of industry (in ton product/year)

Industry Type	2000	2001	2002	2003	2004	2005	2006	2007
Alcohol refining	38,105	38,257	38,410	38,564	38,729	38,970	38,970	17,725
Beer & Malt	154,519	155,601	156,690	157,787	158,891	159,769	204,792	249,815
Coffee	108,548	112,564	116,729	121,048	125,505	129,880	133,459	137,215
Dairy Products	387,621	410,878	435,530	461,662	489,362	516,536	534,615	577,380
Fish Processing	870,114	900,840	932,744	965,874	1,000,279	1,036,011	1,036,011	1,036,011
Meat & Poultry	2,513,003	2,741,931	3,177,618	3,329,360	3,522,802	3,362,254	3,766,860	3,773,519
Organic Chemicals	963,379	963,379	963,379	963,379	963,379	963,379	1,110,398	1,257,416
Petroleum Refineries*	52,593,872	52,763,816	52,263,766	52,343,774	53,440,818	52,217,776	46,290,957	45,858,946
Plastics & Resins	2,511,350	2,511,350	2,511,350	2,511,350	2,511,350	2,511,350	2,511,350	2,511,350
Pulp & Paper (combined)	10,842,008	11,357,152	11,896,822	12,462,190	12,888,500	13,675,160	14,868,789	14,963,134
Soap & Detergents	1,348,785	1,355,562	1,362,373	1,369,220	1,420,479	1,435,293	1,435,293	1,435,293
Starch Production	16,089,020	17,054,648	16,913,104	18,523,810	19,424,707	19,321,183	19,986,640	19,988,058
Sugar Refining	110,846	178,400	259,475	330,528	380,500	722,000	1,138,228	1,445,245
Vegetable Oils	5,324,000	5,237,000	5,231,000	5,580,000	5,863,000	6,136,000	6,229,000	6,465,000
Vegetable, Fruits & Juices	15,476,355	16,571,533	18,288,203	21,003,536	22,899,680	23,657,087	23,657,087	23,657,087
Wine & Vinegar	56,466	56,466	56,466	56,466	56,466	96,646	116,809	125,355
CPO	7,000,508	8,396,472	9,622,345	10,440,834	10,830,389	11,861,615	17,350,848	17,664,725
Sugar (Cane)	1,780,130	1,824,575	1,749,428	1,631,830	2,051,644	2,241,741	2,307,027	2,448,143
Crumb Rubber	1,426,357	1,527,088	1,548,841	1,702,731	1,962,526	2,157,346	2,505,369	2,617,413

Table 3.22 Production value of each type of industry (in ton product/year) (continued)

Industry Type	2008	2009	2010	2011	2012	2013	2014
Alcohol refining	20,439	14,802	11,160	66,356	66,356	57,464	57,464
Beer & Malt	222,904	221,396	206,497	218,602	222,769	276,510	299,601
Coffee	141,450	148,523	182,326	196,000	210,700	221,903	222,905
Dairy Products	622,720	653,142	687,826	729,858	690,000	786,845	800,749
Fish Processing	1,036,011	3,318,584	2,089,809	2,089,809	2,089,809	5,157,860	5,200,010
Meat & Poultry	3,840,727	3,908,786	4,070,100	4,220,291	4,341,881	2,881,711	2,470,016
Organic Chemicals (fossil based)	1,056,951	2,743,573	1,480,312	1,724,488	1,724,488	3,190,617	3,190,617
Petroleum Refineries*	44,906,686	45,659,128	43,285,636	44,604,876	41,861,346	42,876,286	44,206,429
Plastics & Resins	2,511,350	2,511,350	2,511,350	2,511,350	2,511,350	2,511,350	2,511,350
Pulp & Paper (combined)	14,162,388	15,833,324	17,565,401	19,586,627	20,998,978	21,332,613	21,671,549
Soap & Detergents	1,435,293	1,439,735	1,690,247	1,940,760	2,665,335	2,826,993	2,826,993
Starch Production	21,756,991	22,039,145	23,918,118	24,044,025	24,177,372	23,936,921	23,458,128
Sugar Refining	1,256,435	1,900,000	2,356,800	2,192,100	2,470,860	3,053,940	2,758,470
Vegetable Oils	6,835,000	7,144,000	7,004,000	7,192,000	7,529,000	7,912,000	8,157,000
Palm oil cooking and margarine			16,500,000	17,300,000	17,400,000	19,186,940	19,490,789
Oleochemical (palm oil based)			1,195,000	1,250,000	1,300,000	1,600,000	1,656,000
Biodiesel production			2,434,221	2,493,150	2,538,480	2,796,084	3,445,080
Vegetable, Fruits & Juices	23,657,087	23,657,087	23,657,087	30,971,324	30,971,324	30,971,324	30,971,324
Wine & Vinegar	114,308	96,383	49,890	50,045	56,678	48,256	50,726
CPO	17,539,788	19,324,293	21,958,120	23,096,541	26,015,518	27,782,004	29,278,189
Sugar (Cane)	2,303,976	2,624,068	2,214,489	2,228,259	2,591,687	2,551,024	2,579,173
Crumb Rubber	2,616,638	2,318,330	2,597,300	2,840,500	2,861,400	3,076,100	2,993,450

Table 3.23 Wastewater Characteristics of Each Industry

Industry	Wastewater Flow rate, m^3/t product	Source of Data	Chemical Oxygen Demand, kg COD/ m^3	Source of Data
Alcohol refining	24	IPCC 2006 default value	11	IPCC GL 2006 default value
Beer & Malt	7.6	Ministry of Environment Regulation No. 5/2014	2.9	
Coffee	30		9	
Dairy Products	5	Minister of Environment Decree No. 51/1995	2.7	
Fish Processing	10	Ministry of Environment Regulation No. 5/2014	2.5	
Meat & Poultry	13	IPCC 2006 default value	4,1	
Organic Chemicals	67		3	
Petroleum Refineries	0.6		1	
Plastics & Resins	0.6		3.7	
Pulp & Paper (combined)	50	Minister of Environment Decree No. 51/1995	5	Pulp and paper industries, association (APKI - *Asosiasi Pulp & Kertas Indonesia*)
Soap & Detergents	3	Ministry of Environment Regulation No. 5/2014	1.2	IPCC 2006 default value
Starch Production	30		10	
Sugar Refining	9	IPCC 2006 default value	3.2	
Vegetable Oils	25	Ministry of Environment Regulation No. 5/2014	1.2	
Palm oil cooking and margarine	3		1.2	
Oleo chemical (palm oil based)	3		1.2	
Biodiesel production	3		1.2	
Vegetable, Fruits & Juices	20	IPCC 2006 default value	5	
Wine & Vinegar	23		1.5	

Industry	Wastewater Flow rate, m^3/t product	Source of Data	Chemical Oxygen Demand, kg COD/ m^3	Source of Data
CPO	3	Ministry of Environment Regulation No. 5/2014	50	Average value from PROPER data and direct measurement
Sugar (Cane)	5.5		3	Ministry of Environment Regulation No. 5/2014
Crumb Rubber	40		6	Ministry of Environment Regulation No. 5/2014 & expert judgement

5. GHG Emissions Estimates

In 2014, GHG emissions from industrial wastewater was dominated by emissions from wastewater in palm oil, pulp and paper, and tapioca industries. Emissions from refined sugar industry was insignificant since only data from private companies that were used. Data from state-owned companies, which are having larger capacity, were not available.

The total GHG emissions from this category in 2014 amounted to 45,982 Ggram CO_2e with five major contributing industries comprised of CPO (18,445 Ggram CO_2e), pulp and paper (8,533 Ggram CO_2e), tapioca (7,389 Ggram CO_2e), vegetables, fruits and juice industry (4,878 Ggram CO_2e) and organic chemicals (2,694 Ggram CO_2e). GHG emission from industrial wastewater, 2000-2014 is presented in Figure 3.38.

3.4.4.6 Summary of GHG Emissions Estimates from Waste Sector

GHG emissions inventory in waste sector include GHG emissions from MSW, domestic wastewater, and industrial wastewater treatment activities. Summary of the emissions in 2000 – 2014 period is presented in Figure 3.39. Emissions from MSW and domestic wastewater treatment were relatively consistent while emissions from industrial wastewater shows a significant increased due to increase in production.

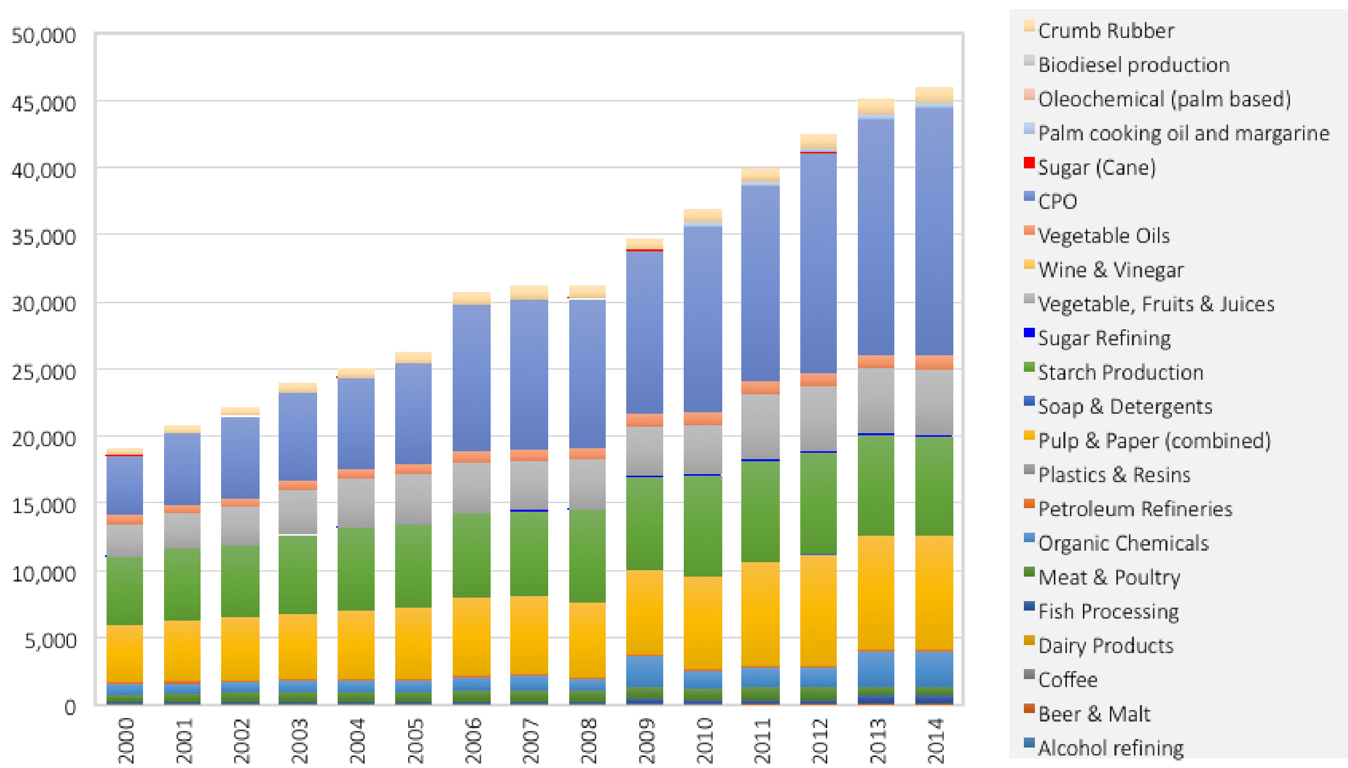


Figure 3.38 GHG Emissions from Industrial Wastewater, 2000-2014

GHG emission from waste sector in 2014 was 101,560 Ggram CO_2e, dominated by emissions from industrial wastewater (45%), followed by MSW (38%). By type of gas, CH_4 was the main gas generated from this sector. Distribution of GHG emissions from waste sector in 2014 by sources and type of gas are presented in Figure 3.40 and Table 3.24.

3.4.4.7 Key Category Analysis for Waste Sector

Based on the key category analysis, the main sources of emissions in this category are industrial wastewater, unmanaged solid waste disposal, and domestic wastewater (Table 3.25).

3.5 Emission Trend

In the 2000 – 2014 period, the national GHG emissions (all gases) increased with an average rate of 4.4% per year with LULUCF, and 4% per year without LULUCF. This shows that land-based sectors especially forestry had significant contributions to the national GHG emissions (Table 3.27).

In 2014, the national GHG emissions (all gases) reached 1,844,370 Gg CO_2e, a 31.4% increase compared to 2013's emission level (1,403,907 Gg CO_2e) or an 83% increased over the 2000's emission level (1,007,731 Gg CO_2e). Trend of national GHG emission 2000-2014 is given in Figure 3.41.

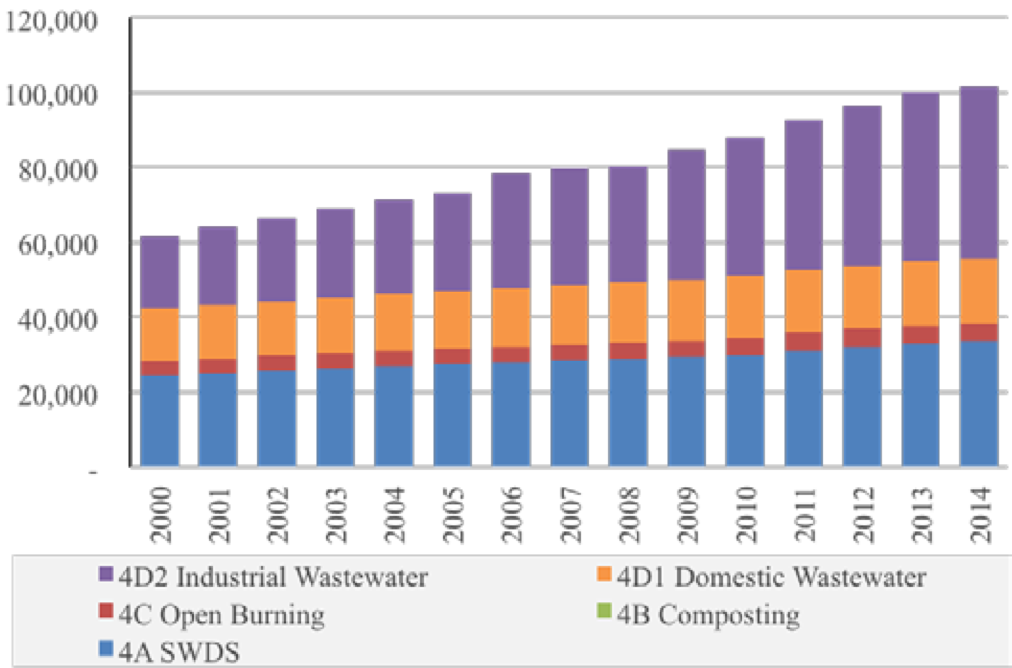
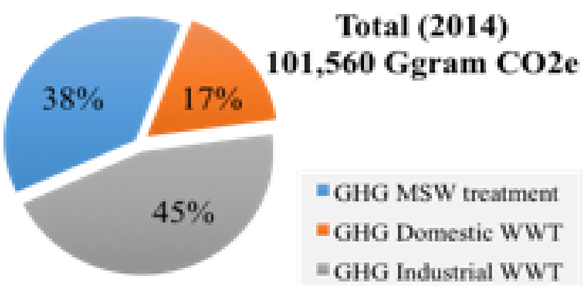


Figure 3.39 GHG Emissions from Waste Sector, 2000-2014



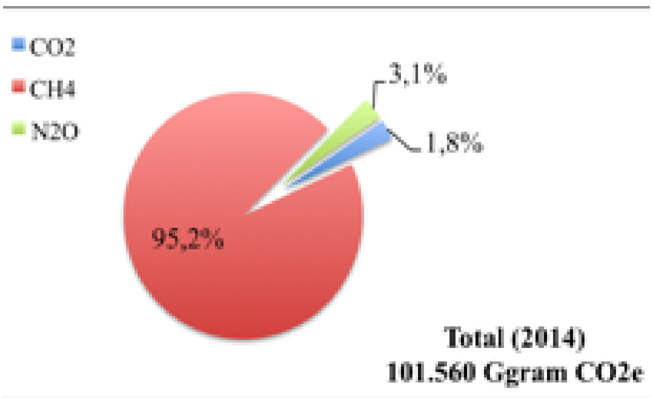


Figure 3.40 Distribution of emission from waste sector by source and type of gas in 2014

Table 3.24 GHG emissions from waste sector in 2014

GHG Emission Category	CO_2 (1)	CH_4	N_2O	CO_2e
	(Ggram)			
Total Waste	**2,653**	**4,566**	**10**	**101,560**
A. Municipal solid waste disposal				
1. Controlled/sanitary landfill				
2. Open dumping		1,594		33,467
3. Uncategorized SWDS				
B. Biological treatment of solid waste				
1. Composting		0.06	0.15	49
2. Anaerobic digestion				
C. Incineration and open burning				
1. Incineration				
2. Open burning	2,653	80	0.98	4,644
D. Wastewater treatment and discharge				
1. Domestic wastewater		703	8.58	17,417
2. Industrial wastewater		2,190	NE	45,982
3. Other				

Table 3.25 Key Category Analysis for Waste Sector

IPCC Category	GHG Emissions ($Gg\ CO_2e$)	Level/ Rank	Cumulative
4D2 Industrial wastewater	45,982	45.3%	45.3%
4A Unmanaged waste disposal sites	33,467	33.0%	78.2%
4D1 Domestic wastewater	17,417	17.1%	95.4%
4C Open burning of waste	4,644	4.6%	100.0%
4B Composting	49	0.0%	100.0%
Total	101,560		

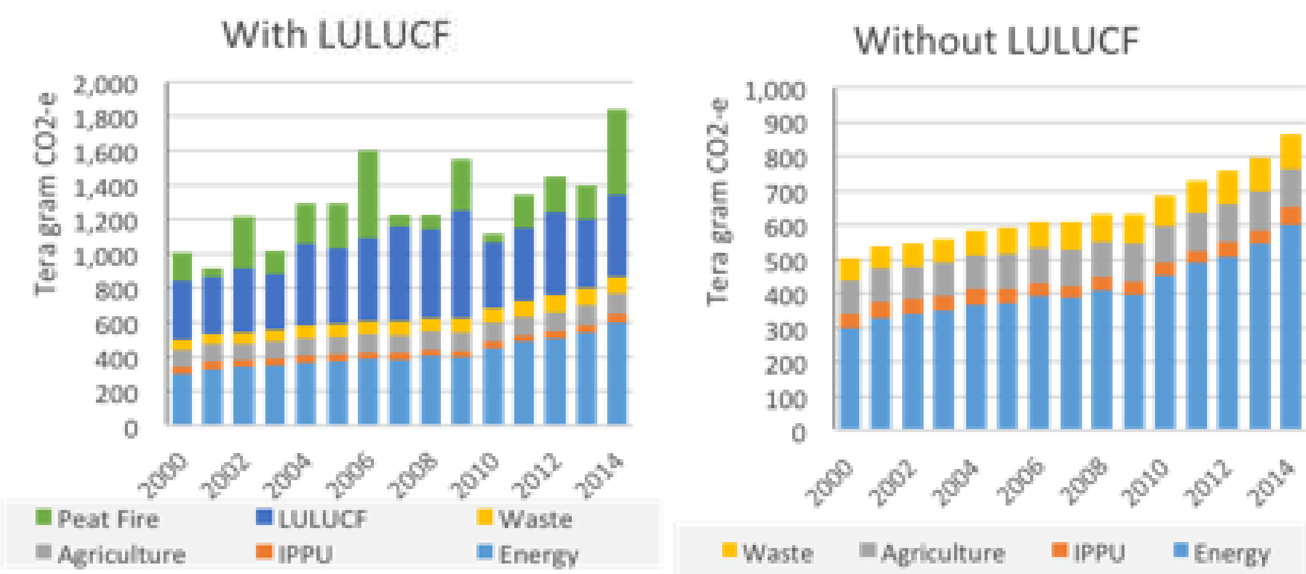


Figure 3.41 National GHG Emissions (all gases) Trend, 2000 – 2014

Table 3.26 Summary of GHG Emissions (all gases) by Sector, 2000 - 2014

Year	Emissions (in Gg CO_2e)						
	Energy	IPPU*	Agriculture	Waste	LULUCF	Peat Fire	Total
2000	298,412	42,883	99,717	61,351	343,797	161,571	1,007,731
2001	327,938	48,269	97,789	63,953	329,243	50,885	918,077
2002	340,323	41,688	97,479	66,421	373,189	301,753	1,220,853
2003	350,044	41,402	98,547	69,146	328,958	132,075	1,020,172
2004	368,508	43,146	100,299	71,148	475,851	232,018	1,290,970
2005	372,891	42,296	102,419	73,130	439,638	258,887	1,289,261
2006	391,424	38,641	101,819	78,358	479,246	510,710	1,600,198
2007	386,593	35,919	105,757	79,678	553,803	62,747	1,224,497
2008	409,736	36,499	103,030	80,445	513,712	81,744	1,225,166
2009	398,639	37,546	107,733	84,644	620,566	299,920	1,549,048
2010	453,178	36,033	108,487	88,013	383,405	51,383	1,120,499
2011	488,936	35,910	108,718	92,698	427,310	189,026	1,342,598
2012	508,120	40,078	112,727	96,325	487,928	207,050	1,452,228
2013	545,408	39,164	112,104	99,903	402,252	205,076	1,403,907
2014	602,458	47,489	113,441	101,560	480,033	499,389	1,844,370

*) include CF_4 and C_2F_6

Table 3.27 Annual increase of emissions by sector

Sector	% Increase
Energy	5.2%
IPPU	0.7%
Agriculture	0.9%
Waste	3.6%
Forestry	12.8%

3.6 Key Category Analysis

Using Tier 1 approach for key category analysis to all emission sources with LULUCF, the 20 key source categories were identified (Table 3.28). The first three main categories are (i) peat fires, (ii) peat decomposition, and (iii) energy industries with cumulative emissions of 1,063,431 Gg CO_2e (49.1%).

For key category analysis on emission sources without LULUCF, there are 17 identified key source , contributing 808,098 Gg CO_2e emissions. The first three main categories are (i) energy industries, (ii) manufacturing industries and construction, and (iii) transportation, with cumulative emissions of 530,849 Gg CO_2e or 62% of the total emissions (Table 3.29).

3.7 Uncertainty Analysis

Uncertainty analysis on the use of data in the estimation of national GHG in 2014 was based on references such as the 2006 IPCC GL, ministry/institution who provided activity data, research results, and expert judgements. Expert judgement was used for uncertainty analysis for waste and agriculture sector, and for peat fire, while uncertainty analysis for forestry sector (peat decomposition) was based on research result. Analysis for energy and IPPU sectors were based on information provided by relevant ministries providing activity data and emission factors to the sector's emission estimation.

Result of the uncertainty analysis show that overall, the uncertainties of the Indonesian National GHG inventory with LULUCF for 2000 and 2014 were approximately 17.6% and 19.2% respectively. Without LULUCF the level of uncertainty was lower for both years, i.e: 10.3% and 13.1%, respectively.

The high uncertainty in land-based sectors especially peat fires was due to the assumption that fires occurred in managed land since data

Table 3.28 Key Category Analysis for National GHG Emission (three gases) with LULUCF

IPCC Category for All Sectors (with LULUCF)		Emission (Gg CO_2e)	Percent-age (%)	Cumula-tive (%)
3D	CO_2 Peat Fire	499,389	23.0%	23.0%
3D	CO_2 Peat Decomposition	341,735	15.8%	38.8%
1 A 1	CO_2 Energy Industries	222,307	10.3%	49.1%
1 A 2	CO_2 Manufacturing Industries and Construction	170,145	7.8%	56.9%
3B2b	CO_2 Non-Cropland to Cropland	141,481	6.5%	63.4%
1 A 3	CO_2 Transportation	138,397	6.4%	69.8%
3B6b	CO_2 Non-Otherland to Otherland	134,546	6.2%	76.0%
3B1a	CO_2 Forest remaining Forest	127,701	5.9%	81.9%
4 D 2	CH_4 Industrial Wastewater Treatment and Discharge	45,608	2.1%	84.0%
3 C7	CH_4 Rice Cultivation	35,994	1.7%	85.7%
3B2a	CO_2 Cropland remaining Cropland	33,729	1.6%	87.2%
4 A 2 a	CH_4 Unmanaged Waste Disposal Sites	33,123	1.5%	88.8%
3 C4	N_2O Direct N_2O Soils	32,575	1.5%	90.3%
2 A 1	CO_2 Cement Production	24,192	1.1%	91.4%
1 A 4 b	CO_2 Residential	20,581	0.9%	92.3%
3B3b	CO_2 Non-Grassland to Grassland	17,118	0.8%	93.1%
3A1	CH_4 Enteric Fermentation	16,084	0.7%	93.9%
1 B 2	CH_4 Oil and Natural Gas	14,095	0.7%	94.5%
4 D 1	CH_4 Domestic Wastewater Treatment and Discharge	14,066	0.6%	95.2%
3B5b	CO_2 Non-Settlement to settlement	10,257	0.5%	95.6%
1 A 4 b	CH_4 Residential	9,788	0.5%	96.1%
1 A 5	CO_2 Non Specified	8,640	0.4%	96.5%
3 C5	N_2O Indirect N_2O Soils	8,520	0.4%	96.9%
2 B 1	CO_2 Ammonia Production	7,947	0.3%	97.5%
3 C6a	N_2O Direct N_2O from manure	7,625	0.4%	97.2%
1 B 2	CO_2 Iron and Steel Production	6,256	0.3%	97.8%
3 C3	CO_2 Oil and Natural Gas	6,190	0.3%	98.1%
3B1b	CO_2 Urea Fertilization	4,836	0.2%	98.3%
2 C 1	CO_2 Non-Forest to Forest	3,675	0.2%	98.5%
1 A 4 a	CO_2 Commercial/Institutional	2,826	0.1%	98.6%
4 D 1	N_2O Domestic Wastewater Treatment and Discharge	2,659	0.1%	98.7%
2 D 2	CO_2 Paraffin Wax Use	2,284	0.1%	98.8%
1 B 1	CH_4 Solid Fuels	2,221	0.1%	98.9%
1 A 3	N_2O Transportation	2,056	0.1%	99.0%
3A2	CH_4 Manure Management	2,031	0.1%	99.1%
2 B 8	CO_2 Petrochemical and Carbon Black Production	1,946	0.1%	99.2%
1 A 4 b	N_2O Residential	1,934	0.1%	99.3%
3 C2	CO_2 Liming	1,920	0.1%	99.4%
4 C 2	CO_2 Open Burning Waste	1,748	0.1%	99.5%
3 C1b	CH_4 Biomass Burning CL	1,204	0.1%	99.5%
3C6b	N_2O Indirect N_2O from manure	1,202	0.1%	99.6%

IPCC Category for All Sectors (with LULUCF)		Emission (Gg CO_2e)	Percent-age (%)	Cumula-tive (%)
4 C 2	CH_4 Open Burning Waste	1,111	0.1%	99.6%
1 A 2	N_2O Manufacturing Industries and Construction	985	0.0%	99.7%
1 A 1	N_2O Energy Industries	836	0.0%	99.7%
1 A 3	CH_4 Transportation	792	0.0%	99.8%
3 C1c	CH_4 Biomass Burning GL	716	0.0%	99.8%
4 B	N_2O Nitric Acid Production	524	0.0%	99.9%
4 B	CH_4 Manufacturing Industries and Construction	463	0.0%	99.9%
2 B 2	N_2O Biomass Burning CL	461	0.0%	99.9%
1 A 2	CO_2 Aluminium Production	320	0.0%	99.9%
3 C1b	N_2O Biomass Burning GL	274	0.0%	99.9%
2 C 3	CO_2 Other Process Uses of Carbonates	221	0.0%	99.9%
3 C1c	CO_2 Lubricant Use	206	0.0%	99.9%
2 A 4	N_2O Open Burning Waste	201	0.0%	100.0%
2 D 1	N_2O Biological Treatment of Solid Waste	199	0.0%	100.0%
4 C 2	CO_2 Lime Production	153	0.0%	100.0%
2 A 2	CO_2 Lead Production	113	0.0%	100.0%
2 C 5	CO_2 Others - natrium carbonate in pulp&paper industry	99	0.0%	100.0%
2 H 1	CH_4 Energy Industries	69	0.0%	100.0%
1 A 1	CH_4 Petrochemical and Carbon Black Production	67	0.0%	100.0%
2 B 8	CH_4 Commercial/Institutional	57	0.0%	100.0%
1 A 4 a	CO_2 Glass Production	31	0.0%	100.0%
2 A 3	CO_2 Carbide Production	29	0.0%	100.0%
2 B 5	CH_4 Non Specified	25	0.0%	100.0%
1 A 5	N_2O Non Specified	22	0.0%	100.0%
1 A 5	N_2O Commercial/Institutional	15	0.0%	100.0%
1 A 4 a	N_2O Oil and Natural Gas	12	0.0%	100.0%
1 B 2	CO_2 Zinc Production	10	0.0%	100.0%
2 C 6	CH_4 Biological Treatment of Solid Waste	5	0.0%	100.0%
2 H 2	CO_2 Others - natrium carbonate in food & beverages industry	5	0.0%	100.0%
2 B 4	CH_4 Iron and Steel Production	0	0.0%	100.0%
2 B 5	CH_4 Caprolactam, Glyoxal and Glyoxylic Acid	-	0.0%	100.0%
2 C 1	CH_4 Carbide Production	-	0.0%	100.0%
2 C 2	CO_2 Ferroalloys Production	-	0.0%	100.0%
2 B 4	N_2O Caprolactam, Glyoxal and Glyoxylic Acid	-	0.0%	100.0%
3B3a	CO_2 Grassland remaining Grassland	-	0.0%	100.0%
3B4a	CO_2 Wetland remaining Wetland	-	0.0%	100.0%
3B4b	CO_2 Non-Wetland to Wetland	-	0.0%	100.0%
3B5a	CO_2 Settlement remaining Settlement	-	0.0%	100.0%
3B6a	CO_2 Otherland remaining Otherland	-	0.0%	100.0%

Table 3.29 Key Category Analysis for national GHG Emission (three gases) without LULUCF

IPCC Category for All Sectors (without LULUCF)		Emission (Gg CO_2e)	Percentage (%)	Cumulative (%)
1 A 1	CO_2 Energy Industries	222,307	26%	26%
1 A 2	CO_2 Manufacturing Industries and Construction	170,145	20%	46%
1 A 3	CO_2 Transportation	138,397	16%	62%
4 D 2	CH_4 Industrial Wastewater Treatment and Discharge	45,608	5%	67%
3 C7	CH_4 Rice Cultivation	35,994	4%	71%
4 A 2 a	CH_4 Unmanaged Waste Disposal Sites	33,123	4%	75%
3 C4	N_2O Direct N_2O Soils	32,575	4%	79%
2 A 1	CO_2 Cement Production	24,192	3%	82%
1 A 4 b	CO_2 Residential	20,581	2%	84%
3A1	CH_4 Enteric Fermentation	16,084	2%	86%
1 B 2	CH_4 Oil and Natural Gas	14,095	2%	88%
4 D 1	CH_4 Domestic Wastewater Treatment and Discharge	14,066	2%	89%
1 A 4 b	CH_4 Residential	9,788	1%	91%
1 A 5	CO_2 Non Specified	8,640	1%	92%
3 C5	N_2O Indirect N_2O Soils	8,520	1%	93%
2 B 1	CO_2 Ammonia Production	7,947	1%	94%
3 C6a	N_2O Direct N_2O from manure	7,625	1%	93%
1 B 2	CO_2 Iron and Steel Production	6,256	1%	95%
3 C3	CO_2 Oil and Natural Gas	6,190	1%	96%
2 C 1	CO_2 Urea Fertilization	4,836	1%	96%
1 A 4 a	CO_2 Commercial/Institutional	2,826	0%	97%
4 D 1	N_2O Domestic Wastewater Treatment and Discharge	2,659	0%	97%
2 D 2	CO_2 Paraffin Wax Use	2,284	0%	97%
1 B 1	CH_4 Solid Fuels	2,221	0%	97%
3A2	N_2O Transportation	2,056	0%	98%
2 B 8	CH_4 Manure Management	2,031	0%	98%
1 A 4 b	CO_2 Petrochemical and Carbon Black Production	1,946	0%	98%
3 C2	N_2O Residential	1,934	0%	98%
4 C 2	CO_2 Liming	1,920	0%	98%
1 A 3	CO_2 Open Burning Waste	1,748	0%	99%
3 C1b	CH_4 Biomass Burning CL	1,204	0%	99%
3C6b	N_2O Indirect N_2O from manure	1,202	0%	99%
4 C 2	CH_4 Open Burning Waste	1,111	0%	99%
1 A 2	N_2O Manufacturing Industries and Construction	985	0%	99%
1 A 1	N_2O Energy Industries	836	0%	99%
1 A 3	CH_4 Transportation	792	0%	99%
3 C1c	CH_4 Biomass Burning GL	716	0%	100%
4 B	N_2O Nitric Acid Production	524	0%	100%
4 B	CH_4 Manufacturing Industries and Construction	463	0%	100%
2 B 2	N_2O Biomass Burning CL	461	0%	100%
1 A 2	CO_2 Aluminium Production	320	0%	100%
3 C1b	N_2O Biomass Burning GL	274	0%	100%
2 C 3	CO_2 Other Process Uses of Carbonates	221	0%	100%
3 C1c	CO_2 Lubricant Use	206	0%	100%
2 A 4	N_2O Open Burning Waste	201	0%	100%
2 D 1	N_2O Biological Treatment of Solid Waste	199	0%	100%
4 C 2	CO_2 Lime Production	153	0%	100%
2 A 2	CO_2 Lead Production	113	0%	100%
2 C 5	CO_2 Others - natrium carbonate in pulp & paper industry	99	0%	100%
2 H 1	CH_4 Energy Industries	69	0%	100%
1 A 1	CH_4 Petrochemical and Carbon Black Production	67	0%	100%
2 B 8	CH_4 Commercial/Institutional	57	0%	100%
1 A 4 a	CO_2 Glass Production	31	0%	100%
2 A 3	CO_2 Carbide Production	29	0%	100%
2 B 5	CH_4 Non Specified	25	0%	100%
1 A 5	N_2O Non Specified	22	0%	100%
1 A 5	N_2O Commercial/Institutional	15	0%	100%
1 A 4 a	N_2O Oil and Natural Gas	12	0%	100%
1 B 2	CO_2 Zinc Production	10	0%	100%
2 C 6	CH_4 Biological Treatment of Solid Waste	5	0%	100%
2 H 2	CO_2 Others - natrium carbonate in food & beverages industry	5	0%	100%
2 B 4	CH_4 Iron and Steel Production	0	0%	100%
2 B 5	CH_4 Caprolactam, Glyoxal and Glyoxylic Acid	-	0%	100%
2 C 1	CH_4 Carbide Production	-	0%	100%
2 C 2	CO_2 Ferroalloys Production	-	0%	100%
2 B 4	N_2O Caprolactam, Glyoxal and Glyoxylic Acid	-	0%	100%

on fire events' location was limited. Uncertainty on activity data and emission factors in peat decomposition were obtained from the Indonesia Forest Reference Emission Level document.

The values used in uncertainty analysis for national GHG emissions with LULUCF is presented in Table 3.30, while values used in uncertainty analysis for national GHG emissions without LULUCF is presented in Table 3.31.

Table 3.30 Uncertainty Analysis on National GHG Emissions (with LULUCF)

IPCC Code	IPCC category	Gas	Base year emissions or removals (2000)	Year *t* emissions or removals (2014)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty
			Gg CO_2e	Gg CO_2e	%	%	%
1 A 1	Energy Industries	CH_4	36	69	15.0	30.0	33.5
1 A 2	Manufacturing Industries and Construction	CH_4	299	463	15.0	30.0	33.5
1 A 3	Transportation	CH_4	314	792	15.0	20.0	25.0
1 A 4 a	Commercial/Institutional	CH_4	63	57	15.0	30.0	33.5
1 A 4 b	Residential	CH_4	7,791	9,788	15.0	30.0	33.5
1 A 5	Non Specified	CH_4	32	25	15.0	30.0	33.5
1 B 1	Solid Fuels	CH_4	374	2,221	15.0	30.0	33.5
1 B 2	Oil and Natural Gas	CH_4	20,834	14,095	15.0	30.0	33.5
1 A 1	Energy Industries	CO_2	89,461	222,307	15.0	30.0	33.5
1 A 2	Manufacturing Industries and Construction	CO_2	71,372	170,145	15.0	30.0	33.5
1 A 3	Transportation	CO_2	57,741	138,397	15.0	30.0	33.5
1 A 4 a	Commercial/Institutional	CO_2	3,409	2,826	15.0	30.0	33.5
1 A 4 b	Residential	CO_2	23,798	20,581	15.0	30.0	33.5
1 A 5	Non Specified	CO_2	11,360	8,640	10.0	5.0	11.2
1 B 2	Oil and Natural Gas	CO_2	8,178	6,190	10.0	5.0	11.2
1 A 1	Energy Industries	N_2O	219	836	10.0	5.0	11.2
1 A 2	Manufacturing Industries and Construction	N_2O	629	985	10.0	5.0	11.2
1 A 3	Transportation	N_2O	861	2,056	10.0	5.0	11.2
1 A 4 a	Commercial/Institutional	N_2O	18	15	10.0	5.0	11.2
1 A 4 b	Residential	N_2O	1,578	1,934	10.0	5.0	11.2
1 A 5	Non Specified	N_2O	29	22	10.0	5.0	11.2
1 B 2	Oil and Natural Gas	N_2O	19	12	10.0	5.0	11.2
2 B 4	Caprolactam, Glyoxal and Glyoxylic Acid	CH_4	-	-	25.0	5.0	25.5
2 B 5	Carbide Production	CH_4	-	-	25.0	5.0	25.5
2 B 8	Petrochemical and Carbon Black Production	CH_4	70	67	10.0	10.0	14.1
2 C 1	Iron and Steel Production	CH_4	0	0	10.0	10.0	14.1
2 A 1	Cement Production	CO_2	16,436	24,192	2.0	5.0	5.4
2 A 2	Lime Production	CO_2	3,688	153	10.0	2.0	10.2
2 A 3	Glass Production	CO_2	245	31	10.0	10.0	14.1
2 A 4	Other Process Uses of Carbonates	CO_2	8,416	221	10.0	10.0	14.1
2 B 1	Ammonia Production	CO_2	8,926	7,947	10.0	6.0	11.7
2 B 5	Carbide Production	CO_2	24	29	10.0	10.0	14.1
2 B 8	Petrochemical and Carbon Black Production	CO_2	1,826	1,946	10.0	10.0	14.1
2 C 1	Iron and Steel Production	CO_2	949	6,256	10.0	10.0	14.1
2 C 2	Ferroalloys Production	CO_2	-	-	25.0	5.0	25.5
2 C 3	Aluminium Production	CO_2	384	320	2.0	5.0	5.4
2 C 5	Lead Production	CO_2	19	113	10.0	10.0	14.1
2 C 6	Zinc Production	CO_2	124	10	10.0	10.0	14.1
2 D 1	Lubricant Use	CO_2	218	206	10.0	10.0	14.1

IPCC Code	IPCC category	Gas	Base year emissions or removals (2000)	Year *t* emissions or removals (2014)	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty
			Gg CO_2e	Gg CO_2e	%	%	%
2 D 2	Paraffin Wax Use	CO_2	613	2,284	10.0	10.0	14.1
2 H 1	Others - natrium carbonate in pulp & paper industry	CO_2	78	99	10.0	10.0	14.1
2 H 2	Others - natrium carbonate in food & beverages industry	CO_2	14	5	10.0	10.0	14.1
2 B 2	Nitric Acid Production	N_2O	149	524	2.0	10.0	10.2
2 B 4	Caprolactam, Glyoxal and Glyoxylic Acid	N_2O	-	-	10.0	10.0	14.1
3 C1b	Biomass Burning CL	CH_4	12,570	1,204	15.0	30.0	33.5
3 C1c	Biomass Burning GL	CH_4	1,422	716	15.0	30.0	33.5
3 C7	Rice Cultivation	CH_4	794	35,994	15.0	20.0	25.0
3A1	Enteric Fermentation	CH_4	885	16,084	15.0	30.0	33.5
3A2	Manure Management	CH_4	38,587	2,031	15.0	30.0	33.5
3 C2	Liming	CO_2	872	1,920	15.0	30.0	33.5
3 C3	Urea Fertilization	CO_2	3,900	4,836	15.0	30.0	33.5
3 C1b	Biomass Burning CL	N_2O	5,265	461	15.0	30.0	33.5
3 C1c	Biomass Burning GL	N_2O	304	274	15.0	30.0	33.5
3 C4	Direct N_2O Soils	N_2O	339	32,575	15.0	30.0	33.5
3 C5	Indirect N_2O Soils	N_2O	26,775	8,520	15.0	30.0	33.5
3 C6a	Direct N_2O from manure	N_2O	7,254	7,625	15.0	30.0	33.5
3C6b	Indirect N_2O from manure	N_2O	751	1,202	15.0	30.0	33.5
3B1a	Forest remaining Forest	CO_2	20,678	127,701	12.0	16.1	20.1
3B1b	Non-Forest to Forest	CO_2	1,260	3,675	12.0	16.1	20.1
3B2a	Cropland remaining Cropland	CO_2	41,587	33,729	12.0	16.1	20.1
3B2b	Non-Cropland to Cropland	CO_2	29,609	141,481	12.0	16.1	20.1
3B3a	Grassland remaining Grassland	CO_2	-	-	12.0	16.1	20.1
3B3b	Non-Grassland to Grassland	CO_2	36,335	17,118	12.0	16.1	20.1
3B4a	Wetland remaining Wetland	CO_2	-	-	12.0	16.1	20.1
3B4b	Non-Wetland to Wetland	CO_2	-	-	12.0	16.1	20.1
3B5a	Settlement remaining Settlement	CO_2	-	-	12.0	16.1	20.1
3B5b	Non-Settlement to settlement	CO_2	1,863	10,257	12.0	16.1	20.1
3B6a	Otherland remaining Otherland	CO_2	-	-	12.0	16.1	20.1
3B6b	Non-Otherland to Otherland	CO_2	29,585	134,546	12.0	16.1	20.1
3D	Peat Decomposition	CO_2	268,575	341,735	20.0	50.0	53.9
3D	Peat Fire	CO_2	161,571	499,389	25.0	50.0	55.9
4 A 2 a	Unmanaged Waste Disposal Sites	CH_4	24,312	33,467	60.0	35.0	69.5
4 B	Biological Treatment of Solid Waste	CH_4	0,004	1	30.0	20.0	36.1
4 C 2	Open Burning Waste	CH_4	1,409	1,687	30.0	20.0	36.1
4 D 1	Domestic Wastewater Treatment and Discharge	CH_4	12,072	14,758	39.4	42.4	57.9
4 D 2	Industrial Wastewater Treatment and Discharge	CH_4	19,124	45,982	37.7	42.4	56.7
4 C 2	Open Burning Waste	CO_2	2,216	2,653	63.4	34.6	72.2
4 B	Biological Treatment of Solid Waste	N_2O	0,14	48	30.0	20.0	36.1
4 C 2	Open Burning Waste	N_2O	255	305	42.4	20.0	46.9
4 D 1	Domestic Wastewater Treatment and Discharge	N_2O	1,963	2,659	36.4	42.4	55.9

Table 3.31 Uncertainty Analysis National GHG Emissions (without LULUCF)

IPCC Code	IPCC category	Gas	Base year emissions or removals (2000) Gg CO_2e	Year *t* emissions or removals (2014) Gg CO_2e	Activity data uncertainty %	Emission factor / estimation parameter uncertainty %	Combined uncertainty %
1 A 1	Energy Industries	CH_4	36	69	15	30	33.54
1 A 2	Manufacturing Industries and Construction	CH_4	299	463	15	30	33.54
1 A 3	Transportation	CH_4	314	792	15	20	25.00
1 A 4 a	Commercial/Institutional	CH_4	63	57	15	30	33.54
1 A 4 b	Residential	CH_4	7,791	9,788	15	30	33.54
1 A 5	Non Specified	CH_4	32	25	15	30	33.54
1 B 1	Solid Fuels	CH_4	374	2,221	15	30	33.54
1 B 2	Oil and Natural Gas	CH_4	20,834	14,095	15	30	33.54
1 A 1	Energy Industries	CO_2	89,461	222,307	15	30	33.54
1 A 2	Manufacturing Industries and Construction	CO_2	71,372	170,145	15	30	33.54
1 A 3	Transportation	CO_2	57,741	138,397	15	30	33.54
1 A 4 a	Commercial/Institutional	CO_2	3,409	2,826	15	30	33.54
1 A 4 b	Residential	CO_2	23,798	20,581	15	30	33.54
1 A 5	Non Specified	CO_2	11,360	8,640	10	5	11.18
1 B 2	Oil and Natural Gas	CO_2	8,178	6,190	10	5	11.18
1 A 1	Energy Industries	N_2O	219	836	10	5	11.18
1 A 2	Manufacturing Industries and Construction	N_2O	629	985	10	5	11.18
1 A 3	Transportation	N_2O	861	2,056	10	5	11.18
1 A 4 a	Commercial/Institutional	N_2O	18	15	10	5	11.18
1 A 4 b	Residential	N_2O	1,578	1,934	10	5	11.18
1 A 5	Non Specified	N_2O	29	22	10	5	11.18
1 B 2	Oil and Natural Gas	N_2O	19	12	10	5	11.18
2 B 4	Caprolactam, Glyoxal and Glyoxylic Acid	CH_4	-	-	25	5	25.50
2 B 5	Carbide Production	CH_4	-	-	25	5	25.50
2 B 8	Petrochemical and Carbon Black Production	CH_4	70	67	10	10	14.14
2 C 1	Iron and Steel Production	CH_4	0	0	10	10	14.14
2 A 1	Cement Production	CO_2	16,436	24,192	2	5	5.39
2 A 2	Lime Production	CO_2	3,688	153	10	2	10.20
2 A 3	Glass Production	CO_2	245	31	10	10	14.14
2 A 4	Other Process Uses of Carbonates	CO_2	8,416	221	10	10	14.14
2 B 1	Ammonia Production	CO_2	8,926	7,947	10	6	11.66
2 B 5	Carbide Production	CO_2	24	29	10	10	14.14
2 B 8	Petrochemical and Carbon Black Production	CO_2	1,826	1,946	10	10	14.14
2 C 1	Iron and Steel Production	CO_2	949	6,256	10	10	14.14
2 C 2	Ferroalloys Production	CO_2	-	-	25	5	25.50
2 C 3	Aluminium Production	CO_2	384	320	2	5	5.39
2 C 5	Lead Production	CO_2	19	113	10	10	14.14
2 C 6	Zinc Production	CO_2	124	10	10	10	14.14
2 D 1	Lubricant Use	CO_2	218	206	10	10	14.14
2 D 2	Paraffin Wax Use	CO_2	613	2,284	10	10	14.14
2 H 1	Others - natrium carbonate in pulp & paper industry	CO_2	78	99	10	10	14.14
2 H 2	Others - natrium carbonate in food & beverages industry	CO_2	14	5	10	10	14.14
2 B 2	Nitric Acid Production	N_2O	149	524	2	10	10.20
2 B 4	Caprolactam, Glyoxal and Glyoxylic Acid	N_2O	-	-	10	10	14.14
3 C1b	Biomass Burning CL	CH_4	12,570	1,204	15	30	33.54
3 C1c	Biomass Burning GL	CH_4	1,422	716	15	30	33.54
3 C7	Rice Cultivation	CH_4	794	35,994	15	20	25.00
3A1	Enteric Fermentation	CH_4	885	16,084	15	30	33.54
3A2	Manure Management	CH_4	38,587	2,031	15	30	33.54
3 C2	Liming	CO_2	872	1,920	15	30	33.54
3 C3	Urea Fertilization	CO_2	3,900	4,836	15	30	33.54
3 C1b	Biomass Burning CL	N_2O	5,265	461	15	30	33.54
3 C1c	Biomass Burning GL	N_2O	304	274	15	30	33.54

IPCC Code	IPCC category	Gas	Base year emissions or removals (2000) Gg CO_2e	Year *t* emissions or removals (2014) Gg CO_2e	Activity data uncertainty %	Emission factor / estimation parameter uncertainty %	Combined uncertainty %
3 C4	Direct N_2O Soils	N_2O	339	32,575	15	30	33.54
3 C5	Indirect N_2O Soils	N_2O	26,775	8,520	15	30	33.54
3 C6a	Direct N_2O from manure	N_2O	7,254	7,625	15	30	33.54
3C6b	Indirect N_2O from manure	N_2O	751	1,202	15	30	33.54
4 A 2 a	Unmanaged Waste Disposal Sites	CH_4	24,312	33,467	60	35	69.46
4 B	Biological Treatment of Solid Waste	CH_4	0,004	1	30	20	36.06
4 C 2	Open Burning Waste	CH_4	1,409	1,687	30	20	36.06
4 D 1	Domestic Wastewater Treatment and Discharge	CH_4	12,072	14,758	39.4	42	57.88
4 D 2	Industrial Wastewater Treatment and Discharge	CH_4	19,124	45,982	37.7	42	56.74
4 C 2	Open Burning Waste	CO_2	2,216	2,653	63.4	35	72.23
4 B	Biological Treatment of Solid Waste	N_2O	0,14	48	30	20	36.06
4 C 2	Open Burning Waste	N_2O	255	305	42.4	20	46.88
4 D 1	Domestic Wastewater Treatment and Discharge	N_2O	1,963	2,659	36.4	42	55.88

3.8 Quality Assurance/Quality Control (QA/QC)

According to the Presidential Regulation No.71/2011 on National GHG Inventory, the GHG Inventory must be supported by QA/QC system. QA/QC applies to activity data and emission factor used in estimating the emissions, as well as results of the estimation.

QC on activity data was conducted by the ministry/institution providing the data. QC was also conducted at the end of GHG Inventory Report through technical sectoral meetings that were conducted to discuss the activity data, emission factors, parameters, and methods applied in development of the GHG Inventory.

Current system of SIGN SMART standardizes and automates calculation methodology, activity data, and emission factor thus allowing to reduce errors in calculating GHG emissions. It also organizes archive, update, and manage GHG inventory data. The system also enables users to perform QA/QC both visually and tabular to the inputted data. Once calculation process was completed, QA/QC can be conducted to obtain results of the calculation by checking on the worksheet, CRF (Common Reporting Format), or displayed graphic in the system.

MoEF established Team of Panel Methodology consisted of representatives from related units in MoEF, other Ministries/Agencies and academicians. The team has the tasked of identifying the methodology for GHG emissions estimation that can be applied at national and local level; performing analysis and testing of GHG emissions estimation methodology, and providing recommendations on methodology for estimating GHG emissions.

The QA was later conducted for the GHG Inventory report through review by experts who were not directly involved in the development of the GHG inventory. The review verified that implementation of GHG inventory process has followed the prevailing procedures and standards, used the best methods in accordance with the latest developments in knowledge and data availability, and supported by an effective QC program.

3.9 Plans for Improvement

Improvements of GHG Inventory are particularly needed with regards to data collection, archiving, and quality. Another area to be improved is using QA/QC for the process of developing the GHG Inventory.

Improvement on activity data and emission factor's quality is the required priority to improve the development of GHG Inventory, especially in key category sectors where application of higher Tier approach is expected. As an example, in agriculture sector, plans for improvements are among others on data for consumption of fertiliser, lime consumption in agriculture, biomass burning, and manure management system for each category of livestock. Improvement will also be conducted to update the emission factors for rice paddy.

In LUCF, improvement plans are focused on reducing the uncertainty of emissions estimates related to land cover changes, better utilisation of remote sensing technology, and improved consistency of data and map usage, among others through One Map Policy, use of high resolution image data, increased accuracy of burnt marks on peatlands and depth of peat burnt.

In energy sector, improvement plans are focused on the (i) development of emission factors for oil and gas, coal, and electricity grid, (ii) improvement of data collection systems, and (iii) capacity building to improve the quality of activity data required in the energy sector.

Plans for the improvement in IPPU sector are focused on the improvement of activity data for estimation of emissions from pulp and paper as well as electronics industry, development of local emission factors, and capacity building to improve the quality of activity data.

In waste sector, plans for improvement include the integration of research results on the characteristics of waste (waste composition, dry matter content and DOC), improvement of sludge data generated from domestic and industrial wastewater treatment activities, as well as COD inlet/outlet and industrial waste water flow rate, development of local domestic wastewater emission factor to determine more accurate BOD value, and improvement of activity data for hazardous waste from hospital.

Based on identification of areas where data may be further improved in future communications, capacity-building support required for the compilation of the GHG inventory, include: collection of activity data for some key categories; disaggregating data on fuel consumption in agriculture, construction and manufacturing industries and differentiating them from energy balance data; estimation of indirect GHG emissions; provision of transparent information on methodologies and assumptions used for uncertainty assessment; and the development of a quality assurance and quality control process for improving the quality of activity data, and to document and archive the data and information.

Source/Location: DKI Jakarta/Kepulauan Seribu

Chapter 4

PROGRAMMES CONTAINING MEASURES TO FACILITATE ADEQUATE ADAPTATION TO CLIMATE CHANGE

4.1 Introduction

Impacts of climate change are projected to pose serious challenges to meet global food supplies and the demands for food consumption of about nine billion human population in 2050 (e.g., Gilland, 2002; Jaggard, Qi, & Ober, 2010; Tilman, Balzer, Hill, & Befort, 2011). The adverse impacts of climate change are also projected to increase the risk of hunger in developing countries (Parry, Rosenzweig, & Livermore, 2005; Schmidhuber & Tubiello, 2007). The increase in temperature will impact the occurrences of extreme weather events and increases the risks of food and water shortages and ecosystems degradation. The temperature's increase in the range of 0.5-2.5°C provides the positive impacts of climate change on the high latitude regions; however, the possibility will be negative when air temperature increases up to 4°C. At 4°C and over, the global food production will be seriously affected.

Ecosystems are vulnerable to climate change, with around 20 - 50% of species potentially facing extinction when global air temperature is higher than 2°C. Increasing air temperature above 1°C can increase the intensity of storms, drought, and heat waves. Increasing temperature at least 0.5°C can affect negatively to coastal ecosystem and mangrove. Further increase in air temperature at least by 1°C will reduce rice productivity and clean water supply. The negative consequences of warming condition will be worse as air temperature increases over 2°C, particularly for agriculture sector (i.e., increased pest and disease infestations, decrease crop production). The increase of 2°C in air temperature is also identified as can affect economic productivity by 1.9%.

The impacts of climate change on a wide range of economic sectors also pose serious challenge. Water resources, which are critical to support many economic activities, are directly influenced by the potential impacts of climate change that may cause erratic rainfall. This changing pattern and intensity of rainfall may potentially cause the changing occurrences of floods and drought such as those happened in Sumatra and Java (MoE, 2007). The linkage of the potential impacts of climate change on increasing the frequency of climate related disasters added more concerns as disasters have been seen as a serious threat that can inhibit the achievement of development plan of a country. For example, in Indonesia, it was reported that the frequency of floods and drought was increasing. For the last four decades, the frequency of drought in Indonesia was also increasing (Boer & Subbiah, 2005). These climate-induced disasters need an attention as they can cause damage as reported by BNPB. As climate change will continue to have significant impacts on the natural and socio-economic systems, the GoI has already taken and will further take effective policies and actions in adapting to climate change to enhance its adaptation capacity.

4.2 Historical and Future Climate of Indonesia

This Chapter delivers an updated analysis of historical climate and future climate scenarios in Indonesia since previous documents of First National Communication (INC) in 1999 and SNC in 2010. The analysis combines the use of both dynamical and statistical downscaling approaches to provide regional climate information. The dynamical modelling is applied for both climate and ocean modelling, separately. The emission scenarios used in this study are updated by using the next generation of climate scenarios, namely as Representative Concentration Pathways (RCPs) employed in the IPCC AR5 report (IPCC, 2013; R. Moss et al., 2008; R. H. Moss et al., 2010).

4.2.1 Historical Climate Change

Historical analysis of climate is updated and conducted through investigation of climatology, variability and trends. As the availability of long historical climate data is very limited, the analysis relies on datasets from various sources, from observed stations and global datasets, i.e. daily rainfall data from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) version 2.0 (C. C. Funk et al., 2014; C. Funk et al., 2015) which has 5 km x 5 km grid resolution from 1981 to present. These data were validated using observed rainfall data from 80 stations across Indonesia. In general, rainfall data from CHIRPS have relatively strong correlations with those from the stations, i.e. within the range of correlation value of 0.6-0.8 and 0.8-1.0. Other climate variables were available from the University of East Anglia Climate Research Unit (UEA CRU) TS3.2 dataset (Harris, Jones, Osborn, & Lister, 2014).

4.2.1.1 Land

1. Temperature

Decadal variability seems to influence the mean temperature condition in Indonesia, although not as large as found in rainfall, since the long-term trends still show distinct upward trends (Figure 4.1). Various regions have experienced increasing temperature, especially after the 1950, with varied rate of increase in temperature across locations, i.e. between 0.01 °C and 0.06°C per year.

Based on the data from Jakarta station, being the longest observational data (134-years), it is clear that temperature has increased consistently with an annual rate of about 0.02°C (Figure 4.2). The Citeko station, situated about 70 km away from Jakarta, with an altitude of about 920 m a.s.l, had shorter record and also showed increasing trend.

2. Rainfall

Annual rainfall trends showed an inconsistent direction of trends for every period, indicating a strong signal of decadal climate oscillation. For the past 30-years, between the years 1981-2010, the observation revealed upward trends of decadal rainfall. Drier rainfall condition in the beginning of the 30-year period in early 1980s and 1990s as the impacts of strong and moderate El Nino events, and wetter condition at the end of 2000s, where strong La Nina occurred in 2010,

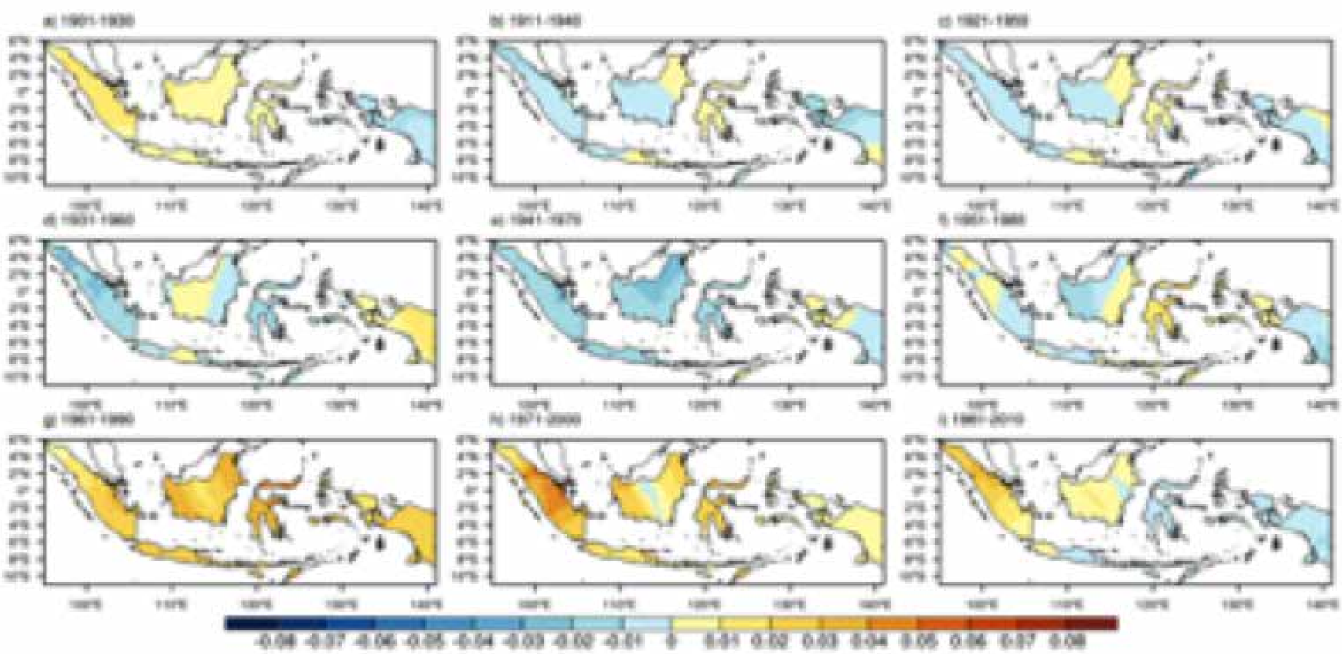


Figure 4.1 Decadal trends of annual mean temperature (°C/year) in Indonesia based on CRU TS 3.22 dataset.

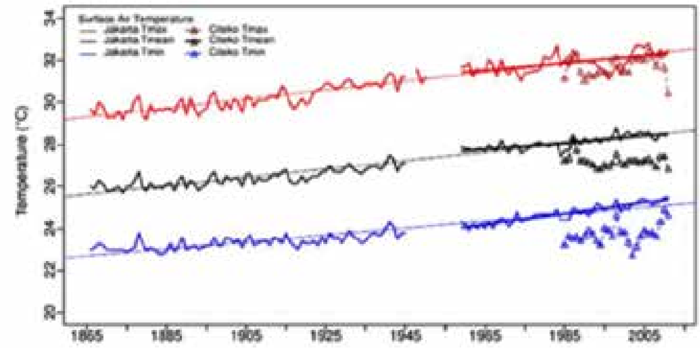


Figure 4.2 Trends of mean, minimum and maximum temperature in Jakarta Obs and Citeko (6.7°S, 106.9°E) stations

had contributed to the trends as observed in almost all regions of Indonesia (Figure 4.3 (i)). Similar upward trends during the same periods were also observed in the frequency of wet days as shown in Figure 4.4 (i). Wetter rainfall conditions seemed to have contributed to the increase of frequency of wet days.

3. Extreme Climate Events

Extreme climate events are important part of climate assessment as they are often associated with climate-related disasters, such as floods, landslide and drought. Several indices representing extreme climate events are selected and analyzed in terms of their climatology and trend. The indices include *annual maximum 1-day and 5-days precipitation* accumulation (RX1DAY and RX5DAY), *annual count of days when daily rainfall ≥ 20mm* (R20MM), *maximum length of wet spell or maximum number of consecutive days with daily rainfall ≥ 1mm* (CWD), and *maximum length of dry spell or maximum number of consecutive days with daily rainfall < 1mm* (CDD). Both RX1DAY and RX5DAY along with R20MM, can be used as proxies for extreme rainfall, where at some conditions can be associated with climate-related disasters, such as floods and landslide. On the other hand, CDD can also be used as a proxy for extreme dry condition, which could be related to drought.

The mean of RX1DAY is generally quite high in the southern part of West and Central Java, as well as over some parts of Papua. The extreme daily rainfall amounts over these regions may exceed > 100 mm/day (Figure 4.5a). This condition differs from Kalimantan, where the average maximum annual daily rainfall was mostly around 50 mm/day. While for R20MM, most parts of West and Central Java as well as most areas in Kalimantan and Papua, are recorded as the areas with high number of daily rainfall occurrence of above 20 mm (Figure 4.5b). The maximum number of consecutive wet days on the eastern parts of Indonesia, especially on most parts of Papua, are amongst the areas with high CWD values, indicating more rainfall

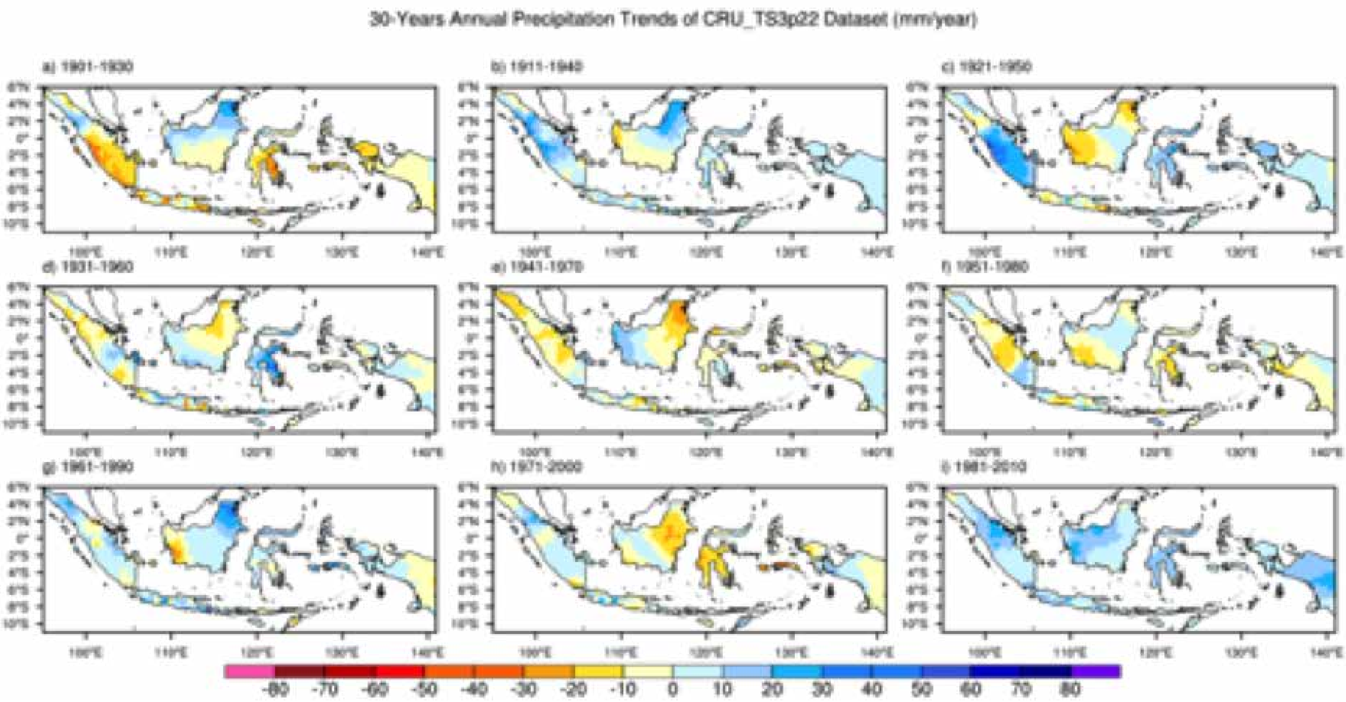


Figure 4.3 Decadal trends of annual rainfall (mm/year) in Indonesia based on CRU TS 3.22 dataset.

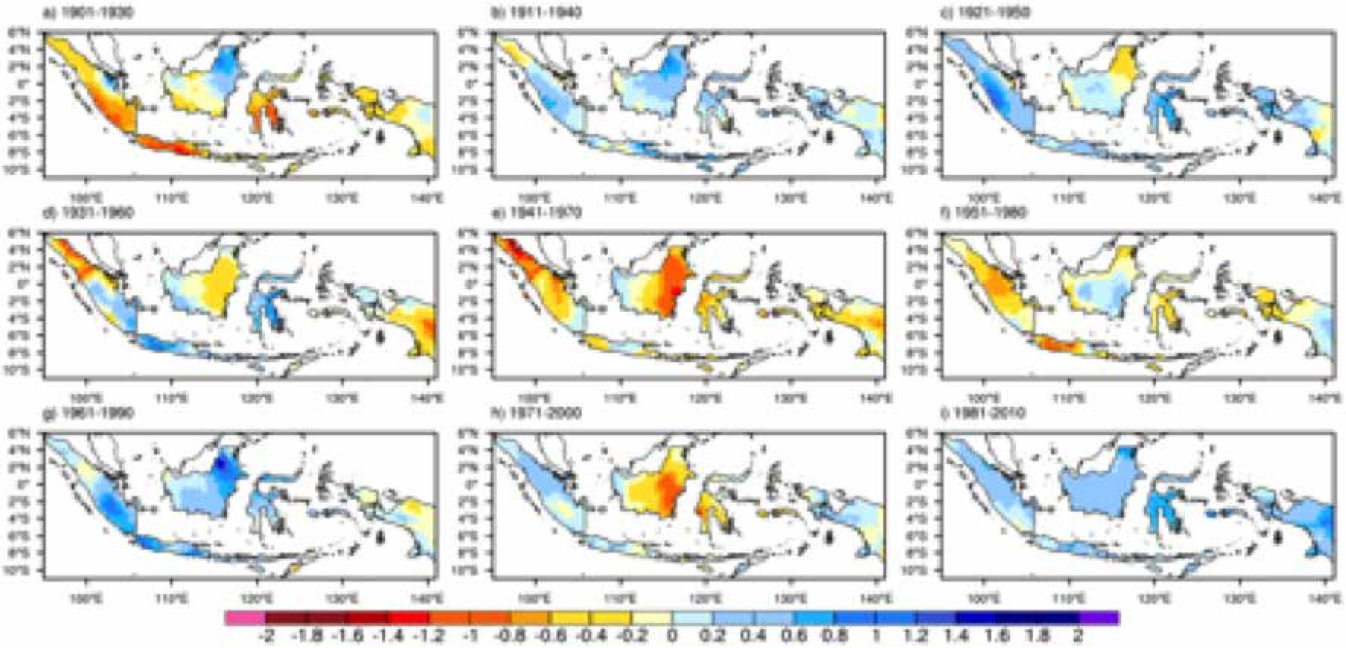


Figure 4.5 **Decadal trends of annual wet days frequency in Indonesia based on CRU TS 3.22 dataset.**

occur with consecutive wet days in the region than over the western part of the country (Figure 4.5c). For CDD, some regions in the southern part of Indonesia especially over Bali and Nusa Tenggara, as well as over some parts of Java have high CDD mean values. This means that on average, these regions hav longer consecutive dry days than the regions in the northern part of the country, excluding some areas in the northern part of West Papua (Figure 4.5d).

The spatial trends of extreme climate events during the last few decades also indicate that the annual maxima daily rainfall (RX1DAY) in some regions especially in Sulawesi and Papua showed considerable increasing trends (Figure 4.6a). While, R20MM in most areas of Sulawesi, Kalimantan and Sumatra show increasing trend (Figure 4.6b). This suggests that the frequency of rainfall above 20 mm per day are increasing indicating higher probability of having extreme daily rainfall that may contribute to the increase of climate related disasters such as floods and landslides. Furthermore, there have been some significant increasing trends of length of maximum number of CWD in Sumatra, Java and Papua (Figure 4.6c). Different from CWD, the trend of CDD is decreasing in these regions (Figure 4.6d). Each of the core extreme climate indices can be used for a variety of climate change study related to extreme conditions and the use of the indices can be tailored to the needs of different sectors.

4.2.1.2 Ocean

Sea level rise represents a major threat of global warming. There are two processes that contribute to the sea level rises. First, warming causes the ocean to expand and sea levels to rise. This process has been the dominant source of sea level rise in the past decade (Bindoff *et al* 2007). The second process is the melting of mountain glaciers and loss of land-ice as the impact of global warming. Global warming may also lead to large losses of the Greenland and Antarctic ice sheets. The impacts of sea level rise related hazards on the coastal zones are well identified (Nicholls et al., 2007; Nicholls and Cazenave, 2010; Nicholls, 2010). The instantaneous effects of sea level rise include submergence, inundation and increased flooding of coastal land, as well as saltwater intrusion of surface waters. Long-term effects also occur as changes in coastlines, erosion and abrasion as well as saltwater intrusion into groundwater.

Climate models and numerical climate simulations, provide one way to estimate the climate response to forcings, but it is difficult to include all real-world processes. The IPCC Coupled Model Intercomparison Project (CMIP5) model output unfortunately does not include sea level as one of the standard output. Hence, simulating the ocean circulation using atmospheric forcing from the CMIP5 model output is inevitable in estimating the future sea level change until 2040.

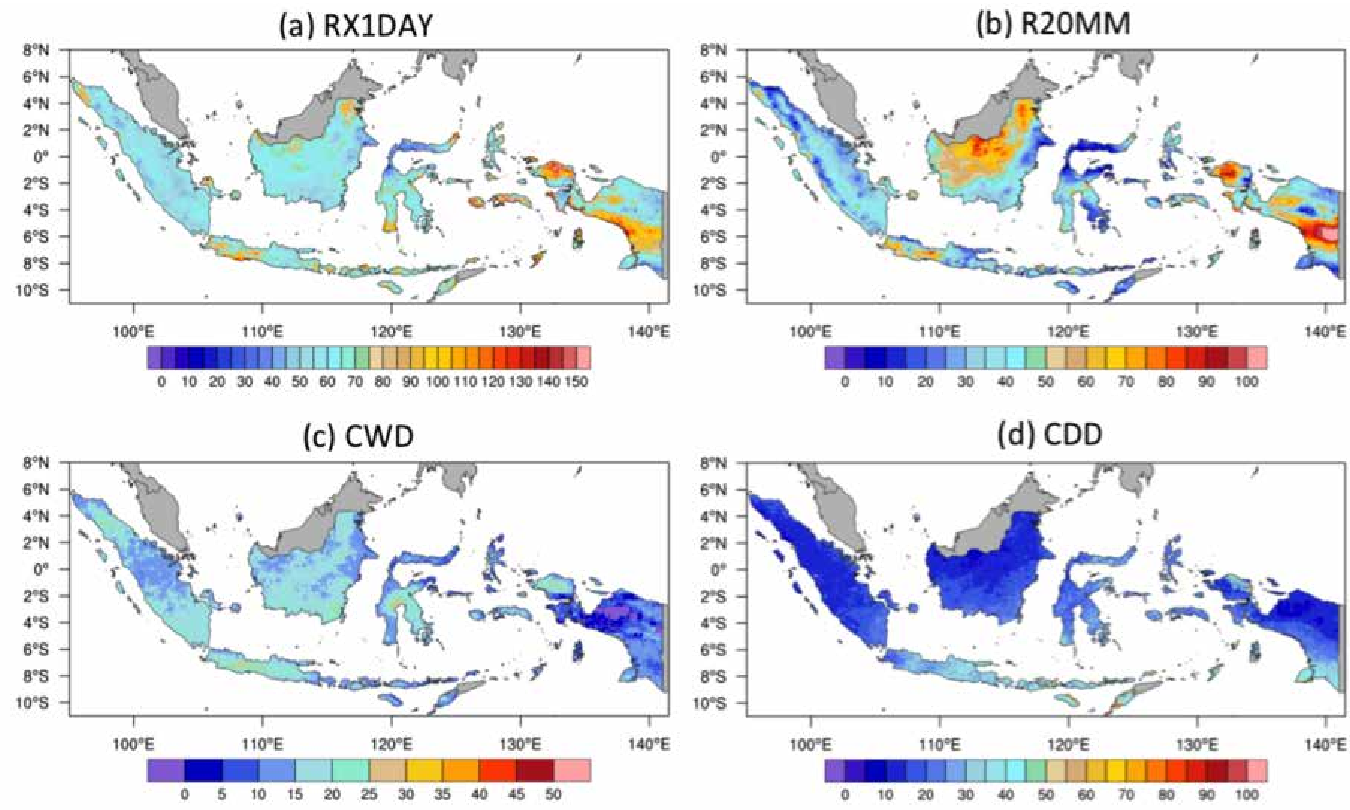


Figure 4.4 Climatology of several Extreme Climate Indices in Indonesia during 35 year periods (1981-2015 periods) based on daily improved CHIRPS v2.0 dataset: a) RX1DAY, b) R20MM, c) CWD, and d) CDD

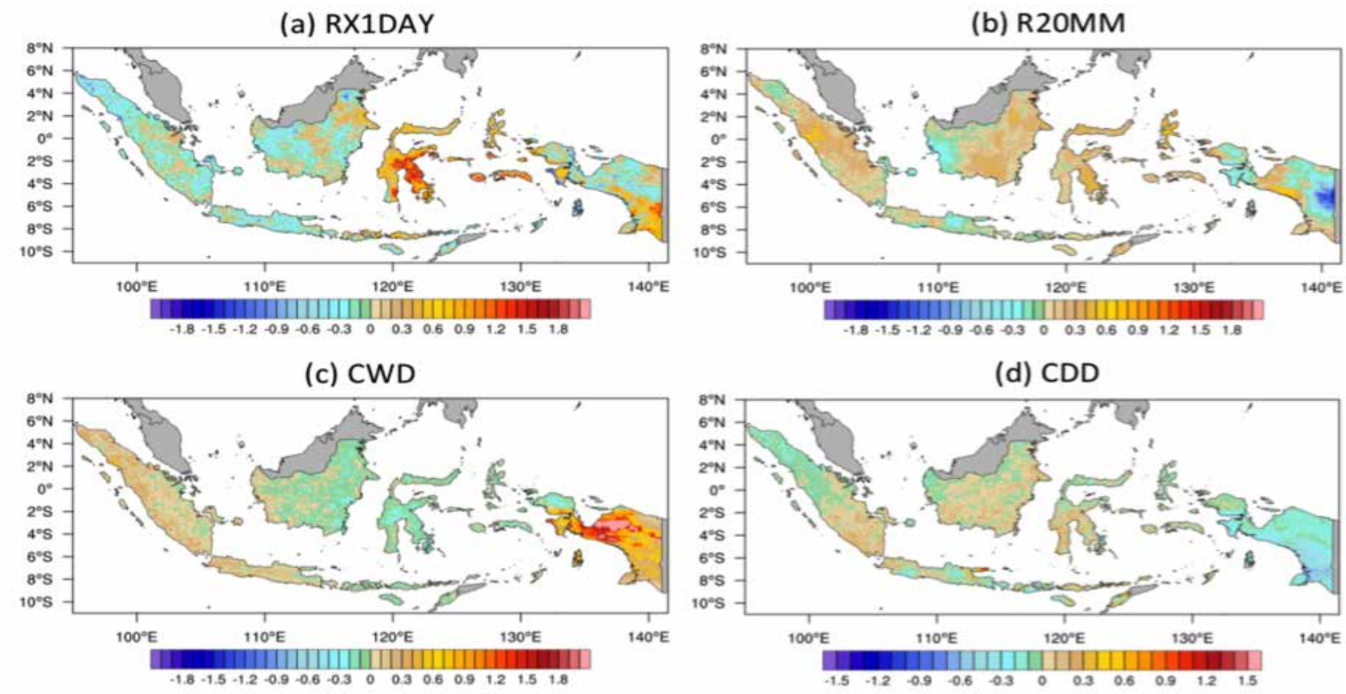


Figure 4.6 Trends of several extreme climate indices in Indonesia during 35 year periods (1981-2015 periods) based on daily improved CHIRPS v2.0 dataset: a) RX1DAY, b) R20MM, c) CWD, and d) CDD

Global models such as MRI, MIROC and the other IPCC's model outputs have low to moderate resolutions, with an accuracy that may still be low. To solve this problem, the use of local scale model or a combination of local and regional scale models is needed. In addition, availability of historical data for the marine sector is still very limited, thus, the use of models is inevitable to simulate the characteristics of some parameters such as high ocean waves and tides. The wave height is calculated by using WAVEWATCH models with medium resolution (12.5km), while, tide is calculated using Ocean Tidal Inverse Solution (OTIS) with the spatial resolution of 4km.

1. Ocean Surface Climatology

The seasonal monthly mean sea level (SST), sea surface salinity (SSS) and surface currents during the Asian Monsoon in December, January and February (DJF) is presented in Figure 4.7 During Asian Monsoon, the Java Sea surface current moves eastward and Karimata Strait surface water directed to southward. The mesoscale anticlockwise eddies are clearly seen in the South China Sea, and generate low mean sea level at this region. Due to heavy precipitation in South East Asia, the salinity in the South China Sea, Karimata Strait and Java Sea is lower. The SST is low as the strong north-westerly wind blows and surface current flows that pushes cool surface water from the northern South China Sea to the Karimata Strait and the Java Sea (Figure 4.7). The southward Karimata Strait and eastward Java Sea surface currents export less saline and low temperature of seawaters to the east thereafter (Figure 4.7).

In general, the surface water that exits from Indonesian Seas to the Indian Ocean is getting weaker during DJF. The southward Makassar Strait surface current is weak, due to the strong Java Sea eastward current that inhibits the southward Makassar Strait surface current, although the total water transport of Makassar Strait still move to the south. The surface water from the Java Sea and western Banda Sea exit to the Indian Ocean via the Lombok Strait. Furthermore, the moderate Indian Ocean South Equatorial Current (IOSEC) is clearly seen at 10°S to 15°S, and flowing from south of Lombok Island directed to the west.

In MAM as the weakening of Asian Monsoon, the north-westerly wind is getting weaker, the wind induced-surface current in the Java Sea and Karimata Strait are slower. The sea level gradients near Bangka-Belitung Island are weakening and diminishing (Figure 4.7). Conversely, when the monsoon changes in JJA, the surface current in the Java Sea and Karimata Strait are directed to the west and north, respectively. However, the surface current speed is not as fast as in DJF (Figure 4.7). The Australian Monsoon is weakened and begins to enter the Asian Monsoon during the transitional period in September, October and November (SON). Along with the weakening of Australian Monsoon, the southeasterly wind is getting weaker, the direction of wind induced-surface current in Java Sea and Karimata Strait are changed from weak westward and northward to weak eastward and southward, respectively (Figure 4.7). The sea level gradient near Bangka-Belitung Island is formed.

2. Wave Climatology

The seasonal climatology of the significant wave height (SWH) is depicted in Figure 4.8. In general, the wave height in Indonesian seas is influenced by seasonal winds. During December to February (DJF), the mean wave height in the Pacific is higher than the wave height in the Indian Ocean as shown in Figure 4.8(a). During MAM, the seasonal SWH in the Indian Ocean is higher, while the SWH in the east of Philippine is weakened. The SWH in the Karimata Strait, South China Sea, Sulawesi Sea and Banda Sea reach the lowest during this period, along with the weakening of monsoonal wind. During JJA, the wave height in Indian Ocean is higher than the wave height in Pacific Ocean. The average SWH during Australian monsoon peak is shown in Figure 4.8(c).

During the monsoon transitional period in SON, the wave heights in the Indian Ocean and east of Philippine are weaken and strengthen, respectively. The SWH in the Karimata Strait and South China Sea is developed and reach its peak in January and February, although, the SWH over the Java Sea, Banda, Flores and south of Karimata Strait is lower than that occurred during JJA.

3. El Nino Southern Oscillation, SST, Sea Level and SSS

Global warming and climate change impacts on the ocean are investigated by simulating an ocean circulation. The ocean circulation from 1961 to 2015 was simulated using the regional ocean modelling systems (ROMS). Sea level, SST and SSS were used as the proxy to investigate the global warming, climate and its variability impacts on the ocean circulations. Figure 4.9 shows the long-term sea level, SST and SSS from 1961 to 2015, while these parameters are regionally averaged from 90°E to 150°E and from 15°S to 15°N.

Climate variability such as the El Nin, also play significant roles in determining the sea level characteristics. The Pacific trade wind weakens and warm-pool move eastward, causing the sea level to drop to more than 15cm during this period. More frequent El Nino during 1980 to 1994 depresses the sea level in the Indonesian Seas. On the other hand, SSS follows the SST characteristics. The SSS may indicate the global ice melting and precipitation of fresh water fluxes.

Conversely, during the La Nina, SST and sea level increase. Due to the warm-pool westward movement and strengthening of the Pacific trade winds, the sea level in the Indonesian Seas is elevated by 10 cm to 20 cm. During the strong La Nina 1999/2000, the sea level in the Indonesian Seas is uplifted by 20 cm as seen in Figure 4.9. It is known that more frequent La Nina generate more frequent storm surges in the Indonesian Seas (ICCSR, 2010). Hence, La Nina does not only elevate the sea level, but also strengthens the wave height. Global warming and more frequent La Nina than El Nino strengthens the sea level rise and increase the intensity of erosion and abrasion with a high level of damage in Indonesia.

Figure 4.10 shows spatial distribution of sea level, SST and SSS changes. In can be seen that the rate of sea level rises to 0.7±0.4 cm/year, with the highest rates occurring at east of Mindanao Island, west of Vietnam and some parts of Indian Ocean at 10ºS. The pattern of salinity changes reflects the pathway of surface water movement from the Makassar Strait to the Indian Ocean. It is clear that the greater part of Makassar Strait surface current, exits to the Indian Ocean via the Savu Sea, Ombai Strait and Timor Sea. Less saline, warmer and less buoyant surface water in the Java Sea may reduce the southward surface current from the Makassar to the Indian Ocean via the Lombok Strait. The Makassar Strait surface water exits to the Indian Ocean via the Savu Sea, Ombai Strait and Timor Sea, thereafter. The less decreasing surface salinity is also seen at the south of Java. This can be attributed to the more intensive upwelling process happening in this region.

4. Extreme SST and Wave Height

More frequent La Nina than El Nino during the recent decades generated more frequent storm surges in the Indonesian Seas (ICCSR, 2010). La Nina does not only elevate the sea level, but also strengthens the wave height. It is predicted that the frequency of the extreme wave height that hits the Indonesian Archipelago are getting higher. Global warming and more frequent La Nina than El Nino will strengthen the sea level rise, increase the intensity of erosion and abrasion, with a high level of damage in Indonesia.

Assessment to InaROMS-estimated SST from 1991 to 2015 indicates that the SST near the coast is relatively higher than that over the open ocean (Figure 4.11). The median of SST ranges from 24°C to 30°C, with a regional mean of 28.7°C. The abrupt change of SST indicated by the 75 to 99 percentiles of data, shows that the Tomini Bay, western coast of Kalimantan, eastern coast of Sumatera and northern coast of Java Islands suffered from the abrupt change. The 75, 90, 95 and 99 percentiles can be attributed to the weak, moderate, moderate to strong and strong La Nina, respectively (Figure 4.11b-e). Figure 4.11b and c show that the upper 25% (75 percentile) of data are rising more than 0.5°C, while the upper 10% (90 percentile) increases by 1°C or higher than normal. During the strong La Nina, the SST abruptly rises more than 2.0°C at the Tomini Bay, western coast of Kalimantan, eastern coast of Sumatera, northern coast of Java Islands, southern coast of Papua and Nusa Tenggara Islands.

Furthermore, analysis of the significant wave height (SWH) from 1990 to 2015 shown that the median of long-term 6 hourly SWH data ranges from 0.2 m to 3.0 m when the median SWH in Java Sea reaches approximately between 0.6 m and 1.0 m (Figure 4.12). In general, the extreme waves were caused by increasing of wind speed due to the storm surges or other extreme weather conditions. The upper 25% of the data, still show moderate to high wave heights (Figure 4.12b). However, starting from the 90 percentile, the wave height is higher with more than 2m observed over the Indonesian Seas, except at near the coast or narrow straits. Extreme wave height in south of Java and west of Sumatera, north of Karimata Strait and South China Sea reach to more than 4m (Figure 4.12e). Eventually, these extreme wave heights will have affect on fisheries, marine transportation safety, prevent the flow of goods and other commodity that are using marine transportation facility, in addition to the

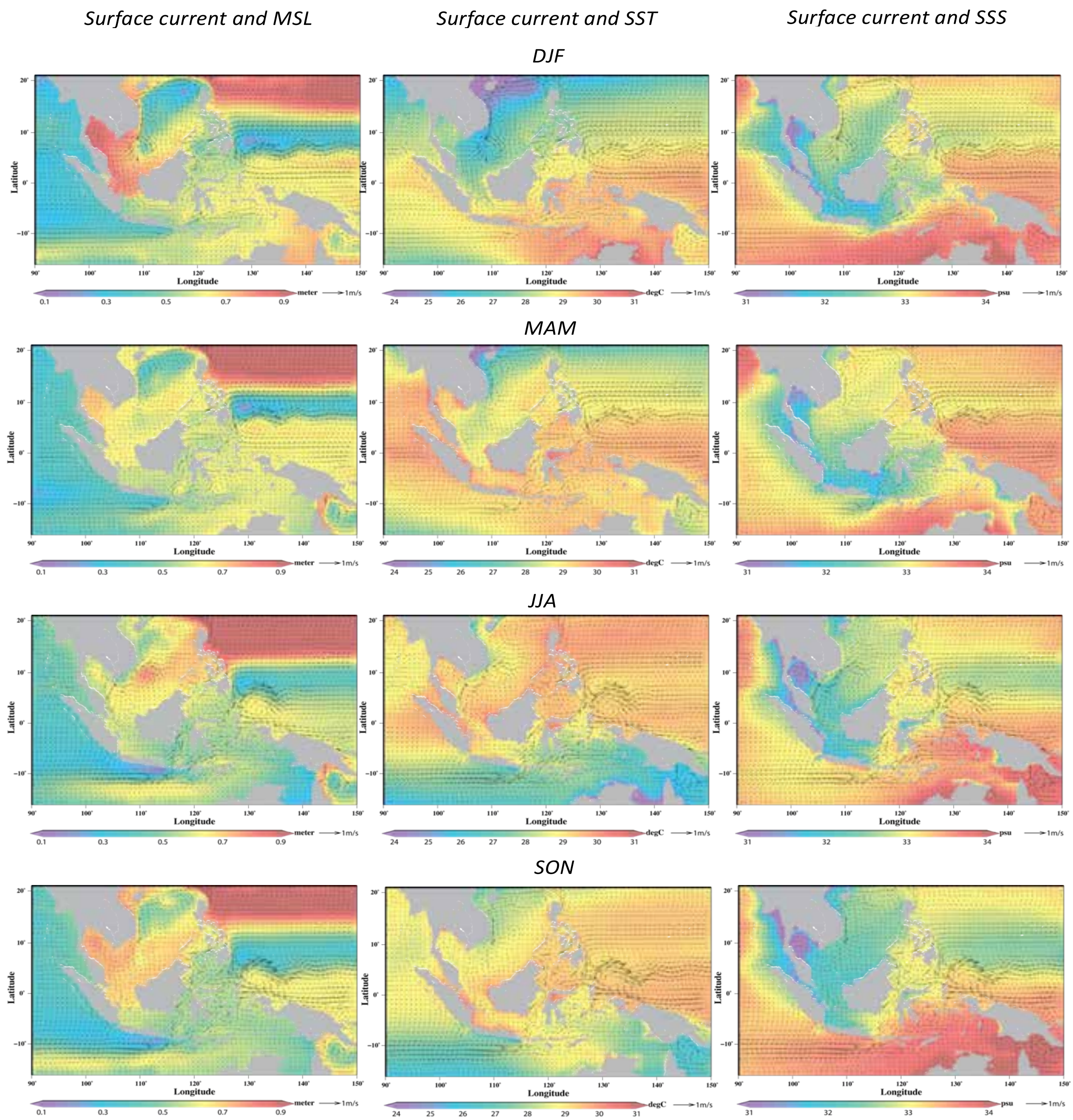


Figure 4.7 The seasonal mean sea level (MSL), sea surface temperature (SST) and salinity (SSS) superimposed with surface current vectors during the monsoon (DJF and JJA) transitional period (MAM and SON)

increasing flood risk in the coastal zone with a low elevation of 0-3m.

4.2.2 Future Climate Change of Indonesia

Studies were conducted on near-term climate predictions, that is, the period from the present to mid-century (2061-2035) where the responses of climate to different emissions scenarios are generally similar. The near-term climate change scenario relies on decadal climate predictions and uses the outputs of CMIP5 models, specifically designed for near-term climate change projections that rely on the prediction of decadal to interdecadal climate variabilities. It covers projections until 2035, targeting the 'End Users' from policy groups and decision-makers. The information of this near-term projection can be useful for Indonesia as a basis for the next 10 to 30 years planning strategy.

The study of long-term climate change projections is conducted using different Representative Carbon Pathways (RCPs) of

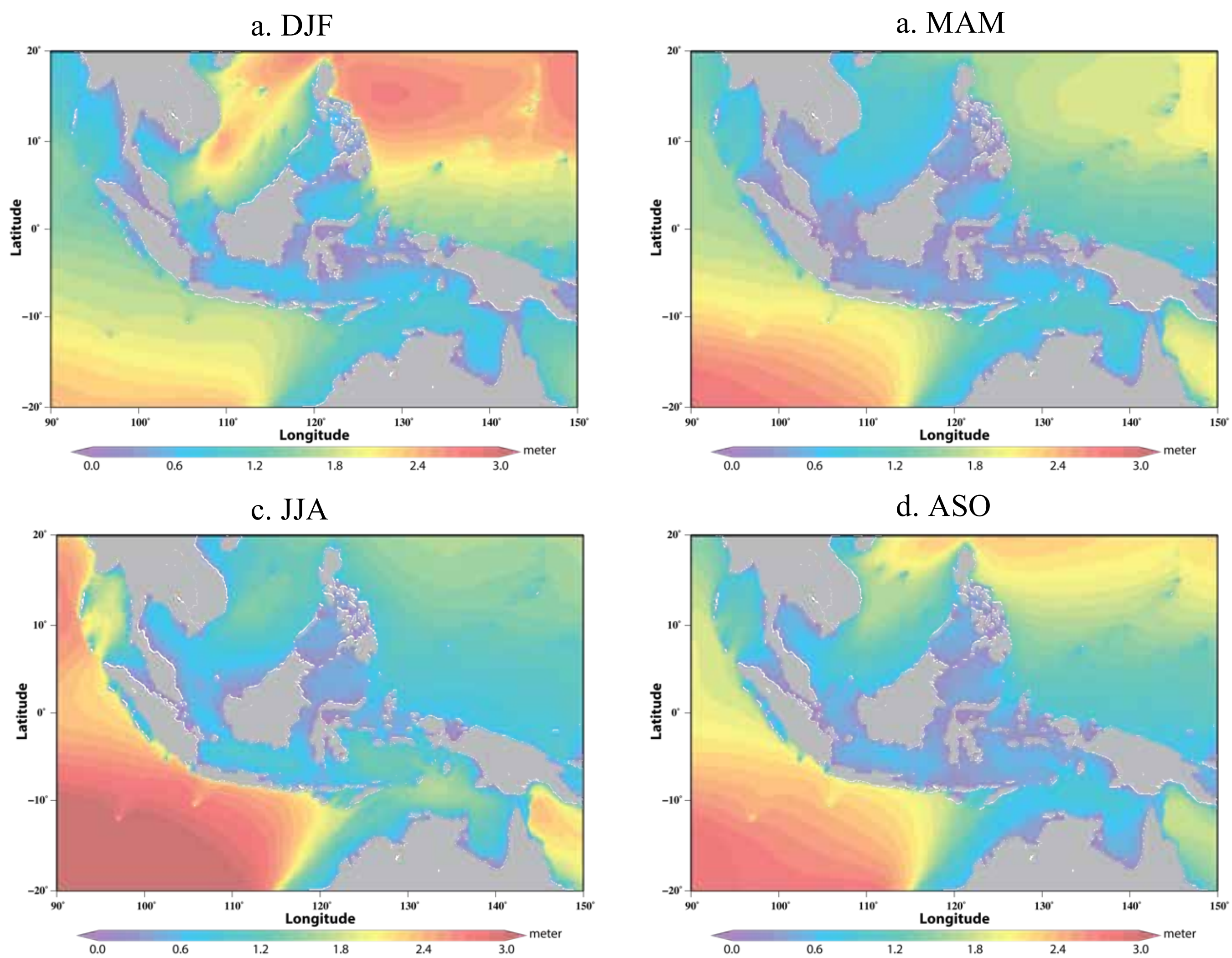


Figure 4.8 The seasonal climatology of significant wave height (SWH) in the Indonesian Seas

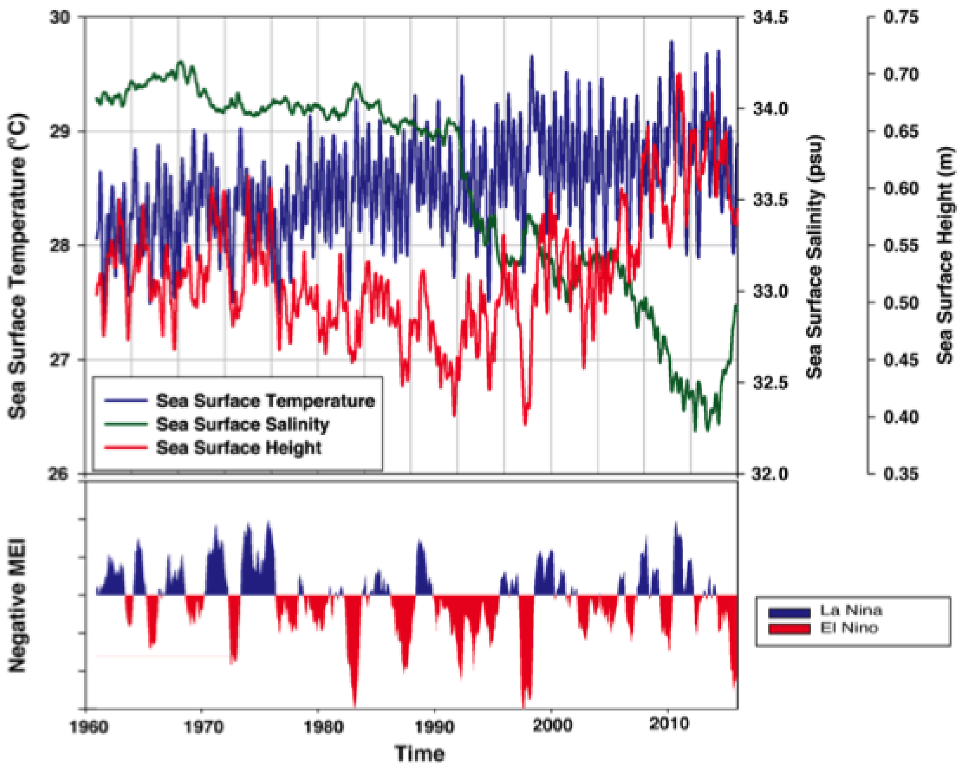


Figure 4.9 Time-series of monthly sea level, sea surface temperature (SST), sea surface salinity (SSS) and ENSO Index from 1961 to 2015

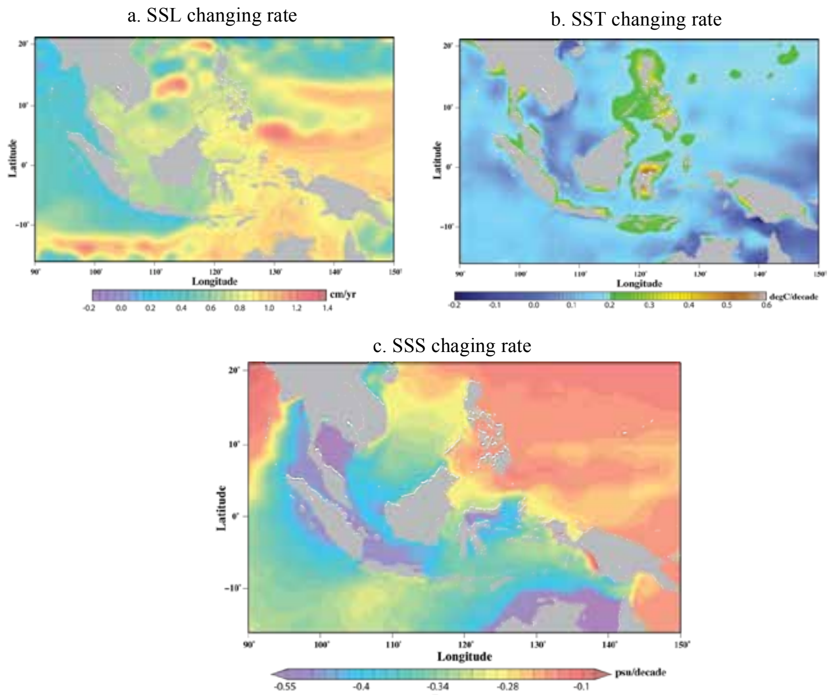


Figure 4.10 **Spatial distribution of sea surface level (SSL), sea surface temperature (SST) and salinity (SSS) changing rates from 1991 to 2015**

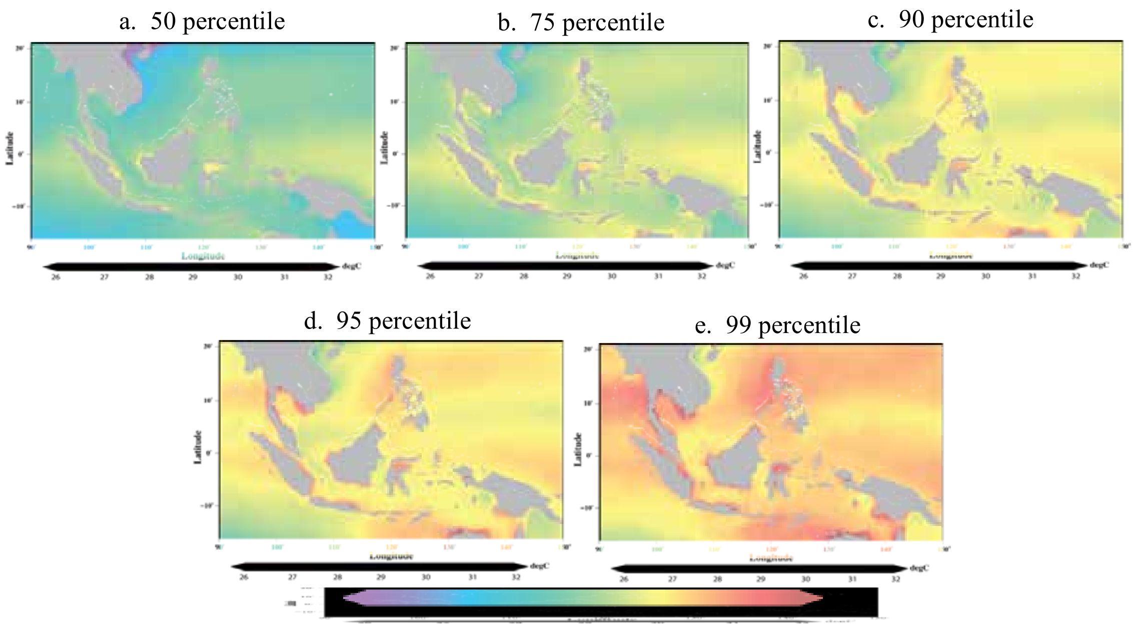


Figure 4.11 **The percentile ranks of daily InaROMS-estimated SST from 1991 to 2015**

24 General Circulation Models (GCM). The RCPs are new scenarios used by the IPCC for their new climate projection studies used in the Fifth IPCC Assessment Report (AR5), which was published at the end of 2013. The RCPs consists of four climate change scenarios that were defined based on the pathways of radiative forcing until 2100 (R. Moss et al., 2008; R. H. Moss et al., 2010), i.e. RCP2.6, RCP4.5, RCP6.0 and RCP8.5. They represent different future pathways of radiative forcing. RCP2.6 is the lowest scenario with radiative forcing peak at ~3 Wm-2 before 2100 and the declines ("peak and decline" pathway). Under this scenario, the increase in global temperature can be hold below 2°C. Meanwhile, the highest scenario is RCP8.5 that has "rising" pathway with radiative forcing expected to be greater than 8.5 Wm-2 in 2100. This will lead to the increase of global temperature of more than 2°C by mid 21st century and may go up to 4.8°C by late 21st century.

GCM outputs usually have coarse resolutions, which are insufficient to obtain detailed information on climate change scenarios at regional/local scales. Many studies solved this problem by using different statistical approaches in order to downscale GCM data outputs into regional/local scale (e.g., Benestad, 2005; Bergant & Kajfez-Bogataj, 2005; Jiafeng & Xuebin, 2008; Mehrotra & Sharma, 2005; Moron, Robertson, Ward, & Ndiaye, 2008; R. L. Naylor, Battisti, Vimont, Falcon, & Burke, 2007). One of the methods that is used as an approach for this purpose is the Delta approach (e.g. Graham, Andréasson, & Carlsson, 2007). In general, Delta method used in this study follows the equations below:

$$x_{cor,i} = x_{mp,i} + \mu_{ob} - \mu_{mb} \qquad (1)$$

$$x_{cor,i} = x_{mp,i} \times \frac{\mu_{ob}}{\mu_{mb}} \qquad (2)$$

In Delta method, addition is mostly used for temperature (Equation 1), while multiplication one is used for rainfall data (Equation 2). The distribution of climate data from the model is corrected using Piani et al. method (2010) in order to align with the distribution of observed data.

Besides the use of statistical downscaling, the future climate of Indonesia is also generated using dynamical downscaling with regional climate model, the RegCM4. This is to produce high-resolution modelling outputs for climate change projections. High-resolution data is needed to get detailed information related to climate change projection studies. The model simulated Indonesian domain with 20 km x 20 km horizontal grid resolution. The RegCM4 simulates only two RCP scenarios, .i.e. RCP4.5 and RCP 8.5. The outputs of HadGEM2-ES GCM (W. J. Collins et al., 2011; Martin et al., 2011) are used as ICBC (Initial & Lateral Boundary Condition) to run the RegCM4. The detail explanation of the method for the climate projection analysis in the TNC document is presented in Faqih (2016).

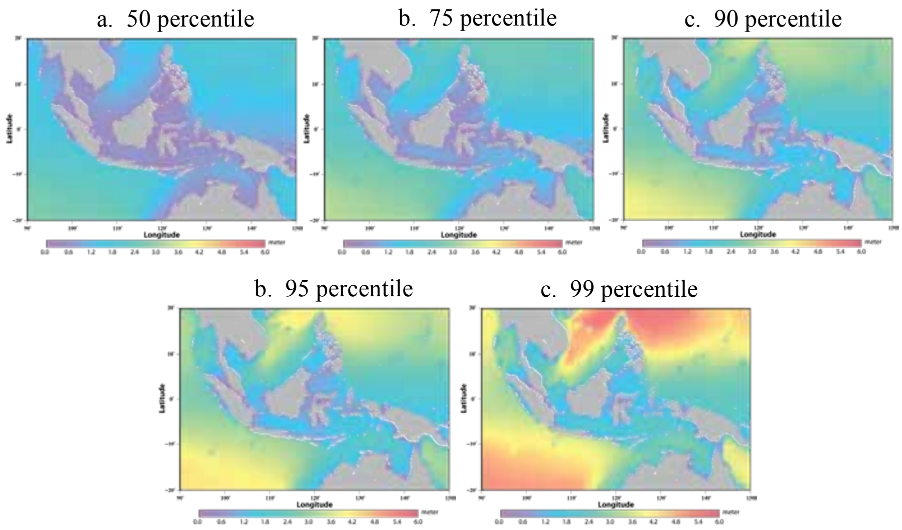


Figure 4.12 The percentile ranks of modelled significant wave heights from 1991 to 2015 period

4.2.2.1 Land

1. Temperature

Projection of regional mean surface temperature over Indonesia based on the ensemble of 24 CMIP5 GCMs, indicates that the surface temperature would continue to increase until 2100 with different rate depending on the scenarios (Figure 4.13). Compare to the projected global surface temperatures (IPCC, 2013), it is suggested that the increase in surface temperatures over Indonesia is lower than global temperature for all RCP scenarios. The temperatures increase in Indonesia at RCP2.6 is projected to be less than 1°C in 2100, while the global value can reach 1°C. The difference of temperature increase in 2100 as shown by RCP4.5 is nearly 0.5°C lower for Indonesia, i.e. around 1.5°C in Indonesia and almost 2°C at global. Moreover, the global mean surface temperature is expected to be almost 1°C higher than the mean temperature in Indonesia as projected by the high emission scenario RCP8.5. Nevertheless, given the spread of climate model uncertainties, the highest increase of the projected mean temperatures in Indonesia could potentially reach similar values as in the global temperature ranges in 2100, i.e. more than 4°C.

In general, the projection shows that the longer the distance of future time-period to the baseline, the higher are the discrepancies, indicating a tendency of increasing temperature in the region (Figure 4.14). The low-range projection scenario (RCP2.6) demonstrates that the annual mean temperature to increase around 0.67°C in 2026-2050, and 0.75°C in

a) Global (IPCC, 2013) **b) Indonesia**

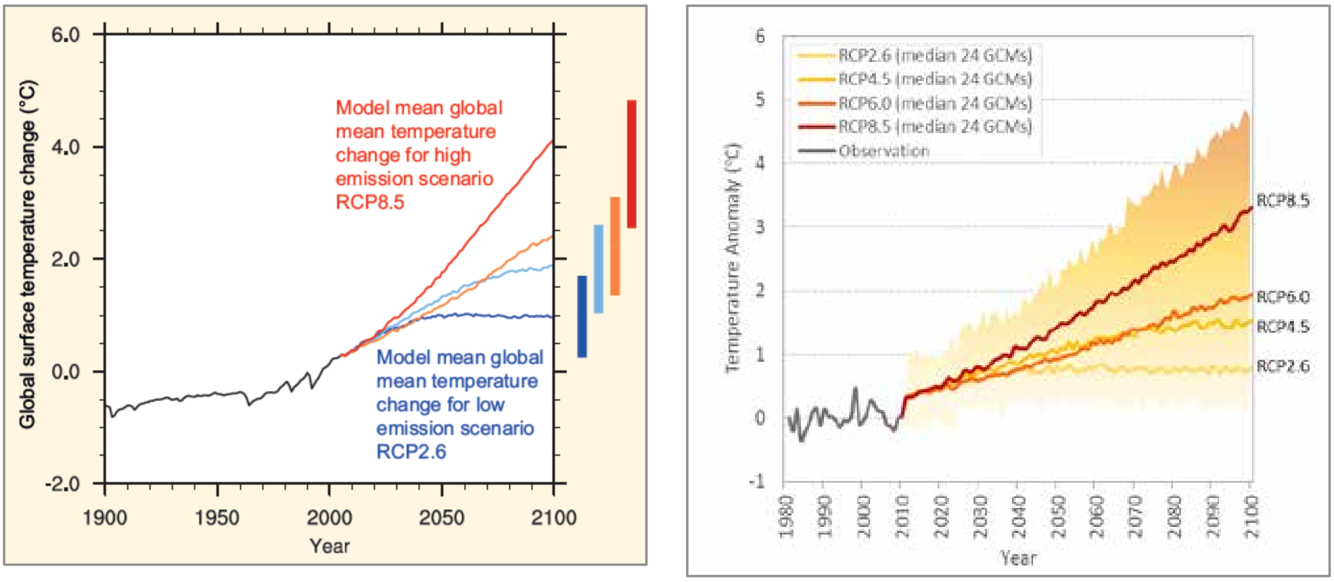


Figure 4.13 **Trends of future temperatures from a) global mean surface temperatures as shown in the AR5 (IPCC, 2013), b) mean temperature anomalies in Indonesia as projected by 24 CMIP5 GCMs under four RCP scenarios. Light shaded colour shows range of uncertainties across all models and scenarios.**

2051-2075 and 2076-2100 from the current temperature (1981-2005). For RCP4.5, the temperature changes are expected to increase around 0.87°C in 2026-2050, and 1.22°C in 2051-2075 and 1.41°C in 2076-2100. Similar increase is shown for RCP6.0. Under the extreme scenario (RCP8.5), the temperatures are projected to increase by 1°C in 2026-2050, by 1.8°C in 2051-2075 and by 2.7°C in 2076-2100.The spatial differences of the future temperature patterns relative to the baseline periods by islands are presented in Figure 4.15).

The change in temperature between scenarios based on the RegCM4 is consistent with the GCM. The only difference is that the RegCM4 results provide more detail information on the spatial changes of the surface temperatures. It is also found that the surface temperatures over land increases higher than the temperature over oceans. The differences of the increases between land and ocean are increasing under extreme scenarios (RCP8.5) at the end of the 21st century, during 2076-2100 periods.

2. Rainfall

Distributions of future monthly rainfall from multi Model Ensemble (MME; 24 GCM models) indicate that the changes of the future scenarios for mean monthly rainfall were not significant, however the variability increase (Figure 4.16). Probability of having monthly rainfall beyond a certain value will increase in the future. For example, the probability of having rainfall above 350 mm/month will increase in most periods and scenarios, suggesting higher probability of having future extreme rainfall.

From spatial analysis, it is indicated that in general the future annual rainfall tends to be drier during dry season and wetter during rainy season and transition period (from wet to dry season). The uncertainty of future climate also tends to increase in the future, particularly under the extreme scenario (RCP8.5). The mean annual rainfall would increase in the northern part of Indonesia, especially over most parts of Sumatra, Kalimantan and Papua (Figure 4.17). The increase in mean annual rainfall is mostly more prominent in the eastern part of Indonesia, especially in Papua and Kalimantan. In contrast, decreases are observed mostly over the southern part of the country.

Seasonally, the pattern of rainfall changes varied between regions (Figure 4.18). The DJF seasonal rainfall will increase mostly over Java and Kalimantan, while the MAM seasonal rainfall will increase not only in Kalimantan, but also in Papua. In contrast, the June-August (JJA) seasonal rainfall will decrease, especially over Java, Sulawesi, and the southern parts of Sumatera and Kalimantan. During the transition period in SON, some regions will

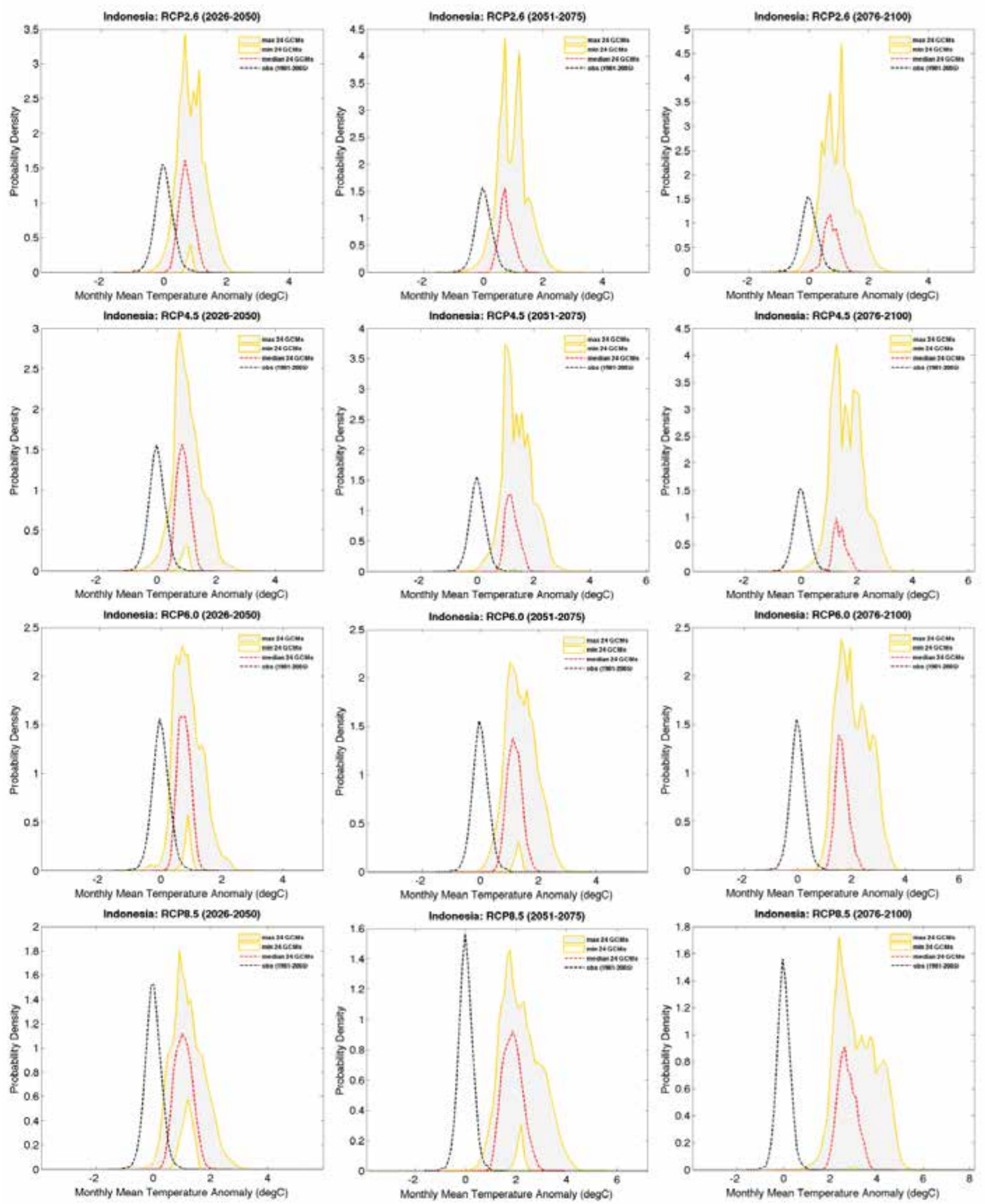


Figure 4.14 **Distribution of future mean temperature anomalies in Indonesia as projected by 24 CMIP5 GCMs under four RCP scenarios in every 30-year periods (2026-2050, 2051-2075 and 2076-2100). Light shaded colour shows range of uncertainties of all models and scenarios, with the dashed-red line shows the median temperature**

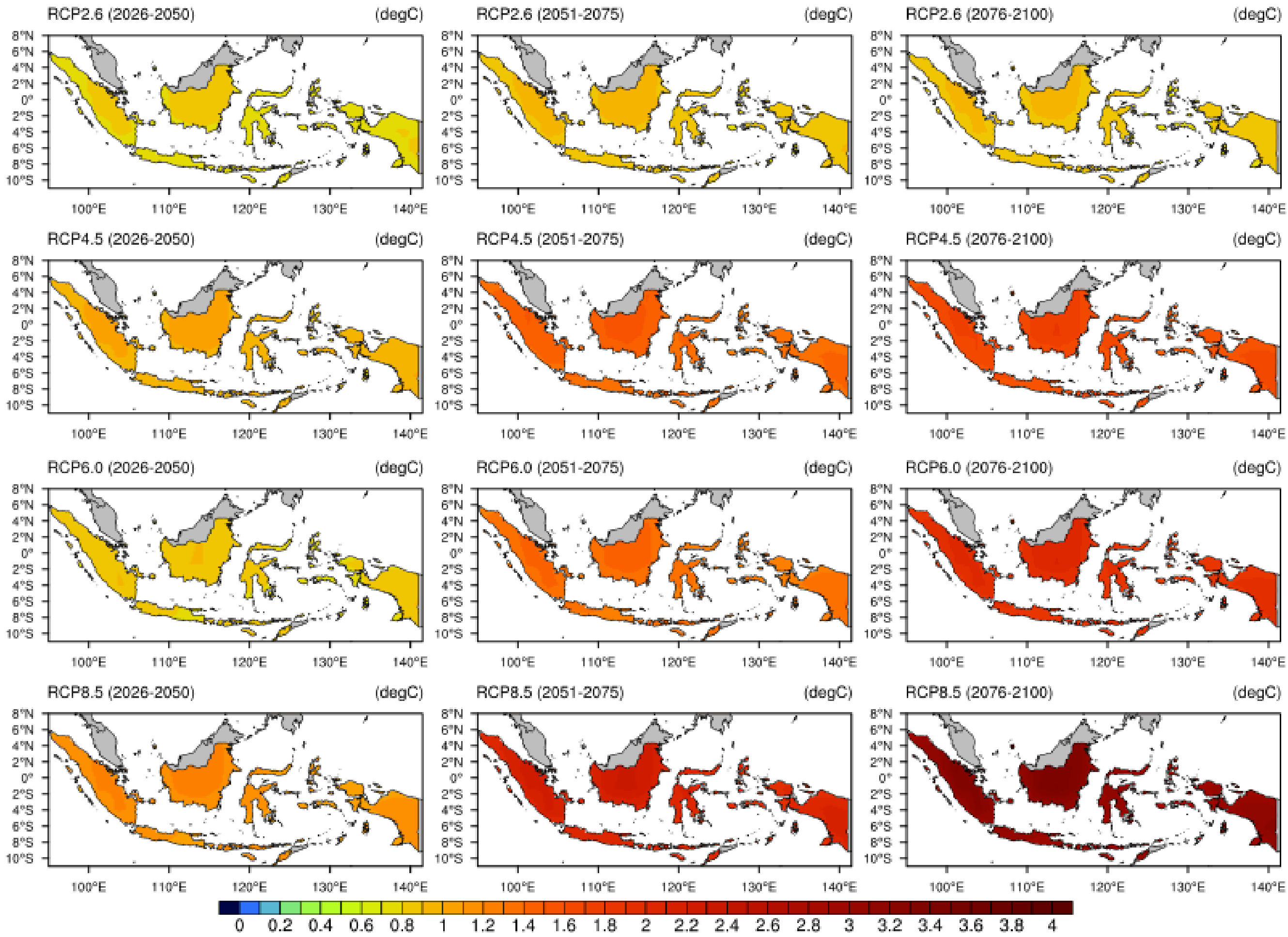


Figure 4.15 **Annual mean temperatures differences in Indonesia from MME of 24 CMIP5 GCMs under all RCP scenarios (2026-2050, 2051-2075 and 2076-2100 periods), relative to observation (1981-2005 periods)**

have more rainfall, with the most prominent rainfall increases in Kalimantan. Consistent to the previous result, in more extreme scenario (RCP8.5), the change in seasonal rainfall is more significant.

The current and future spatial changes of the annual and seasonal rainfall are not very significant across areas (Figures 4.17 & 4.18), mostly due to the coarse resolution data from GCM that is interpolated into higher resolutions. Using different statistical downscaling approaches that consider the spatio-temporal characteristic in every grid locations, the change in current and future rainfall is quite different among regions, and the uncertainty of the future rainfall also increases.

Using dynamic downscaling approach with RegCM4 (Figure 4.19), there are general consistencies for the future rainfall, especially over land area. During the Australian Summer Monsoon (ASM) season that usually coincide with the rainy season (DJF), the seasonal rainfall will increase, while during the Boreal Summer Monsoon (BSM) season which normally corresponds to the dry season in JJA, the seasonal rainfall will decrease over most parts of the country.

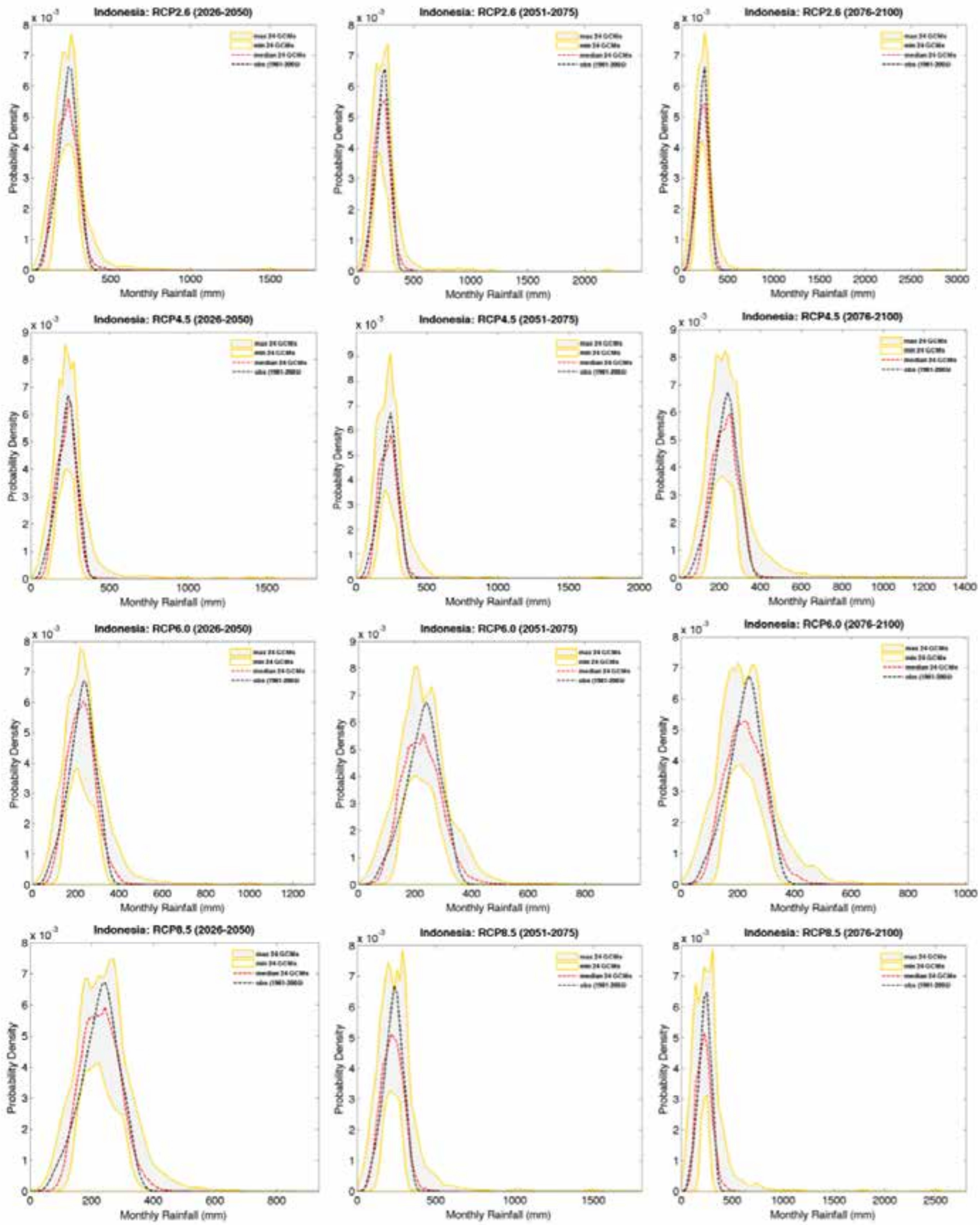


Figure 4.16 **Distribution of future rainfall in Indonesia as projected by 24 CMIP5 GCMs under four RCP scenarios in every 30-year periods (2026-2050, 2051-2075 and 2076-2100). Light shaded color shows range of uncertainties across PDFs of all models and scenarios, with the dashed-red line shows the median values of those PDFs.**

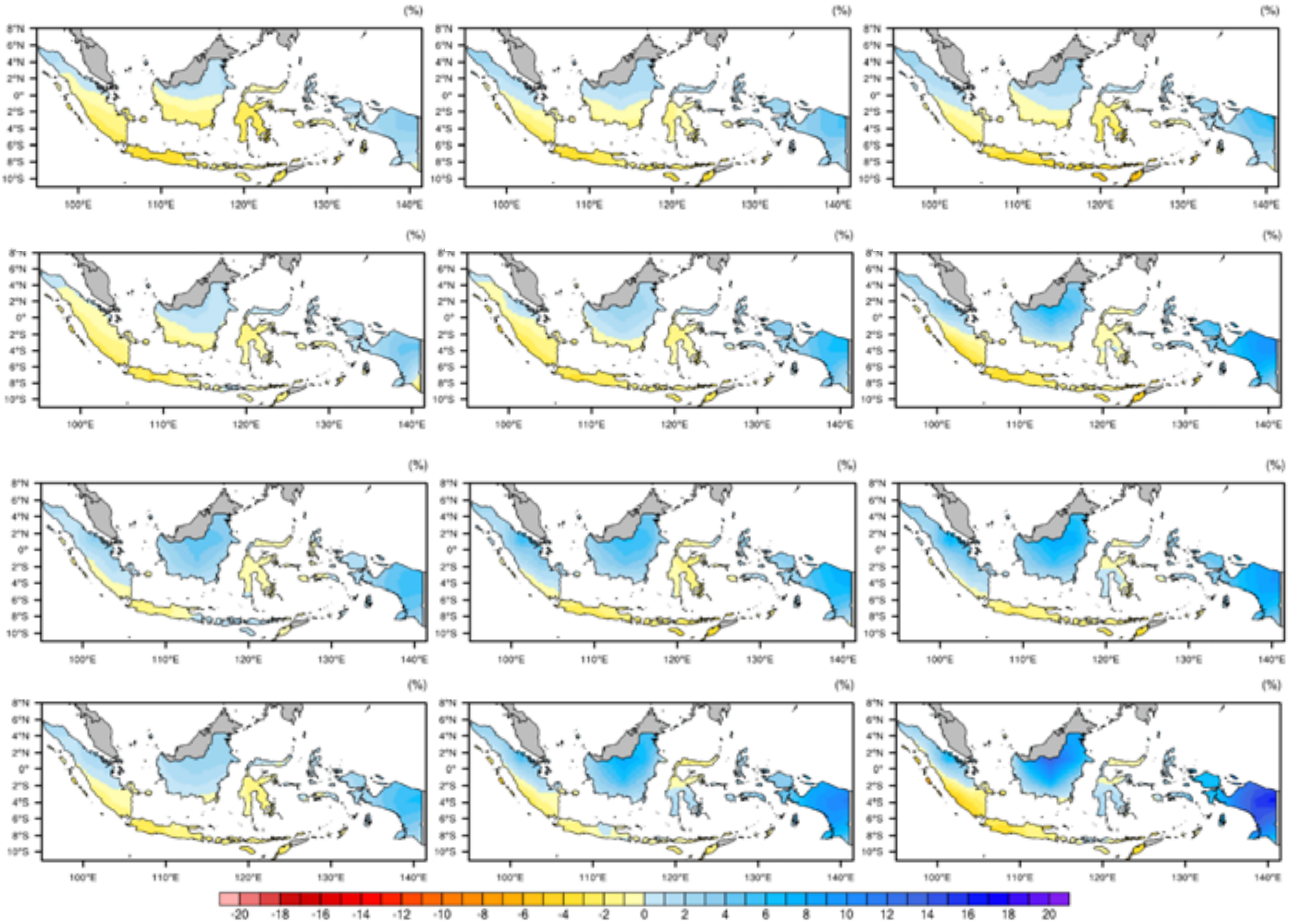


Figure 4.17 Changes (in %) of annual rainfall climatology calculated from MME mean of 24 CMIP5 GCMs separately calculated for each RCP scenarios at three different time periods (The changes are relative to the observed baseline (1981-2005 periods) using CHIRPS v2.0 dataset.

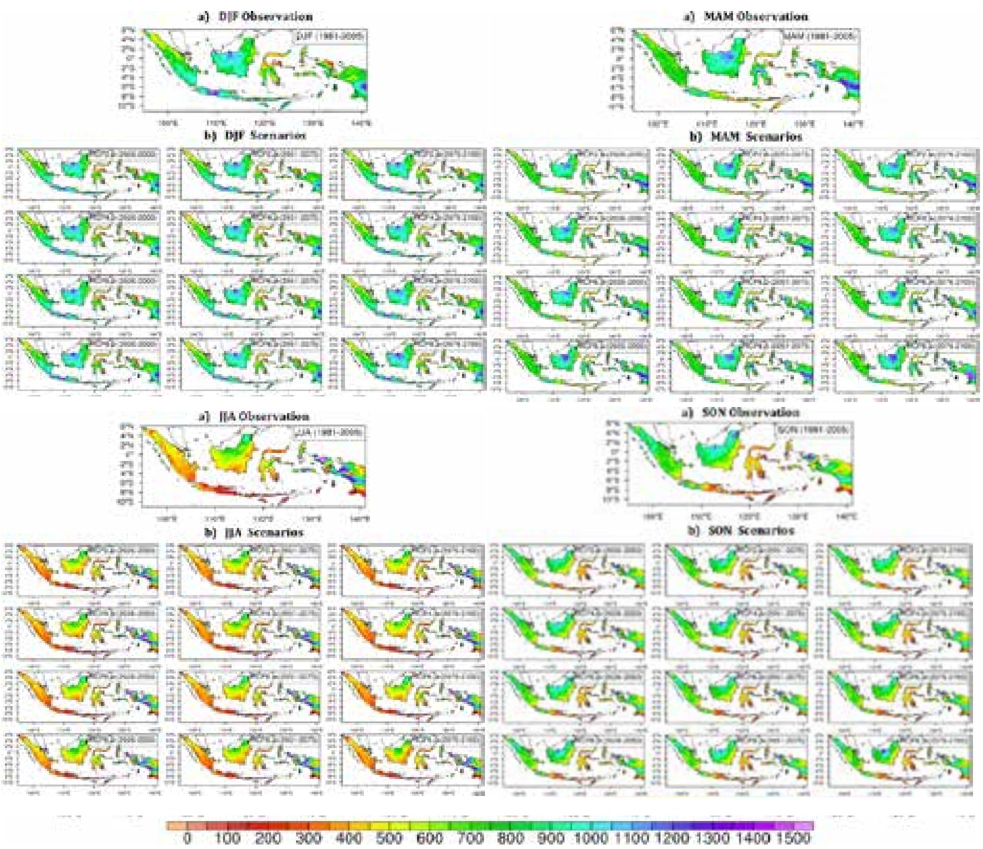


Figure 4.18 Seasonal rainfall climatology during 1981-2005 periods, and seasonal rainfall scenarios of the three different time periods calculated from MME median of 24 CMIP5 GCMs

RegCM4 result

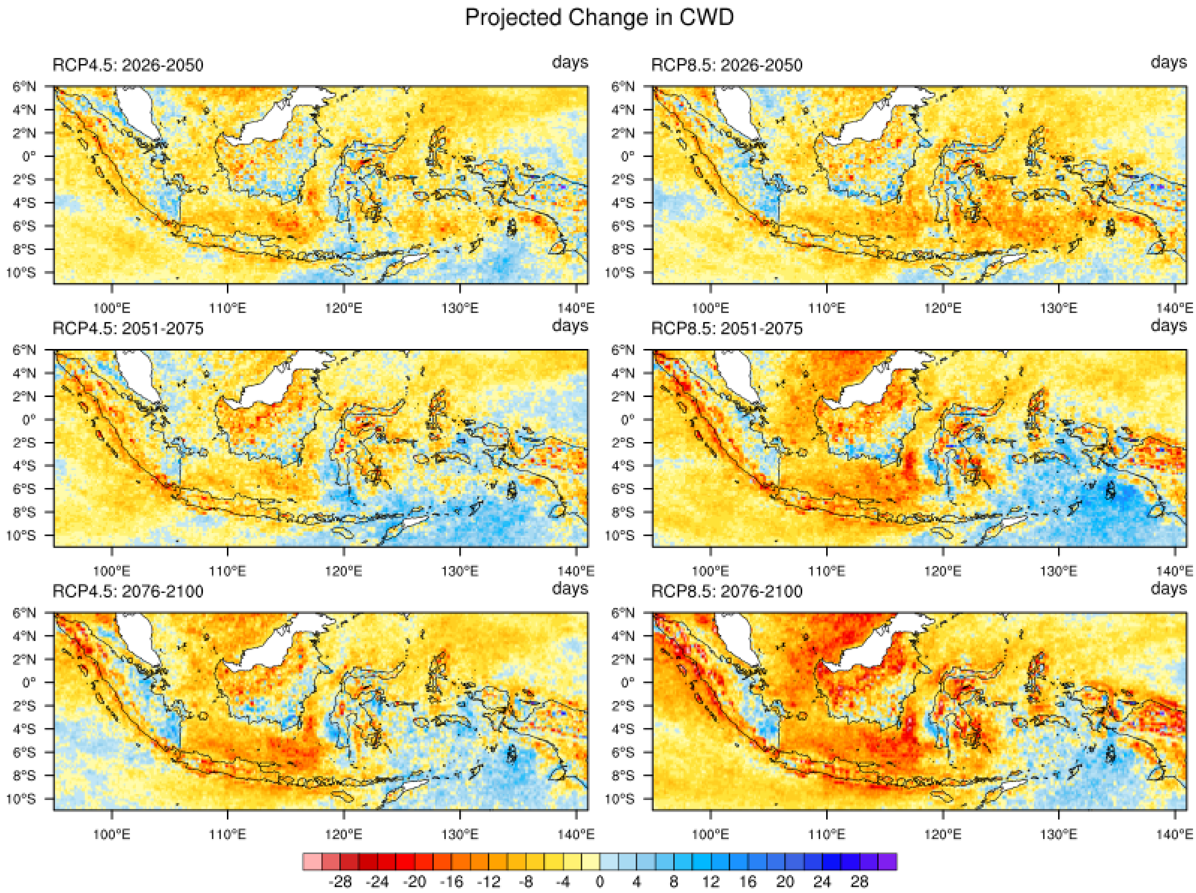


Figure 4.19 Projected changes (relative to the 1981–2005 reference period) in CWD, the maximum number of consecutive wet days when precipitation is equal or more than 1 mm, projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs under RCP4.5 (left) and RCP8.5 (right).

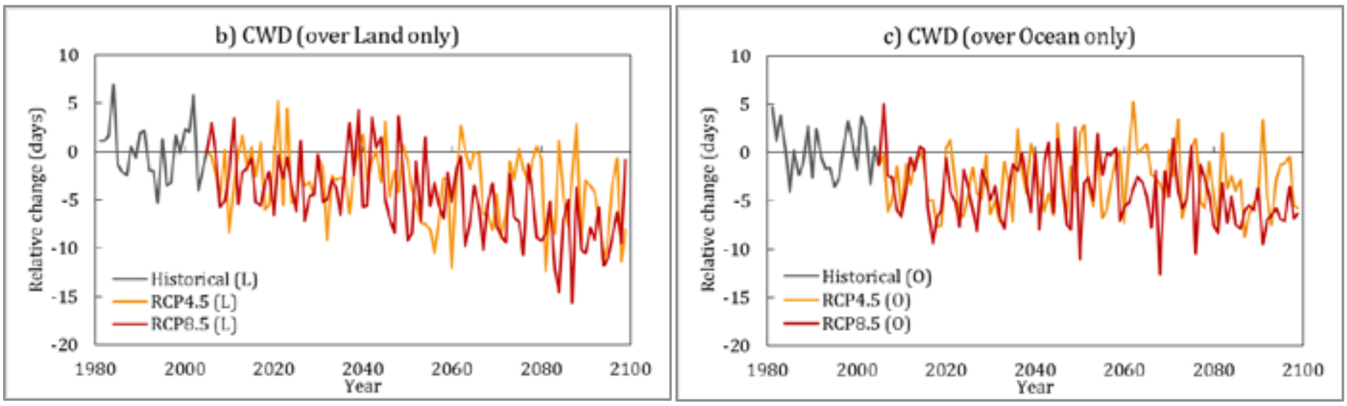


Figure 4.20 Indonesia average change in CWD, the maximum number of consecutive wet days when precipitation is equal or more than 1 mm, over land & ocean for the RCP4.5 and RCP8.5 scenarios.as projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs.

On the contrary to CWD, CDD can be a representative proxy for drought condition since it provides information on the longest time in a certain period with no rainfall, consecutively. The spatial projected changes of CDD in the future tend to increase in almost all regions of Indonesia (Figure 4.20). The time series of relative changes of the CDD over ocean show substantial upward trends with increasing variability compare to land area (Figure 4.21).

In general, warming atmosphere will have impacts on the increase of intensity of extreme climate events, although the frequency may decrease. The future climate in Indonesia is projected to be drier than the baseline period as indicated by the increase of trend and variability of CDD, which is a proxy for drought event. The considerable decreasing trend of CWD supports this condition.

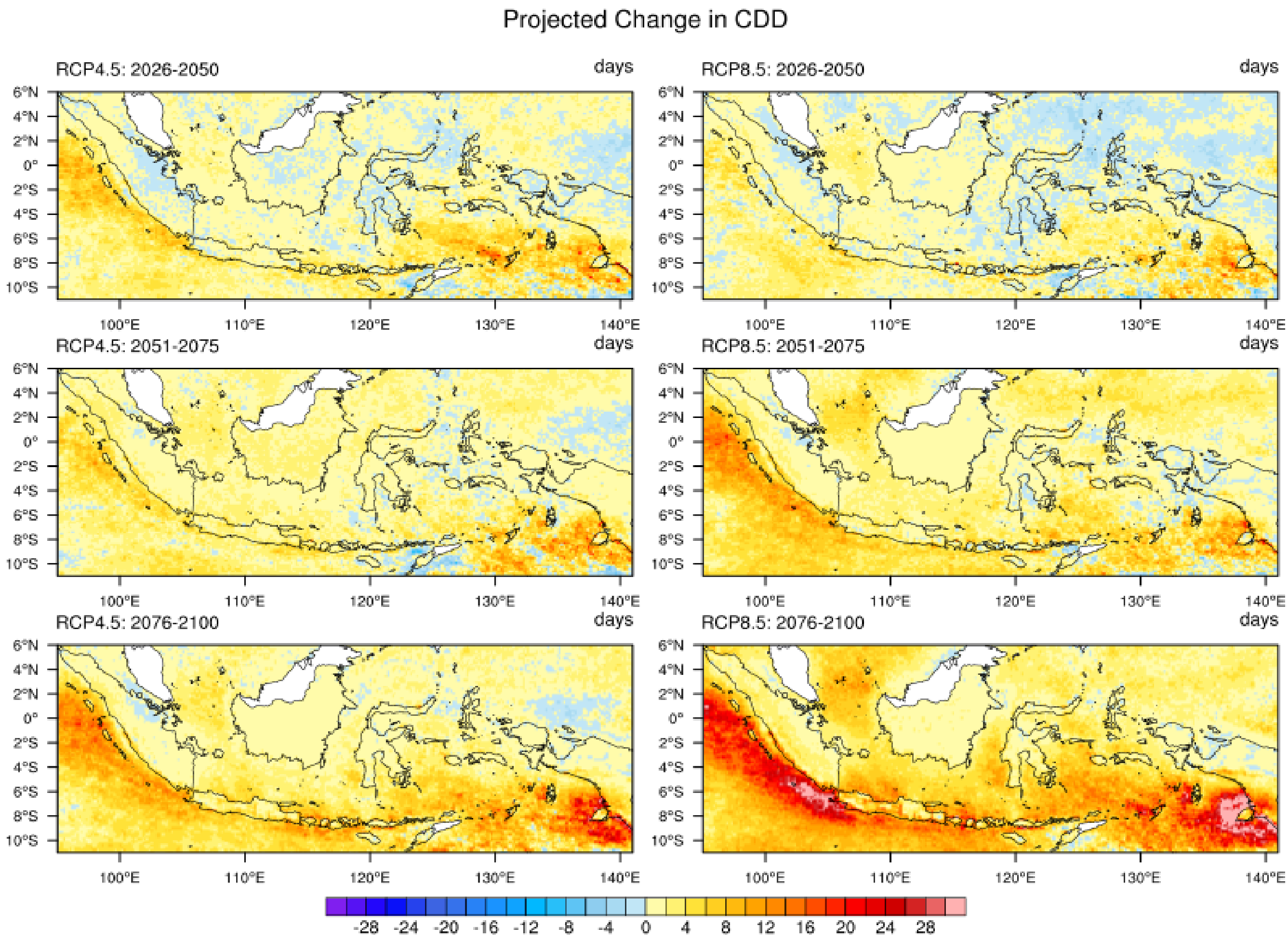


Figure 4.21 Projected changes (relative to the 1981–2005 reference period) in CDD, the maximum number of consecutive dry days when precipitation is less than 1 mm, projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs under RCP4.5 and RCP8.5.

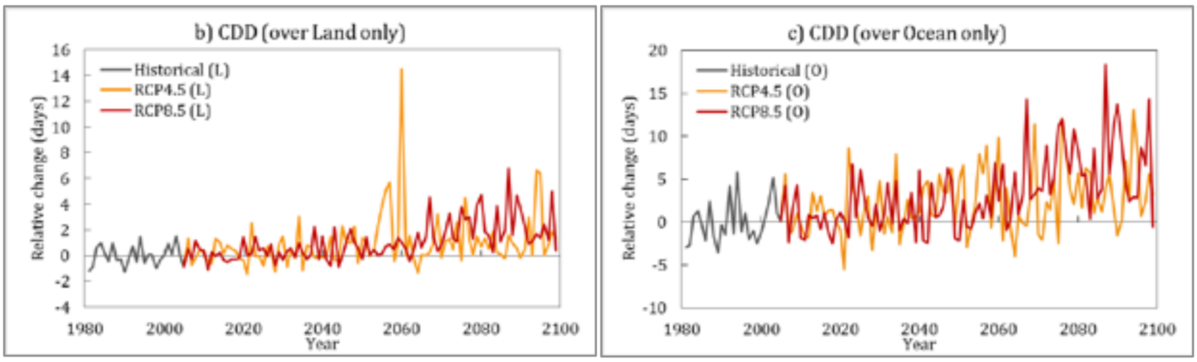


Figure 4.22 Indonesia average change in CDD, the maximum number of consecutive dry days when precipitation is less than 1 mms, over land & ocean for the RCP4.5 and RCP8.5 scenarios as projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs

4.2.2.2 Ocean

Based on simulation results from 1961 to 2015 and RCP4.5 from 2006 to 2040, it is shown that the regional averaged sea level, sea surface temperature and salinity over area of 90°E to 150°E and 15°S to 15°N, are relatively in line (Figure 4.23). The sea surface height (sea level) will continue to increase to 2040. The sea level in 2040 will be 50cm higher than in 2000. The sea surface temperature will also be increasing. By 2040, the sea surface temperature will be higher 1°C than in 2000, or 2°C than in 1961. Meanwhile, the surface salinity continues to decreases from 33.2psu in 2000 to 32.1psu in 2040.

The ocean responses on the interannual variations can also be seen from the sea level and SST characteristics. The model is likely to succeed for ENSO simulation. However, the ENSO is projected to be regular in every 7 years. Hence, the strong El Nino and La Nina are likely to be occurring every 6 to 7 years.

1. Sea Surface Temperature (SST) Projection

The increasing rate of SST for the period 2006-2040, on average may reach 0.25°C/decade under the RCP4.5 (Figure 4.24). The highest rise is likely to occur at South China Sea and Karimata Strait reaching 0.5°C/decade. The increasing rate at Java Sea, Banda Sea, Sulawesi Sea and its surrounding seas range from 0.2 to 0.3°C/decade. While, the trend at the Pacific and the northern part of Papua is likely to be the lowest compared to the increased rate observed for other regions. SST is known to be the proxy to estimate surface water temperature up to 50m in depth.

2. Sea Level Projection

Sea level rise due to global warming will bring inevitable consequences. Seasonal current

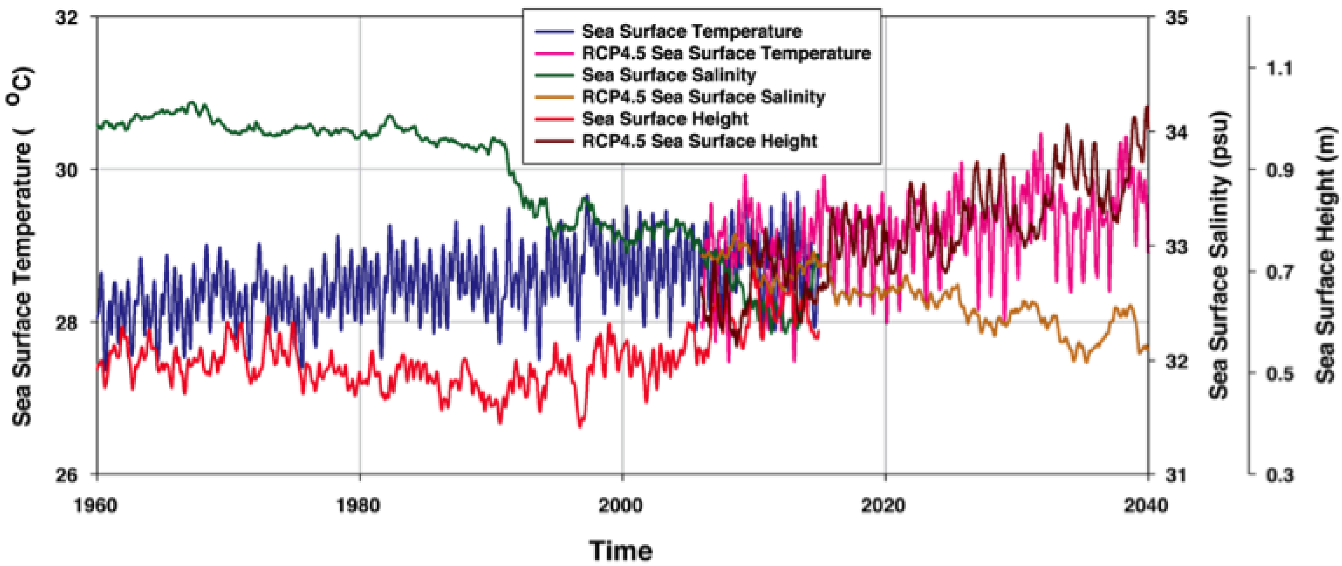


Figure 4.23 Time-series of monthly sea level, sea surface temperature (SST) andsea surface salinity (SSS) from 1961 to 2040

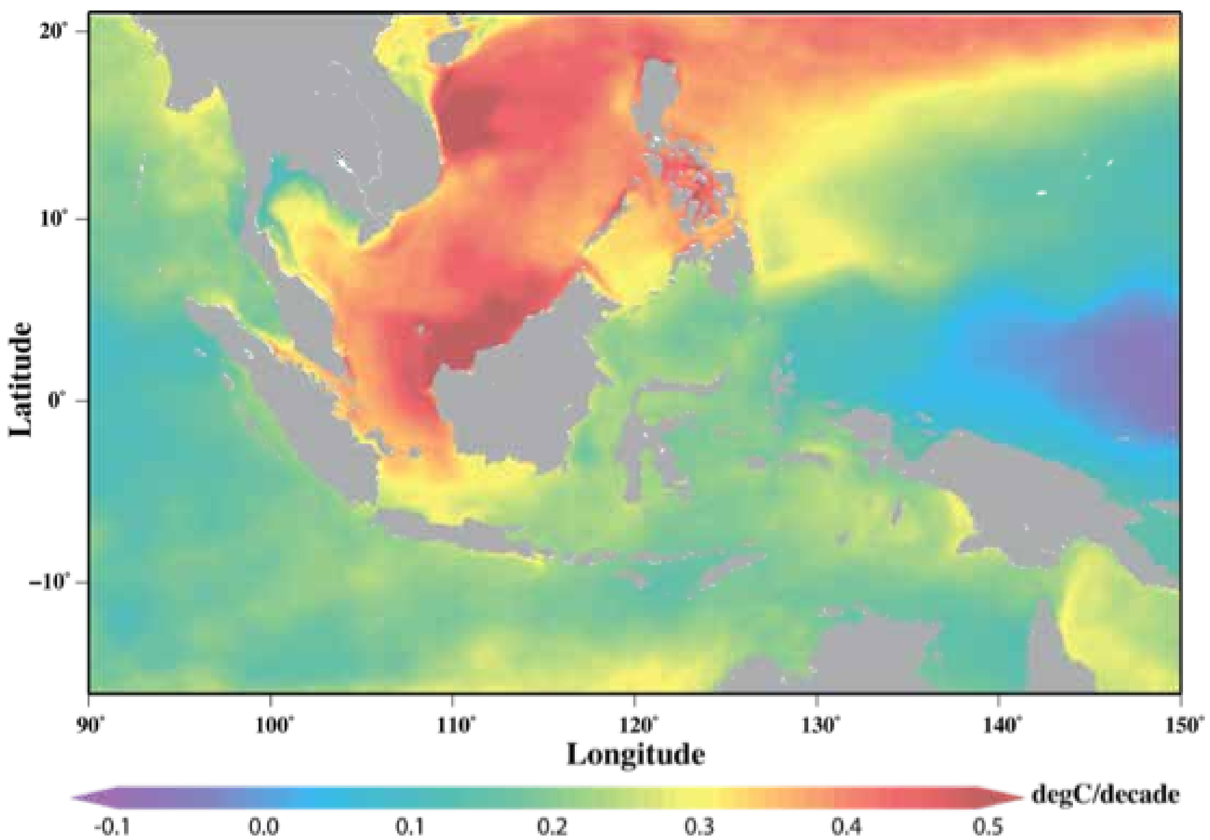


Figure 4.24 Rate of SST increase in the period 2006-2040 under RCP4.5

patterns and the Indonesian through flow (ITF)[1] might be influenced by the changing of rate of sea level rise, particularly in areas where sea level rise of the Pacific Ocean is greater than that of the Indian Ocean. Hence, these changes are likely to change the characteristics of the ITF transport that carries warm water from Pacific to Indian Oceans via the Sulawesi Sea and the Makassar Strait.

The projection results show that the rate of sea level rise is relatively homogeneous. In general, the rate of sea level rise varies from 0.6cm/yr to more than 1.2cm/yr (Figure 4.25). The highest sea level rise is projected to occur at South China Sea, while it varies from 0.7cm/yr to 1.0cm/yr, at the other locations. Therefore, the sea level in the Indonesian Seas is likely to rise more than 30cm for a time-span of 40years.

Rahmstorf (2007) uses the relationship between sea level rise and surface temperature to predict the sea level rise at the end of the 21st century. The estimation of sea level rise ranges from 50 cm to 140 cm, relative to the sea level in 1990. Abdalati (2006) argues that the global glaciers and ice sheets contain enough ice to raise the sea-level by approximately 70m if they were to disappear entirely with most of the ice located in the climatically sensitive Polar Regions. Fortunately changes of this magnitude would probably take many thousands of years to occur, but recent discoveries indicate that these ice masses are responding to changes in today's climate more rapidly than previously thought (Abdalati, 2006).

To avoid the impact of ice melting, Bryan (1995) calculated the thermosteric sea level rise using the ocean model. Results of the model found an average rise in sea level of approximately 15±5cm by the time atmospheric carbon dioxide doubles for the 80 years model running. Sofian (2013) calculated the recent thermosteric sea level rise using the HYCOM. The model suggests that the thermoteric sea level rise is roughly 30% from the total sea level rise observed by altimeter. The steric sea level rise is approximately 20mm from 1993, when, the total sea level rise reaches to 58mm. This

[1] The Indonesian Through Flow (ITF) is an ocean current with importance for global climate since it provides a low-latitude pathway for warm, fresh water to move from the Pacific to the Indian Ocean and this serves as the upper branch of the global heat conveyor belt

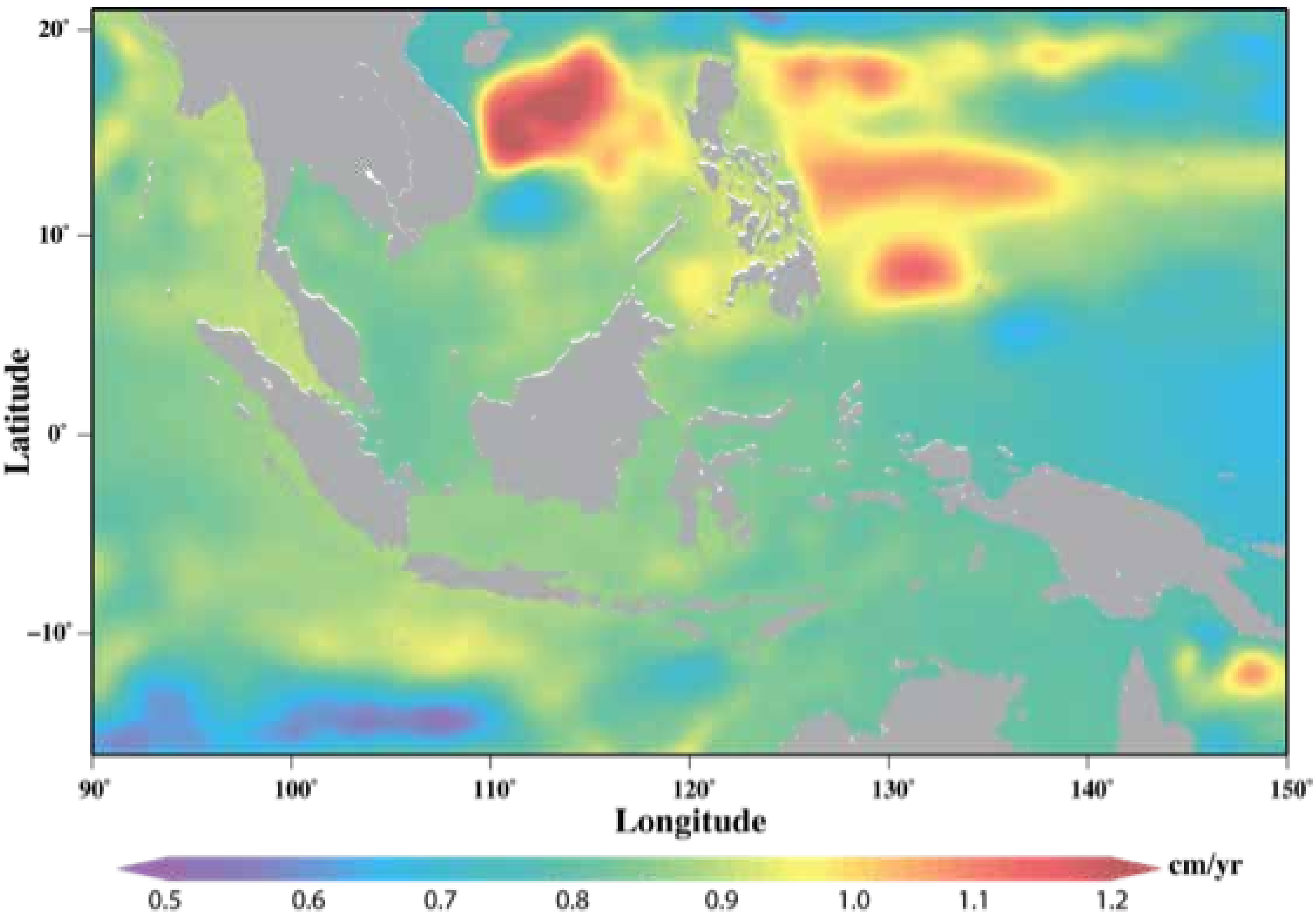


Figure 4.25 *Rate of sea level rise in the period of 2006-2040 under the RCP4.5*

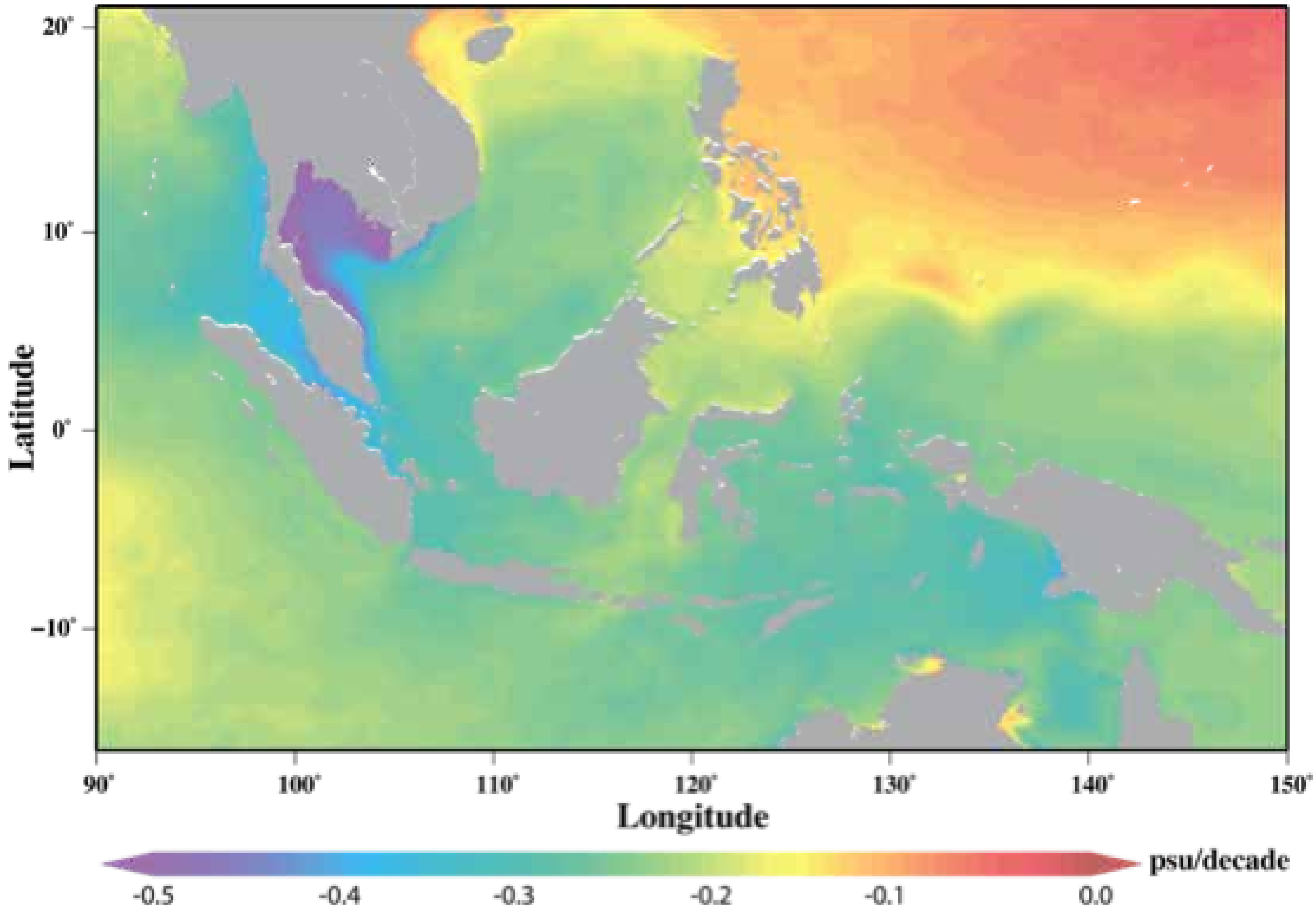


Figure 4.26 *Sea level rise rate projection based on the RCP4.5 scenario*

fact indicates that ice melting contributes more than 60% of the total sea level rise.

As a result, rapid sea level rise not only leads to the strong changes in current patterns, but also strengthens erosion, coastline alteration, and the reduction of wetland area in coastal zones. Wetland ecosystems in coastal zones might be damaged if the sea level rise exceeds the maximum limit of adaptive capacity of coastal life forms. Moreover, the rise of sea level also increases the rate of intrusion by seawater into the coastal environment.

3. Sea Surface Salinity Projection

The projections of sea surface salinity changes correspond to the simulated projections from 1991 to 2015. The SSS projection changes are lower compare to the results for the period of 1991 to 2015. The sea surface salinity (SSS) is likely to decrease with the rate of -0.3±0.2psu/decade. The SSS lowest changing rates are occurred at Gulf of Thailand, when other locations show moderate to high SSS negative changes, as depicted in Figure 4.26 This difference from the simulated one can be addressed to the lower rainfall projection than historical data at north of Australia, southern part of Java Sea, west and east of Sumatera, Tomini Bay, and Molucca Strait.

Conversely, the projections pattern of salinity changes shows less negative changing rate at the pathways from Makassar to the Indian Ocean via the Lombok Strait. It may indicate that the greater part of Makassar Strait surface current exits to the Indian Ocean via Lombok Strait, when the lesser part exits via the Savu Sea, Ombai Strait and Timor Sea.

4. Significant Wave Height (SWH) Projection

The projected wave height changes from 2006 to 2040 at 50 to 99 percentile data are presented in Figure 4.27 In the La Nina phase, generally, the trade winds from the Pacific Ocean strengthen, which should enhance the wave height. The influence of climate variability such as La Nina is clearly noticed from the increasing wave height at 50 to 99 percentiles as shown in Figure 4.28 However, the wave height also increases at the Indian Ocean, south of Java and west of Sumatera. This may also indicate that the Indian Ocean Dipole is likely to play more significant role compare with the historical data.

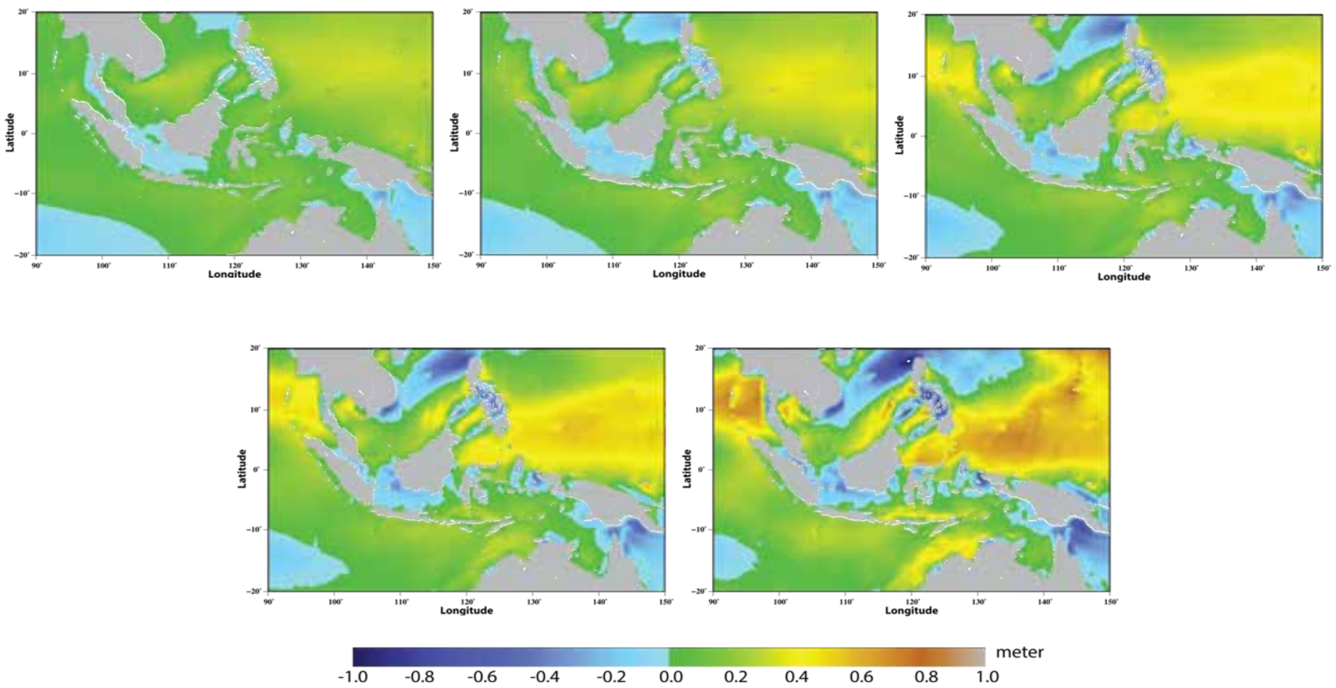


Figure 4.27 Wave height difference of percentile rank of projected SWH respect to the historical data

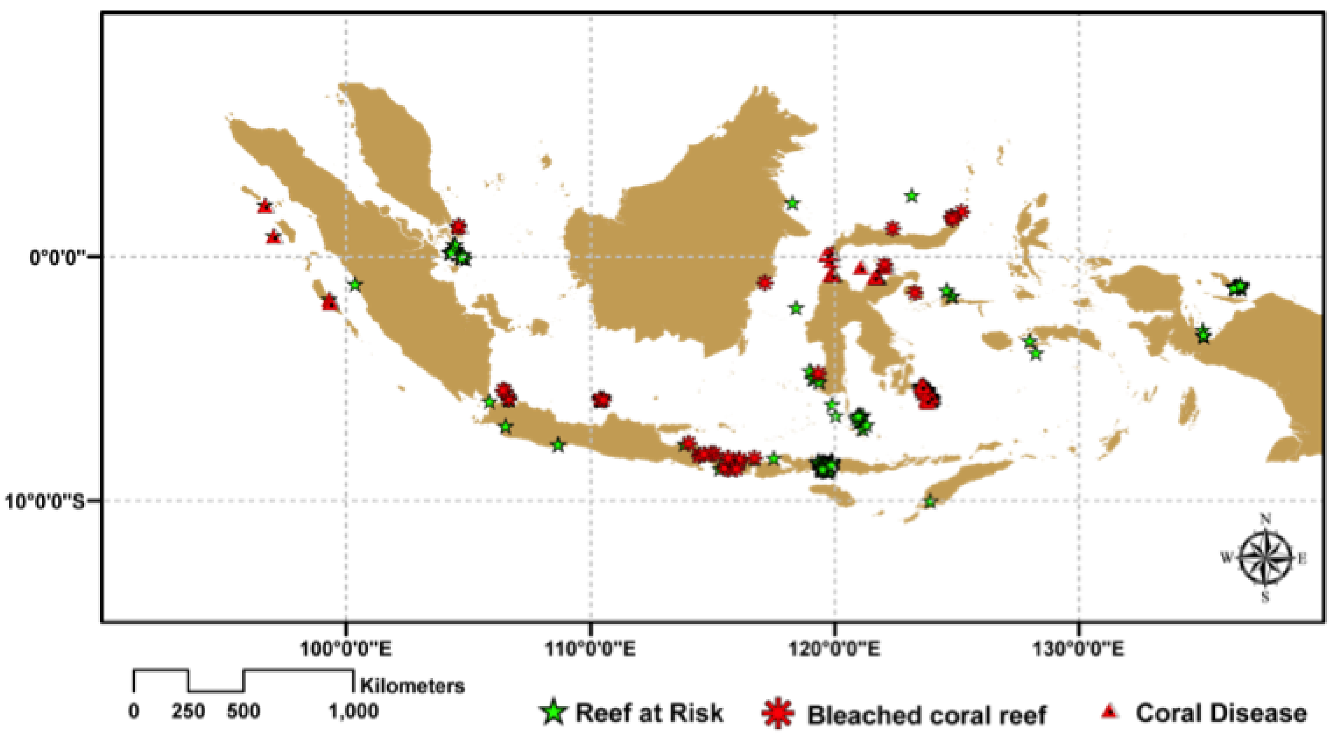


Figure 4.28 Map of coral reef damage and coral bleaching based on data from Basereef.org (ICCSR, 2010)

The shallow North Karimata Strait and Riau Islands reduce the remotely Rossby wave propagation from the South China Sea. Therefore, the wave height at the east coast of Sumatera and most parts the Java Sea is getting lower. Nevertheless, the wave height at Banda Sea, Sulawesi Sea, South of Java, west of Sumatera and southern part of South China Sea are getting higher. The stronger wind speed at Banda Sea, northern coast of Java Island, Sulawesi and Flores Seas produces higher wave height than historical data.

In conclusion, although 1% of the projected extreme wave height indicate an increase of extreme waves of less than 1.0m, but in the real condition, it would be possible to have a rise of more than 1.5m, because of changes in the local and regional wind speeds due to more frequent climate variabilities than projected, and sea level rise due to global warming.

4.3 Impact of Climate Change on Sectors

Historical changes of climate and extreme climate events, have caused serious impacts on many sectors. Under warming atmosphere, the frequency and intensity of extreme climate events are increasing and causing more serious damages. The change of climate will be an additional constraint to achieve sustainable socio-economic development for Indonesia. Many studies have been done on the potential impacts of climate change on sectors and also on ecosystems. The important sectors affected by climate change in Indonesia are the coastal (marine and fisheries), agriculture, water resources, forest, special areas (urban/ rural), and health. Several impacts assessments of climate change on sectors and ecosystems in a number of regions in Indonesia are being conducted and those assessments identified such climate change impacts, clustered as below[2]:

A. Marine and fisheries and coastal sector:

1. Flood impacted various fields such as shrimp farming, fish, salt ponds, rice fields, and settlements.
2. Increase seaweed production
3. Unfavourable for the structure of the root, seedling, and the process of photosynthesis. Modification of the geographical distribution of mangroves, increasing the diversity of mangrove species at higher latitudes and stimulate the spread of mangrove salt marsh environments territory to the sub-tropics
4. Affects mangrove zone (seaward mangrove), longer and the stagnant tides can cause death mangrove
5. Affects mangrove spread far inland, simultaneously shift zoning and change the composition of mangrove species along environmental gradients
6. Mangrove stress and mangrove missing
7. In 2050 and 2100, sea level rise in Indramayu coastal areas are in the range of 0.5 and 1 meter
8. The flooding area cover several areas in Sub Kandanghaur, Losarang, Sindang and Indramayu (about 2900 ha of flood inundation
9. Widespread flood-prone areas to about 7300 ha
10. Flood inundation area are estimated, with a range of about 34600 ha and at about 42000 ha

B. Marine and fisheries and urbanization:

1. Destruction of coastal ecosystems leading to migration and economic losses to fishing communities
2. Seawater intrusion in coastal aquifers, decreasing water availability for poor coastal communities
3. Slow onset loss of coastal land due to abrasion in island and low elevation coastal zones
4. damage to precarious physical infrastructure set up by coastal communities
5. impoverishment and forced displacement affected coastal communities
6. Illness caused by water and mosquito-borne disease
7. Damage to settlements and infrastructure mainly in low elevation zones
8. Contamination of wells with e-coli from surrounding wells
9. Damage to agricultural crops in rural and peri-urban areas
10. Damage to businesses and households, leading to costly economic losses
11. impoverishment of coastal communities who may lose assets and homes
12. Displacement of coastal communities, leading to migration
13. Decrease of catch for small boat fisherman
14. Further migration to the city of rural workers
15. Heat strokes impact mainly children and elderly
16. Declining local food supply, impacts poor households
17. Declining water availability, impacts poor households

C. Water resources sector: a drastic reduction in surface runoff for Mojokerto, affects the availability of water supply in the region

D. Forestry sector: increasing temperature at an average of 0.02 0C/year and changing rainfall patterns in the region, early peak.

[2] Sources: Rositasari, Setiawan, H.Supriadi, Hasanuddin, and Prayuda (2011), Ramdhan and Riadi (2015), Kusmana (2010), Dasanto (2010), Pujiraharjo et al. (2014), Iswati, Atmojo, and Budiastuti (2013), Zubaidah (2012), ICCTF, UI, and KEMENKES (2014), Syaukat (2011), BMKG and JICA (2013), Pekalongan and Tengah (2011), Makassar, UNDP, Habitat, and UNEP (2013).

E. Health sector: increased incidence of Dengue High Fever (DHF)

F. Agriculture sector:

1. Decreasing yield to >10% and decreasing production to 32% in agriculture sector.
2. Rice production declined by 20% in the last 20 years due to a decrease in rainfall
3. Availability of water and humidity affect populations of some insects.

Wider impacts of climate change on sectors at national scale under new climate change scenarios (RCPs) are still limited. Nevertheless, from the previous assessment reported in the SNC, it is indicated that failure to mitigate climate change will lead to higher damage and loss and set back the development.

4.3.1 Impact of Climate Change on Coastal Area

Climate change has impacted the coastal areas through several ways (IPCC, 2005) namely: biophysically include the increase of coastal erosion, inhibition of primary production processes, increased food frequency, increase intensity of flood events caused by storm-surge, saltwater intrusion into estuaries and aquifers, changes in the quality of surface water and groundwater characteristics, changes in the distribution of pathogenic microorganisms and increase of sea surface temperatures, and economic and social that include increase of numbers of home lost and coastal habitats, increase risk of flooding and the number of lives potentially lost, damage to buildings and other infrastructure, and coastal protection, increased risk of disease outbreaks, loss of resources that can be replaced, loss of tourism, recreation and transportation, loss of cultural assets and historical values and impacts on inland fisheries and agriculture due to declining quality of soil and water as a result of saltwater intrusion.

In Indonesia, the potential impacts of climate change on coastal areas and fisheries are significant. In general, coral reefs can live well in temperature between 26°C and 30°C. An increase of SST between 1°C and 2°C from mean annual value can trigger coral bleaching (Hoegh-Guldberg, 1999, Coles and Brown, 2003). A significant increase in SST can cause coral bleaching in a short period of time, as little as 2-3 weeks. Meanwhile, the decline in SST lowers the coral bleaching. Aside from SST, coral reefs are also vulnerable to changes of sunlight intensity. During calm wind and clear sky conditions, sunlight penetrates to a depth of 100m, intensifying ocean heating and triggering coral bleaching (Marshall and Schuttenberg, 2006). Historical data showed that many corals in Indonesian water have been bleached as illustrated in Figure 4.28 (ICCSR, 2010).

Figure 4.24 shows that the probability and occurrences of high sea surface temperature near the coasts are relatively higher than over the open ocean. The median of SST ranges from 24°C to 30°C, with regional mean of 28.7°C. The abrupt change of SST that indicated by the 75 to 99 percentiles, indicate that the Tomini Bay, western coast of Kalimantan, eastern coast of Sumatera and northern coast of Java Islands have suffered from the abrupt change of SST. It is estimated that coral reef area located in southern equator are relatively more affected by the increasing of SST, and is suspected to suffer from massive bleaching, although there are reports of recovery processes in Kepulauan Seribu and Bali. However, this does not guarantee that other areas that have suffered from severe bleaching with SST increases of more than 2.5°C, will also recover. In addition, the projected increase of SST of 2°C until year 2100 will inhibit the recovery process if the rate of SST rise exceeds the adaptation capacity of coral reefs. As shown in Figure 4.28, if the increase of SST by 0.2°C/decade or more, continues, it strengthen the risks of coral bleaching of all of the coral reefs locations in Indonesia.

Coral bleaching has significant impacts on fish population, as it is the habitat of thousands of species of reef fish. In addition, the reef also functions as a high energy and wave absorber that reduces the risks of coastal erosion. Therefore, damage to reefs increases the risk of coastal erosion. Coastal erosion has been observed in many parts of Indonesian coastal areas, and primarily due to sea level rise and strong wave action. Based on data released by the Ministry of Public Works, about 40% of the 81,000 km coastline has been eroded. Along the northern coast of Java, the coastal erosion impacts on 5,500 hectares of land spread over 10 districts (MoE, 2011). For example, in Tegal Regency, erosion of 40 km of shoreline has resulted in moving the coastline inland as far as 50 to 100 meters. Approximately 3 km out of the 10.5 km of shoreline erosion has also resulted in a loss of 25 ha of ponds.

The increase in wind speed, sea level, and wave and tidal actions due to climate change will have significant impacts on coastal and marine resources. As an archipelago country, Indonesia will suffer significantly from climate change-induced sea level rise. The extreme wave height will affect the fisheries, marine transportation safety, prevent the flow of goods and other commodity that are using marine transportation facility, other than increasing the flood risk in the coastal zone with a low elevation of 0-3m.

Potential economic losses due to the sea level rise as the result of climate change, have been estimated occurring in a number of urban coastal areas (MoE, 2011). The loss is mainly due to the damage on settlements, rice fields, ponds and harbours/airports and number of population being affected. As shown in Figure 4.25 the rate of sea level rise may reach 1 cm per year. If this continues by 2050, the sea level rise may reach about 30cm. Similarly, climate change will also increase the SWH as shown in Figure 4.27 The effect of the combine sea level rise and wave height will increase the loss. In Jakarta, by considering only the impacts of sea level rise, the magnitude of loss in the coastal areas of Jakarta in 2050 will reach about IDR 6,490 billion (Table 4.1). This level of loss is will increase further increase if the impact of sea level rise is combined with tide and high wave.

4.3.2 Impact of Climate Change on Agriculture

In most of centre of agriculture areas located in the southern part of equator such South Sumatra, Lampung, Java, Bali, West Nusa Tenggara, South Sulawesi will often experience longer dry season. In addition, the increase in temperature will also reduce the yield significantly. In Java for example, by 2025 and 2050, the increase in temperature may cause significant decrease in rice production which is equivalent to about 1.8 and 3.6 million tons, respectively assuming the rice growing area in Java remain the same (MoE, 2011).

Long dry season years significantly affect not only annual crops, but also perennial crops. Based on field observations, a long dry season generally destroys young plants. During the 1994 El Niño for example, the percentage of young plants (age of less than 2 years) die back due to the long dry season could go up to 30%. Based on observations in a number of locations, the average young plant dieback for tea crops was approximately 22%, between 4% and 9% for rubber, about 4% for cacao, between 1.5% and 11% for cashew nuts, about 4% for co ee and between 5% and 30%for coconut. For mature plantation crops such as coconut and palm oil, the impact of severe drought appears after 4-9 months (Hasan *et al.*, 1998).

The dynamic interactions of crop pests and diseases on crops also appear to be related with change in rainfall pattern and temperature. For example, rice growing area destroyed by brown plant hopper ('wereng coklat') tended to increase significantly when rainfall during the monsoon transitional period (MAM) increases.

Table 4.1 Potential impacts of sea level rise in three big cities of Indonesia (MoE, 2011)

Damage	Sea Level	Jakarta	Surabaya	Semarang
Economic Loss (Billion IDR)	SLR: (0.25-0.30) m	6490.70	137.87	1.49
	SLR+tides+wave: (2.28-3.16) m	6500.53	144.73	3.25
4.1.2. 4.1.3.	SLR+tides+wave+Land Subsidence: (3.03-3.91) m	8637.67	336.03	3.37
Number of People Affected	SLR: (0.25-0.30) m	74,000	61,000	31,000
	SLR+tides+wave: (2.28-3.16) m	236,000	310,000	177,000
4.1.4. 4.1.5.	SLR+tides+wave+Land Subsidence: (3.03-3.91) m	381,000	751,000	443,000

Note: The magnitude loss was calculated only for settlement, harbor, ponds and rice field

This condition is often occurred during La Nina years. In West Java, during the La Nina years of 1998 for example, total area destroyed by brown plant hopper could increase up to 80 times the size of the area lost during normal years. There is also an indication that types of major crop pests and diseases have shifted recently. Historically, pink rice stem borer (*Sesamia inferens*), for example, was only a minor problem in Java (e.g. Indramayu, Magelang, Semarang, Boyolali, Kulonprogo, and Ciamis) compared to yellow rice stem borer (*Scirpophaga incertulas*) and white rice stem borer (*Scirpophaga innnotata*). Today, this disease has become dominant (Nastari Bogor and Klinik Tanaman Institut Pertanian Bogor [IPB], 2007). Bacterial leaf blight (*Xanthomonas oryzae pv. Oryza*) in the last three years has also become one of the dominant rice crop diseases when historically, this disease was not important. Saddler (2000) stated that the optimal temperature for growth of this disease is around 30°C, where in most of area Indonesia my expose to this temperature condition in the future. Similar phenomenon has also been observed in non-rice crops. In the past twisting disease caused by *Fusarium oxysporum* was not an important disease for red onion crops, but now this is a very important disease not only in lowland areas, but also in the highlands. In the last two years, this disease has seriously attacked red onion crops in a number of onion production centres such as Brebes (Wiyono, 2007).

Changes in rainfall and increases in temperature will also both directly and indirectly affect dairy cattle production and reproduction performance. The direct impacts are the effects on production and their reproduction systems, while the indirect impacts to impacts on the quality and quantity of grass or forage needed for livestock feed. Feed shortages limit the dry matter and nutrient intake of the animal resulting in low productivity, reduced reproductive performance, increased mortality rates, increased culling rates and changes in the population of the animal in some regions. High temperatures may have negative impacts on dry matter intake, milk yield, growth rate, and resistance of the animal to diseases and reproductive performance of dairy cattle. A decrease in dry matter intake in dairy cattle during high ambient temperatures is main factor reducing productivity of dry cattle. For example, a study conducted in Java indicated that rainfall and temperature affect length of the pregnancy period (PP) and interval of birth of sheep (Rohman and Boer, 2001). Sheep raised in regions with lower annual rainfall and higher temperatures tended to have a longer pregnancy period. The interval between two births (BI) was also found to be longer.

4.4 Vulnerability Assessment

4.4.1 Vulnerability of Indonesian Villages

Considering the importance of adaptation measures that will be directed for community development in order to reduce vulnerability to the impacts of climate change, MoEF has developed tools for assessing the level of vulnerability at the village level called SIDIK (*Sistem Informasi Data Indeks Kerentanan* – Vulnerability Index Information System). The level of vulnerability is determined by the indicators that affect exposure, sensitivity and adaptive capacity of the village. The diversity of these factors, change over time in line with the implementation of development activities and adaptation efforts. The level of exposure, sensitivity and adaptive capacity levels is mirrored by the biophysical and environmental conditions, as well as socio-economic conditions. SIDIK has been used by local governments in developing adaptation action plans. Assessment of vulnerability at national level indicates that about half of the villages in Indonesia fall under the category of medium to very high vulnerabilities. Village with high to very high vulnerability levels are mostly located in Papua Province (Figure 4.29).

Currently, MoEF established National Registry System (see Chapter II) and portal on Proklim (see Chapter VII) that provide access to report and obtain initiatives and other related information on adaptation. Particular initiative in this system is the Climate Village Program (Program Kampung Iklim, Proklim). This programme aims to increase community response and resilience to climate change. The program evaluates the community initiatives on combating climate change by recapitulating the community actions that contribute to GHG

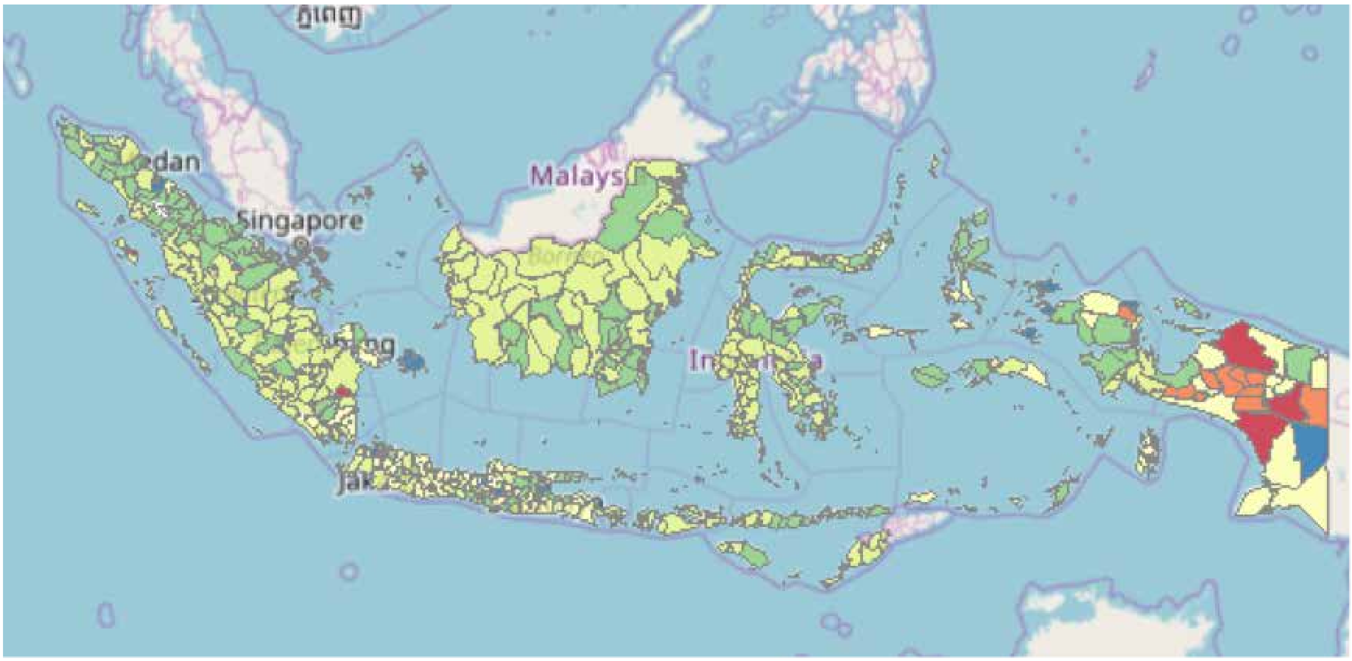


Figure 4.29 Vulnerable districts based on 2014 data. Note: Level of vulnerability: Very high (red), High (orange), Medium (Yellow), Low (ligh green) and Very Low (Dark green)

emission reduction and local climate change adaptation and mitigation.

The Proklim covers initiatives on the management of floods, landslides or droughts; the enhancement of food security; the response to sea level rise; the management of climate related diseases; the management and utilization of garbage/waste; the use of new energy, the renewable and energy conservation; the innovative agricultural practices with low GHG emissions; the replenishment of vegetation cover; and the prevention and management of forest and land fires. The ProKLim has evaluated actions reported by over 450 villages or sub-villages during 2012-2017 with the total awardees as described in Figure 4.30.

4.4.2 Vulnerability Assessment of Sectors

Vulnerability assessments on sectoral basis have also been carried out by many agencies (Table 4.2). Most of the studies indicated that most sectors are vulnerable to the impacts of climate change due to the unfavourable socio-economic and environmental conditions. The level of vulnerability may increase in the future if climate change is not properly addressed and mainstreamed into the long-term development programme.

4.5 Adaptation Action Plans

4.5.1 National Action Plan for Climate Change Adaptation

The Government has established the principle of sustainable development used in the 2015-2019 Medium-term Development Plan (RPJMN) The GoI has also considered the concept of integration between mitigation and adaptation to climate change as an attempt to build resilience and security against flooding, availability of water and energy resources. National Action Plan for Adaptation to Climate Change (RAN-API) has been developed to mainstream into the National Development Plan

Objectives of RAN-API are to: (i) build economic resilience, (ii) establish livelihood resilience, (iii) maintain environmental service resilience and (iv) strengthen special areas (*e.g.* urban, coastal and small islands) resilience, and (v) strengthen supporting systems (e.g. knowledge management, capacity building, planning and budgeting, monitoring and evaluation). These five objectives will lead toward the ultimate goal of sustainable development that is adaptive to climate change (Figure 4.31).

More detailed objectives and action plans were devised in order to achieve each of these five resiliencies. Building a synergy between

Figure 4.30 The distributed areas of Awardees on Proklim in 2012-2017

Table 4.2 Vulnerability assessment by sector in specific locations in Indonesia

Sector	Locations	Vulnerability Assessment	Source
Agriculture	Bali island	Assessing vulnerability of rice farming system to climate change with the high vulnerability in the northeast of Bali	BMKG and JICA (2013)
	Malang-East Java and North Sumatra	Most of lowland rice areas are highly vulnerable to climate change. In 2030, the vulnerability will increase	Ruminta and Handoko (2012)
	Garut to Indramayu, West Java	Factors that have high influence in causing vulnerability of supply chain for the food crops (corn and rice) are family income sources and agricultural workers, and also ratio of rice and maize production per area planted and the ratio of food to the area of agricultural land area	Perdinan et al. (2015 & 2016) &Estiningtyas (2015)
Health	Bali, DKI Jakarta, East Java and Central Kalimantan	In the period of 2006-2012, the vulnerability of these areas to dengue and malaria has increased. Climate change is likely to have an impact on the changing patterns of dengue fever and malaria incidence	RCCUI and Ministry of Health (2013)
Watershed Sector	DAS Serayu in Cilacap and Banyumas of West Java	About 76% of the downstream watershed in Cilacap and between 21% and 33% of the downstream of watershed located in Banyumas (subzone Klawing, Tajum and Serayu Downstream) are flood-prone areas.	Jariyah and Budi (2013)
Coastal	Coastal city of Tegal	Most of sub districts in Tegal city are vulnerable to the impact of sea level rise (robs). Most of communities in the vulnerable areas are relatively poor and will be highly impacted by the climate change	Wulandari and sunarti (2013)
	Semarang City, Central Java	Sub districts with high vulnerability situated near the coast with high rate of land subsidence. Vulnerability level of some village in 2030 will increase to highly vulnerable, such as Tanjung Emas, Bandarharjo and Kemijen. Large area of the kelurahan will be inundated and damaged infrastructure	Suhelmi (2013)
Vulnerable group (Children)	Surabaya, East Java	Areas with high vulnerability are mostly located in the north of the city of Surabaya. Factor causing the vulnerability are lack of disaster preparedness, limited common facility and low family welfare	Perdinan et al. (2016)
Water resource and Tourism	Malang, East Java	Water shortages tend to occur during the dry season, especially in the western parts of Poncokusumo (i.e., Pajaran, Jambesari, Agrosuko, and Ngebruk). The highest potential water shortage is projected to occur in Pajaran due to the highest demand for the irrigation area.	TNC (2016)
Lake Ecosystem	Solok, West Sumatra	Ecosystem of Singkarak Lake in West Sumatra are vulnerable to the impact of climate change. The change in rainfall pattern and temperature will reduce the water level in the lake, and this will affect population growth of fish particularly the endemic species such as '*ikan bilih*' which is one of the main sources of community income surrounding the lake. Continuity of electricity production from the lake will also disturbed due to the increasing frequency of extreme rainfall. Floods will be more frequent in the downstream area of the Singkarak lake.	TNC (2016)

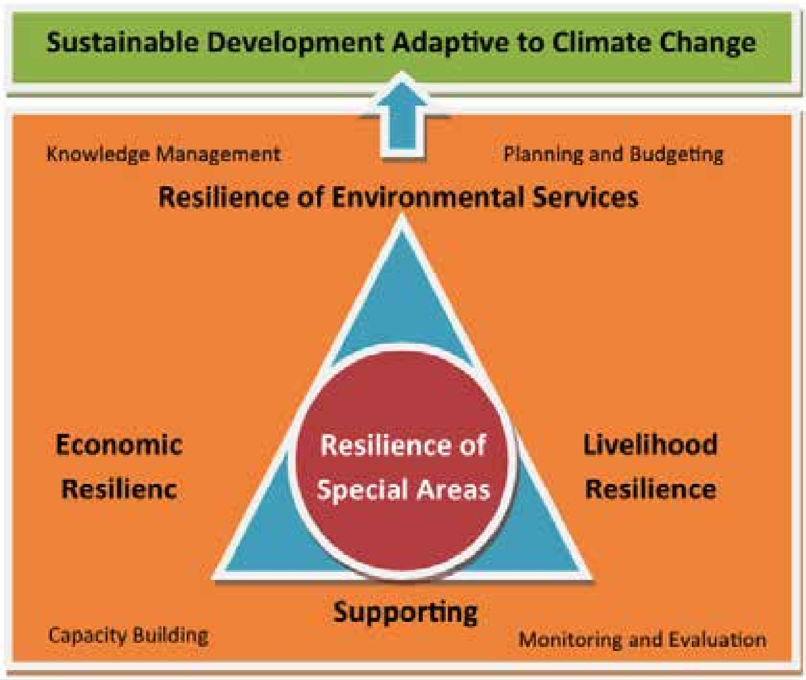


Figure 4.31 Strategic goals and objectives of RAN API (Bappenas, 2014)

sectors would ensure the effectiveness of adaptation programme and actions, in order to support the implementation of climate resilient development systems. Strategy and action plans of RAN API are synergized between sectors to fill the adaptation action gaps in order to achieve the RAN-API targets. A more detail action plans are further described in each group (cluster) as presented in Table 4.3 and see Box 2.

4.5.2 Mainstreaming Climate Change Adaptation into Development Plan

There are several lessons learned in Indonesia for mainstreaming of Climate Change Adaptation into development plan, i.e. the Asian Cities Climate Change Resilience Network (ACCCRN) program and ADB TA in cooperation with MoE in mainstreaming climate change adaptation into RPJMD, RTRW and RKP in several cities (i.e. Cities of Lampung, Semarang, Cirebon, Blitar, Probolinggo, Pekalongan, Bandung, and Tarakan) and also support from the ADB TA Project including from the development of the TNC (Districts of Bandung, Indramayu, Kerawang, Tanah Toraja, Ciamis, TN Bantimurung-Bulusaraung, Sumbawa, District of Malang, Lake Singkarak District of Solok and TN Wakatobi). The process of mainstreaming CCA into the development plan has involved multi-stakeholders.

In the TNC, facilitation for local governments and stakeholder in mainstreaming climate change into the local development plans, was initiated with a kick-off meeting held in each region. Assistance was provided through various trainings aimed at building capacities of the local stakeholders in conducting vulnerability and climate risk assessments. SIDIK is introduced as analytical instrument for future analysis on climate change vulnerability and risk that can be done independently.

The integration of vulnerability assessment results and the risk of climate change into the development plan is conducted through the process of *tagging*. Tagging is a structured mechanism aimed at identifying programmes and actions of various sectors that could contribute to building community resilience in facing environmental changes and challenges related to climate change. This document is established under the principle of coordination, integration, and synchronization among agencies involved in the development (Figure 4.32). A pilot project on climate change adaptation action is implemented in each location at the final stage of the study by taking into account the results of specific climate change impact analyses and inputs from stakeholders. Monitoring and evaluation of the action is carried out in a participatory manner. The results of this pilot activity serve as lessons

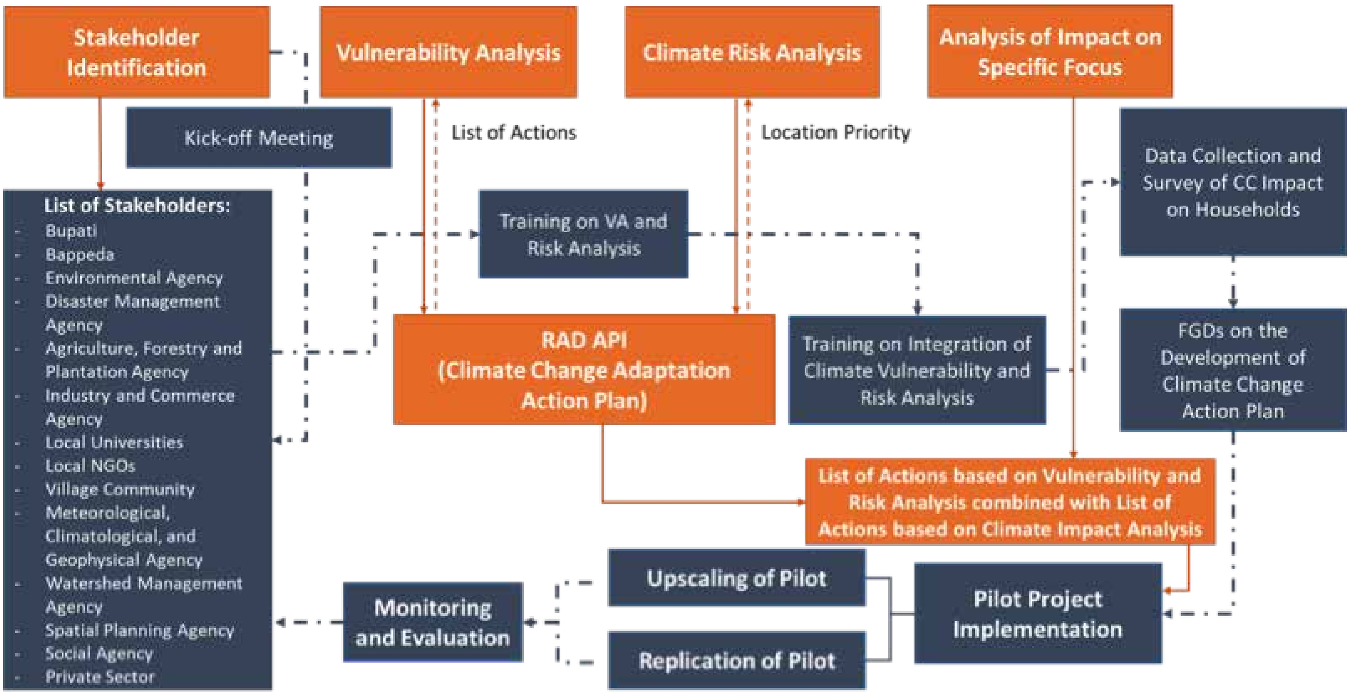


Figure 4.32 Process for facilitation local government and other stakeholders in mainstreaming climate change adaptation into local development plan

Table 4.3 Typology of action plans clustering in the RAN API

No.	Resilience	Sub-Sector	Action Plans Cluster
1	Economic	Food Security	1. Adjustment of Food Production Systems 2. Areal expansion of Food Agriculture and Aquaculture 3. Improvements and Development of Climate Proof Agriculture Infrastructures 4. Food Diversification Acceleration
		Energy Security	1. Expansion of Utilization of Renewable Energy Sources 2. Development of Innovative Technology and Adaptive Resources for Cultivation of Biofuel and Forest Plants for Energy 3. Supporting program
2 3.0.1.	Livelihood 3.0.2.	Health	1. Identification and Control of Vulnerability and Risk Factors to Climate Change-related Public Health 2. Strengthening Surveillance System and Utilization of Early Warning System Against Outbreaks of Infectious Diseases and Non-Communicable Diseases caused by Climate Change 3. Strengthening Regulation, Legislation, and Institutional Capacity in National and sub-national Levels Against Risk to Public Health caused by Climate Change 4. Increasing Science and Knowledge, Technology Innovation and Public Participation Related to Health Adaptation to Climate Change
		Settlement	1. Studies and Research 2. Development and Management of Settlement 3. Community Empowerment 4. Increasing Access to Reasonable and Affordable Housing
		Infrastructure	1. Infrastructure Resilience Studies 2. Improving Access to Roads and Bridges 3. Institution Strengthening 4. Integration to Sustainable Development
3	Environ-mental Service	Ecosystem and Biodiversity	1. Improvement of Spatial/Land Use Plans 2. Sustainable Management and Utilization of Productive Region 3. Improving Governance of Essential Ecosystem Conservation Areas 4. Rehabilitation of Degraded Ecosystems 5. Reducing Threat/Pressure to Ecosystem 6. Development of Information and Communication Systems 7. Supporting program

No.	Resilience	Sub-Sector	Action Plans Cluster
4 3.0.3.	Special Areas 3.0.4.	Urban Area	1. Integrating Climate Change Adaptation Measures in Urban Spatial Planning Urban 2. Adjustment of Infrastructure and Urban Facilities to anticipate the threat of climate change. 3. Improving Urban Communities Capacity to Climate Change Threat
		Coastal Areas and Small Islands	1. Building Life Capacity of the Community in Coastal and Small Islands 2. Management and Utilization of Environment and Ecosystems for Climate Change Adaptation 3. Implementation of Structural and non-structural Adaptation Measures to anticipate the threat of Climate Change 4. Integrating Adaptation Measures in Management of Coastal Areas and Small Islands 5. Improving Climate Change Adaptation Support Systems in Coastal Areas and Small Islands (research and communication)
5	Supporting System	-	1. Enhancing Capacity of Stakeholders in the Adaptation to Climate Change 2. Development of Reliable and Up-to-date Climate Information 3. Enhancing Research and Development of Science and Technology Related to Climate Change Adaptation 4. Planning and Budgeting and Legislation to Respond to Climate Change 5. Monitoring and Evaluation of Climate Change Adaptation Activity

Table 4.4 Adaptation actions by sectors based on various studies

Sector	Adaptation Options		Source
Coastal (Marine and Fishery)	Diversifying revenues	5	Rindayati, Susilowati, and Hendrarto (2013); Parura et al., (2010); Patriana & Satria (2013); Adiatma et al. (2013); Romadhon (2014); Rahardjo (2013); Wijaya, 2015; McLeod et al. (2010); Latief et al. (2012a); ADB, Initiative, & GEF (2014)
	Mangrove zonation/restoration	3	
	Development of resilient strategies	3	
	Expansion of green space	3	
	Expansion of fishing area during a fishing season	2	
	Extensification of job creation	1	
	Applyng a variation of fishing gear	1	
	Involving in ecotourism activities	1	
	Alternate job being a farmer or a fisherman	1	
Agriculture	Irrigation technology	7	Sumaryanto (2012); Surmaini et al. (2010); Lamid (2011); Foerster et al., (2011); Sakya & Mahardhika (2010); IFC (2009); Kartikasari et al. (2015); Ruminta & Handoko (2012); Syaukat (2011); Lassa, Mau, Li, & Frans (2014); Muslim (2013); Supriadi & Heryana (2011); Maulidah, Santoso, Subagyo, & Rifqiyyah (2012); Muslim (2013). Surmaini et al. (2010); Rachmiati et al. (2014)
	Improve farmer activities	3	
	Use of superior varieties	3	
	Climate Insurance	2	
	Develop varieties tolerant	2	
	Increasing crop productivity	2	
	Adjustment of plant season	2	
	Land expasion	2	
	Food diversification	1	
	Global partnership	1	
	Reducing food consumption	1	
	Modification of planting media	1	
	Crop replanting	1	
	Simulation technology	1	
	Forecast harvest time	1	
	Transpotation access	1	
	Climate field school	1	
Water Resources	Sea water desalination	2	USAID (2012); Kirono et al., (2014); Manez, Husain, Ferse, & Costa (2012); Amalia & Sugiri (2014); Kusuma & Setyono (2013); Widiyanti & Dittmann (2014);
	Water purchase	2	
	Plant type adjustment	2	
	Water use efficiency	1	
	Building DAM	1	
	Building a new water treatment plant	1	
	Rehabilitation of damaged watershed	1	
	Rainwater harvesting	1	
	Building water storage system	1	
	Protection of water source	1	
	Deepening wells	1	
	Water allocation	1	
	Water supply from PDAM	1	
	Water use bin	1	
	Use of resistant vareties dry	1	
Forestry	Storage improvement	1	Iswati et al., (2013); Hendrati, Putri, & Setiadi (2012); Hendrati et al., (2012); Purnomo, Herawati, and Santoso (2011)
	House with many air vent	1	
	Extensification of agricultural land	1	
	Wear clothes that easily absorb sweat	1	
	Ecotourism development	1	
	Environmentally agricultural tecnologies	1	
	Controling pests and diseases	1	
	Access to energy sources and health services	1	
	Proliferation benefits	1	

Sector	Adaptation Options		Source
Special areas (Rural/ Urban)	Early warning	2	Hotimah (2013); Butler et al. (2014); Perdinan et al., (2015)
	Development of ecotourism	1	
	Proper spatial planning	1	
	Energy efficiency	1	
	Technology to mitigate disaster	1	
	Dry land management	1	
	Promote sustainable development	1	
	Media communication	1	
Health	Improve woman participation	1	Rochmayanto & Kurniasih (2012); Wirawan (2010)
	Capacity building	1	
	Reconstruction culture	1	
	Promotion of health	1	
	Relocation of population	1	
	Training health workers	1	

learned and inputs to governments and other stakeholders in developing climate change adaptation activities in the affected areas, for the future, by utilizing other potential funding sources. SIDIK could also be one of the instruments used by the stakeholders in the process of monitoring and evaluation of adaptation action (see Box 1 as example).

In addition, Indonesia is developing special program for child on climate change adaptation called APIFA (*Adaptasi Perubahan Iklim Fokus Anak* – Child Cantered Climate Change Adaptation, C4R) which is in line with the RAN API. This initiative was proposed by the Ministry of Women Empowerment and Child Protection (MoWEC) supported by UNICEF. Currently, UNICEF Indonesia conducts activities namely: evaluation of available national climate change related policies, disaster risk reduction, children and the analysis of national indicators for C4R. The policy analysis is directed to mapping existing national regulations on CCA, DRR (Disaster Risk Reduction), and children as well as the interconnection among the regulations on the basis of child needs and rights. The analysis on national indicator focuses on evaluating the C4RA indicators in response to the government programmes (KLA, SIDIK, Proklim, IRBI, Desa Tangguh[3], and Sekolah Aman[4]) and the linkages with the SDG goals and indicators. The main goal is to define agreed national indicators for C4RA that can be used in Indonesia.

Specifically, the works are to map data availability nationally to support the agreed indicators. The result can be a flagship to create a digital national map on the child vulnerability, with which climate change adaptation strategies focussing on children can be devised. For these two proposed steps, Climate Change Literacy of the children is the critical component that should also be considered. Adequate knowledge of the children on climate change subjects is important to allow children as the agents of change to actively participate in response to climate change. Thus, the APIFA should also be taught to children to enhance their capacity on climate change issues through capacity building programs as an effort to create Climate Smart Generation. A Guidance for capacity building will be developed in web-based form shows the concept of framework for APIFA while Figure 4.34 shows the Concept of Scopes and Plans.

4.5.3 Regulatory Framework

To support the implementation of CCA, the MoEF issued a legal basis for Climate Change Adaptation through a Ministerial Decree No. P33/2016, as a guidance derived in accordance to the Act No.32/2009 on Environmental Protection and Management. In addition, Table 4.5 shows list of regulation that are directly instructing a mandate to address climate change adaptation.

4.5.4 Gaps and Constraints

Many initiatives have been done in the utilization of climate change projections for climate change impact assessments to which the proper Climate Change Adaptation strategies should be devised. However, majority of the climate change vulnerability, impact and adaptation (CCVIA) 'only' employed historical climate information, i.e. the temporal series of precipitation and temperature, or the historical

3 Disaster-resilience Village: village/subdistrict with self-sufficient capacity to adapt and address disaster

4 Safe School: program to build schools readiness in facing natural disaster

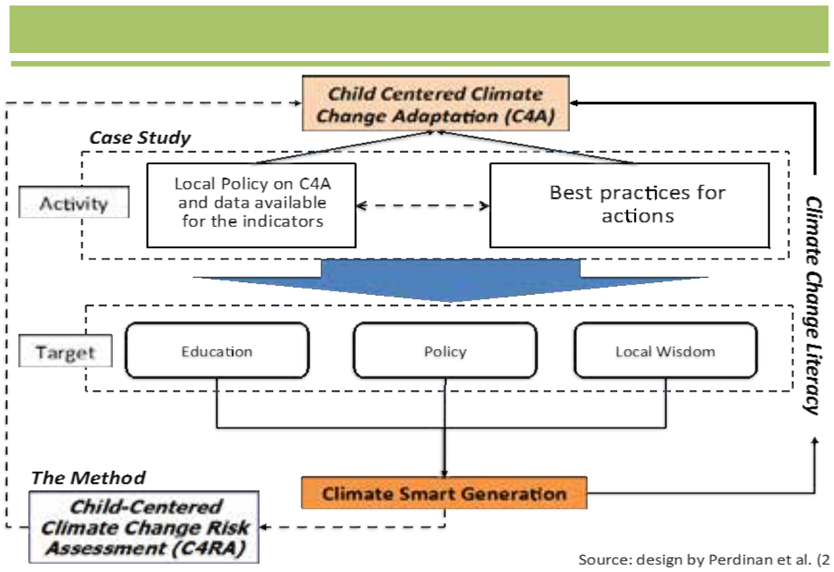


Figure 4.33 Concept of Framework for APIFA

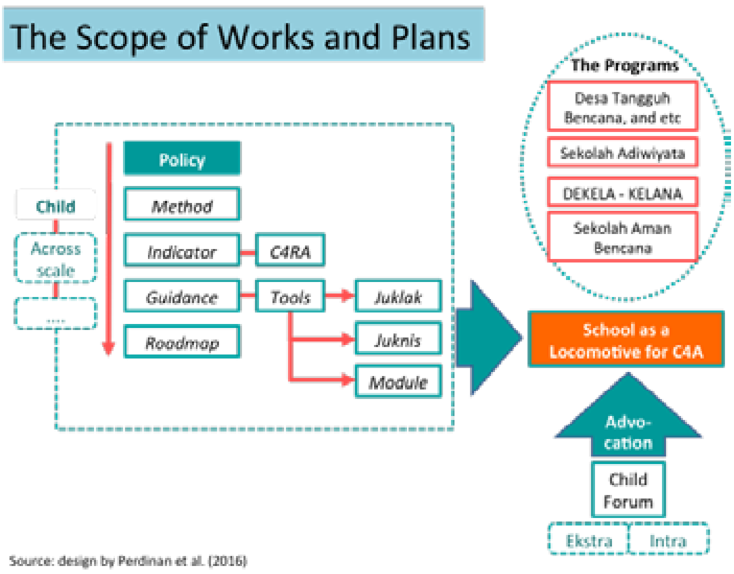


Figure 4.34 The Concept of scope of work and Plans

Table 4.5 List of regulations directed supported the implementation of climate change

No.	Title of Legal Documents	CCA related-items
1	Minister on Environment and Forestry Decree No. P.84/MENLHK-SETJEN/ KUM.1/11/2016 on Climate Village Programme.	Regulation on implementation of climate change adaptation as well as mitigation at village level
2	Governmental Regulation No. 46/ 2016 on Procedural Implementation of Strategic Environmental Assessment	Governmental Regulation encourages stronger actions to conduct climate change vulnerability assessment and to include in decision making process on spatial arrangement, and
3	Ministerial Regulation No. 09/ 2011 on General Guidance of Strategic Environmental Assessment	Guidance to conduct Strategic Environmental Assessment
4	Minister of Environment and Forestry Decree No. P.33/Menlhk/Setjen/ Kum.1/3/2016 on Guidance for Development of Climate Change Adaptation	A guidance to implement CCA
5	Ministerial Circular Letter No. SE 04/ Menlhk-II/2015 on Implementation of Strategic Environmental Assessment	A guidance conduct climate change vulnerability assessment and to include in decision making process on spatial arrangement.
6	Government Regulation no. 57/ 2016 on Revision of Regulation No. 71/ 2014 on Peatland Ecosystem Protection and Management.	Climate change Adaptation has been included to be taken into consideration on peatland ecosystem protection and management
7	Minister of Environment and Forestry Regulation No. P.74/Menlhk/Setjen/ Kum.1/ 2016 on Guidance for Regional/ Local Governmental Organization Nomenclature.	Guidance for local governments on establishment of environment and forestry (including adaptation) related organization
8	Act no. 8/ 2012 on Food	Climate change issue (including adaptation issue) has been taken into consideration. However, scientific consideration needs to be given more attention.

information of climate related disasters to identify the impacts of climate change and their implications to specific sectors. On the basis of the historical analysis, the climate change adaptation was then proposed. The employment of ensemble climate projections to define climate change scenarios is indeed still lacking understanding on the utilisation of short-series period of analysis and limited use of climate change projections. Additionally, limited studies employed gridded data and has not yet been employed for regional climate change impact assessments. There are other gaps and constraint that still needs to be addressed as discussed below.

4.5.5 Climate Change Literacy

People's understanding on climate change should further be enhanced. Climate change information has not been well-disseminated and well-applied. In response to this, in 2015, BPS already has an initiative to include questionnaire on climate change into the Intercensal Population Survey (*Survey Penduduk Antar Sensus*– SUPAS) that had been conducted since 1976. The SUPAS target was about 652,000 households located in 40,750 Census Blok. The questionnaire includes knowledge, attitude, and actions on climate change at the basic level (BPS, 2015). This enhancement of literacy is also supported by the needs to develop regional planning that considered the impacts of climate change, particularly the consequences of extreme events on climate related hazards that may inhibit the achievement of the development targets.

4.5.6 Focusing Sector

CCVIA studies can be grouped into several key sectors, namely: Coastal (Marine and Fisheries), Agriculture, Water Resources, Forestry, Special Areas (Urban/Rural), and Health. Many articles also specifically discussed climate data and information so that they were grouped into the group of Climate. For impact assessments, most studies specifically discussed the climate change impacts within the context of key sectors. This finding pointed the lack of integrated studies focusing on the multiplier effects of climate change on different key sectors in a region. There are few studies focused on multi-sectors, such as the article entitled "Water scarcity in the Spermonde Archipelago, Sulawesi, Indonesia: Past, present and future" (Máñez et al., 2012). This article discussed water resources and its relation to climate change, which considered the demographic condition of the study area, particularly the provision of clean water for the settlement areas. The limited number of integrated studies is caused by the absence of common (i.e., agreed) indicators that can be employed to measure the impacts of climate change on multiple sectors in a region. The integrative assessment can contribute to enhance our understanding on the comprehensive regional impacts of climate change on a region. The studies focused on agriculture are relatively well advance, and those focused on the other key sectors are also growing. Further improvement is needed to assess the impacts of climate change on several key sectors. The sectors include special areas (urban/rural), particularly related to transportation and rural-urban interaction: forestry, specifically the impacts on biodiversity, and; human health. Human health need more attention because the health sector is sensitive to climate fluctuation; however, the application of dynamic models in understanding the mechanism of how climate fluctuations affect human health are still absent. Studies on other important sectors, which cover cross regional landscape and sensitive to climate fluctuations such as the tourism sector, are still deficient.

4.5.7 Study Site

The CCVIA studies scattered throughout Indonesia, but most studies focused on the Java Island. Studies located in West Java are mostly assessing the water resources and climate information, while the studies in Central and East Java focused more on climate information, agriculture and water resources. Unfortunately, the studies conducted in the eastern part of Indonesia (i.e., Sulawesi, Nusa Tenggara Timur, Maluku, and Papua) are limited. This unequal spatial distribution encourages that the future CCVIA studies should be conducted in the eastern part of Indonesia. This suggestion is made because topography and regional characteristics contribute to varying regional impacts of climate change.

4.5.8 Main Approach

Most studies employed the main approach categorized into I (Impact) and A (Adaptation). The impact studies are considered 'favourite' as a lot of studies employed historical analysis using either climate data or information on disaster events to make judgment on the potential impacts of climate change in a region or sector. However, the development of CCA strategies does not always utilize the impact assessments as many studies proposed CCA strategies on the basis Vulnerability assessment. The studies focusing on A (Adaptation) has already engaged stakeholders in devising CCA strategies, but the employment of simulation techniques for adaptation assessment is still missing. The prioritization of CCA strategies is on the basis of current experience and knowledge, which confirms why the development of climate change scenarios for uncertainty analysis has not been conducted.

4.5.9 Time Horizon

Most studies focused on the impact assessments completed their analysis for the current or historical period. Whereas, there are some studies already included future climate scenarios in their analysis. This evaluation confirms the limited use of future climate change projections in the impact articles. Most studies that already considered the future climate change projections are articles or reports classified into the Climate group. This situation promotes the needs for studies focused on supplying future climate change projections with which climate change scenarios can be developed. Downscaling techniques, either dynamical approach, through the utilization of regional climate models nested with global climate models, or empirical/statistical methods that established statistical relationships between the outputs of global climate models with noteworthy climate variables, should also be considered as a finer spatial and temporal resolution of climate change scenarios and are frequently required for the CCVIA studies.

4.5.10 Analysis Methods

Statistical techniques are frequently applied by the CCVIA studies in Indonesia analysing both secondary data that include point-based climate data, and surveyed data and information collected for site specific locations or regions. The frequent statistical methods applied are correlation, regressions, and statistical tests. However, dynamic models that can explain the effects of weather patterns and intensity represented by climate variables to specific sectors have not been frequently employed. Spatial techniques are also rarely applied for regional climate change impact assessments as most studies discussed the variation of climate change impacts on the basis of point-based analysis; thus, as a consequence the conclusion of climate change impacts on district or provincial levels is drawn on the basis of relatively 'small' sample size. This situation is confirmed since grid-based data (e.g., remote sensing, climate model outputs, and reanalysis) are infrequently employed for the CCVIA studies. Regional climate types over a certain region also need to be defined so that the variation of climate signals and impacts can be evaluated on the basis of different climate types over a region. The development of Regional climate zones can be developed using cluster or spatial similarity analysis applied to point-based or grid-based data. The analysis that combine biophysical and socio-economic data for ecosystem-based analysis are also another opportunity as the administrative-based analysis currently dominates the CCVIA studies considering the required data for the studies, particularly the published socio-economic data are available at the administrative level.

In addition, the utilisation of ensemble climate model outputs, e.g., the use of at least two climate models and two emission scenarios, is still lacking. Only less than ten of the collected articles employed the model ensembles particularly the use of ensemble outputs of GCMs. Downscaling techniques particularly the statistical downscaling methods have also been applied by few studies focused in climate analysis to produce finer resolution of regional climate change projections derived for some locations. This evaluation means that regional climate change projections at finer resolution published in grid-based system should be promoted to be available for supporting the CCVIA studies in Indonesia. The new initiative to produce regional climate change projections over the Southeast Asia coordinated through a

CORDEX project also opens the opportunity to supply reliable climate change projections at a finer spatial and temporal resolution.

4.5.11 Climate Data

Climate data is a critical element in the CCVIA studies. However, many studies did not use climate data as the main input or consideration. Majority of the studies -about 68%- of the collected 262 articles, are already utilized climate data formatted in point-based, grid-based, or satellite-based data. The point-based climate data were frequently utilized by the CCVIA studies in Indonesia. Unfortunately, limited attention is given to the data quality as discussion on the data quality tested using homogeneity analysis is rarely included when discussing the climate data used for the studies. As discussed in earlier sub-section, grid-based and satellite data are infrequently employed for regional climate change impacts assessment and regional climate types have also not been discussed. There are also some articles that do not apply any climate data and only used the issue of climate change as a background for the research. In addition, temperature and precipitation are the two most common climate variables employed for the CCVIA studies; whereas, analysis on the basis of other surface climate variables such as solar radiation, humidity and wind needs further investigation. This situation may be driven by data availability. For example, air temperature is frequently used to derive the values of other climate variables, e.g. evapotranspiration and humidity. Therefore, improvement of climate stations in terms of the distribution and the monitoring instruments is necessary. Reference climate stations should also be installed to maintain or measure the quality of the other climate stations throughout Indonesia.

4.5.12 Extreme Events

The impacts of extreme climate events such as El Niño and La Niña on drought and floods, respectively, have been known in Indonesia. The government have also paid much attention to alleviate the potential negative impacts particularly on agricultural sector. However, the employment of climate data and information in understanding the potential climate change impacts on the extreme events are still limited. Fortunately, an initiative has been made to include climate variability into disaster risk assessment. This initiative needs further support, particularly in supplying required data and information that covers geo-physical and socio-economic data and information. The system that is proposed to collect historical information on climate extreme events and disaster occurrences, such as the DIBI initiated by BNPB can be the basis for further improvement to link with the other available data collected by several institutions. The projection of extreme climate events in relation to climate change also needs more rigorous analysis particularly on the uncertainty associated with the projections so that the potential impacts can be better estimated and anticipated strategies can be devised. In addition, the responses of the affected communities to a certain climate extreme event causing a disaster have not been collected properly. A voluntary database system that can collect the local responses can be the venue. Reliable climate data at station and/or at regional level are necessary to support the study on the occurrences and magnitudes of climate extremes at specific location and zonation prone to a specific climate related hazard.

4.5.13 Regional Climate

The impacts of global climate change on regional climate have been indicated by trends in air temperature and precipitation. Further analysis is needed to detect areas across the archipelago of Indonesia with varying climate change signals to provide an insight on the local variation of the impacts. Spatial climate data either in grid format or representative climate stations for a region, are demanded for better analysis on the impacts of global climate change on regional climates. This demand is needed because analysis on the basis one or few climate stations are not sufficient to indicate the impacts of global climate change on regional climates. Furthermore, the review reveals that the regional analysis covering the country wide on the global climate change impacts are still lacking, ever since the issuance of the ICCSR. The employment of climate zoning can be proposed as an approach to identify the variation of global climate change impacts on different climate types in Indonesia. The ensemble of climate change projections should also be used to provide information on the confidence level in interpreting spatially projected climate variables. The potential availability of ensemble higher resolution climate change projections for the Southeast Asia such as CORDEX can trigger studies on regional climate change analysis in Indonesia. The availability of reliable climate data can provide benefit in evaluating the contribution of climatic and non-climatic factor to understand the regional impacts of climate change on specific sector. The representation of the analysis result in a map can help to understand which areas in Indonesia are sensitive to climate change.

4.5.14 Impact Assessments

The climate change impacts on a wide range of key sectors have been studied, and the impacts are frequently associated with the effects of climate extreme events causing disasters. However, it is interesting that the threshold values of climate variables as a signal for the tolerant level of specific response variables represented for each key sector are hard to be identified and collected based on the CCVIA studies in Indonesia. Most studies are dictated by the availability of data, hence, discussions on the philosophy or the mechanisms of how certain climate variables affect certain response variables may help in identifying the threshold values. The threshold values are one of the critical elements for the development of early warning system to which a specific impact can be predicted to occur. The combined impacts of climate change and the other non-climatic factors are also need further investigation. The review also revealed that the CCVIA studies are largely focused on specific sector and/or administrative boundary; whereas, the studies employing ecosystem-based approach are still lacking. This situation may be triggered by the involvement of ministries or local government on the CCVIA studies that focused on specific sectors or administrative boundary. The study on an administrative level also rarely evaluated the impacts of climate change on multiple sectors in the regional area so that the multiplier impacts are still hardly reported. This situation reveals that the impact assessments are still fragmented. Thus, the comprehensive assessments of climate change impacts in a region should consider the linkages across sectors. The other venue for further study is the ecosystem based assessments as an ecosystem as an object is sensitive to climate change, in that climate change can disturb ecosystem functions and services. Therefore, the CCVIA studies that focused on ecosystem and employed ecosystem-based assessment should be promoted as the numbers of the studies are still limited. This type of study requires a coordination of scientists from different backgrounds and users with different needs.

4.5.15 Initiative on Adaptation Actions

There are many initiatives of adaptation actions implemented as efforts to increase resilience. However, these initiatives are not necessarily devised based on proper climate change risk and impact assessments. Thus, adaptation strategies may be defined in a general term that is not purposed for a specific impact at a specific location or area. The implementation of climate change adaptation has also not been reported, so that nationwide best practices on climate change adaptation cannot be proposed. This is because the information system for climate change adaptation is not yet available.

To devise proper climate change adaptation strategies, the government may help by providing national database on the potential impacts of climate change and their potential adaptation strategies of which the interested community can refer to. The mutual adaptation strategies for multiple sectors should also be proposed so that collaboration between different users can be promoted. Initiative on designing method for devising and prioritizing climate change adaptation has also be proposed, however, the studies focused on assessing the impacts of implementing climate change adaptation options in a specific region or area are not yet available. The studies are important, particularly to evaluate the potential benefits, including the economic advantages, of certain climate change adaptation. Therefore, adaptation costs and benefits can be listed and offered. The next challenge is the design of funding mechanisms for climate change adaptation that allows the affected communities or other associated parties to access the funding for adaptation. A registration system for climate change adaptation may also be needed to boost the implementation of proposed climate change adaptations.

ts also indicate that the spatial distributions of the rainfall changes vary across months, even within the same island (Figure 4.35). For example, the increase of rainfall over land areas during wet season is dominantly found in January especially over Sumatera and Kalimantan and in February over Sumatera. In contrast, the rainfall climatology over both Islands decreases during December. Similarly, the decrease of rainfall during dry season in JJA, for Java Island as an example, is largely found only in August. Furthermore, the sea areas adjacent to the west coast of Sumatera and Java, are projected to receive less rainfall in the future almost at all months. The rainfall decrease will be higher under extreme climate scenario in 2075-2100 (RCP8.5). Similar conditions are also expected over other sea areas in Indonesia.

4.5.15.1 Extreme Climate Index

The RX1DAY index is projected to increase in the future for most of the terrestrial areas within Indonesia (Figure 4.36). Over the surrounding waters or sea, the RX1DAY will decrease in the western part and increase in the eastern part of Indonesia. The percentage of changes of RX1DAY compare to the baseline period, indicates that there is an increasing trend and variability of RX1DAY in the future (Figure 4.37). The increase in the variability is higher over ocean rather than over land areas. However, the trend is not consistent over time. From 2050, the trend is decreasing followed by an increase after 2080. This indicates the influence of internal factors dominantly working on decadal to interdecadal timescales.

The spatial change of RX5DAYalso shows an increasing trend in most part of land area, except in inland Java (Figure 4.36), while on ocean areas, both RX1DAY and RX5DAY are decreasing in the western parts and increasing in the eastern parts of the country. However, the RX5DAY over land shows no significant increase in trend and small increase of variability in the future. RCP4.5 tend to shift to positive changes, while RXP8.5 tends to shift to negative changes (Figure 4.37).

R20MM is projected to decrease in the future over most areas of Indonesia, including over the ocean (Figure 4.38). The most notable decreases are found in the ocean within the eastern part of the country, especially in the adjacent sea of West Sumatera and Java. The decreases of R20MM are projected to be higher (more than 50%) under extreme scenario (RCP8.5), especially during 2076-2100 period. Figure 4.39 confirms this condition by showing downward trends of change in the future under RCP4.5 and RCP8.5 scenarios. It is interesting to find that the R20MM index show downward trends, while the RX1DAY index tend to show upward trends. Based on this, it is projected that the number or frequency of extreme rainfall (above 20 mm/day) will decrease in the future, although the intensity of extreme rainfall, as shown by RX1DAY, will increase.

CWD provides information regarding the maximum number of consecutive days with daily rainfall ≥ 1mm. The index is not necessarily related to extreme events since for the humid region that may experience small rain or drizzle for several days, may not be considered as an extreme event. It is indicated that the direction of change of CWD in the future may vary across different regions in Indonesia. However, the decrease seems to be more dominant, both spatially (Figure 4.38) and temporally (Figure 4.39).

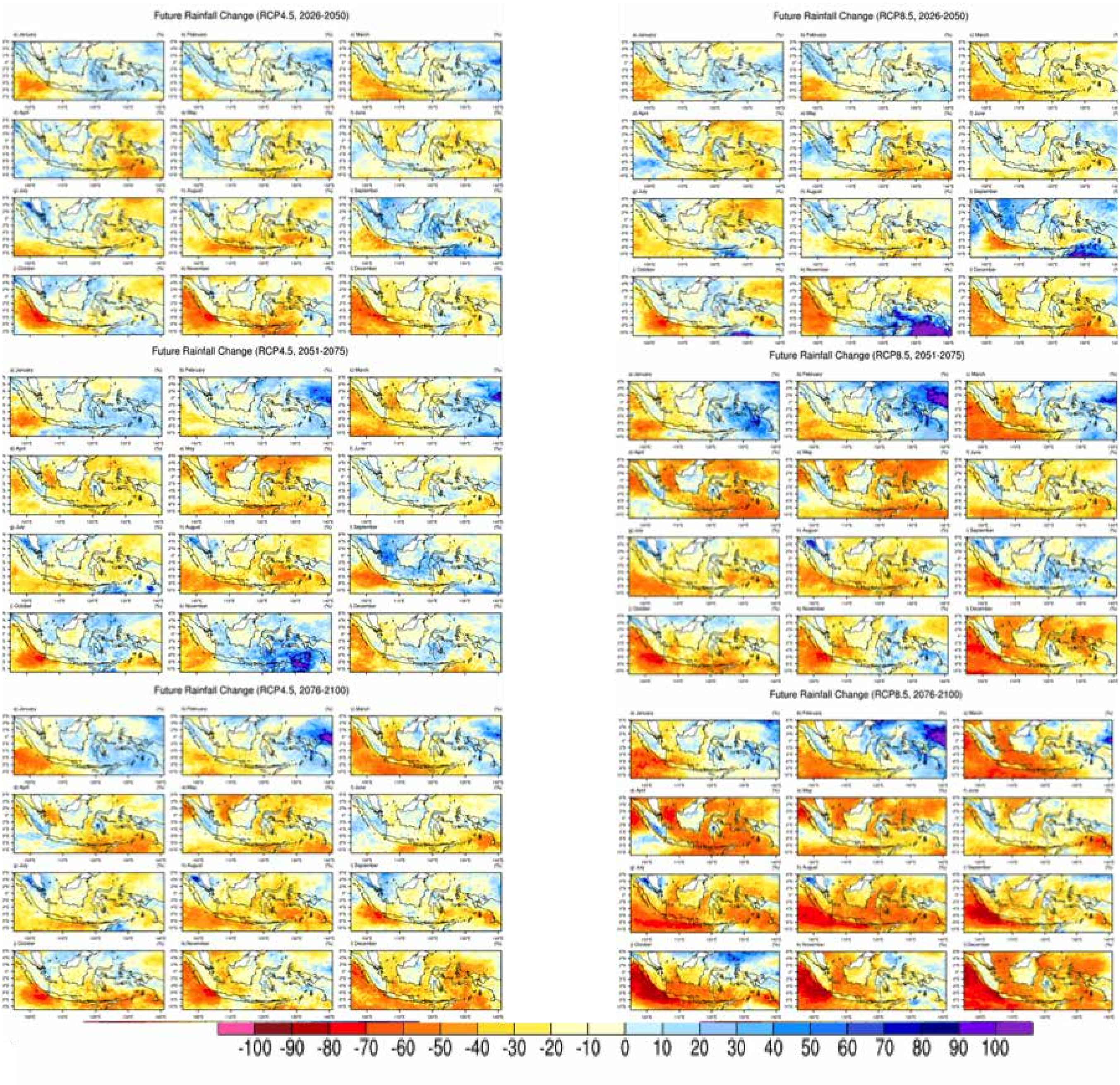


Figure 4.35 Future rainfall changes in Indonesia during the three different time periods respective to that of 1981-2005 as projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs under RCP4.5 and 8.5 scenarios

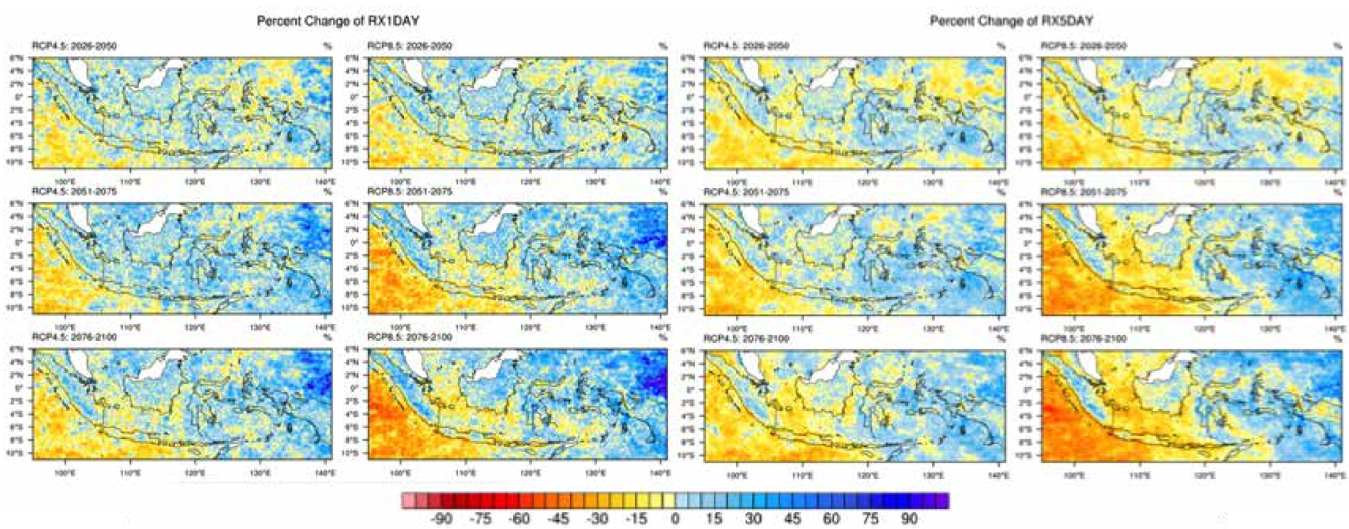


Figure 4.36 Projected percent changes (relative to the 1981–2005 reference period) in annual maximum one-day and five-days precipitation accumulation (RX1DAY and RX5DAY) projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs under RCP4.5 and RCP8.5

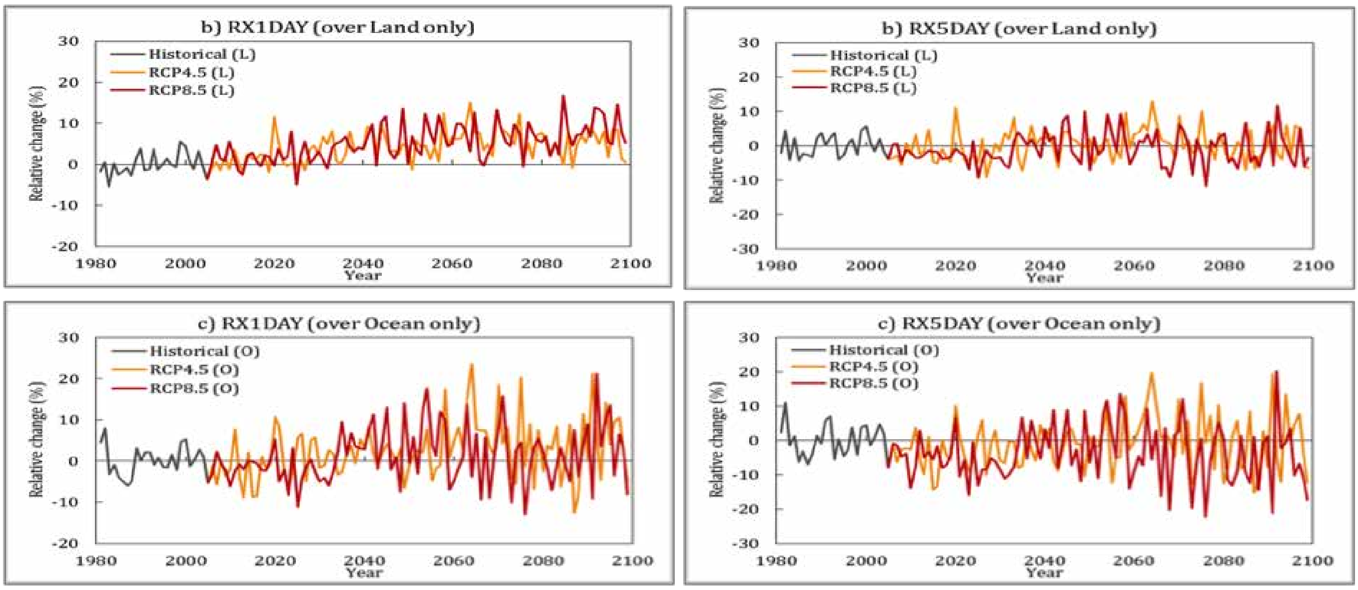


Figure 4.37 Indonesia average percent change in annual maximum one-day ad five days precipitation accumulation (RX1DAY and RX%DAY) over land & ocean for the RCP4.5 and RCP8.5 scenarios as projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs.

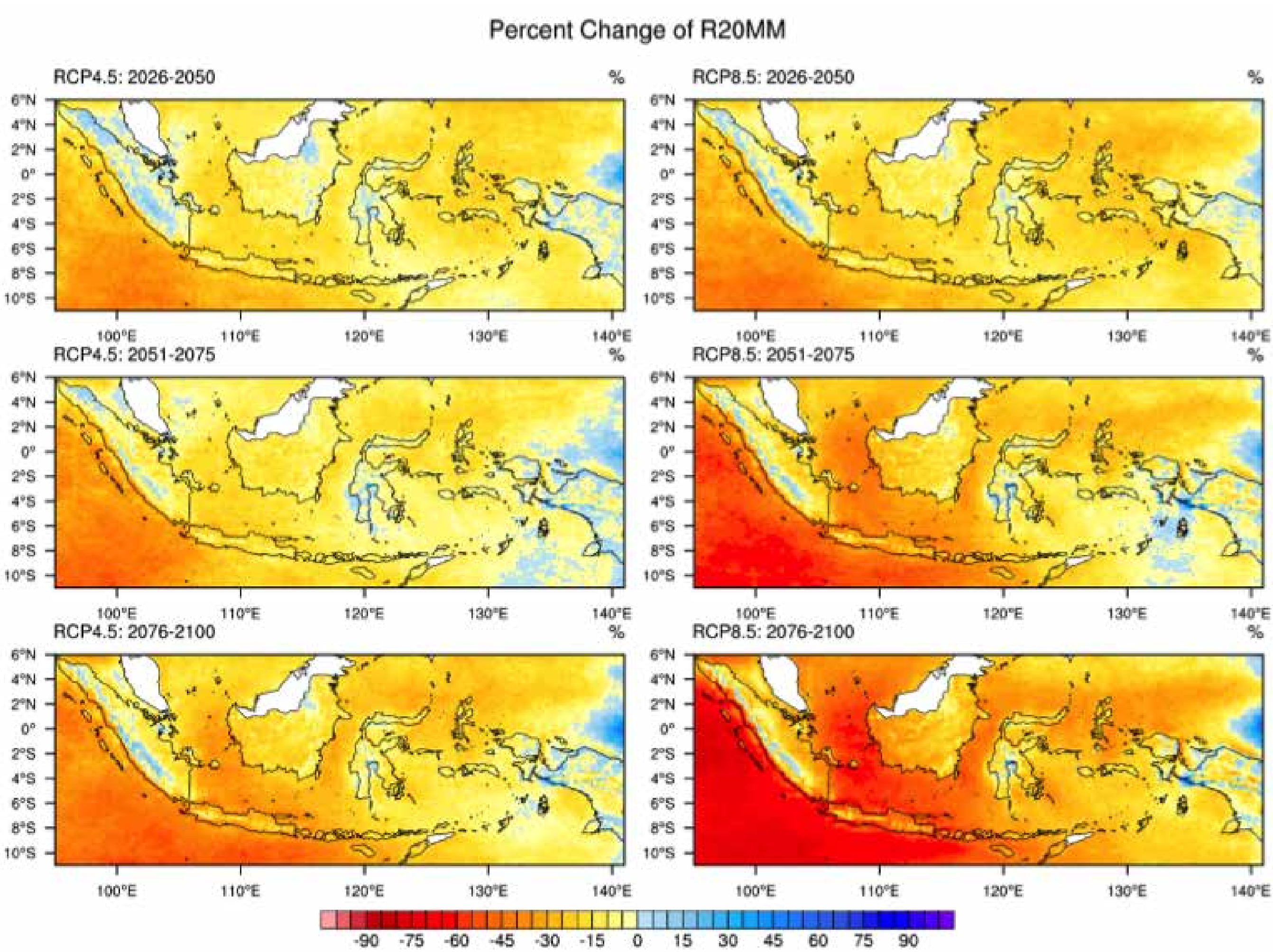


Figure 4.38 Projected percent changes (relative to the 1981–2005 reference period) in R20MM, the number of days with daily precipitation sum exceeding 20 mm, projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs under RCP4.5 (left) and RCP8.5 (right).

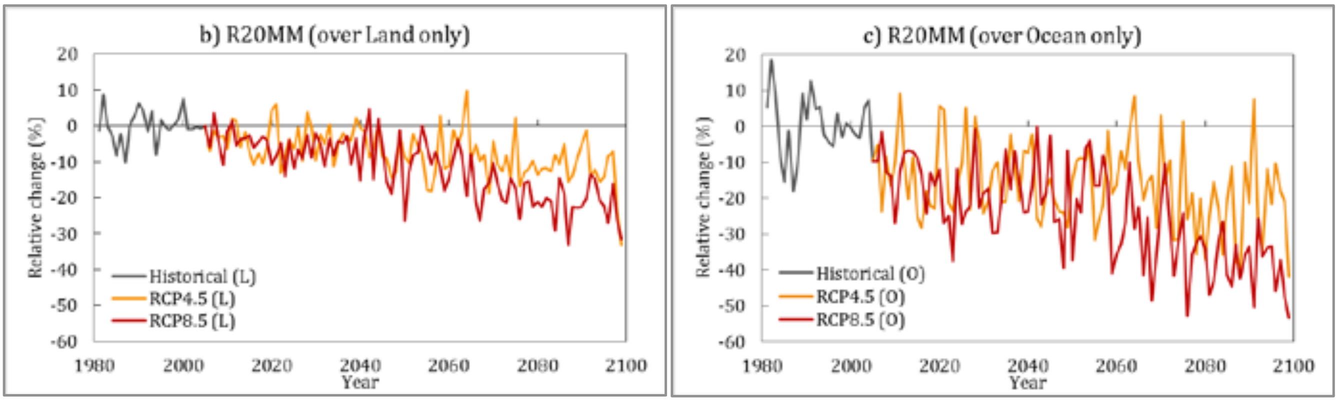


Figure 4.39 Indonesia average percent change in R20MM, the number of days with daily precipitation sum exceeding 20 mm, over a) land & ocean, b) land only, and c) ocean only regions for the RCP4.5 and RCP8.5 scenarios. as projected by RegCM4 regional climate model driven by HadGEM2-ES GCM outputs.

Source/Location: Directorate of Mitigation MOEF/Cement Factory, Palimanan, Cirebon, West Java

Chapter 5

PROGRAMMES CONTAINING MEASURES TO MITIGATE CLIMATE CHANGE

5.1 Introduction

Presidential Regulation No. 61/2011, concerning the National Action Plan for Greenhouse Gas Emission Reduction (RAN-GRK) set emission reduction target of 26% with domestic efforts or up to 41% with international support under the reference emission level, by 2020.

Prior to the COP 21 UNFCCC in Paris, the GoI has conducted a review of Indonesia's baseline emissions and referred in post-2020 emission reduction target under the INDC in 2015 and under the First NDC in 2016.

Baseline emissions in the TNC have undergone significant changes compared to those delivered in SNC and BUR, especially for the AFOLU sector and refer to the baseline emissions in the First NDC. The new baseline emissions have been used as a reference for measuring emissions reduction achieved from the implementation of mitigation action activities from the four sectors, namely energy, IPPU, AFOLU and waste. The emission reduction target is set at 29% of the reference emission level by 2030 with an unconditional target and up to 41% with international support (conditional target).

This chapter describes the implementation of climate change mitigation policies and actions and their impacts on GHG emission and sequestration levels for the four sectors, including changes in the baseline emission level. In addition, this chapter also describes mitigation actions conducted by Non-Party Stakeholders, mitigation actions through carbon market schemes, particularly Clean Development Mechanism (CDM).

5.2 Overview of Mitigation Actions

5.2.1 Classification of Mitigation Actions

Based on its developer, implementation of mitigation policies and actions are classified into two categories, i.e. Party Stakeholders and Non-Party Stakeholders (NPS). Mitigation actions developed by Party Stakeholders are implemented within the framework of fulfilling the national voluntary GHG emission reduction commitment targeted by the government through RAN-GRK. Mitigation actions by NPS are voluntary and are implemented by local governments (sub-national) at provincial, district/municipal level, or non-government (private/community groups).

5.2.2 Institutional Arrangement

Implementation of climate change mitigation policy and action follow on several phases from planning, implementation, monitoring, reporting, verification and/or registration as shown in Figure 5.1.

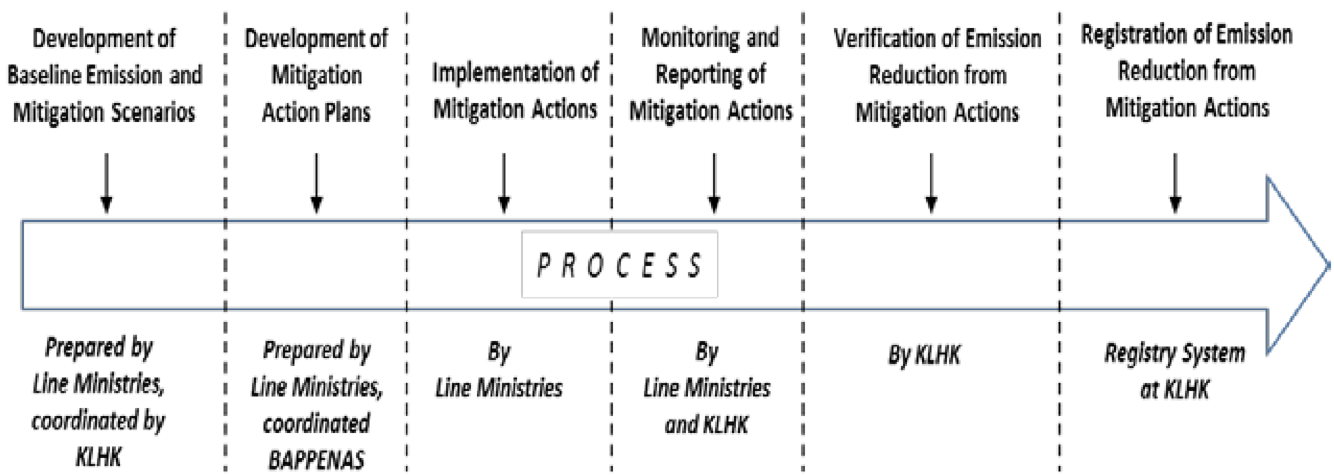


Figure 5.1 Institutional arrangement for implementation of climate change mitigation at national level

Institutions responsible for Indonesia's climate change mitigation actions are MoEF, Bappenas, and related ministries, i.e. ministries whose activities are directly related to the sector generating GHGs. Mitigation action plan is prepared by the relevant Ministries and coordinated by Bappenas, making the mitigation action an integral part of national development. The planning is developed based on mitigation scenarios prepared and coordinated by MoEF and Bappenas. Implementation, monitoring and reporting of mitigation actions are undertaken by each related Ministry and the reports are submitted to Bappenas, MoEF, and Ministry of Home Affairs (MoHA). Mitigation actions reported by each Ministry are verified by MoEF, and subsequently recorded in the National Registration System managed by MoEF. Responsibility for the implementation of climate change mitigation actions for each sector falls under each related Ministry in accordance with the mandate stated in the Presidential Regulation No. 61/2011, reinforced by Ministerial Regulation/Decree as listed in Table 5.1.

Regarding On the subject of MRV for GHG emission reduction achievement of national GHG mitigation actions, MoEF has developed several verification tools to ensure accurate, transparent and accountable GHG emission reduction achievements. Further explanation on the verification of mitigation action activities is given in Chapter 5.7.

5.3 Policy and Planning

Indonesia has a strong legal foundation in developing, issuing and implementing climate change mitigation policies and programmes for each sector at national and local levels (Table 5.2). In addition to legislation and regulations, several sectors have also issued policies that are directly and indirectly related to climate change. The indirect policies are those that encourage enabling conditions for the implementation of climate change mitigation actions (Table 5.3).

Table 5.1 Implementer of mitigation actions and reporting of each sector

Sector	Ministry	Responsible Unit	Regulation/Legal Basis
Energy	Ministry of Energy and Mineral Resources	• Directorate General for New Renewable Energy and Energy Conservation	Minister Regulation No. 13/2016 regarding Organization and Working Procedures at the Ministry of Energy and Mineral Resources
	Ministry of Transportation	• Centre for Sustainable Transportation Management • Directorate General for Land Transportation • Directorate General for Sea Transportation • Directorate General for Air Transportation • Directorate General for Railways	Ministerial Decree No. KP.909/2011 regarding Working Group for Implementation of the Ministry of Transportation's RAN-GRK
	Ministry of Industry	• Agency for Industrial Research and Development	Minister Regulation No. 107/M-IND/PER/11/2015 regarding Organisation and Working Procedures at the Ministry of Industry
IPPU	Ministry of Industry	• Agency for Industrial Research and Development	Minister Regulation No. 107/M-IND/PER/11/2015 regarding Organization and Working Procedures at the Ministry of Industry
AFOLU	Ministry of Agriculture	• Agency for Research and Development • Secretariat General	Ministerial Decree No. 752/2014 regarding Working Group for Implementation of the Ministry of Agriculture's RAN-GRK
	Ministry of Environment and Forestry	• Directorate General for Forest Plan and Environmental Governance • Directorate General for Control of Protection Forest Watershed • Directorate General for Sustainable Forest Management • Directorate General for Natural Resources and Ecosystem Conservation • Directorate General for Social Forestry and Environmental Partnership • Directorate General for Law Enforcement of Environment and Forestry • Directorate General for Climate Change Control	• Minister Regulation No 18/2015 regarding Organization and Working Procedures at the Ministry of Environment and Forestry • Ministerial Decree No. 335/2012 regarding Implementation Unit of RAN-GRK in Forest Sector
Waste	Ministry of Public Works and Housing	• Ditjen Cipta Karya Directorate General for Human Settlements	Minister Regulation No. 15/PRT/M/2015 regarding Organization and Working Procedures at the Ministry of Public Works and Housing
	Ministry of Environment and Forestry	• Directorate General for Pollution Control and Environmental Damage • Directorate General for Management of Waste, Hazardous Waste and Hazardous Materials	Minister Regulation No. 18/2015 regarding Organization and Working Procedures at the Ministry of Environment and Forestry

Table 5.2 Major acts and regulations related to climate change

No	Law/Regulation	Description
1	Act No.6 of 1994 on the Ratification of United Nations Framework Convention on Climate Change	Ratified
2	Act No. 32 of 2009 on Environmental Protection and Management	Regulate the protection and management of environment in general, including mandate on climate change adaptation and mitigation
3	Act No.16 of 2016 on Ratification of Paris Agreement to the UNFCCC	Ratification of the Paris Agreement by the Government of Indonesia
4	Government Regulation No. 46/2016 on procedures for the Implementation of Strategic Environmental Assessment (*Kajian Lingkungan Hidup Strategis – KLHS*)	Regulate the implementation of strategic environmental assessment, which is the obligation of sector and local government in the preparation of medium term development plan and region's spatial plan. Climate change is one of the strategic environmental issues that should be reviewed by the sector and local government.
5	Presidential Regulation No. 61/2011 on National Action Plan to Reduce GHG Emissions	Guideline for the drafting and implementation of GHG emission reduction actions managed by the national government from 2010 to 2020 with a 26% emission reduction target under the reference emission level of 2020 in the sectors of agriculture, forestry and peatland, energy and transportation, industry, waste management and other supporting activities.
6	Presidential Regulation No. 71/2011 on National GHG Inventory	Implementation of national GHG inventory on energy, IPPU, AFOLU, and waste sectors.

Table 5.3 Enabling policies for implementation of climate change

No	Sector	Scope	Regulation	Description
1.	Energy	Renewable energy for transportation	Biofuel Blending (Minister Regulation No. 12/2015)	Regulate the provision, utilisation, and administration of biofuels.
2.	Energy	Renewable energy, energy efficiency and energy conservation	National Energy Policy (Government Regulation No.79/2014)	Regulate the national energy policy, including the renewable energy share target of 23% by 2025, and the energy elasticity target of <1.
3.	Energy	Electricity	Electric Power Supply Plan year 2017-2026 (Minister Regulation No. 1415.k/20/MEM/2017)	Electric Power Supply Plan developed by the state-owned electricity company (PLN) features plan for renewable share in power mix target of 22.4% in 2026
4.	Energy	Energy efficiency	Minister Regulation No. 7/2015	Implementation of Minimum Energy Performance Standards and Inclusion of Energy Saving Label for Air Conditioning Devices
5.	Energy and Waste	PROPER	Minister Regulation No. 3/2014 regarding Programme on Corporate Performance Rating in Environmental Management	Performance rating policy for company in environmental management. The rating is based on assessment of the company's performance in the category of waste management, energy efficiency, reduction of air pollution and GHG emission, and planting (biodiversity)
6.	Energy and IPPU	Green Industry	Minister Regulation No. 51/2015 regarding Guidelines for the Development of Green Industry Standards	Policies that define standards for raw materials, energy, auxiliary materials, waste management, and corporate management for green industry
7.	Forestry	Moratorium	Presidential Instruction No. 8/2015	Regulate moratorium/suspension of new licenses and the improvement of primary natural forest governance and peatlands
8.	Forestry	Law enforcement in forestry sector	National Strategy for Forest Law Enforcement in Indonesia 2005	A comprehensive programme to combat illegal logging. Since 2000 the Indonesian government has undertaken a comprehensive programme to combat illegal logging under the National Strategy for Forest Law Enforcement (FLENS). Presidential Instruction No. 4/2005 directed 18 government agencies and local government officials to cooperate in combating illegal logging

5.4 National Mitigation Actions

5.4.1 National Mitigation Action Plans

National Mitigation Action Plan has been incorporated into the National Medium Term Development Plan (RPJMN) 2015-2019 and the target to reduce GHG emissions has been set under RAN-GRK. The forestry and peatland sectors are expected to contribute the most in achieving the emission reduction targets (87% of total target), followed by the energy sector (6.5% of total target).

5.4.2 National Baseline and Emission Reduction Targets

5.4.2.1 National Baseline

GHG emission reductions are defined based on the difference between the baseline emission level and the mitigation emission level. Baseline emissions are projected GHG emission levels without mitigation, i.e. implementing a business as usual national development, where all decisions and options in the implementation of development do not take into consideration aspects related to climate change mitigation efforts. The baseline emission depends on the definition of "business as usual" development, the calculation methodology and the assumptions of variables used in the estimation of emissions.

National baseline emissions can be developed by using an integrated model covering all sectors of national development, or modelling of each sector and the result is then summed up as national baseline emissions. Indonesia's baseline emission projection used the second approach, where the baseline emission is an aggregation of four sectors' baseline emissions, i.e. energy, IPPU, AFOLU (Agriculture, Forestry and Land Use) and waste. The baseline emission in the Second National Communications (SNC) was developed by the SNC working group team together with relevant ministries and agencies, while the baseline emission in TNC was developed by responsible unit in each sector and coordinated by the Directorate General of Climate Change, MoEF.

The national baseline in TNC is the projection of Business as Usual scenario up to 2030 with the base year of 2010 used in the development of NDC. With some methodological changes and assumptions, as well as improvements in activity data and emission factors, the national baseline in TNC is not the same as the baseline reported in the SNC (Figure 5.2). There are significant differences between the two baselines, especially in the forestry sector, due to the changes in forest definitions due to a review in deforestation rates and changes in calculation methodology. Other causes for the differences are: (i) the differences in assumptions for macro drivers of growth in emission levels (economic growth) in the energy sector, (ii) increase in the scope of emission sources in waste sector, and (iii) changes in calculation methodology in the IPPU sector. SNC used economic growth of all industries aggregate, while TNC used growth per industry type. Aggregation of results of baseline estimation from all sectors generate baseline emission level of 1,971,241 Gg CO_2e in 2020 amounted and 2,868,932 Gg CO_2e in 2030. Further explanations on the changes of baseline emission between SNC and TNC are described in the following sub-chapters.

5.4.2.2 National Emission Reduction Target

GHG emission reduction targets by 2020 in accordance with the Presidential Regulation No. 61/2011 are 26% (unconditional) and 41% (conditional) below the national baseline emission level, while by 2030 it is targeted at 29% (unconditional) and 38% (conditional; Table 5.4). The distribution of emission reduction targets for each sector is determined by considering the contribution of each sector to the total national emissions. Forestry/peatland and energy are the two main sectors whose contributions to national emissions all together reach more than 80%.

5.4.3 Mitigation Actions in Energy Sector

5.4.3.1 Baseline

Baseline used to evaluate the achievement of GHG emission reduction from energy sector's mitigation action is an updated baseline with adjustments to the current conditions in the energy sector, i.e.:

4. Changes in base year of projected emissions calculation (SNC use base year of 2005 while TNC use base year of 2010).
5. Adjustment on the assumptions and parameters of socio-economic development (drivers of growth in energy demand). By comparison, SNC assumes the average GDP growth of 2005-2025 at 7.5% while TNC (2010-2030) uses a value of 5.5%.
6. Changes in the reference for calculation of electricity demand. In SNC, projection for electricity demand referred to General Plan of National Electricity (*Rencana Umum Ketenaga listrikan Nasional - RUKN*) referenced by the electric power supply plan (RUPTL) of 2009-2018 while TNC refers to RUKN referenced by RUPTL 2016-2025.

Figure 5.3 shows the 2010-2030 baseline emissions projection for energy sector. For comparison, the figure also shows the baseline emission for energy sector used in SNC. It can be seen in the figure that the baseline emissions in TNC are significantly lower than the baseline emissions in SNC, especially in 2020 to 2030. This is because the assumption of economic growth in TNC is lower than that of SNC. The assumption of low economic growth in TNC resulted in lower energy demand estimates that led to lower GHG emission estimates. Further discussion in baseline emissions is focused on the TNC baseline emissions.

As shown in Figure 5.3, Indonesia's energy sector baseline emissions will continue to increase and by 2030 it is expected to reach around 1.67 million Ggram CO_2e (1.67 Gigatons of CO_2e). The increase in emissions is equivalent to an average annual growth of 6.7%. By 2030, GHG emission sources are dominated by power generation sub-sectors (48.6%) and manufacturing industries (31.4%), followed by transportation (14.5%), household (3.12%), and commercial (0.8%).

The above-mentioned 2010-2030 baseline emissions were derived from the assumption of an average economic growth of 5.5% per year, an average population growth of 1.1% per year, and the energy sector was assumed not to undertake climate change mitigation actions by continuing development path from years before the base year. With these assumptions, the final energy demand is expected to increase from about 1,000 million BOE in 2010 to about 2,500 million BOE in 2030 or grow at an average of 4.7% per year. The projection of final energy demand by sub-sector of energy user and energy type is presented in Figure 5.4.

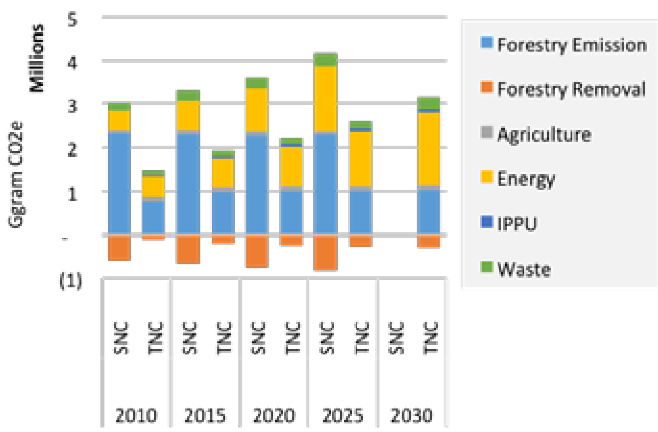


Figure 5.2 Comparison between BAU emission level in SNC and NDC/TNC

Table 5.4 Emission reduction targets and sector contributions for achievement of target (in percentage)

Sector	Emission Reduction Target by 2020[1]		Emission Reduction Target by 2030[2]	
	26% (Unconditional)	41% (Conditional)	29% (Unconditional)	38% (Conditional)
Forestry and peatland	87.62	87.38	59.31	60.15
Waste	6.26	6.56	1.31	2.61
Energy and Transportation	4.95	4.71	37.93	36.61
Agriculture	1.04	0.93	1.10	0.34
Industry	0.13	0.42	0.34	0.29
Total	100.00	100.00	100.00	100.00

Source: [1]Presidential Regulation No.61/2011, [2]MoEF (2016)

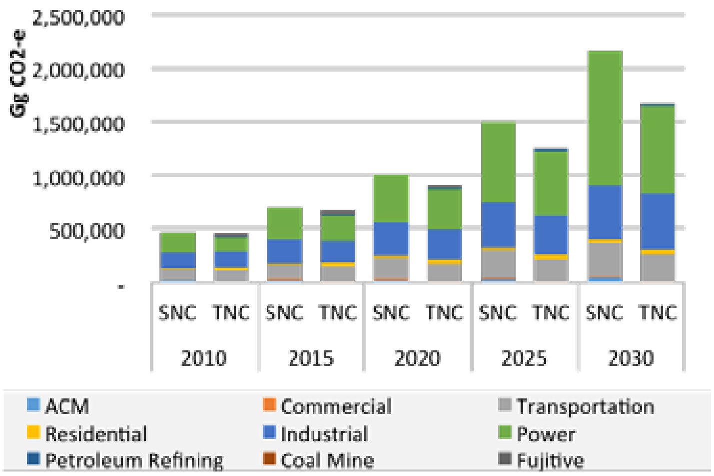


Figure 5.3 Comparison of projected baseline emission for energy sector, SNC vs. TNC

Sub-sectors whose energy demand is increasing in line with high growth rates

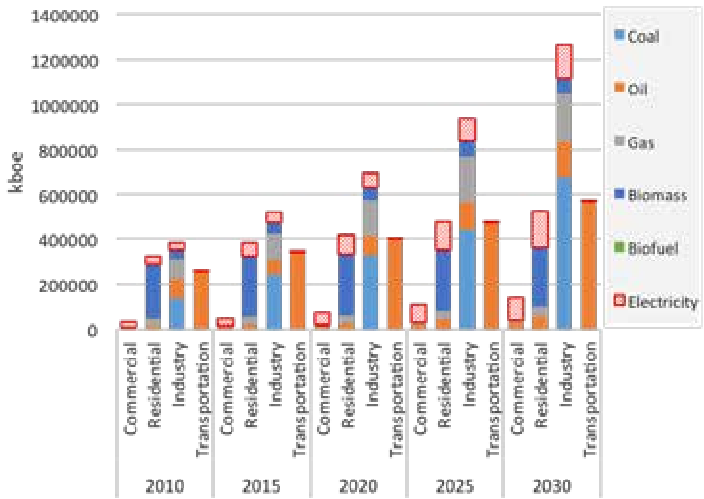


Figure 5.4 Projection of final energy demand by sub-sector and energy type, 2010-2030

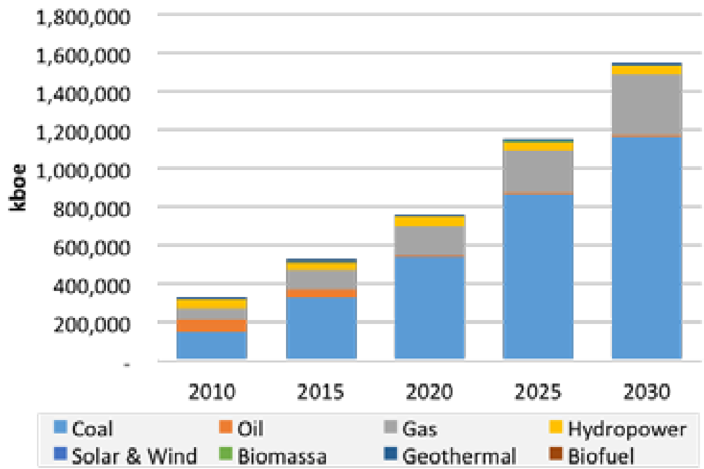


Figure 5.5 Projection of energy supply mix for power plant, 2010-2030

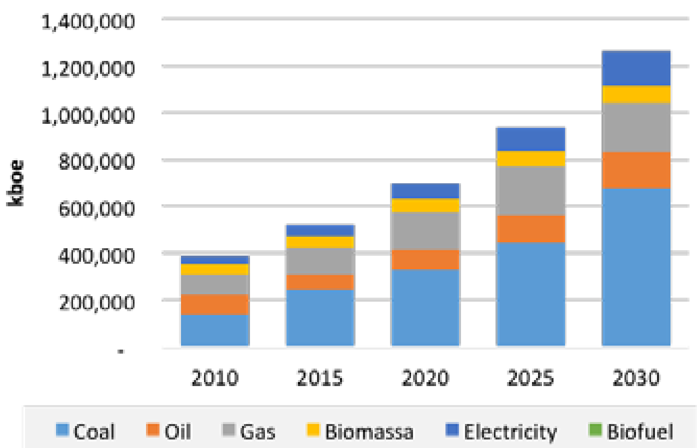


Figure 5.6 Projection of final energy demand in manufacturing industry, 2010–2030

are commercial industry (7.5%/year) and manufacturing industry (6.1%/year), followed by transportation (4.1%/year), and households (2.4%/year). Types of energy whose demand will grow at high speed are coal (8.3%/year) and electricity (7.9%/year), followed by natural gas (4.1%/year) and oil (4%/year). By 2030, the manufacturing industry will be the sub-sector with the highest share of energy demand (51%), followed by transportation (23%), household (21%) and commercial (6%). By type of energy, the largest share of energy demand in 2030 will be from fuel (32%), coal (27%), electricity (17%) and biomass (14%).

As indicated earlier, the largest source of GHG emissions in the energy sector is from the sub-sector of power generation. In the baseline scenario, GHG emissions from this sub-sector are expected to grow at an average of 9.5% per year. The large GHG emission growth occurs because in baseline scenarios, the types of plants to be added in the 2010-2030 period are fossil fuel-based power plants such as coal and natural gas. The projection of the energy generation mix is shown in Figure 5.5 where in 2030, the share of power generation is dominated by coal (76%) and natural gas (20%). Renewable energy generation considered in the baseline scenario are from plants that have been operating since the base year (2010).

Energy demand in manufacturing industry is expected to continue to increase with an average rate of 6.1% per year. The types of energy expected to experience high demand growth are coal (8.3% per year), electricity (8.2% per year) and natural gas (4.6% per year). The projection of demand for energy in manufacturing sub-sector is shown in Figure 5.6. In 2030, the demand for energy of this sub-sector will be dominated by coal (54% of total demand), followed by gas (17%), electricity (12%) and fossil fuel (12 %).

The transportation system in Indonesia is projected to continue the development that occurred in the base year, which focuses on (i) passenger transportation system dominated by private vehicles, (ii) goods transport dominated by trucks, and (iii) almost entirely fuelled by fossil fuel. Under this scenario, energy demand in transportation is expected to increase with an average rate of 4.1% per year (Figure 5.7).

The demand for energy in residential sub-sector is estimated to increase with an average rate of 2.4% per year. Drivers for the growth are population (average growth of 1.1% per year) and increase in people's welfare (resulting from national economic growth, averaging 5.5% per year). The projection of the energy demand in residential sub-sector by type of energy, including gas and LPG, is shown in Figure 5.8.

Figure 5.8 shows that types of energy whose demand will grow at a fairly high rate are electrical energy (7.7% per year) and kerosene (6.9% per year), whereas demand for biomass energy is expected to decline after 2020. Biomass is mostly use for cooking in the countryside, and considering that around 50% of Indonesia's population lives in rural areas, the share of biomass in residential energy demand is the highest. Despite the decline, the share of future biomass energy demand is expected to be significant.

The energy demand in commercial sub-sector is expected to continue to increase in line with the growth of the service sector in Indonesia. In the period of 2010-2030, the energy demand is expected to grow at an average of 7.5% per year. Energy in commercial sub-sector is dominated by electricity, followed by kerosene and gas. The projected growth in energy demand for commercial sub-sectors is shown in Figure 5.9. The demand for gas in the picture includes piped gas and LPG.

5.4.3.2 Mitigation Action Plan and GHG Emission Reduction Targets

In RAN-GRK, mitigation activities in the energy sector are grouped by sub-sectors of energy supply and energy user, namely transportation sub-sector, manufacturing sub-sector, and buildings sub-sector (commercial and household). At the planning stage, RAN-GRK mitigation actions under the management of the MEMR are those related to energy supply and post-mining land reclamation activities. Those mitigation actions have the potential to reduce 72,500 Ggram CO_2e of emissions by 2020. In energy sector, the target for GHG emission reduction is 38,000 Ggram CO_2e by 2020 (53% of the emission reduction potential).

The energy sector mitigation actions are focused on increasing the utilisation of renewable energy, fuel-switching towards cleaner (lower emission) energy sources and efforts to improve energy efficiency and conservation. Table 5.5 provides the list of mitigation actions and potential GHG emission reduction in the energy sector under the responsibility of the MEMR.

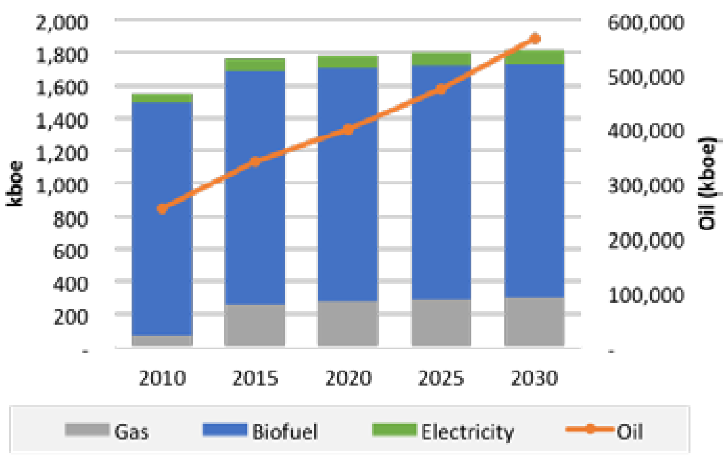


Figure 5.7 Projection of final energy demand in transportation sub-sector, 2010-2030

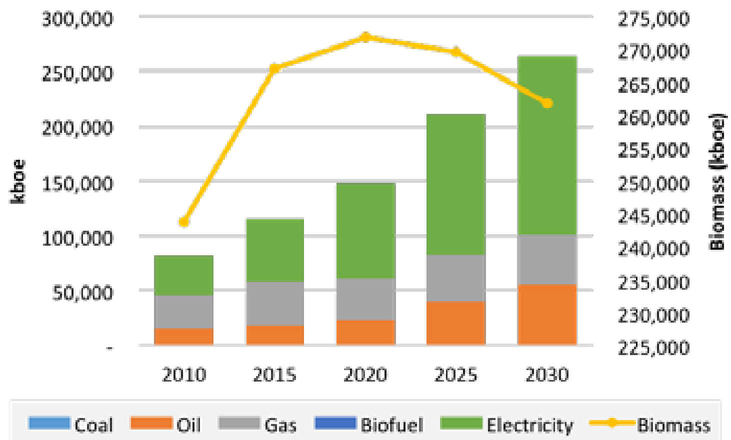


Figure 5.8 Projection of final energy demand in residential, 2010-2030

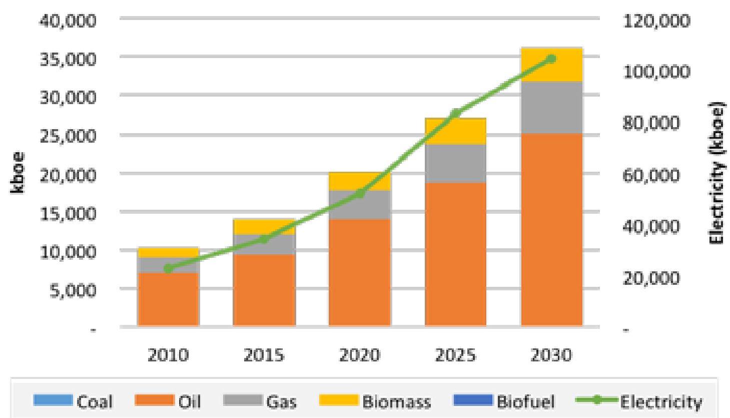


Figure 5.9 Projection of final energy demand in commercial sub-sector, 2010-2030

Table 5.5 Mitigation action plan and RAN-GRK target in energy sector

	Mitigation Action (RAN-GRK)	GHG Emission Reduction Potential by 2020 (Ggram CO_2e)	Responsible Institution
1	Implementation of mandatory energy management for energy-intensive users	10,160	MEMR
2	Implementation of energy conservation partnership programme	2,110	MEMR
3	Increased efficiency of household appliances	9,750	MEMR
4	Provision and management of renewable energy and energy conservation	4,400	MEMR
5	Utilisation of Biogas	130	MEMR
6	Utilisation of natural gas as fuel for urban public transports	3,070	MEMR
7	Increased number of houses with piped natural gas connection	150	MEMR
8	Construction The development of Liquid Petroleum Gas (LPG) mini plant refinery to meet Kerosene to LPG Conversion Target	30	MEMR
9	Post-mining land reclamation	2,730	MEMR
	Total	**32,530**	

Table 5.6 Mitigation action plans and RAN-GRK targets in transportation sub-sector

	Mitigation Action (RAN-GRK)	GHG Emission Reduction Potential by 2020 (Ggram CO_2e)	Responsible Institution
1	Development of Intelligent Transport System (ITS)	1,770	MoT
2	Application of Traffic Impact Control (TIC)	240	MoT
3	Application of parking management	1,070	MoT
4	Congestion charging and road pricing (combined MRT)****	410	MoT
5	Reformation of transit system - Bus Rapid Transit (BRT) / Semi-BRT	690	MoT
6	Rejuvenation of public transport fleets*****	360	MoT
7	Installation of converter kit (public transport gasification)*	40	MoT
8	Smart driving (eco-driving) training and socialization	2	MoT
9	Building Build of non-motorized transport lanes (pedestrian and bicycle lines)	210	MoT
10	Development of Bandung's city railways****	4,560	MoT
11	Construction of double-double track (including electrification)	21,210	MoT
12	Procurement of new electric rail car (KRL)	4	MoT
13	Modification of diesel rail-train (KRD) into electric-diesel rail train (KRDE)	0.05	MoT
14	Construction of North South Mass Rapid Transport (MRT) Phase I and Phase II**	2,770	MoT, Jakarta Provincial Government
15	Construction of Soekarno-Hatta Airport railway track**	190	MoT
16	Construction of Jakarta Monorail***	520	MoT, Jakarta Provincial Government
17	Road construction/improvement and preservation	1,100	MoPWH
	Total	**35,146**	

*transferred to MEMR/MoI;**under construction;***dispensed and changed into LRT (*Light Rapid Transit*);****not yet implemented;*****implemented by local government

Mitigation action in transportation sub-sector is under the responsibility of the Ministry of Transportation (MoT) and the Ministry of Public Works and Housing (MoPWH). MoT is responsible for activities related to traffic management and transportation, and the use of mass transportation, while MoPWH is responsible for the development and improvement of transportation infrastructure. Table 5.6 shows the mitigation action plan and the GHG emission reduction targets of the transportation sub-sector under the responsibility of MoPWH, MoT, and the DKI Jakarta Provincial Government, considering some of the mitigation actions are related to mitigation actions in DKI Jakarta.

Following up on Presidential Decree No.61/2011, the Ministry of Transportation has issued the Ministry of Transportation Decree No. 201/2013 on the Stipulation of the National Action Plan for GHG Emission Reduction and GHG Inventory in Transportation Sector Year 2010-2020.

Mitigation actions in the manufacturing industry are under the responsibility of the Ministry of Industry. Based on the sources of emissions, manufacturing industry mitigation action consists of two categories: (i) emissions related to energy use and (ii) emissions associated with industrial processes (IPPU). The discussion on this sub-chapter concerns the emissions from energy use while industrial process-related emissions are presented in the IPPU sub-chapter.

Based on the RAN-GRK, industrial mitigation actions are carried out in three main action plan groups. Among the three action plan groups, mitigation actions that are directly related to GHG emission are: (1) modification of biomass and blended cement utilisation processes and technologies; and (2) conservation and energy audits to be achieved during 2010-2020 with GHG emission reduction targets as presented in Table 5.7. The reduction targets in Table 5.7 will be achieved through two mitigation categories, namely energy and IPPU, which are supported by the policies and strategies developed by MoI.

The mitigation actions listed in Table 5.7 are related to process modification and utilisation of biomass and cement blended technologies in the cement industry including reduction of

GHG emissions for two categories, namely energy sector and IPPU. In this sub-chapter, the discussion one mission reduction target is limited to the reduction of GHG emissions in energy sector, while the discussion for GHG emission reduction related to IPPU is presented in IPPU Sub-Chapter.

1. Non RAN-GRK Mitigation Activities

Non RAN-GRK mitigation actions managed by the Ministry of Energy and Mineral Resources are the utilisation of biodiesel, energy conservation, conversion of kerosene to LPG in households, hydropower development, as well as the use of clean coal technology, cogeneration, and fuel switches from diesel oil to natural gas in power plants. Table 5.8 presents a summary of Non RAN-GRK mitigation actions.

Non RAN-GRK Mitigation actions in transportation sub-sector are managed by the Ministry of Transportation, mainly implemented in marine and air transportation infrastructure systems, as presented in Table 5.9.

Non RAN-GRK mitigation actions in manufacturing industries managed by the Ministry of Industry are more focused on improving energy efficiency and conservation in energy-intensive industries. Based on reports from the action managers, Table 5.10 summarizes the non RAN-GRK mitigation actions in the manufacturing industry sub-sector.

To encourage the implementation of climate change mitigation, the Ministry of Industry developed an online information system used to gather information on GHG emissions in industries. At present, the ready-to-use information system includes inventory of emissions related to energy utilisation in the manufacturing sub-sector. Industries in which reporting of information on GHG emissions is mandatory are energy-intensive Industries, in accordance with the categories defined by the MEMR, i.e. industries with energy consumption of >6,000 TOE (Government Regulation No. 70/2009 on Energy Conservation and MEMR Regulation No 14/2012 on Energy Management). In the future, an online information system will be developed so that it can include recording of mitigation actions in manufacturing industry sub-sector.

The Government of Indonesia also conducts mitigation activities in energy sector through Nationally Appropriate Mitigation Actions (NAMAs), i.e. the NAMA SUTRI

Table 5.7 Mitigation action plan and RAN-GRK target in manufacturing industry sub-sector*

No.	Mitigation Action	Emission Reduction Target by 2020 (Mt CO_2e)	Responsible Institution
1	Modification of process and utilisation of biomass and 'cement blended' technology in the cement industry	2.75	MoI
2	Energy Conservation and Audit • Development of energy management system in 9 cement industry, 35 steel industry, 15 pulp paper (2010-2014) • Development of energy management system in glass, ceramics, fertiliser, petrochemical, food and beverage, textile and basic chemicals industries (2015 - 2020)	 2.06 2.75	MoI

*Energy efficiency in industry and utilisation of AFR (biomass/waste in cement industry)
Source: Presidential Regulation No. 61/2011 (RAN-GRK)

Table 5.8 Non RAN-GRK mitigation actions

	Mitigation Action
1	Utilization Utilisationof Biodiesel
2	Application of Presidential Instruction No. 13/2011 onEnergy and Water Saving
3	Electricity Sector Mitigation Action
	- Development of hydro power plant
	- Clean Coal Technology for power
	- Co-generation for power
4	Conversion of kerosene to LPG

Table 5.9 Non RAN-GRK mitigation actions in transportation sub-sector

	Mitigation Action
1	Efficiency in Port Operational Management: Solar-cell for Sailing Navigation Support Facilities
2	The construction of double track across the North of Java
3	Rejuvenation of air transport fleet
4	Improvement of aircraft operating systems and procedures as well as aircraft maintenance
5	Implementation of direct flight path (Direct Routes, RNAV 5, RNP 10)
6	Continuous Climb and Descent Operations (STAR-SID-RNAV1) Navigation Service Procedures
7	Development of RNP Approach Procedure (RNP 0.3, RNP 0.1)

Table 5.10 Non RAN-GRK mitigation actions in manufacturing industry sub-sector

	Mitigation Action
1	Energy conservation in the energy-intensive industries (DIPA PPIHLH, BPKIMI)
2	Implementation of EnMS and System Optimization in Energy Industry (cooperation with UNIDO)
3	Implementation of EnMS and EE in the pulp & paper industry, steel, textile and food (cooperation with ECCJ)

(Sustainable Urban Transport Programme Indonesia), which is a series of activities to demonstrate the capabilities of urban transport policies and action in mitigation action planning. The expected outcomes of the programme are:

1. Efficient and sustainable arrangement of urban transport;
2. Assist Assistance to the City Government in developing mitigation action strategies that are suitable to local characteristics;
3. Development of a National Mitigation Action Plan for Transportation Sector

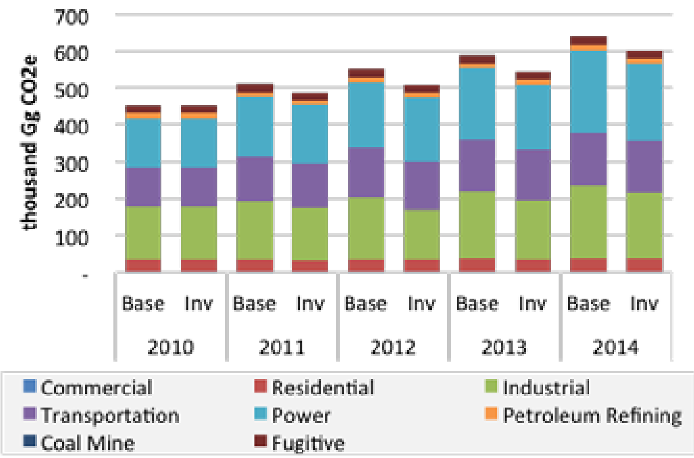


Figure 5.10 **Comparison of projected baseline and inventory of GHG emissions by sub-sector**

in a roadmap related to climate change under the coordination of the Ministry of Transportation.

Objective of the NAMA SUTRI is to promote sustainable transportation in Indonesian cities by providing financial and technical supports, capacity building and recognition for urban transportation policy where NAMA SUTRI activities are conducted, including:

1. Establishment and implementation of Technical Support Unit (TSU);
2. Policy and technical assistance to improve funding mechanisms;
3. Capacity building in urban transport planning;
4. Support for funding and implementation in pilot cities;
5. Development and mainstreaming of MRV system (Measurement, Reporting and Verification).

The programme also includes provision of assistance to 7 (seven) pilot cities in the implementation of NAMA SUTRI. The NAMA SUTRI has been registered with the UNFCCC NAMAs Registry and approved for assistance from the NAMAs Facility.

5.4.3.3 Status of GHG Emission Reductions in Energy Sector

In addition to the amount of mitigation outcomes calculated on the basis of the projects reported by each relevant ministry, annual emissions reductions can be estimated from the difference between baseline emissions and GHG emissions according to GHG inventory calculations. It should be noted however, that such reduction is not solely the result of mitigation activities undertaken by the Government or by non-government, but also include the reduction attributable to other factors such as decrease of industrial production, the slowing down of economic activity, etc.

Figure 5.10 shows the results of GHG emissions inventory and projected baseline GHG emissions in the energy sector for the 2010-2014 period. The emission reduction achievement of each sub-sector is evident from the comparison between the baseline emissions with the inventory.

During the 2011-2014 period, there was a 68% increase in GHG emission reduction from mitigation actions, from 21,835Ggram CO_2e in 2011 to 36,735Ggram CO_2e in 2014. The results of data analysis per sub-sector found that the emission reduction from energy sector activity occurred in three main sub-sectors, namely manufacturing industry, transportation, power plant, petroleum refining, and fugitive sub-sectors. Figure 5.11 shows the reduction of GHG emissions by sub-sector in 2011-2014.

It can be seen in Figure 5.11 shows that GHG emissions reduction by sub sector from 2010 - 2014 do not show any specific trend (increase nor decrease). This occurs because the calculation of GHG emission level in the national inventory (see Chapter 3) is based on data on energy utilisation recorded in the energy statistics book (Handbook of Energy and Economic Statistics Indonesia) published by Pusdatin-MEMR. Based on these energy statistics, there appears to be a significant decrease in energy consumption in 2012 (especially coal consumption) in the manufacturing sector. However, in 2013 and

2014, this coal consumption shows a significantly increase. Therefore, the accuracy of the reduction calculation is very dependent on the accuracy and consistency of the recorded data on the energy statistics book.

Mitigation efforts in manufacturing industries under RAN-GRK were implemented in energy intensive industries through efficiency and in cement industries through the use of biomass as alternative fuels and cement blended (called AFR or co-processing). This sub-chapter discusses the impact of alternative fuels utilisation on cement industries. The impact of alternative material utilisation in cement industries is discussed in IPPU sector. The combined impacts of the utilisation of AFR to the GHG emission reduction is used to evaluate the achievement of mitigation action target (RAN-GRK) in cement industries. Figure 5.12 shows the projected baseline and inventory of GHG emission and cementitious production for 2010 - 2014.

In general, mitigation actions can be directed at reducing certain types of gas emissions. In the energy sector, where much of it comes from the burning process of fossil fuels, the reduction targets are CO_2 gas. As illustrated, Table 5.11 shows emission reductions by sub-sector based on the type of fuel utilisation and the type of greenhouse gas emission. The table shows that the most dominant reduction is the CO_2 gas reduction in all sub-sectors.

5.4.3.4 Funding for Mitigation Action in Energy Sector

Mitigation actions under the responsible ministries are implemented in synergy with other stakeholders, namely local government, state-owned enterprises (*Badan Usaha Milik Negara* – BUMN) and provincial enterprises (*Badan Usaha Milik Daerah* –BUMD). Therefore, funding sources for mitigation activities can be derived from state budget (APBN), provincial budget (APBD), or State-Owned Enterprises/ Provincial Government-Owned Enterprises (BUMN/BUMD) budget, particularly for the implementation of policy-based (ministerial or regulatory regulations) mitigation activities, such as energy management by industry and building, funding sources may also come from private parties.

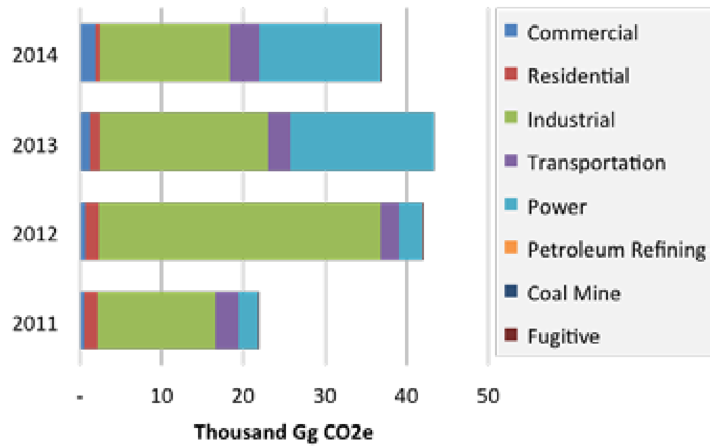


Figure 5.11 Reduction of GHG emissions by sub-sector

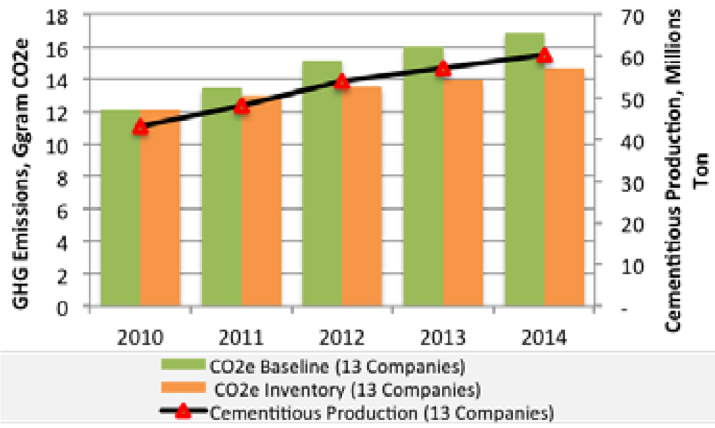


Figure 5.12 Projected baseline, GHG emission inventory and cementitious production for 2010 - 2014

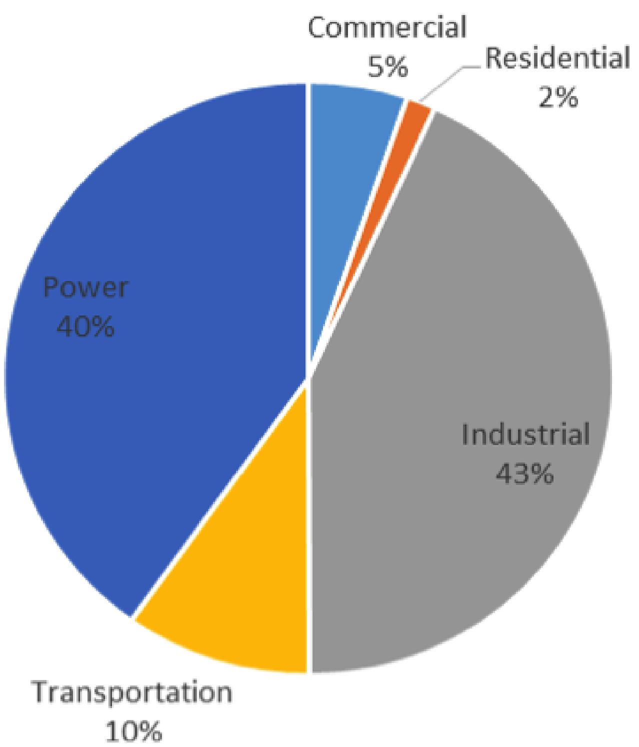


Figure 5.13 Distribution of GHG emission reduction by sub-sector in 2014

5.4.3.5 Co-Benefits of Mitigation Action in Energy Sector

Climate change mitigation action in energy sector is expected to provide co-benefits or benefits other than GHG emission reduction. Here are examples of the co-benefits:

1. Savings in energy consumption costs can be achieved through mitigation actions related to increased utilisation of efficient technologies and energy conservation strategies. The decline in energy consumption in industry and transportation has implications for increase in domestic market competence by lowering production and transportation costs.
2. Energy diversification can strengthen national energy security as well as reduce GHG emissions. Diversification of energy can be done through the utilisation of sustainable energy sources (renewable energy) and natural gas. Diversification can also be conducted by utilizing clean coal technology and can decrease the level of dependence on imported energy (petroleum oil).

Referring to Table 5.11, the main GHG emission reduction occurs in industrial and power sub-sector. Figure 5.13 shows the distribution of GHG emission reduction of energy sector by sub-sector in 2014.

1. The utilisation of mitigation technologies will encourage the development of science in the field of low carbon technology in the country. Mastery of new renewable energy technologies and conservation energy/ energy efficiency in the country can be developed to achieve the climate change mitigation targets in the energy sector. The development of science and technology and the mastery of strategic assets supporting low-carbon technology (low-emission technology) can be Indonesia's competitive advantage in global market.
2. Mitigation actions with implications in increase of energy access (such as utilisation of biogas from livestock manure for power generation) will be able to improve the welfare of the people through job creation.
3. Increase of social welfare through the creation of advanced skilled-labour employment can be achieved through promotion of green investment and

Table 5.11 GHG emission reductions by sub-sector based on type of fuel utilisation and the type of greenhouse gas emission, 2014

Sub-sector	Fuel type	GHG Emission Baseline (Gg)				GHG Emission Inventory (Gg)				GHG Emission Reduction (Gg)			
		CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e
Commercial	Oil	3,854	0.5	0.0	3,875	2,350	0.3	0.0	2,361	1,505	0.2	0.0	1,514
	Gas	874	0.1	0.0	876	477	0.0	0.0	478	397	0.0	0.0	398
	Biomass	-	3.1	0.0	77	-	2.4	0.0	60	-	0.7	0.0	17
Residential	Oil	7,058	1.0	0.1	7,097	2,082	0.3	0.0	2,093	4,976	0.7	0.0	5,003
	Gas	14,140	1.1	0.0	14,170	18,500	1.5	0.0	18,539	(4,360)	(0.3)	(0.0)	(4,370)
	Biomass	-	462.0	6.2	11,612		464.3	6.2	11,670	-	(2.3)	(0.0)	(59)
Industrial	Oil	31,058	2.2	0.3	31,183	23,096	1.8	0.2	23,192	7,962	0.5	0.1	7,991
	Gas	36,078	0.6	0.1	36,112	31,107	0.6	0.1	31,136	4,971	0.1	0.0	4,976
	Coal	127,408	13.3	2.0	128,303	124,582	13.0	1.9	125,457	2,826	0.3	0.0	2,846
	Biomass	-	8.5	1.1	528	-	8.0	1.1	496	-	0.5	0.1	32
Transportation	Oil	141,931	38.0	6.7	144,807	138,329	37.5	6.5	141,147	3,601	0.5	0.2	3,660
	Gas	66	0.1	0.0	69	68	0.1	0.0	72	(2.1)	(0.0)	(0.0)	(2.2)
	Biofuel	-	0.0	0.0	10	-	0.1	0.1	26	-	(0.0)	(0.0)	(16)
Power	Oil	25,066	1.0	0.2	25,149	21,394	0.9	0.2	21,465	3,673	0.1	0.0	3,684
	Gas	26,103	0.5	0.0	26,127	29,967	0.5	0.1	29,995	(3,864)	(0.1)	(0.0)	(3,868)
	Coal	171,272	1.8	2.7	172,138	156,419	1.6	2.4	157,210	14,853	0.2	0.2	14,928
	Biomass	-	0.0	0.0	1	-	0.0	0.0	1	-	(0.0)	(0.0)	(0.7)
Total		**584,907**	**533.8**	**19.4**	**602,133**	**548,370**	**532.8**	**18.8**	**565,398**	**36,537**	**1.0**	**0.6**	**36,735**

advanced technology in climate change mitigation actions in energy sector.

4. Mitigation actions in the transportation sub-sector have implication in improving smoothness of traffic, which can lead to improvement in worker productivity in urban areas. Examples of these mitigation actions are mass transportation (BRT, MRT) and application of intelligent transportation system (ITS).
5. Development of transportation infrastructure and substitution of transportation fuel (from oil to gas) has implications in improvement of air quality, which will lead to improved public health quality.
6. Mitigation action in saving of electricity will be able to reduce the need for construction of new power generation units.

5.4.3.6 Main Barriers of Mitigation Action in Energy Sector

Based on the experience in the implementation of RAN-GRK and non-RAN-GRK activities, there are a number of obstacles in implementing mitigation actions. Some of the obstacles to the implementation of climate change mitigation activities in the energy sector include:

1. Policy barrier

Energy subsidies are the cause of consumers' reluctance to implement energy efficiency activities. At the moment, the government still provides subsidies on electricity, diesel fuel for transportation, and kerosene for households. Previously, premium fuel subsidies were abolished in 2015.

To reduce the burden of increasing electricity subsidies, PLN is trying to lower the cost of supply (*Biaya Pokok Penyediaan – BPP*) for electricity. This interest is in contrast to the increasing interest in the use of renewable energy that is relatively more expensive than the BPP PLN at this time. In 2017 the government sets the maximum price for purchasing electricity from renewable energy by PLN no more than the local BPP. Although the regulation also requires PLN to purchase electricity from renewable energy, the low price made it difficult for power plant developer to achieve benefits.

2. Financing barrier

Climate change mitigation action requires a lot of investment funds. This is often become a constraint in the implementation of mitigation. Currently, there are various alternative sources of funding, both from domestic and international sources. Private sector can also implement energy sector mitigation using its own investment as well as investment cooperation scheme through Energy Service Company (ESCO), especially in energy conservation activities.

In the future, it is expected that there will be a more effective funding mechanism from financial institutions (banks), which in present still considers investment for energy sector as very risky. It is also expected that financing mechanism may come from non-bank financial institutions, such as Indonesia Infrastructure Finance (IIF) and PT. Sarana Multi Infrastruktur (SMI) to facilitate financing cooperation with privates or multilaterals. On the other hand, there is a relatively large amount of funding in some international agencies to be used for development of new renewable energy, but utilisation of the funding for implementation of mitigation is not yet optimal. This may be caused of the lack of funding mechanism and the lack of stakeholder knowledge of the existing mechanism.

Other barriers associated with financing are issues related to land acquisition prior to implementation of mitigation activity, for example in the construction of power plants.

3. Capacity barrier

Barriers in terms of human resource capacity lie in three subjects, namely government, investors, and implementer of mitigation actions. From the government side, there are institutional weaknesses in planning, implementation and monitoring, including evaluation in effectiveness/ efficiency of mitigation actions. At the local government level, basic understanding of mitigation actions, such as mitigation concept, activity data collection, and emission calculation, still need to be improved.

In addition, commercial parties, industry actors, and communities have limited knowledge regarding the opportunities and benefits of mitigation, technical operation, and potential funding mechanisms. Similar limitations are also exists in investors so that interest in investment in mitigation activities is still low. These things ultimately lead to unrealized mitigation action potentials.

4. **Technology barrier**

Dependency on technology from abroad has the implications for spending of funds on import. In addition, procurement of technology, including spare parts from abroad, takes longer time. The case in the transport sector, bus operators prefer to buy diesel bus due to faster procurement process than the BBG (gas-based) bus and ease in obtaining spare parts.

5. **Technical barrier**

Small-scale power generators generally do not have the reliability as required by PLN, so they cannot be connected to national grid. The same thing happens to the excess power in the industry. This causes the utilisation of renewable energy resources for small-scale electricity can only be utilized locally and is difficult to be developed widely.

6. **Transparency barrier**

Access to information on energy consumption in building and industry is still limited, given the absence of provisions governing the obligation of declaring public information on energy consumption. This makes it difficult for policymakers and ESCOs to conduct a study/analysis on market opportunity of energy efficient technologies.

7. **Social and environment barrier**

Social barriers in the implementation of mitigation actions are caused by two things, namely culture and community behaviour. Conflicts with local culture are generally concerning the location of the construction of renewable energy power plants. For example, the government cannot utilize renewable energy potential for power generation if it is located on customary land. This problem has occurred in several places, especially in the development of geothermal. Community behaviour that obstructs mitigation actions in the transportation sub-sector, among others, is in the behaviour that prioritizes the use of private vehicles rather than public transport. It is hoped that this behaviour can be changed if there is a mass transportation infrastructure that attracts the public interest (cheap, safe, free of traffic jam, and on time).

8. **Institutional barrier**

Changes in government structures that often occur are seen as one of the obstacles in the implementation of mitigation action, since the change in organizational structure can lead to changes in authority and duties. For example, the restructuring of the Ministry of Transportation in 2017, which led to the loss of some of the functions responsible for the implementation of RAN-GRK. In addition to structural changes, constraints that often encountered are the transfer of human resources/employees involved in mitigation action to other unit and lack of transfer mechanism for knowledge on climate change mitigation at an institution. As a result, the new employee assigned to handle the mitigation action takes a long time to do the work.

Other constraint is the lack of coordination between ministry/institution in the handling of mitigation action, especially in actions involving multi ministries/institutions. An example is the use of gas-fuelled buses whose operations are handled by the Ministry of Transportation. The procurement of the gas is handled by the MEMR, and the construction of infrastructure handled by the MoPWH. Presently, better coordination and alignment of work programme between ministries/institutions are needed to support optimum implementation of mitigation action.

Another important factor in the implementation of mitigation action is the working relationship with local government and local universities. Lack of cooperation between the government, local government and universities can lead to minimal supervision in implementation of mitigation at local level.

5.4.3.7 Capacity Building Needs

In order to improve the future implementation of mitigation actions, the identified obstacles must be addressed. One way to overcome the obstacles is by way of capacity building efforts. Referring to the above mentioned constraints, the following addresses some of the needs for capacity building at the individual, institutional, and social levels.

1. **Capacity Building at Individual Level**

Human resources in government institutions require capacity building in terms of technical capacity for, among others, designing and evaluating the implementation of mitigation actions. Scientific mitigation scenario planning capabilities, for example with the principle of least cost, need to be owned by individuals in government institutions. Project planning capabilities, such as the technical writing of proposals to access various sources of funds, also need to be improved. Particularly for local government personnel and mitigation implementers of commercial or industrial enterprises, it is necessary to increase the basic knowledge of climate change mitigation actions that include GHG emission calculations and mitigation concepts.

2. **Capacity Building at Institutional Level**

To improve the sense of ownership and responsibility on mitigation actions to achieve the national GHG emission reduction targets, it is important to increase the understanding that climate change issues in development are not the sole responsibility of the MoEF and the Sub-National Environment Agency, but are the responsibility of all parties. An urgent special aspect to be addressed is capacity building in terms of monitoring and evaluation, as well as verification of mitigation actions including the access to National Registry System.

3. **Capacity Building at Community Level**

The community needs to have an understanding of the benefits of climate change mitigation actions both from economic and social aspects as well as environmental quality. Particularly in the energy sector, public awareness plays an important role in the success of mitigation actions, which involve the use of energy-saving technologies and the transition from the use of private transport to public transport modes. For mitigation activities involving site-level communities, such as small-scale power plants in rural/remote areas and the use of solar-powered lights for village road lighting, community awareness raising is needed in terms of ownership of such actions so that communities can actively participate in maintaining equipment systems to operate sustainably.

5.4.4 Mitigation Actions in IPPU Sector

5.4.4.1 Baseline

GHG baseline emission in IPPU sector is needed to calculate achievement of GHG emission reduction from mitigation actions related to industrial process and product use activities. The industrial process referred here is the conversion of chemical raw materials into products in which during their conversion produce gases categorized as IPPU GHG emissions. Meanwhile, product use referred here is the use of chemicals in which in its utilisation releases gases categorized as IPPU GHG emissions. The institutions responsible for preparation of IPPU's GHG emission baseline are Ministry of Industry together with related industries and institutions, while the coordination for aggregation of IPPU baseline with other sector baselines is the responsibility of the MoEF.

Based on type of gas, IPPU's mitigation actions are aimed at reducing emissions of CO_2, CH_4, N_2O, HFCs, PFCs (CF_4/C_2F_6), and SF_6 gases from industrial sector in Indonesia. National GHG Emission Inventory (see Chapter 3) shows that the national GHG emissions from IPPU sector are dominated by CO_2(98% of total GHG emissions from IPPU sector). Although CO_2 is the main GHG emission, the preparation of IPPU GHG emission baseline not only covers CO_2 emissions, since mitigation action in IPPU sector implemented in Indonesia not only covers CO_2 but also other GHG emissions, including N_2O (Acid Nitrate) and PFCs (CF_4/C_2F_6).

Based on the emission source category, the IPPU emission categories reported in Indonesia's First BUR and TNC have been updated with the addition of 2H category (IPCC2006), which are other industries using carbonate for its production process in Pulp/Paper, Food/Beverage, and other industries. Referring to data in First BUR and TNC, the industries that contribute significantly to the national GHG emissions from IPPU sector in Indonesia are the cement industry, ammonia-urea fertilisers, and iron-steel processing, whereas product use activities that contribute significantly to GHG emissions national are the use of carbonate, paraffin/wax, and lubricants (Figure 5.14).

Figure 5.14 shows that national GHG emissions from IPPU in 2010 and 2014 are dominated by emissions from process activities in cement, ammonia and metal industries that are the main sources of IPPU GHG emissions. The dominance of these industries is expected to remain the same in the future. Although the GHG emission levels in the aluminium and nitric acid industries are not significant but the emissions reduction outcome has been calculated, so the baseline also includes process activities in the industries, and the mitigation actions of those industries are also reported in the TNC.

Mitigation action in IPPU is aimed at reducing GHG emissions from industrial processes and the product use that are significant contributors to the national GHG emissions. Among these industries, achievement of mitigation action in cement and ammonia-urea fertilisers can be reported, while achievement of mitigation actions in iron processing have not been reported due to data limitations. In addition to cement and ammonia-urea fertilisers, there are nitric and aluminium acids industries, which do not contribute significantly to national GHG emissions, where mitigation actions were carried out and emission reductions achievement from the aforementioned have been accounted. TNC reports IPPU sector mitigation actions that have been implemented and have recorded emissions reductions through 2014, i.e. mitigation actions in cement, ammonia-urea fertilisers, nitric acid, and aluminium industries. TNC has not yet covered record on mitigation related to product use activities.

Aside from changes in the scope of GHG emission types and sources, there is also change in the methodology used to calculate GHG emission levels and their reduction outcomes. In the TNC, IPPU emission reductions in some industries (cement, nitric acid, ammonia-urea fertilisers and aluminium)are estimated by applying higher Tier approach using activity data and factory-level emission factors, while in SNC only the aluminium industry uses factory-level data. Particularly in cement industry, the basis for calculation in TNC is cementitious production capacity and national specific emission factor determined based on national aggregation of all cement factories in Indonesia.

Referring to various changes on the scope and methodology on calculation of GHG emission level, the baseline used to evaluate achievement of GHG emission reduction from IPPU in TNC is an updated baseline in line with current conditions, with changes on:

1. Base year, where TNC base year is 2010 while SNC base year is 2005;
2. The methodology for calculation of emission level, wherein TNC uses higher Tier (Tier 2/3) for some industries whereas in the SNC the entire IPPU industry sector still uses Tier 1;
3. Coverage of emission source, where additions of industrial process (category 2H IPCC2006) and product use (carbonate usage) categories can be found in TNC;

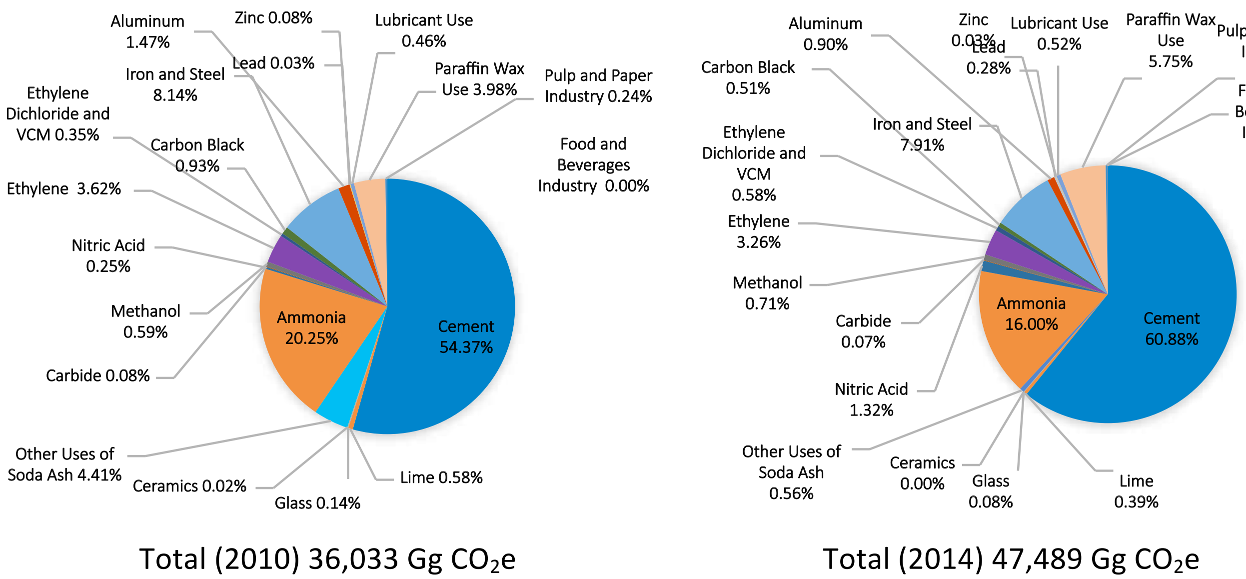


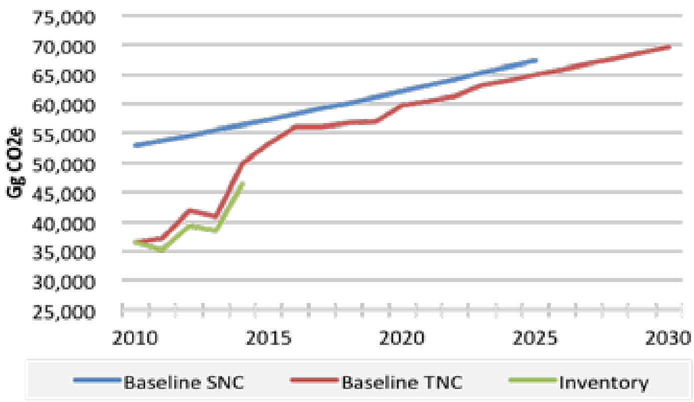
Figure 5.14 Main sources of emissions from IPPU sector (include CF_4 and C_2F_6)

4. The basis for calculation of projected production capacity and product consumption in TNC refers to historical data and real production capacity development plan (factory level) of several major industries with significant growth, while SNC refers to statistical data of average growth of manufacturing sector in 2005-2020.

To obtain an overview of the baseline change with the updated data in TNC, a comparison between baselines in TNC and SNC is presented in Figure 5.15 below. There is a significant difference between TNC and SNC baselines, where the numbers on TNC are relatively lower than those of SNC. This difference is mainly due to the difference in base year, GHG emission level calculation methodology, and production capacity projection assumptions as presented in (a) to (d). In addition, the low economic growth and the growth of the manufacturing sector during 2000-2014 have also significantly affected the development of industrial production capacity and the use of products in Indonesia.

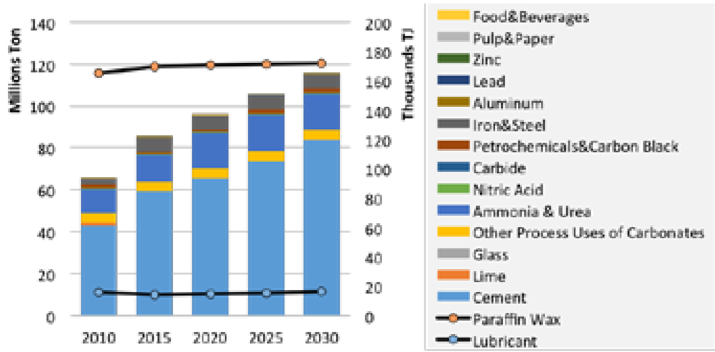
The IPPU baseline showed in Figure 5.15 is an aggregate baseline from each industry covered by the national GHG emissions inventory from IPPU sector. The projected production capacity of each industry and the consumption of the products used in the calculation of the baseline in TNC refer to historical data and real capacity production plans (plant level) in 2010-2030 as shown in Figure 5.16. It should be noted that the data on paraffin wax and lubricant use are expressed in thousand TJ/year while the production capacity and product use are in million ton/year.

Result of the projected baseline emissions for each respective industry listed in Figure 5.16 is presented in Figure 5.17. It can be seen that the IPPU's emission level is fluctuating by years, influenced by production level of the industries, thus do not reflect emission factors and technological efficiency used in the baseline scenario. The level of emissions is also affected by other product's variation, such as product changes, quality, conditions of production process, and any additional activities or disruptions resulting in the increase of GHG emission levels. In order to ensure that the GHG emission rate in a given year is basically



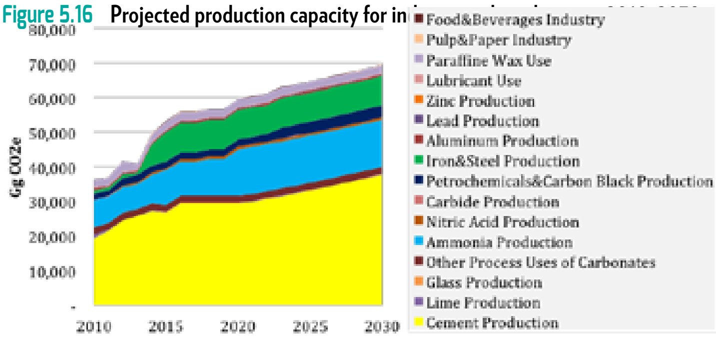
Source: Document of SNC Indonesia (2011) and national industrial production data processing

Figure 5.15 Comparison of IPPU Sector's Baseline in TNC and SNC



Source: estimated based on historical data and industry planning

Figure 5.16 Projected production capacity for in



Source: Processed from the data of national industrial production and product use in Indonesia

Figure 5.17 Baseline of IPPU Sector by sources sub-category

derived from an industrial production activity under baseline conditions and not because of the successful implementation of mitigation action in the year or the effect of production conditions in the industry, the appropriate parameters used to describe the IPPU's emission level is the emission intensity (ton of GHG/ton of product),since it is not influenced by production level or other production condition.

5.4.4.2 Mitigation Action Plan and GHG Emission Reduction Target

As mentioned in Sub-chapter 5.4.4.1, mitigation actions on product use are not available in Indonesia, while mitigation actions that have been implemented during 2010-2014 are limited to activities related to production processes in the cement industry, ammonia-urea fertilisers, aluminium, and nitric acid. The discussion on IPPU sector's mitigation action planning and GHG emission reduction targets in this sub-chapter covers only the implementation of mitigation actions related to the process in the industry, even though the baseline emission discussed in Sub-chapter 5.4.4.1 has covered all categories of IPPU emission sources in Indonesia (Figure 5.16 and Figure 5.17).

Mitigation actions planned for the cement industry, ammonia-urea fertilisers, aluminium and nitric acid are mostly being implemented voluntarily by private sector or within the framework of CDM, which are not intended to meet national GHG emission reduction targets. However, there is mitigation action related to production process in cement industry, which the Ministry of Industry stipulates as a mitigation action aimed at meeting the target of RAN-GRK.

RAN GRKRAN-GRK in industrial sector will be implemented in three main action plan groups: (1) process modification and technology of biomass utilisation or other technology in cement industry as cement blended, (2) energy conservation and audit; and (3) elimination of ozone depleting substances (ODS). In its implementation, only one action is directly related to GHG emission mitigation in IPPU, i.e. process modification and biomass utilisation and blended cement technology. The GHG emission reduction target from the action is estimated as much as2.75 Million Tonnes of CO_2e to be achieved during 2010-2020 (Table 5.12). The reduction target will be achieved through two mitigation categories, namely IPPU and energy. In this sub-chapter, the discussion on industrial mitigation actions in the field of industry only covers mitigation directly related to IPPU. Mitigation actions related to energy use are presented in Section 5.4.3 of the Energy Sector.

To encourage the adoption of process and technology modifications in cement industry, MoI has developed guidelines for the utilisation of biomass as alternative fuels and other technologies for the application of blended cement in the utilisation of AFR in cement industry. From this activities, it is expected that the total GHG emission reduction from cement industries will reach 2,750 Ggram CO_2e as targeted in RAN GRK.

RAN-GRK is planned to be implemented by 9 cement industries in 9 provinces, namely Aceh, West Sumatra, South Sumatra, West Java, Central Java, East Java, NTT, South Sulawesi and South Kalimantan, during 2010-2020..As previously mentioned, implementation of RAN-GRK mitigation action for IPPU is planned only in the cement industry through reduction of clinker ratio by substitution of clinker with fly additive (fly ash coal power plant) in the application of AFR technology (Alternative Fuel and Raw Material). The reduction in clinker ratio will reduce the intensity of GHG emissions, which in the cement industry is represented by the specific emission factor of the calcined cement process (tons of CO_2 per ton of cementitious products). Although positive for climate change mitigation, the decrease in clinker ratio is limited by the quality of cement products that must meet the desired specifications of the market and the technical standards of cement quality in Indonesia, thus affecting the level of GHG emission reduction achievements.

The IPPU GHG emission mitigation action implemented in the cement industry is not only within the RAN-GRK framework but also the CDM scheme. The achievements of mitigation actions within the framework of RAN-GRK or CDM are technically inseparable so they would be count as aggregates. The reduction calculated as the achievement of RAN-GRK, is the difference between the total reductions and the size of the CDM issuance. After the CDM project ends in 2017, all IPPU GHG emission reduction achievements from the cement industry can be calculated as the result of RAN-GRK, and after 2020 IPPU GHG emission reduction achievements from the cement industry can be accounted for as a result of party-stakeholder mitigation action.

Based on MoI report as the responsible party for RAN-GRK mitigation in the industrial field, GHG emission reduction achieved until 2014 is 1,624 Ggram CO_2. The amount of GHG emission reduction calculated using specific calcination emission factor in the baseline scenario (emission factor in base year 2010), i.e. 451.6 kgCO_2/ ton cementitious) and specific emission factors on mitigation scenarios that depend on how much mitigation action is implemented. This GHG emission reduction includes a 675 Ggram CO_2 issuance of CDM credits. The amount of emission reduction that can be claimed for meeting the RAN GRK targets is the achievement of GHG emission reduction excluded CDM, which is 949 Ggram CO_2 in 2014. However, after 2020, the CDM will no longer be claimed. Therefore, after 2020, all GHG emissions reductions claimed by RAN-GRK, will no longer be deducted by the amount of GHG emission reductions that in previous years, were claimed by the CDM. The amount of GHG emission reductions for IPPU sector mitigation actions in the cement industry in 2010-2014 period is presented in Table 5.12.

The calculation of IPPU GHG emission levels in the cement industry uses the WBCSD (World Business Council for Sustainable Development) methodology - CSI 3.1. Achievements of GHG emission reductions during 2010-2014 and comparison of baseline emission and mitigation emissions are given in Figure 5.18. It is observed that the potential for GHG emission reduction from activities in the cement industry in 2014 from the IPPU sector totalled to 1,654 Gg CO_2e. When added to the potential reduction of the cement industry from the energy sector activity of 2,197 Gg CO_2e, the total reduction of GHG emissions in the industrial sector in 2014 is 3,851 Gg CO_2e. Referring to the target of RAN-GRK of IPPU sector, it appears that if the achievement of mitigation action in cement industry through AFR program covering the mitigation category of energy sector and industry can be maintained, the emission targets in the RAN GRK can be fulfilled.

1. Non RAN-GRK Mitigation Action in IPPU

Despite being implemented by private sector, non-RAN GHG emission mitigation action in IPPU industry is coordinated by MoI that it can be categorized as mitigation by party stakeholder. The mitigation actions include the process in the ammonia-urea fertiliser and nitric acid industries that achieve significant emission reductions.

Among the process-related mitigation actions in the industry reported in TNC, only the one related to process in the aluminium smelting industry is CDM project.

Table 5.12 RAN-GRK Mitigation Action Plan in Industry

No.	Mitigation Action	Emission Reduction Target by 2020 (MTon CO_2e)	Responsible Institution
1	Process modification and utilisation of biomass and blended cement in the cement industry	2.75	MoI

Source: RAN-GRK (Presidential Regulation No. 61/2011)

Table 5.13 The amount of GHG emission reductions from mitigation action in the cement industry

	2010	2011	2012	2013	2014
Production (13 companies), Thousand Ton cementitious	43,091	48,027	54,097	57,085	60,199
Klinker / cementitious ratio	0.825	0.796	0.784	0.787	0.777
Emission factor specific of Calcination (kg CO_2/ton cementitious) – Baseline (BaU)	451.6	451.6	451.6	451.6	451.6
Emission factor specific of Calcination (kg CO_2/ton cementitious) - Mitigation	451.6	439.3	430.6	433.7	424.2
Emission Level of BaU, Thousand Ggram CO_2	19.46	21.69	24.43	25.78	27.19
Emission Level of Mitigation, Thousand Ggram CO_2	19.46	21.10	23.29	24.76	25.53
GHG Emission Reduction Potential, Thousand Ggram CO_2	-	0.59	1.14	1.02	1.65
CDM Issuance, Thousand GgramCO_2	-	0.59	0.67	0.67	0.67
GHG Emission Reduction Potential after CDM (for RAN GRK), Thousand Ggram CO_2	-	-	0.46	0.35	0.98

Note: Mitigation action on IPPU in cement industry was implemented prior to 2010. However, TNC only reports the achievement starting 2010 as the base year

Source: MoI report, 2016

2. Ammonia Industry

Ammonia production capacity of the national ammonia-urea fertiliser industry currently reaches about 5.2 million tons in 2014 and is expected to grow to 8 million tons by 2030. The ammonia production comes from 6 companies with 15 units of ammonia plant. Most of the ammonia plants in Indonesia are integrated with urea plants except for one unintegrated industry (producing only ammonia). IPPU GHG emissions derived from ammonia production process is in the form of CO_2. In ammonia plant integrated with urea plant, about 42% of CO_2 produced by ammonia plant is used as raw material in urea production.

There are lots of potential mitigation actions in the fertiliser industry, but those related to IPPU emission reduction are (i) improvement of the performance of ammonia plant by increasing efficiency of CO to CO_2 conversion, (ii) improved efficiency of CO_2 absorption in scrubber, and (iii) improved efficiency in methanation of CO_2 residues to purify synthetic gas.

3. Nitric Acid Industry

Total production capacity of Indonesia nitric acid industry is currently around 235,000 tons per year, supplied from 3 companies. The mitigation effort implemented in nitric acid industry is to install secondary catalyst in Ammonia Oxidation Reactor (AOR) to reduce N_2O, which is one of greenhouse gas emissions. N_2O is an undesirable by-product in the production of nitric acid. Installation of secondary catalyst can convert the N_2O formed during the ammonia oxidation process to Nitrogen (N_2) and Oxygen (O_2) which do not have any adverse impact on the environment and human health.

4. Aluminium Industry

The current IPPU emission source from this sub-category is from smelting process at PT Inalum Asahan (located in Kuala Tanjung), which started its operation in 1982. The production capacity of this industry in 2005 was 250,000 tons per year. The technology used in the smelter is the Centre Work Prebake (CWPB) type that generates perfluorinated (PFC) emissions during the production process as an impact of the Anode Effect (AE). AE is a condition in which the voltage in the reduction furnace suddenly increases due to anode polarization in the electrolysis process simultaneously lowering the dissolved alumina concentration in the reduction furnace far below normal (≤1%).

The mitigation action implemented in this industry is replacing the Process Controller System (CEGELEC process control system), an old technology, with the new ALCAN ALESA control system to reduce AE (frequency, duration, over voltage) significantly. The replacement of the process control system decreases the AE so that the emissions of PFC (CF_4/C_2F_6) generated out of the smelter pot decreases. GHG emission reductions achieved through the replacement of this technology are used for carbon credits through CDM project scheme. As stated in the project's GHG emission reduction monitoring report, the types of GHG included within the scope of the CDM project are only PFC (CF_4 and C_2F_6) gases originating from AE in pots.

5. GHG Emission Reduction of IPPU Non-RAN-GRK (by Type of Gas)

In general, mitigation actions can be directed at reducing certain types of gas emissions. Based on the report of the MoI as responsible party of the mitigation actions in IPPU (Kemen Perin, 2016), GHG emission reduction resulted from mitigation actions in various industries to reach RAN GRK target as well as non-RAN GRK is presented in Table 5.14. It should be noted, the GHG emissions are also categorised by type of gas.

5.4.4.3 Funding for Mitigation Action in IPPU Sector

Development of mitigation action in IPPU is guided by MoI while the implementation is carried out by company. The guidance includes aspects of preparation, policies, capacity building, and development of infrastructure for monitoring (online). Funding issued for the guidance from 2011-2014 is shown in Table 5.15, covering various aspects of climate change (inventory, mitigation), in sectors of IPPU, energy and waste

The guidance of climate change in the Ministry of Industry is also supported by various international institutions, such as AFD (Agence Française de Développements) through the Programme of "Establishment of A Greenhouse Gas Emission Reduction Scheme in The Cement Industry in Indonesia", GIZ through PAKLIM programme(2011-2014), UNDP, and UNIDO for Human Resource Capacity Building Programme in Industrial Energy Optimization, Industrial Competency Improvement in Energy Management Under ISO 50001 and Technical Guidance of Implementation of Energy Conservation and Energy Management (ISO 50001) in the Industrial Sector.

Table 5.14 GHG emission reductions by type of GHG emission in each type of IPPU

Mitigation Action	GHG Emission Baseline, Gg CO_2e			GHG Emission Inventory, Gg CO_2e			GHG Emission Reduction, Gg CO_2e			
	CO_2	N_2O	PFC*	CO_2	N_2O	PFC*	C_02	N_2O	PFC*	CO_2e
2014										
Cement blended in cement industry	27,187			25,534			1,653	-	-	1,653
Ammonia industry	8,048			7,947			101	-	-	101
Nitric acid industry		524			415		-	109	-	109
Aluminium industry	320		129	320		39	-	-	90	90
TOTAL	35,555	524	129	33,801	415	39	1,754	109	90	1,953
2013										
Cement blended in cement industry	25,781			24,775			1,006	-	-	1,006
Ammonia industry	6,696			6,597			99	-	-	99
Nitric acid industry		519			382		-	137	-	137
Aluminium industry	411		165	411		50	0	-	115	115
TOTAL	32,888	519	165	31,783	382	50	1,105	137	115	1,357
2012										
Cement blended in cement industry	24,431			23,294			1,137	-	-	1,137
Ammonia industry	7,171			7,168			3	-	-	3
Nitric acid industry		377			327		-	50	-	50
Aluminium industry	386		156	386		47	-	-	109	109
TOTAL	31,988	377	156	30,848	327	47	1,140	50	109	1,299
2011										
Cement blended in cement industry	21,690			21,100			590	-	-	590
Ammonia industry	7,227			7,111			116	-	-	116
Nitric acid industry		89			89		-	-	-	-
Aluminium industry	385		155	385		47	0	-	108	108
TOTAL	29,302	89	155	28,596	89	47	706	0	108	814

*PFC ((C2F4/C2F6); Sources: MoI as responsible party of RAN GRK Implementation in IPPU Sector (MoI, 2016)

5.4.4.4 Co-Benefits of Mitigation Action

Mitigation actions in IPPU can provide co-benefits or benefits other than GHG emission reduction in the form of savings of raw materials, energy and water consumption, which implies reduction of production cost, waste processing cost, environmental pollution problem, and increase competitiveness. In addition to these 'tangible' benefits, there are also some intangible benefits that cannot be quantified in physical or monetary form, i.e. better public image for companies, such as green image, efficient, eco-friendly, and others. Here are examples of co-benefits from climate change mitigation activities in IPPU.

Table 5.15 State Funding for Guidance of Climate Change in MoI

Year	Fund (Rupiah)
2011	1,250,000,000
2012	981,276,000
2013	7,081,840,000
2014	2,795,000,000

1. Cement blended mitigation actions reduce clinker ratios that imply reduced production costs, improved corporate image (green image). Meanwhile, mitigation action in cement blends that utilize waste (industry/domestic) as AFR helps solve environmental problems at waste sites;
2. The use of mitigation technology encourages the development of science

and the mastery of strategic assets related to low carbon technology that will encourage the mastery of technology in the country. This later on implies on improved competitiveness in global markets; and

3. Increase social welfare through the creation of advanced skilled-labour employment, which can be realized through increased green-investment and advanced technology.

5.4.4.5 Main Barriers

Based on experience in implementing mitigation actions in IPPU, both aimed at meeting the national GHG emission reduction targets (GHG) and not (non-RAN-GRK), a number of obstacles are identified:

1. Policy Barrier

1. Air pollution related regulations and permits for the use of fly ash and waste in industries utilizing AFR (such as cement) are required to meet environmental quality standards, so that innovation is needed in the implementation of more environmentally friendly mitigation actions;
2. There is no supportive policy towards the implementation of IPPU-related mitigation actions;
3. There is no tangible/intangible incentive for industries implementing mitigation so that the implementation of mitigation actions becomes less attractive to the company.

2. Financing barrier

1. IPPU's mitigation actions substantial investment funds, as the cost of mitigation technology is relatively expensive and must be imported, has often become a constraint in the implementation of mitigation by the company.
2. There is no specific commercial financing available for mitigation, since mitigation actions are deemed to be non-profitable.
3. Some mitigation actions provide only intangible benefits, which makes it difficult to serve as basis to obtain commercial funding.
4. Ineffective utilisation of mitigation financing caused by two main things, namely the lack of mechanisms for channelling of funds and lack of stakeholder knowledge of the mechanisms. As explained in energy sector mitigation, it is expected that financing barriers can be addressed by more effective funding mechanisms of non-bank financial institutions such as Indonesia Infrastructure Finance (IIF) and PT. Sarana Multi Infrastruktur (SMI) which facilitates the cooperation of private or multilateral funding

3. Capacity barrier

Barriers in terms of human resource capacity lie in three subjects, namely government, investors, and implementer of the mitigation actions. From government side, there are institutional weaknesses in planning, implementation and monitoring including evaluation on effectiveness/efficiency of mitigation actions. While at local government level, basic understanding such as mitigation concept, activity data collection, and emission calculation still need to be improved.

There is also the limited knowledge of commercial, industrial, and community actors regarding the opportunities and benefits of implementation of mitigation, technical operation, and potential funding mechanisms. Similar limitations are also exists in investors that lead to low interest to invest in mitigation activities. These things ultimately lead to unrealized mitigation action potentials.

4. Technology barrier

Dependency on low-carbon and efficient technologies from abroad has the implications for spending of funds on import. In addition, procurement of technology including spare parts from abroad takes longer time and requires overseas human resources (technical assistant, maintenance, and R & D).

5.4.4.6 Capacity Building Needs

In order to improve the future implementation of mitigation actions, the identified obstacles must be addressed. One way to overcome this is through capacity building efforts.

1. Improvement in human resources' capacity in mitigation actions includes capacity in identification, planning, implementation, monitoring and evaluation. One crucial capacity to note is the ability to estimate the magnitude of emissions reduction from a mitigation action (industrial process technology that can reduce emissions).

2. Capacity building in the development of methodologies and local GHG emission parameters (emission factors) for baseline emissions and project emissions.
3. Development of information system to collect information related to implementation of mitigation actions by sectors. This includes integration of data on various programmes such as PROPER and green industries.
4. Socialization and improvement of human resources capacity to demonstrate the benefits of mitigation actions.
5. Capacity building to formulate policies that encourage the implementation of mitigation actions, which include means of incentives, rewards, and fiscal incentives.
6. Capacity building in funding aspect and its access, for example Green Climate Fund and Global Environment Facility.

5.4.5 Mitigation Actions in AFOLU Sector

5.4.5.1 Baseline

The methodology used in estimation of baseline emissions in agriculture and forestry and other land uses (AFOLU) within TNC has changed, compared to SNC, as it is semi-dynamic and integrated. This approach is used because of the high level of closeness of the two sectors, where the drivers of land use change of the two sectors cannot be separated. In this case, future emission changes from both sectors are driven by population growth, Gross Domestic Product (GDP), consumption levels of both food and feed, agricultural and forestry production targets, land productivity, and land use intensity. The rate of future land use change will be greatly influenced by the assumptions used in projecting changes in drivers. The key assumptions used are related to changes in population and GDP, similar to those used in the energy sector. The model for projection of AFOLU baseline emissions uses the AFOLU Dashboard used by the Deep Decarbonisation Pathway Project (DDPP) under the Sustainable Development Solution Network (SDSN; Boer et al., 2016).

In the SNC, projections on inter-sector baseline emission are carried out separately (not integrated). For the forestry sector, baseline emissions are estimated only for deforestation and carbon sequestration (from forest regeneration and tree planting or land rehabilitation). For agriculture sector, estimated baseline emissions are only from rice field cultivation and livestock. Baseline emissions from deforestation are assumed to be the average of historical emissions, whereas emissions from the rice cultivation and livestock follows historical trend. Especially for deforestation, calculation of the baseline emissions between SNC and TNC have no difference, since bothuse historical average; however, the reference period used in determining the average historical emission value is not the same. Similarly, activity data (deforestation rate) has been reviewed and the definition of forest used is different. In summary, the differences in estimation of baseline emissions between SNC, BUR and TNC can be seen in Table 5.16, while deforestation data as the results of the review are presented in Table 5.17.

The projected baseline emissions of the AFOLU sector can be seen in Figure 5.18. AFOLU sector baseline emissions in 2010 are estimated to be 757,055 Gg CO_2e, then increased to 873,491 Gg CO_2e and 834,698 Gg CO_2e in 2020 and 2030, respectively. The projection resulted from the use of actual deforestation data of 347,000 hectares in 2010, while deforestation rate for 2011 - 2020 use FREL projected rates for REDD +, where it is assumed to follow the average historical deforestation rate over the period of 1990-2012 (MoE, 2016), i.e.0.92 million ha/year. While in the period of 2021-2030 the rate of deforestation is projected at 0.82 million ha/year.

The combined baseline emissions shown in Figure 5.18 above can be split into two baselines with respect to emissions sources, namely the baseline of agricultural sector and the baseline of forestry/other land use sector. In Figure 5.19 and Figure 5.20 it can be seen that the baseline emissions from agricultural sector are much smaller than the baseline in forestry/other land use sectors. The baseline emissions for the agricultural and forestry sectors, respectively, are 110,510 Gg CO_2-e and 646,545 Gg CO_2-e in 2010, will be 115,925 Gg of CO_2-e and 757,566 Gg of CO_2-ein 2020, and will be 120,457 Gg CO_2-e and 714,241 Gg of CO_2-ein 2030.

Table 5.16 Differences in data, methodology assumptions used to estimate baseline emissions in SNC, BUR and TNC

Category	SNC	BUR (GHG Inventory)	TNC*
Activity data	Land cover map 2000-2003; 2003-2006 ***before the review***	Land cover map 2000-2003; 2003-2006; 2006-2009; 2009-2011 and 2011-2012,***after the review***	Landcover Map 1990-1996; 1996-2000; 2000-2003; 2003-2006; 2006-2009; 2009-2011 and 2011-2012,***after the review***
Activity	Deforestation, carbon sequestration from forest regeneration and tree planting, rice cultivation and livestock		All categories of land use change includingpeat fires
Forest definition	Natural forests and plantation forests	Natural forests and plantation forests	Natural forests
Methodology for emission estimation	Gain and Loss	Gain and Loss	Gain and Loss
Methodology for baseline projection	Historical average	No projection	Semi Dynamic Models (integration of Agriculture, Forests and Other Land Use). Estimation for emissions from deforestation and peat fires use historical average method.
Land cover categories	22 land cover categories	23 land cover categories (mineralsoil and peat)	23 land cover categoriesmodified into 14 land cover categories
Carbon Pool	Above and below ground biomass for mineral soil, plus soil carbon for peat	Above and below ground biomass and soil carbon (mineral soil and peat)	Above and below ground biomass for mineral soil, plus soil carbon for peat
Gases	CO_2, N_2O and CH_4	CO_2, N_2O and CH_4	CO_2, N_2O and CH_4
Emission Factor**	Local emission factors and IPCC 2006 default values	Local emission factors and IPCC 2006 default values	Local emission factors and IPCC 2006 default values

Note: * The baseline used in TNC follows the NDC baseline **For the SNC, the emission factor is compiled from limited research results, whereas BUR and TNC use data from the national forest inventory and research results from several regions.

Table 5.17 Difference in deforestation rate (million ha/yr.) before and after review

	2000-2003	2003-2006	2006-2009	2009-2011	2011-2012	2012-2013
Before review*	1.080	1.170	0.832	0.451	0.613	0.727
After review *	0.346	0.741	0.865	0.341	0.471	0.727
After review **	0.444	0.842	0.913	0.550	0.786	0.887

*Natural forests and plantations are included in forest categories (Used in SNC and BUR); ** only natural forest is included in forest category (Used in FREL-REDD and NDC)

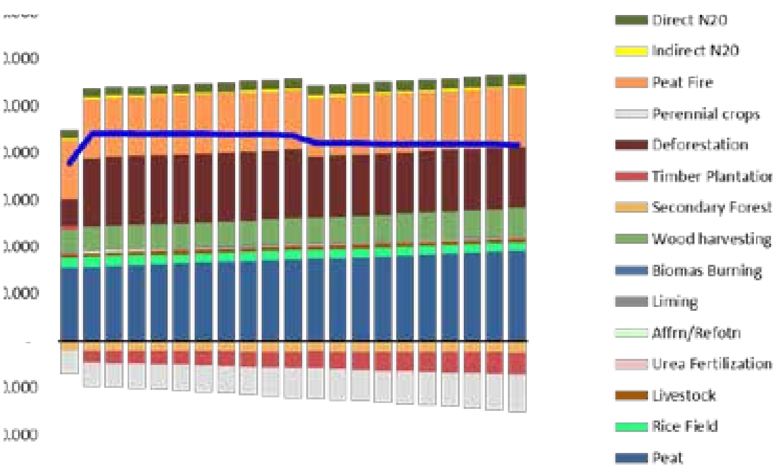


Figure 5.18 AFOLU Baseline Projection, 2010-2030

5.4.5.2 Mitigation Action and Emission Reduction Target

AFOLU sector mitigation actions are based on action plan stipulated in RAN-GRK which consisted of 2 sectors, namely agriculture and forestry/peat. The actions are under the management of 3 ministries, namely Ministry of Agriculture (MoA), MoEF and MoPWH.

1. Agriculture Sector

The RAN-GRK of the agricultures sector has 6 core mitigation action plans and 4 supporting action plans. The six core mitigation action plans have the potential to reduce around 130,730 Gg CO_2e (0.131 Giga Tons CO_2e) emissions by 2020. However, the target set for agriculture sector is only 8,000 Gg CO_2e.

Of the six core mitigation action plans of the agricultural sector, MoA manages five core mitigation action plans, with an emission reduction potential of 130.570 Gg CO_2e. Meanwhile, MoPWH manages 1 core mitigation action plan, with an emission reduction potential of 160 Gg CO_2e. The core action plan for mitigation of the agriculture sector at the relevant ministries is presented in Table 5.18 below.

In addition to agricultural sector mitigation activities through RAD-GRK, there are mitigation activities undertaken by provinces whose GHG emission reduction contributions have not been reported because the activity data reporting mechanism is still under development. In addition, several districts/municipalities, villages, companies and community groups also conduct mitigation activities in the agricultural sector but the results of their implementation cannot be measured because of the lack of institutional mechanisms for the collection of data on such activities.

The data collection and reporting mechanisms on GHG mitigation and greenhouse gas emissions from non-party stakeholders will be developed through a data management system integrated with the existing information systems, such as Village Information Systems, Regional Development Information Systems and others. Cooperation with the Ministry of Village, Development of Disadvantaged Area, and Transmigration (MoV), the Ministry of Home Affairs (MoHA) or other relevant ministries/institutions, especially with data and information centres or statistical bodies, will be implemented soon.

2. Forestry Sector

The RAN-GRK in forestry sector has 13 (thirteen) core mitigation action plans and 17 supporting mitigation action plans. The 13 core mitigation action plans contribute to 810,600 Gg CO_2e (0.811 Giga Ton CO_2e) emissions reduction by 2020. However, the target set for the forestry sector is 672,000 Gg CO_2e.

Only 10 of the 13 core mitigation action plans are managed by MoEF. Other two action

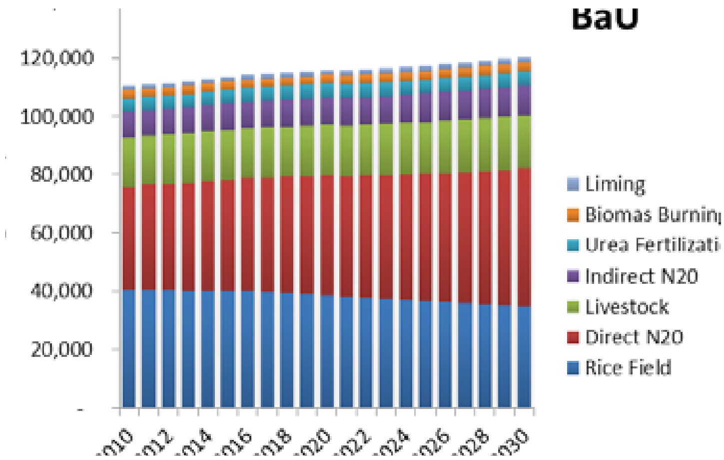


Figure 5.19 Projected baseline in agriculture, 2010- 2030

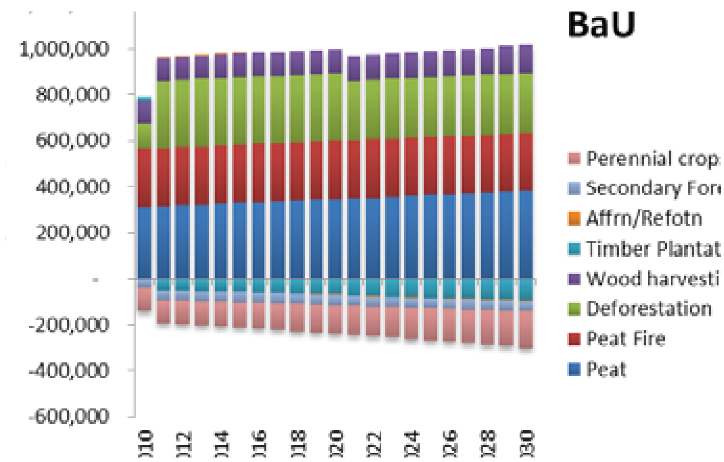


Figure 5.20 Projected baseline in forestry and other land use, 2010- 2030

Table 5.18 Core Mitigation Actions in Agriculture sector

No	Mitigation Action	Emission Reduction Target (Gg CO_2e)	Responsible Institution
1	Repair and maintenance of irrigation networks	160	MoPWH
	Sub-Total	*160*	
2	Optimizing land	4,810	MoA
3	Application of plant cultivation technology	32,420	
4	Utilisation of organic fertiliser and bio-pesticide	10,000	
5	Development of plantation area (palm oil, rubber, cocoa) on non-forested land/abandoned land/ degraded land/Other Use Areas (APL)	Palm oil : 74,530	
		Rubber: 2,380	
		Cocoa: 5,420	
6	Utilisation of livestock's manure/urine and agricultural waste for biogas	1,010	
	Sub-Total	*130,570*	
	Total	*130,730*	

plans are managed by MoA while another one is managed by MoPWH.

In general, ten core mitigation action plans managed by the MoEF can be divided into two categories: actions aimed at avoiding carbon emissions (avoiding deforestation and degradation), and actions aimed at increasing carbon sequestration (reforestation), with a total emission reduction potential of 600,700 Gg CO_2e. Meanwhile, the three core mitigation action plans managed by the MoA and MoPWH have the potential to generate 209,950 Gg CO_2e emission reductions. The core mitigation action plans and its managing ministries are presented in Table 5.19.

5.4.5.3 Implementation of Mitigation Action and Its Impact

The impact of the implementation of mitigation action activities in AFOLU sector can be seen from the physical achievements in both sectors: agriculture and forestry.

1. Agriculture Sector

MoA has implemented and reported three cores mitigation actions of the six actions listed in the RAN-GRK (Table 5.20). The development in the implementation of the three mitigation actions and its physical achievements are presented in Table 5.20 below.

The baseline emissions from the three agricultural sector's mitigation actions are based on the assumption that mitigation technology has never been implemented or has not become a commonly used technology.

Implementation of the UPPO and Batamas programmes are expected to increase from year to year since these two activities, introduced to farmers with the assistance of capital expenditures in the form of cows, organic fertiliser processing units, and bio-digesters, are assumed to be maintained in subsequent years. There is an exception to the UPPO action where the number of cattle aid distributed in 2013 onward are lower than in 2012, i.e. previously 35 cows per unit UPPO and recently 10 cows per unit UPPO.

In contrast to UPPO and Batamas actions, data on harvested area from the application of cultivation technology (SL-PPT, SRI and low-emission varieties) fluctuates, since the action is assumed to occur only in the current year. The action, introduced to farmers in the form of a package of cultivation technology (not capital expenditure), is conducted in different location every year. Meanwhile, there are no reports by MoA on the continuation of implementation of the previous years' locations because there is not yet any mechanism for evaluation and monitoring of mitigation actions. Several researches conducted by research institutes or universities show that the adoption rate by farmers on SL-PTT or SRI technology is quite high, since it resulted in increase productivity, which in turn increase farmers' income. Thus the action in application of cultivation technology introduced to farmers by MoA may still be adopted by farmers in the coming years. Results of interviews with farmers in East Kalimantan indicate that 40% of the respondents apply the technology (Purwantiningdyah and Hidayanto, 2015; Maryani et al., 2014; Mulyani and Jumiati, 2012; Kementan, 2012).

2. Forestry Sector

The core activities included in forestry sector mitigation action in RAN-GRK consist of 13 (thirteen) activities. The 10 core activities managed by the MoEF can be grouped into two groups of activities, i.e. (i) avoided deforestation and forest degradation, and (ii) sink enhancement (reforestation). The physical outcomes of these 10 activities are presented in Table 5.21. In addition, various policies have also been established for sustainable forest management and to address the issue of deforestation, including on peatlands.

The impact of implementation of mitigation actions in forestry sector cannot always be measured directly by activity, since emission reductions may be resulted from implementation of several activities. For example, reduced emissions due to reduced deforestation rates in an area may not only be the result of monitoring and safeguarding of forests but also because of implementation of other activities, directly or indirectly addressing drivers of deforestation, that will reduce the pressure on forests.

Several activities that directly addressed drivers of deforestation are provision of access for encroaching community to manage the forest through social forestry scheme, development of economic activities for communities surrounding forest, community awareness raising programmes on the importance of conserving forests or the environment, etc. These activities were being conducted but were not included in RAN-GRK. Other examples

Table 5.19 Core Mitigation Plans in Forestry Sector

No.	Mitigation Action	Emission Reduction Target (Gg CO_2e)	Responsible Institution
Avoid Deforestation and Degradation		***508,920***	MoEF
1.	Development of Forest Management Unit	31,150	
2.	Planning for utilisation and expansion of forest area	24,320	
3.	Development of environmental services utilisation	3,670	
4.	Inauguration of forest area	123,410	
5.	Development of social forestry	100,930	
6.	Forest fire control	21,770	
7.	Forest investigation and security	2,300	
8.	Development of conservation areas, essential ecosystems and protection forest	91,270	
9.	Improvement of forest plantation business	110,100	
Reforestation		***91,750***	
10.	Implementation of forest rehabilitation, and forest reclamation in priority watersheds	91,750	
	Sub Total	***600,670***	
11.	Peatland management for sustainable agriculture	103,980	MoA
12.	Development of agricultural land management in abandoned and degraded peatlands to support the subsector of plantations, livestock and horticulture	100,750	
	Sub Total	***204,730***	
13.	Improvement, rehabilitation, operation and maintenance of swamp reclamation networks (including peatland)	***5,230***	MoPWH
	Sub Total	***5,230***	
	Total	***810,600***	

Table 5.20 Implementation and physical achievement of mitigation action plans in agriculture sector

No.	Action Plan	Activity/Goal	Physical achievement in 2010-2014
1.	Application of plant cultivation technology (Field School on Integrated Crop Management/*SLPTT*, System of Rice Intensification/SRI, Application of Low Emission Variety)	Technology to protect food crops from disturbance of plant-disturbing organisms and the impact of climate change is implemented on in area of 2.03 million ha	• Total harvest area in SLPTT areas reached 14,774,849 ha • Total harvest area in SRI areas reached 435,999 ha. • Application of 15 low-emission varieties in 19,196,154 ha of rice field
2.	Utilisation of organic fertiliser and bio-pesticide (Organic Fertiliser Management Unit- *UPPO*)	Utilisation of organic fertilisers and bio-pesticides in an area of 250,000 ha	• The Ministry of Agriculture has distributed 2,829 units of UPPO to the community • The amount of organic fertiliser that has been utilized reaches 3,770,863 tons.
3.	Utilisation of manure/ urine livestock and agricultural waste for biogas (*Biogas Asal Ternak Masyarakat - BATAMAS*)	Development of BATAMAS programme in remote and densely populated areas of 1,500 community groups	1,592 units of BATAMAS and 119,400 cattle have been distributed to the community.

are the application of mitigation technologies in peatlands (improvement of water systems) in plantations and industrial plantation forests (Table 5.22).

Implementation of policies in the form of law enforcement and/or moratorium policy for permits in utilisation of natural forest or clearing of peatlands may also contribute to reducing deforestation (Table 19). Therefore, reduction of the rate of deforestation and/or forest degradation cannot be entirely claimed to be the result of implementation of a single policy or programme of activity, but the result of many of them. Based on this rationale, the impact of implementation of mitigation policies and programmes on emissions reductions in the forestry sector is measured by comparing baseline emissions with actual emissions from greenhouse gas inventories from four sources of emissions from deforestation, forest degradation, peatland decomposition, peatland fires and sink enhancement. The relationship

Table 5.21 Implementation and physical achievement of mitigation action plans in forestry sector

No.	Action Plan	Activity/Target	Physical achievement in 2010-2014
Avoid Deforestation and			
1	Development of Forest Management Unit	Establishment of 120 units of FMU	Establishment of 120 units of FMU with a total area of 16,437,656.5 ha. It consists of 80 units of KPHP (Production FMU) with area of 12,888,862.5 Ha, and 40 units of KPHL (Protected FMU) with area of 3,548,794 ha
2	Planning for utilization and expansion of forest area	Timber Forest Product Utilization Permit - Natural Forest/Ecosystem Restoration (IUPHHK-HA /RE) in Logged Over Area (LOA) were awarded for area of 2.5 million ha	Award of IUPHHK -HA/RE in LOA covering 4,421,834 ha, consists of IUPPHK-RE of 461,100 ha and IUPHHK-HA of 3,958,734 ha
		Increased production of non-timber forest products/ environmental services	20 provinces have produced 15 non-timber forest products commodities
3	Development of environmental services utilization	Implementation of two REDD Demonstration Activities in conservation areas (peat forest)	Implementation of REDD DAs in Sebangau National Park covering 85,000 ha, and Berbak National Park with an area of 140,000 ha
4	Inauguration of forest area	Establishment of Forest Area Boundaries (outer boundary and function boundary) of 25,000 km	Establishment 25,577 km of outer boundary and 25,567 km of function boundary
5	Development of social forestry	Facilitation on the establishment of 2,500,000 ha of management work area of community forest (HKm)/village forest (HD)	Facilitation on the establishment of 328,452 ha of community forest and 318,024 ha of village forest
		Establishment of business partnership in 250,000 ha of community forest area	Facilitation on establishment of business partnership in community forests (946 units) and Forest Farmers Group (381 units) with total area of 318,024 ha
6	Forest fire control	Decrease in the number of hotspots on the islands of Kalimantan, Sumatra, and Sulawesi by 20% per year from the average 2005-2009 number of 58,890 hotspots/year by 67.90%	Decrease of 57.91% of hotspots number in the period of 2010-2014
7	Forest investigation and security	Completion of at least 75% of new cases of forestry crime (illegal logging, illegal mining and fire)	655 new cases of forestry crime (76.8% out of 853 cases) were completed
8	Development of conservation areas, essential ecosystems and protection forest	10% increase of management of essential ecosystems	Assignment of 17 units of essential ecosystem area in 17 provinces
		The issue of encroachment in conservation forest and protected forest in 12 priority provinces is addressed.	The issue of encroachment in 135,107 ha of conservation forest and protected forest in 12 priority provinces was managed.
9	Improvement of plantation forest business	3 million ha of industrial timber plantation and plantation forests (HTI/HTR) area is reserved	2,961,417.05 ha of industrial timber plantation and plantation forests (HTI/HTR) area wasreserved
Reforestation			
10	Implementation of forest and land rehabilitation, and forest reclamation in priority watersheds	Implementation of forest rehabilitation in 500,000 ha of priority watershed	Implementation of forest rehabilitation in 434,284 ha of priority watershed, with 283,018,338 of trees planted
		Implementation of forest rehabilitation in 1,954,000 ha of critical lands in priority watershed	Implementation of forest rehabilitation in 1,868,472 ha of critical lands in priority watershed, with 1,117,613,763 of trees planted
		Development of 6,000 ha of urban forest	Development of 5,122 ha of urban forest with 11,672,530 of trees planted
		Rehabilitation 40,000 ha of mangrove/ coastal forests	Rehabilitation 31,675 ha of mangrove/coastal forests with 66,904,433 of trees planted

between the implementation of policies within the RAN-GRK on emissions reductions from these sources is presented in Table 5.23.

5.4.5.4 Status of GHG Emission Reductions in AFOLU Sector

1. Agriculture Sector

GHG emission reductions in agriculture sector in Indonesia in this document were generated from the implementation of three mitigation actions, (i) management of rice cultivation (the SRI & PTT programs), (ii) utilisation of livestock manure for biogas

Table 5.22 **Non RAN-GRK programmes and policies in forestry sector contributing to reduction of emissions from forestry sector**

No	Policy/Programme	Activity/Target
1	Tree planting in peatlands	Establishment of demonstration plots for land rehabilitation in degraded peatlands, and introduction of agroforestry in 50 ha of peatlands in 2014
2	Ground water level< 0,4 m	Establishment of 12 demonstration plots in creation of canal blocking in six villages. Implemented in the framework of water governance in peatlands. The community later self-developed it into 60 blocking canals in 2014
3	Development of boundary in concessionaires	Reduction in the decrease of groundwater level in logged-over area (LoA) that can reduce the rate of peatland decomposition
4	Improved water governance in industrial forest plantations and plantation areas in peatlands	Implementation of improved water management system in peatlands in 24 plantation companies and industrial forest plantations with a total area of 955,018 ha
5	Rehabilitation of 2 million ha of peatlands	Per year 2016, is in the planning process including processing of data based on map on the location of degraded/damaged peatland
6	Empowerment for community with main livelihoods from the forest	Empowering communities with key livelihoods from forests with alternative economic activities
7	Development of permanent farming system	Empowering the shifting cultivators to engage in permanent farming systems
8	Moratorium for permits (Presidential Instruction No. 10/2011; 6/2013; and 8/2015)	Moratorium of new permits for plantation and forestry in primary natural forests and peatlands

Table 5.23 **Relationship between implementation of mitigation policy and programme with GHG emissions reduction**

No.	Action Plan	Deforestation	Forest Degradation	Sink Enhancement	Peat Decomposition	Peat Fires
1	Development of Forest Management Unit (*KPH*)	√	√	√	√	√
2	Plan for utilisation and improvement of forest area business	√	√	√	√	√
3	Development of utilisation of environmental service	√	√	√	√	√
4	Inauguration of forest area	√	√			
5	Development of social forestry	√	√	√		
6	Forest fire control					√
7	Forest investigation and security					√
8	Development of conservation areas, essential ecosystems and protection forest	√	√	√		
9	Improvement of plantation forest business	√	√	√		
10	Implementation of forest and land rehabilitation, and forest reclamation in priority watersheds			√		

(Batamas program), and (iii) utilisation of livestock manure for organic fertiliser (UPPO program), which were primarily implemented as a part of the government's (MoA) programme. These actions contributed to the reduction of emissions in sub-categories of rice cultivation and manure management.

The emission reductions from these actions were calculated under the assumption that this type of technology under baseline condition, would never be used since such practices required certain skills and investments, which would actually hinder the farmers in adopting the technology. Thus, without supporting programmes for their implementations, these practices might not be implemented in common practices.

Using that assumption, the total estimated emission reductions for the periods of 2010-2014 was 1.89 million Gg CO_2e. However, such practices might also be implemented through supports from other entities, in adiition to supports from the government, which at the time being, are unable to be captured due to lack of reporting procedure. Should all the efforts able to be captured, it would be reflected in the GHG Inventory.

2. Forestry Sector

The impact of implementation of mitigation policies and programmes on reducing emissions from deforestation can be seen in Table 5.24. Referring to the rates of emission from deforestation during the 2011-2014 periods, baseline emissions are higher than the actual emissions. This indicates generation of emission reductions from implementation of mitigation policies. Nevertheless, emissions from deforestation during the periods showed an increasing trend even though it decreased again in 2014 (Table 5.24). Cumulatively, the reduction of emissions during the period has reached 365,569 Gg CO_2e or equal to 91,392 Gg CO_2 per year.

Emissions from peat decomposition in baseline scenario are relatively higher compared to those in GHG inventory (Table 5.25). This suggests that peatland damage or peatland use for agricultural activities still continues beyond the previous rate. It should be noted, however, that emissions from peat decomposition from GHG inventories come from more land use categories, including from settlements and mining. In the NDC, emissions from peat decomposition from land use categories of settlements and mines were not calculated because these two categories were incorporated into the category of other perennial crops. On the other hand, in the GHG Inventory, emissions from peat decomposition on plantation land were assumed to be the same for all plantation types, while in NDC emissions from peat decomposition of plantation land were broken down into three categories: palm oil, rubber and other annual crops. The inconsistencies in categorization of land use in GHG Inventory and NDC also contribute to the large difference in emissions between the NDC baseline and GHG inventory. Improved consistency of land use categorisation between NDC and GHG inventory will be conducted in subsequent submissions.

Table 5.24 Baseline, actual, and reduction of emissions from deforestation

NO	CRITERIA	Emission (Gg CO_2e)			
		2011	2012	2013	2014
1.	Actual	123,611	176,396	271,715	235,534
2.	Baseline	293,206	293,206	293,206	293,206
3.	Emission reductions	169,595	116,810	21,492	57,572

Table 5.25 Baseline, actual, and reduction of emissions from peat decomposition

NO	CRITERIA	Emission (Gg CO_2e)				
		2010	2011	2012	2013	2014
1.	Actual	312,968	322,595	328,567	341,443	341,735
2.	Baseline		323,949	328,137	332,383	335,598
3.	Emission reductions		1,354	(430)	(9,060)	(6,137)

In 2014, emissions from peat fires on the GHG inventories are higher than baseline emissions on the NDC (Table 5.26). This is due to the event of widespread forest fires affected by extreme dry climatic in the year. In the IPCC guidelines, emissions from wildfires in extreme years are calculated as anthropogenic emissions if the fires extend to managed lands. Currently, the GHG inventory considers all land as managed land, so emissions from widespread fires occurring in extreme dry years are all counted as anthropogenic emissions. Field conditions indicate that the widespread of fires in the extreme dry years on peatlands can also occur on unmanaged peatlands. Under the IPCC Guidelines, emissions from peat fires in unmanaged lands are considered as natural emissions rather than anthropogenic. Therefore in the future submissions, the definition of managed and unmanaged lands will be established so that emissions from peat fires in unmanaged land are no longer included in the GHG inventory.

The quantity of carbon sequestration from new planting activities can only be seen after 2014 (Table 5.27), despite higher actual rate of planting than the one in baseline (Figure 5.21). This is because in the early growth of the trees, the amount of carbon absorption from planting is still smaller than the emissions that occur due to land clearing before planting activity started.

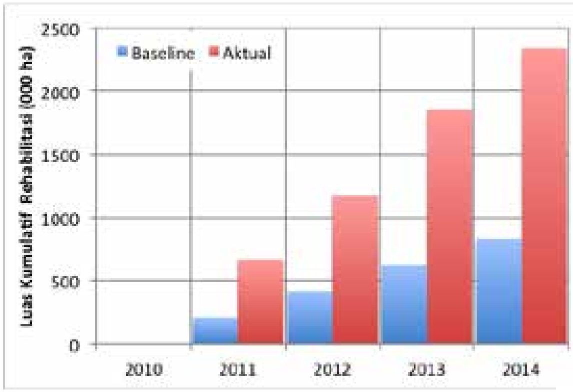


Figure 5.21 Comparison on actual cumulative area of land rehabilitation between baseline and actual

5.4.5.5 Co-Benefits of Mitigation Action

Implementation of mitigation action activities in land-based sector have long-term positive impacts on the environment and people.

There are at least five aspects of the co-benefits of land-based mitigation action activities:

1. Biodiversity conservation
2. Provision of non-carbon environmental services
3. Improved governance
4. Certainty of community rights
5. Increase in the income of community surrounding forest

The co-benefits in terms of biodiversity conservation for Indonesia is very important because of Indonesia's immense biodiversity. Mitigation activities in forestry and non-forestry areas have the potential to maintain the sustainability of Indonesia's biodiversity especially for endangered flora and fauna.

An example of potential non-carbon environmental services is the provision of water to communities and the environment. Communities around the forest area and public in general will experience the positive impact of short-term and long-term availability of clean water.

For the government, mitigation activities, either directly or indirectly, will have impact in improved governance, as there are various regulations need to be prepared by the government at the national and local levels to meet the requirements in emission reduction schemes.

For communities, especially those living in the vicinity of forests, mitigation activities have the potential to increase their incomes and ensure the community's rights on forest land. The community's social needs and life of the forest cannot be replaced by economic value. The linkage between several of RAN-GRK-based mitigation actions to various co-benefits is presented in Table 5.28.

5.4.5.6 Main Barriers

To participate in the global GHG emission reduction plan, the Government of Indonesia, in addition to issuing various regulations at the national and sub-national levels, also facilitates mitigation actions in the form of Demonstration Activities (DA) in several locations. Cooperation with international, national and local institutions has also been conducted through various schemes. However, there are still barriers to improve the effectiveness and performance of mitigation actions in the field level.

Table 5.26 Baseline, actual, and reduction of emissions from peat fires

NO	CRITERIA	Emissions (Gg CO_2e)				
		2010	2011	2012	2013	2014
1.	Actual	51,383	189,026	207,050	205,076	499,389
2.	Baseline		251,537	253,443	251,488	251,460
3.	Emission reductions		62,511	46,393	46,412	-247,929

Table 5.27 Baseline, actual, and reduction of emissions from land rehabilitation

NO	CRITERIA	Emissions (Gg CO_2e)				
		2010	2011	2012	2013	2014
1.	Actual	0	6,244	3,454	3,006	-2,568
2.	Baseline	0	2,053	1,103	154	-795
3.	Emission reductions	0	-4,191	-2,351	-2,852	1,772

Note: negative (-) sign means emissions are still being generated and/or the amount of carbon sequestration is smaller than emissions'

Table 5.28 Co-benefits of Mitigation Action

No.	IMPLEMENTED AND PROPOSED MITIGATION ACTIONS (*)	POTENTIAL CO-BENEFITS OF LAND-BASED MITIGATION ACTIONS				
		Poverty Allevia-tion	Biodi-versity Conser-vation	Non-Car-bon Envi-ronmental Services	Im-prove-ment of Gover-nance	Protec-tion of Rights
1	Application of plant cultivation technology (Field School on Integrated Crop Management/ SLPTT, System of Rice Intensification/SRI, Application of Low Emission Variety)	√		√	√	
2	Utilisation of organic fertiliser and bio-pesticide (Organic Fertiliser Management Unit-UPPO)	√				
3	Utilisation of manure/ urine livestock and agricultural waste for biogas (*Biogas Asal Ternak Masyarakat* - BATAMAS)	√				
4	Development of Forest Management Unit		√	√	√	
5	Planning for utilisation and expansion of forest area	√			√	
6	Development of environmental services utilisation		√	√		
7	Inauguration of forest area				√	√
8	Development of social forestry	√			√	
9	Forest fire control		√	√		
10	Forest investigation and security				√	√
11	Development of conservation areas, essential ecosystems and protection forest		√		√	√
12	Planting in peatlands	√	√	√		
13	Rehabilitation of 2 million ha of peatlands		√	√		

1. Policy Barriers

a. Understanding on International Scheme

The level of stakeholders' understanding at the national and local levels is still limited, especially in relation to regulations at the international level. The lack of understanding is not only in the context of language differences but also technical matters that are constantly evolving.

b. National Regulations

1. Efforts in encouraging private parties to participate in meeting the national GHG emission reduction plans are limited. Currently, the private sector's participation in supporting the national GHG emission reduction plan is not yet optimal.
2. There are conflicting policies. For example, there are several spatial plan that in contrast with other sectors plans and local governments.
3. Free trade practices that tend to eliminate the non-tariff barrier treatment have a major impact on the Indonesian agriculture sector.

c. Local Regulations

Mitigation actions are generally implemented in the district/municipality's administration area. Unfortunately, only a few of the area currently have regulations and documents to support the implementation of mitigation actions. The government needs to encourage districts/municipalities to accelerate the development of documents and creation of regulations that can provide strong legal basis for implementation of mitigation activities.

2. Institutional Barriers

a. Post issuance ofActNo. 23 of 2014, there were institutional changes especially in the land-based sector at provincial and district levels. The withdrawal of districts' authority in forest management to the provincial level will affect some predetermined plans. Thus the institutional changes at the district/municipal level needs to be accelerated.
   The Forest Management Unit (*KPH*) will be a direct institution in the field. With regard to the KPH's relatively new establishment and simple institutional conditions, stakeholders need to assist in accelerating the institutional capacity building of KPH.
b. Data Structure. The format of data collected by each sector is currently not always in accordance with the requirements for calculation of GHG emission reduction, either with regard to type of data collected or its unit.
c. Land Ownership. There is discontinuity of rehabilitation in critical lands in APL area due to community ownership of land.
d. Land Access. Many lands, both in forest areas and APLs have tenurial conflicts, making it difficult to plan/implement activities of the Ministries (Example: land rehabilitation, village forest, community plantations, etc.).

3. Barriers in Human Resources Capacity

a. National and local competency gap. There are still huge gaps in human resources capacity between national and local level. Understanding on mitigation issues at the local level still needs to be improved, including in the technical issues of carbon measurement for baseline, leakage and MRV.
b. Capacity in land management. Currently, community's capacity in managing Community Forest/Community Plantation Forest/Village Forest is still limited. Limitation also exists in FMU managers in implementing FMU land management.
c. Water management in peatlands. Inadequate water management in peatlands is still one of the causes of peat fires.
d. Data collection and management. The MoEF and MoA have mechanism for collection of data on mitigation activities. Unfortunately it does not always work well because the process is not regular and field data collected is not necessarily the activity data required for emissions calculations.
e. The capacity of farmers' understanding is still limited so that many programmes cannot be sustainable.
f. Decrease in the number of absorbed workforce in agriculture sector followed by decrease in agricultural productivity.

4. Funding Barriers

a. Access to international funding. In implementing mitigation actions, project implementers and local stakeholders often have difficulty in accessing information on the mechanisms of international cooperation, especially on its cooperative procedures and funding agencies.

b. Information on national funding. In addition to difficult access to funding at the international level, local project implementers are also unaware of the available funds at the national level. This poses a challenge for effective socialization mechanisms between national and local or with project implementers. The national government has allocated several budget items at the national level but only few have used them.

c. Funding from Local Government. Currently, at local government level, there is a need to have binding regulations for local agencies to implement mitigation actions. Without policies at the district or municipal level, mitigation actions will be difficult to be properly implemented. Local governments need to provide specific budgets for mitigation actions so that any planning, implementation and verification can be well executed.

d. Private sectors participation, which currently is still low. In practice, many private parties are already implementing mitigation actions, but their activities have not been well coordinated with the government.

e. Funding for strengthening KPH and forest boundary. High investment is needed to establish borders, conduct planting, and operate KPH. For example, establishment of boundaries requires a cost of at least IDR 15 million per hectare. The absence of forest boundaries increases the risk of encroachment and ownership conflicts in areas with potential mitigation activities.

Table 5.29 Capacity building needs in AFOLU sector

CATEGORY	CAPACITY BUILDING	LEVEL		
		NA-TIONAL	SUB-NA-TIONAL	COMMU-NITY
Policy	• Policy analysis at national and international levels	√	√	
	• Analysis on environmental and forestry policies, in order to show the policy's facts and appropriate policy alternatives, as to not overlap and in line with public interest	√	√	
	• Improvement on stakeholders' understanding on the issue of climate change	√	√	
	• Development of network for management of environment and forestry	√	√	√
	• Tracking of funding sources for management of environment and forestry	√	√	√
	• Improvement on management of KPH, Community Forest, and Village Forest		√	√
	• Development of institution for Community Forest and Village Forest		√	√
	• Planning for climate change mitigation action	√	√	
Technical	• Development of system for database, monitoring, evaluation and reporting	√	√	√
	• Improvement in capacity to calculate land-based carbon emissions baseline, leakage and reductions	√	√	√
	• MRV	√	√	√
	• GIS	√	√	
	• Tagging for priority programmes, deforestation trend, deforestation risk, and determination of priority location	√	√	
	• Research on emission factors	√	√	√
	• Development of local stakeholders' understanding on emission reductions		√	√
Communi-cation	• Media campaign and communication strategy for stakeholders regarding implementation of mitigation action in an area	√	√	√

5.4.5.7 Capacity Building Needs

Program Programmes for strengthening the capacity of sectors, local governments and communities in the planning and implementation of mitigation activities consist of technical and non-technical aspects. From non-technical side, capacity building needs to be directed at strengthening institution, policy revision and awareness raising. Meanwhile from technical side, capacity building needs to be directed towards strengthening the development of baseline, policies and programmes to achieve emission reduction targets, and the capacity to measure, report and verify the results of implementation of mitigation policies and programmes.

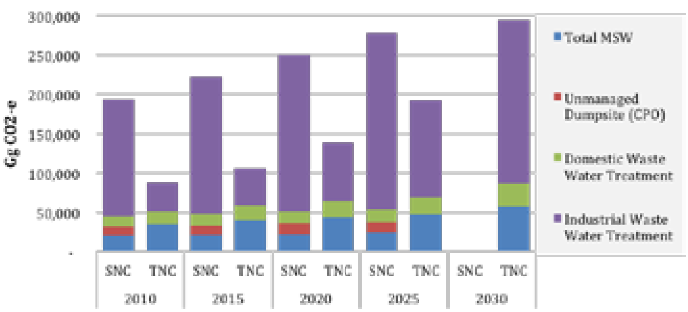
5.4.6 Mitigation Actions in Waste Sector

5.4.6.1 Baseline

Baseline emissions in waste sector are required to calculate the achievement of GHG emission reduction activities related to waste treatment. Referring to the main sources of GHG emissions in Chapter 3, National GHG Emission Inventories and mitigation actions in the waste sector are grouped into (a) domestic solid waste treatment, (b) domestic wastewater treatment, and (c) industrial wastewater treatment. The GHG emissions baseline is calculated based on GHG emission projection from each of these waste treatment processes in the absence of any efforts and regulations that lead to GHG emission reduction. Each category of waste treatment has baseline emission with different value from the baseline defined in SNC.

In accordance with various changes related to the coverage and methodology for calculation of GHG emission level, the baseline used in TNC is an updated baseline, with the following changes:

1. Base year, where TNC base year is 2010 while SNC base year is 2005;
2. Methodology for calculation of emissions from solid waste disposal site (SWDS) is changed from the mass balance approach (based on revised 1996 IPCC) to First Order Decay (FOD) approach (based on 2006 IPCC);
3. Higher tier on activity data and emission factor in some categories of waste treatment, in accordance to changes in the methodology for GHG emission level calculations. In TNC, some categories have used higher Tier (Tier 2/3) whereas in SNC the entire waste sector used Tier 1.



* Emissions from unmanaged dumpsite of palm oil's empty fruit bunch in CPO factories was calculated in SNC but not in TNC

Figure 5.22 Comparison between baseline emissions from waste sector in TNC and SNC

To obtain an overview of the changes in baseline with regard to updated data in TNC, Figure 5.22 presents a comparison between baseline in TNC and in SNC.

Figure 5.22 shows a significant difference between TNC and SNC baseline, where TNC's is relatively lower than SNC's. The difference is mainly due to the changes in base year, GHG emission calculation methodology, and update on several parameters related to activity data and emission factor as mentioned above. Significant baseline differences between TNC and SNC lie in the emissions from industrial wastewater and solid waste management in SWDS (solid waste disposal site), as both categories contribute significantly to the generation of GHG emissions. This can be seen from the GHG emission inventory results in 2010, which is used as the base year for projection of baseline scenario, where the contribution of GHG emissions from industrial wastewater treatment reaches 42% and solid waste processing accounted for 39% of total GHG emissions of 88,013 CO_2e (see Chapter 3). Baseline emissions from industrial wastewater in TNC are lower than those of SNC, while domestic solid waste emissions in TNC are higher than those of SNC's.

In industrial wastewater treatment, lower baseline emissions in TNC were caused by revisions (additions/improvements) of activity data and related parameters on specific intensities of wastewater generated per industrial product (waste flow rate) and COD (chemical oxygen demand) value determining the organic content in industrial wastewater. In the SNC, GHG emissions from industrial waste water were estimated using IPCC default numbers resulting in a relatively higher emission calculation when compared to using local (country-specific) data and parameters. In TNC, estimates of GHG emissions from industrial wastewater in several categories use the national and local specific data and parameters.

In the domestic solid waste sub-sector, baseline emissions in TNC are higher than SNC's due to change in methodology, i.e. from the mass balance approach to the FOD approach, which assumes that domestic solid waste stockpiled this year will still produce emissions in the coming years. The differences between TNC and SNC are also due to improved emission parameters. In SNC, all parameters used were default numbers of Revised 1996 IPCC, whereas in TNC GHG emissions are calculated based on local parameters, i.e. composition of domestic solid waste dumped in landfill and dry matter content for every component of domestic solid waste.

Based on the abovementioned rationales, in overall, the baseline emissions of TNC are lower than those of SNC. The high growth of emissions in baseline of TNC is due to the assumption that GHG emissions growth projection in the industry is high, in line with the significant growth of manufacturing industries that generates GHG emissions, namely CPO, starch (tapioca), pulp and paper, and fruit and vegetable juices. The projection of industrial production capacity uses plant-level production capacity development data and growth of each industry obtained through discussions with stakeholders (PPIH-LH and relevant Directorates in MoI, associations, and the industry itself). In SNC, projection of production capacity referred to the assumption of manufacturing sector growth from BPS.

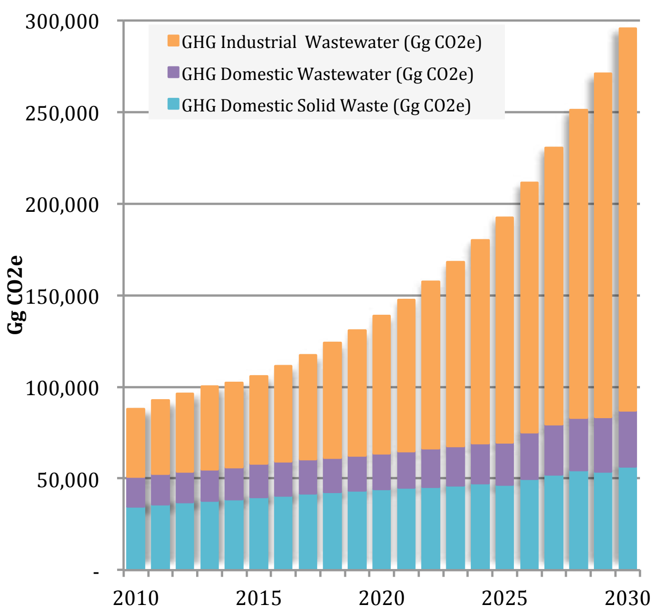
Figure 5.23 shows that GHG emissions from industrial waste processing contribute significantly to baseline emissions. Given that the type of GHG from industrial wastewater treatment is CH_4, thus baseline emissions are largely determined by the rate of CH_4 gas generation that is in line with the growth of industrial production capacity.

1. Baseline Emissions from Domestic Solid Waste

Contributors of baseline emission in domestic solid waste treatment are treatment of the waste in landfill, with open burning, and composting. The domestic solid waste baseline emissions are expected to grow at an average rate of 2.5% per year from 34,584Ggram CO_2e in 2010 to 56,596Ggram CO_2e in 2030. The projected baseline emissions indicate that the largest emissions contributor is the disposal of domestic solid waste in the landfill (Figure 5.24). The baseline emission projection is calculated based on the amount of domestic solid waste generation and domestic solid waste management of waste stream in Indonesia as shown in Figure 5.25.

2. Baseline Emissions from Domestic Wastewater

GHG emission in domestic wastewater comes from various types of domestic wastewater treatment in Indonesia, namely septic tanks, latrine (*cubluk*), sewerage, and *IPAL* (Integrated Wastewater Treatment Plant). The parameters used in the baseline emission calculation follows the 2006 IPCC defaults. The calculation methods used in TNC are the same as in the SNC. The results of the baseline calculation are presented in Figure 5.26.



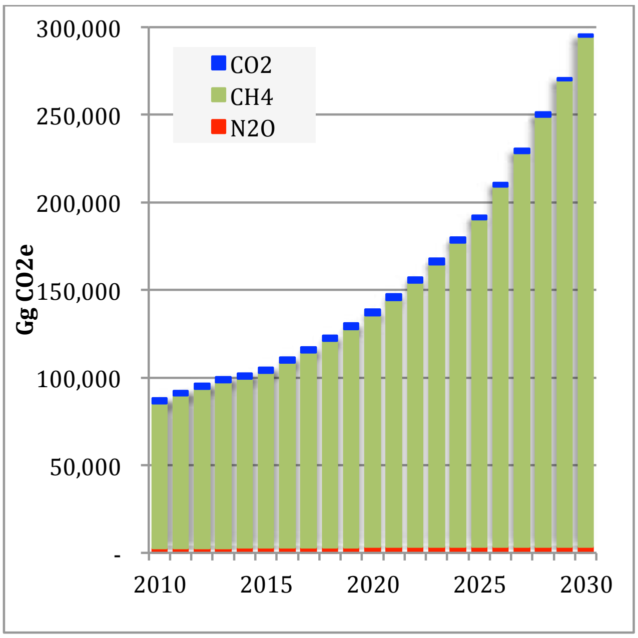


Figure 5.23 Baseline emissions in waste sector by source and type of gas

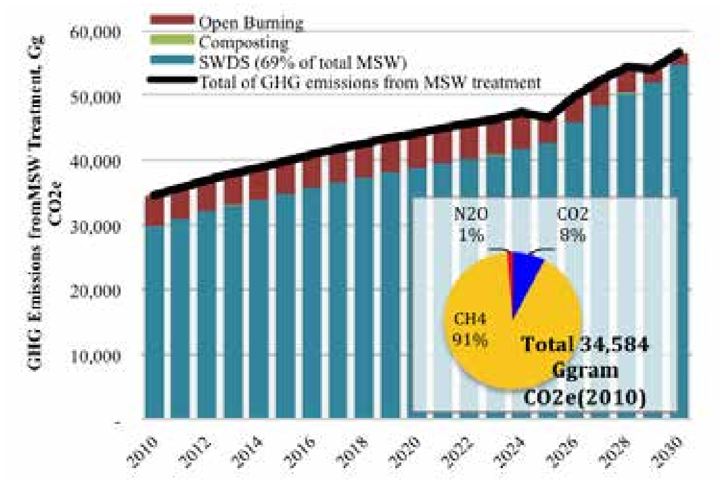


Figure 5.24 Baseline emissions from domestic solid waste

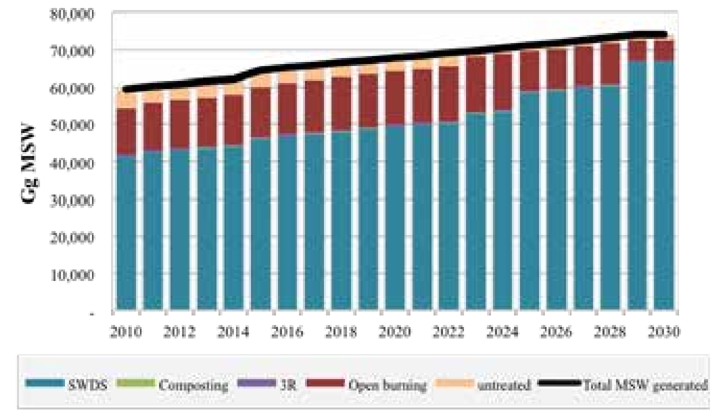


Figure 5.25 Waste stream of domestic solid waste (estimated based on Adipura data)

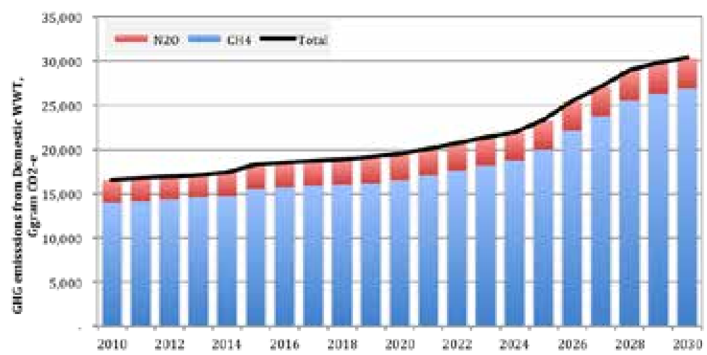


Figure 5.26 Baseline emissions from domestic wastewater

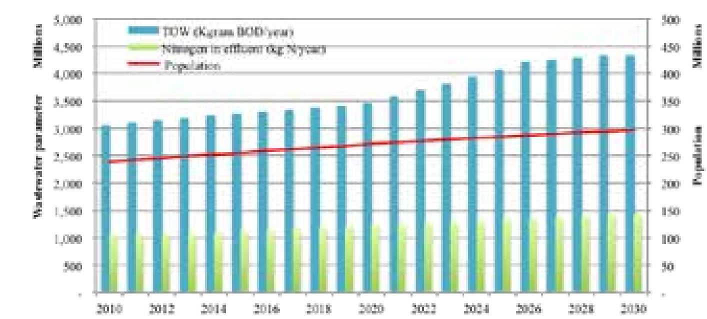


Figure 5.27 Projected data on population, TOW, and nitrogen content in domestic wastewater

Figure 5.26shows that baseline emissions from domestic wastewater treatment increase from 16,526Gg CO_2e in 2010 to 30,358Gg CO_2e in 2030 with growth of 3% per year. This increase is influenced by the increasing amount of organic content in domestic wastewater (TOW) due to the increase of population, BOD and Nitrogen content in waste water. Projected data on population growth as well as on organic content in domestic wastewater are presented in Figure 5.27.

3. Baseline Emissions from Industrial Wastewater

Emissions from industrial wastewater are derived from various processing technologies and industrial types in Indonesia. The processing technology is distinguished by the aeration level of the technology, i.e. aerobic treatment, unmanaged aerobic treatment, anaerobic digesters for sludge, anaerobic reactors (e.g. UASB), shallow anaerobic lagoons, and deep anaerobic lagoons. The type of industry is divided into 22 industries, namely 16 types of industries based on IPCC categorization and 6 types of specific additional industries in Indonesia. Emissions from 6 additional types of industries are calculated using IPCC methodology with COD value and specific waste flow rate based on factory data in Indonesia. Baseline emission calculation results from industrial waste treatment is presented in Figure 5.28.

Figure 5.28 shows that baseline emissions from industrial wastewater increases from 36,903 Ggram CO_2e in 2010 to 208,677Ggram CO_2e in 2030with an average growth of 9% per year. The growth is projected based on the growth of waste volume of each industry in line with increasing production capacity, while COD is assumed to be constant. Growth of waste volume is estimated from the growth of production levels of each industry. Figure 5.29 shows the projection of industrial production capacity used for estimating emissions from industrial wastewater treatment.

According to the amount of TOW, the main contributor of GHG emissions in industrial wastewater treatment is the CPO industry followed by starch and pulp and paper industries. For starch production, although the TOW value is high, emission is relatively lower due to application of anaerobic shallow lagoon[1] as its waste treatment technology. On the other hand, the TOW value of palm oil is lower than pulp and paper, but the technology used in the palm oil industry is anaerobic reactor/digester with high emission factor (0.2 kgCH_4 / kg COD).

The assumptions used in the development of the baseline emissions from waste sector are presented in Appendix V-C.

5.4.6.2 Mitigation Action Plan and GHG Emission Reduction Target

Based on the RAN-GRK, GHG emission reduction targets from the waste sector in 2020 is 0.078 Giga ton CO_2e. Mitigation action plans in this sector include (a) establishment of integrated wastewater infrastructure (*IPAL*) with offsite and on site systems and (b) development of SWDS and integrated waste management and 3R. The emission reduction targets of these actions are shown in Table 5.30.

Non RAN-GRK Mitigation Action

Non-RAN-GRK mitigation actions, despite being implemented under coordination of a Ministry, have not been reported to the TNC as there has been no data regarding such action programmes or achievements in emission reductions. Mitigation actions currently being conducted by private sector (industry) are still voluntary activities that have not been coordinated by Ministry for mitigation purposes. Further elaboration on mitigation activities initiated by private sectors is discussed in the sub-chapter of Non-Party Stakeholder Mitigation Action.

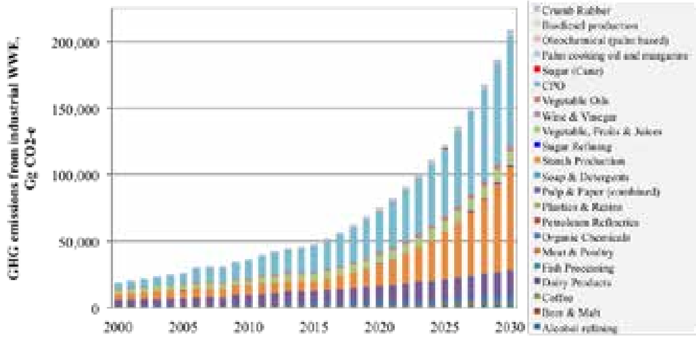
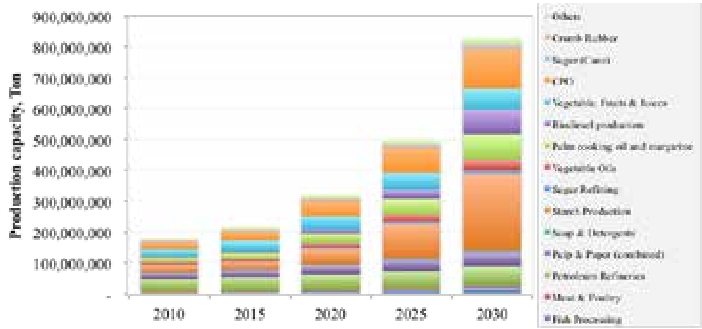


Figure 5.28 Projected baseline emission from industrial wastewater treatment by types of industry



Note: Category of others includes alcohol refining, beer and malt, coffee, dairy product, organic chemicals, plastics and resins, palm oil-based oleo chemical, wine and vinegar

Figure 5.29 Growth in production capacity of major GHG generating industries

Table 5.30 Mitigation Action Plan in Waste Sector

No	Mitigation Action	Emission Reductions Target (Ggram CO_2e)	Responsible Institution
1	Establishment of integrated wastewater infrastructure (IPAL) with offsite and on site systems	2,000	MoPWH
2	Development of SWDS and integrated waste management, and *reduce, reuse, recycle* (3R)	46,000	MoPWH

Source: RAN-GRK, Presidential Regulation No. 61/2011

5.4.6.3 Status of GHG Emission Reductions in Waste Sector

In addition to the amount of mitigation achievement from project activities reported by relevant Ministry in the waste sector, the GHG emission reductions can be estimated from the difference between baseline emissions and GHG emissions inventory. It should be noted, however, that such reduction is not only the result of mitigation activities undertaken by the Government (RAN GRK and non-RAN) or non-governmental, but also including reductions caused by other factors such as decreasing production in industry, economic development, increasing energy prices, etc. Figure 30 shows the comparison of inventory figures and projected of baseline emissions of the waste sector for the 2010-2014 period.

It can be seen in Figure 5.30, inventory emissions level in 2014 is lower than baseline emissions. It indicates the achievement of mitigation activity with GHG emission reduction of 679 Ggram CO_2e. The distribution of GHG emission in the baseline and inventory level can be seen in Table 5.31. It should be noted that increased composting activities reduce

[1] it has low emission factor value (0.05 kgCH_4/kgCOD)

Figure 5.30 Comparison of projected baseline and inventory of GHG emissions in waste sector

the organic waste sent to the landfill thereby reducing the formation of CH_4 emissions in the landfill. However, composting also produces GHG emissions in the form of CH_4 and N_2O. Therefor, the calculation of GHG reduction in TPA must be corrected with emissions from composting activity.

5.4.6.4 Funding for Mitigation Action in Waste Sector

Mitigation actions in waste sector under the RAN-GRK framework are essentially infrastructure development projects financed by the government. Data on costs for implementation of mitigation in waste sector is not yet available. However, as an illustration, the following sections presents funding model for mitigation action in waste sector.

1. **Domestic solid waste**

a. Development of SWDS:

1. Construction costs: IDR 8M/ha with assumed capacity for waste disposal of 57,400 person x 0.6 kg/person/ha, age of cell = 5 years
2. Operation costs: IDR 74,408/ton waste
3. *Development of Waste-based power plant/ RDF:*
4. Investment: IDR 1 –1.5 billions/1,000 ton waste processed per day,
5. Tipping fee for incinerator: IDR 400,000/ ton (as stipulated in Minister of Public Works Regulation No. 3/2013)

Tipping fee:

1. Small city: IDR 80,000/ton input waste to SWDS
2. Benowo SWDS (in Surabaya): IDR 140,000/input waste (including waste utilisation for electricity generation and leachate treatment)
3. SWDS (in Bogor): IDR 120,000/ton (includes RDF processing in 2018, for Holcim, investment value of RDF plant as much as USD 48 million for 1,500 ton waste/day, excluding cost for land)
4. Integrated SWDS in Bantar Gebang: IDR 130,000/ton (management by private includes: electricity generation, composting unit, and leachate treatment).

b. Industrial Wastewater:

Utilisation of biogas from POME/tapioca for energy generation Investment: 1 MW capacity (gas engine) costs USD2.5 – 3 million

Table 5.31 Distribution of GHG emissions reduction by sources and types in waste sector

2014	Baseline, Ggram CO_2e				Inventory, Ggram CO_2e				Reduction, Ggram CO_2e			
	CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e
Domestic Solid Waste Treatment	**2,803**	**35,709**	**327**	**38,840**	**2,653**	**35,155**	**352**	**38,160**	**150**	**554**	**-25**	**679**
SWDS (69% of National MSW)		33,927		33,927		33,467		33,467		460		460
Composting		0.14	5	5		1	48	49		-1	-42	-43
Open burning	2,803	1,782	322	4,907	2,653	1,687	305	4,644	150	96	17	263
Domestic wastewater treatment		**14,758**	**2,659**	**17,417**		**14,758**	**2,659**	**17,417**		-	-	-
Industrial wastewater treatment		**45,982**		**45,982**		**45,982**		**45,982**		-		-
Total Waste Sector	**2,803**	**96,450**	**2,986**	**102,240**	**2,653**	**95,896**	**3,011**	**101,560**	**150**	**554**	**-25**	**679**

(30 ton EFB/hour); 2 MW capacity costs USD4 million. For tapioca with inputs of 200 ton/day, considered economic to have2 MW capacity (gas engine or boiler).

5.4.6.5 Co-Benefits of Mitigation Action

Climate change mitigation action in waste sector is expected to provide co-benefits (benefits other than GHG emission reduction). Here are examples of the co-benefits.

1. Savings in raw materials from substitution by secondary raw materials (recycled waste). 3R activities (reduce, reuse, recycle) can be a source of supply of recyclable waste mainly in the form of plastics and paper that can be utilized as raw materials in industries. Similar to the utilisation of domestic solid waste as AFR in the cement industry.
2. Savings in fossil fuel consumption from substitution by waste. The methane (CH_4) gas produced from solid waste treatment in landfills can be recovered and used as an alternative fuel to fossil fuels. This can contribute to the supply of non-fossil fuel energy, thus supporting the fossil fuel based energy saving programme and minimize dependence on fossil fuels.
3. GHG emission reduction in the agricultural sector through the replacement of chemical fertilisers with compost. The biological treatment on solid waste, primarily the organic solid waste either from domestic or agricultural activities, produces valuable products in the form of compost fertiliser. Compost fertiliser is an alternative to utilisation of chemical fertiliser in agriculture sector, and its application can reduceN_2O emissions generate from the use of chemical fertilisers.
4. Reduced emissions from leachate by optimizing waste treatment technology on cleaner new landfill. The design and operational management of a new landfill (controlled landfill or sanitary landfill) generally applies the concept of integrated processing equipped with better leachate water treatment.
5. Improvement to waste management practice commonly applies improper treatment practices such as open burning. Mitigation actions in domestic solid waste treatment are based on regulations (Act18/2008) on waste management which expressly prohibits open burning (burning waste that is incompatible with the technical requirements of waste management). Biological waste processing, especially for organic waste, can be an alternative to waste treatment to avoid open burning practices, where the resulting GHG emissions are also lower. In addition, avoiding open burning can help in maintaining the quality of environmental health and reduce air pollution resulting from burned waste.
6. Develop controlled decomposition and composting techniques to avoid undesired methane emissions. Act No. 18/2008 on Waste Management also explicitly stipulates the prohibition of waste management practices that cause pollution or environmental destruction, open disposal, and inappropriate disposal of garbage, which can be categorized as untreated and potentially generate methane emissions from undesired waste deposits. Controlled process of decomposition and composting can serve as alternative that produces lower methane emissions as well as maintaining aesthetics and environmental health.
7. Increased awareness and better consumer behaviour to reduce waste.

5.4.6.6 Main Barriers

The following section describes types of barriers in the implementation of climate change mitigation activities in the waste sector, based on the experience in implementation of RAN-GRK.

1. Domestic Solid Waste

a. Non-compliance between the designs of landfill with the realization of the operation. For example, a SWDS is designed for sanitary landfill equipped with venting but is operated as open dumping without the management of methane gas (flaring).
b. Compost produced from the landfill cannot be marketed for agriculture because its quality does not meet the specifications set by the Ministry of Agriculture. The compost produced in the landfill is then only used

for landscaping and the drive to increase compost production becomes lower.

c. In the future, mitigation action in domestic solid waste is likely to face constraints related to provision of land for landfill, i.e. the MoPWH (the provider of infrastructure) is unable to provide the landfill as to fulfil the MoEF's target; the MoEF's target is to have 70% of the total national waste disposed in landfills while MoPWH capacity can only accommodate 65%.

d. Limited human resources capacity at both national and local levels in identifying, planning, implementing, monitoring and evaluating mitigation actions.

2. Wastewater Treatment

a. Mitigation technology for wastewater treatment is still limited, expensive and mostly still imported.

b. The utilisation of energy sourced from mitigation action in the waste sector is not economically feasible. In some cases, existing knowledge and understanding on GHG emissions are still inadequate.

5.4.6.7 Capacity Building Needs

In order to enhance the implementation of future mitigation actions, the identified barriers must be addressed through, among others, capacity building on the following aspects.

1. Identification, planning, implementation, monitoring and evaluation of mitigation actions. Another important capacity is in estimating emission reduction generates from implementation of mitigation action.
2. Development of local GHG emission methodologies and parameters (emission factor, dry matter content, waste composition and waste volume intensity per product ton) for the estimation of baseline and project emissions.
3. Development of information systems to collect information related to mitigation actions by sector or region. This includes integration of data on various programmes, such as Adipura, Proklim, PROPER and others.
4. Socialization and enhancement of human resources to demonstrate the benefits of mitigation actions.
5. Development of policies that encourage the implementation of mitigation actions, such as by means of incentives, rewards, and fiscal incentives.
6. Capacity building in accessing funding for implementation of mitigation activities, for example from Green Climate Fund, Global Environment Facility
7. Increased capacity and funding in development of landfills or industrial wastewater treatment systems integrated with power plants connected to PLN grids.

5.5 Non Party Stakeholder Mitigation Actions

GHG emission reduction actions in Indonesia, in addition to being implemented by the national government (party) are also being implemented by sub national, industry, private sectors, and community. The following sub-chapters presents an overview of private sector initiatives and non-party stakeholders in climate change mitigation actions in Indonesia.

5.5.1 Sub-National (Province)

To encourage the involvement of local communities in climate change mitigation, the Indonesian government through Presidential Regulation No. 61/2011 mandates the implementation of GHG emission reduction at the sub-national level through RAD-GRK[2] activities. Similar to the national level, within the RAD framework, provincial governments prepare their respective provincial-level GHG emissions baseline. Development of provincial baselines is based on the development dynamics and priorities in each province and does not refer to sectoral baselines. Implementation of RAD-GRK in each province is decided through governor regulations or circular letters covering GHG emission reduction activities in energy and transportation, forestry, agriculture and livestock, and waste. The regulations or letters also include institutional arrangement for implementation of the activities by local work units (*Satuan Kerja Perangkat Daerah – SKPD*) through the formation of working groups.

At the end of 2012, all provincial governments have developed their mitigation action plan (RAD-GRK). The number of

[2] Local Action Plan on GHG Emissions Reduction (*Rencana Aksi Daerah Penurunan Gas Rumah Kaca*)

mitigation activities in the provincial RAD-GRK varies from five to nine activities per year. In terms of the type of activity, most of the RAD mitigation activities are in land-based sector (forestry and agriculture).

An example of RAD-GRK and its implementation is for DKI Jakarta (Table 5.32). RAD DKI Jakarta is formalized in Governor Regulation No. 131/2012 which serves as guideline for all stakeholders in DKI Jakarta to implement various emission reduction activities, either directly or indirectly related to the 30% target of emission reduction from the baseline in 2030.

Most of the mitigation actions have been implemented. As an illustration, one of the mitigation action activities is the BRT Development action described in the following box.

5.5.2 Municipalities

As the centre of economic activities, urban area will be the source of GHG emissions, especially from waste management. The GoI conducts a clean city programme, known as Adipura. The programme encourages municipalities to maintain the quality of the environment, especially in terms of urban cleanliness. One of the criteria in Adipura is urban waste management. GHG mitigation actions that may be implemented are the reduction of municipal solid waste entering landfill through composting activities, 3R, Waste Bank and improvement of green open space and forest fire prevention. City or district capital participated in Adipura must have urban infrastructure and facilities such as urban forest, city park, waste landfill, Garbage Bank or other waste treatment model and municipal solid waste treatment facility.

Table 5.32 Mitigation action stipulated in DKI Jakarta's RAD GRK

Authority	Sector	Sub-sector	GHG Emission reduction potential (ton)			
			Mitigation	Action	2020	2030
Medium	Energy	Residential	Energy conservation	Utilisation of energy saving electricity utilities	1,539,558	5,154,772
		Transportation	MRT	23.3 km North-South (2016); 47.6 km North-South and West-East (2027)	81,000	104,000
			BBG	Public transportation (bus, taxi, etc.); operational vehicles of the province, and private vehicles 7%	153	352
			Emission test for private cars	All private cars	181,187	325,464
		Industry	Energy conservation	DSM and application of efficient technology	4,253,774	10,756,028
		Commercial	Provincial government buildings	3444 green buildings and energy conservation	49,430	129,458
			Non-provincial government buildings	green buildings and energy conservation	1,749,086	5,522,972
	LULUCF	Forestry	Green open space	Considered for area not managed by provincial government	347,263	653,050
	Total for medium authority				**7,931,451**	**22,646,095**
Low	Energy	Residential	Diversification of energy	Substitution of kerosene with LPG	91,633	101,581
		Transportation	Fuel economy	Fiscal regulation/incentive: fossil fuel efficiency 5-10%	0	1,920,000
			Railway	Commuter Jabodetabek: double track	169,500	171,300
			Hybrid	Fiscal regulation/incentive: passenger car, fossil fuel efficiency 30-40% per km trip	976,000	1,646,000
			Biofuel	Mixture for bioethanol: 15% in biodiesel; 20% in gasoline and diesel	1,396,733	7,948,081
	Total for low authority				**2,633,733**	**7,984,081**

BUS RAPID TRANSIT IN DKI JAKARTA

Since 2004 the government of DKI Jakarta has implemented Bus Rapid Transit (BRT) (Figure 31) system to break down congestion in the capital city. BRT triggers the transfer of modes of transportation from private vehicles to public transport. A survey in 2012 showed that 33% of passengers switched from private cars and 29% of passengers switched from motorcycles. BRT development is included in Jakarta's RAD-GRK and is projected to contribute to GHG emission reduction of 310,000 tons of CO_2e by 2030.

In the period of 2010-2014, BRT service's coverage (Figure 32) expanded from 8 corridors to a total of 12 corridors which led to an increase in passenger numbers by 29%. DKI Jakarta Provincial Government reported the emission reduction achieved from BRT operation in 2014 amounted to 333,835 tons of CO_2e.

Figure A. Bus Rapid Transit in DKI Jakarta (Transjakarta)

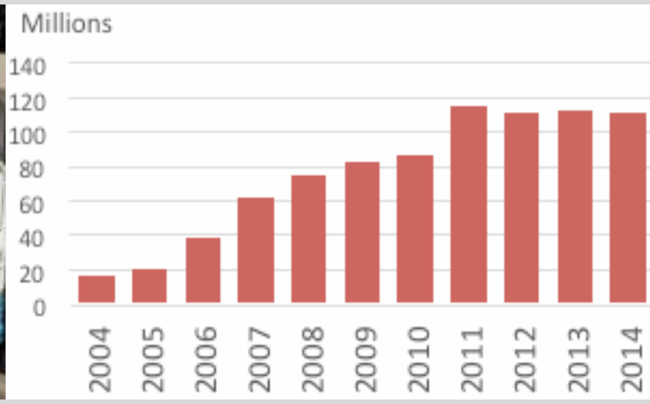


Figure B Number of BRT DKI Jakarta users

5.5.3 Private Sector

Corporate Performance Rating Programme (*Program Penilaian Peringkat Kinerja Perusahaan – PROPER*)

PROPER is an industrial performance rating programme with regards to requirements of environmental conservation. Information on the rating indicating the performance of an industry/company is communicated using colour symbols to facilitate the absorption of information by the community. The rating for environmentally conscious industry is Blue PROPER. Industries, whose environmental management is beyond compliance, are awarded rating of green or gold. Some of the beyond compliance criteria are environmental management systems, energy efficiency, 3R waste management, water efficiency, reduction of air pollution, and biodiversity protection. These activities are considered as mitigation in the context of climate change. CSR programmes implemented in PROPER can be actions that have impact on climate change mitigation, such as tree planting for forest rehabilitation.

PROPER programme is one of the MoEF's programmes to encourage corporate compliance in environmental management through information instruments. It is conducted through various activities aimed at: (i) encouraging companies to comply with legislation through incentives and reputation disincentives, and (ii) encouraging companies with good environmental performance to implement cleaner production.

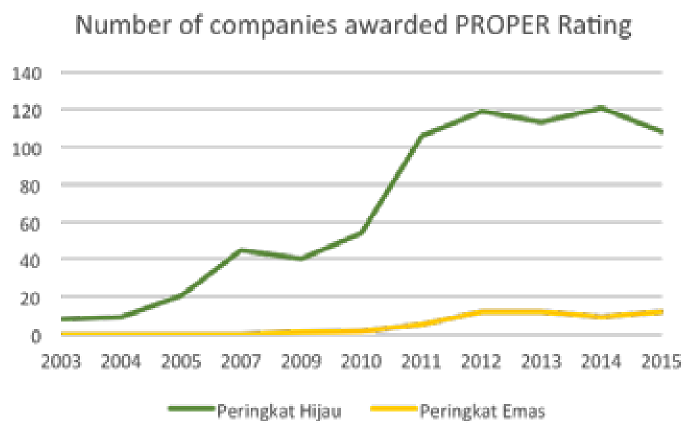
PROPER is developed with some basic principles, namely: PROPER participants are selective, which is intended for industries that have a large and widespread impact on the environment and care about the image or reputation of their company. Therefore, PROPER's chosen approach is to take advantage of community participation and market influence to put pressure on industry to improve its performance in environmental management.

Based on the result of assessment of PROPER for 2015-2016 (following the Minister Regulation No. 3/2014 regarding Corporate Performance Rating Programme in Environmental Management), the number of companies that meet the beyond compliance criteria was 184 companies, of which 12 companies obtained gold rating, and 172 companies obtained green rating. This number increased from the previous periodof 2014-2015 in which 120 companies met the beyond compliance criteria. This indicates increased concern of the private sector on environmental issues, including climate change.

In the context of climate change mitigation actions, only actions of companies whose environmental management is beyond compliance are included in mitigation efforts, as compliance to the prevailing laws or regulations is the obligation of every company. Therefore, only Gold and Green-rated companies are considered as havingclimate change mitigation action. In general, the number of companies with Green and Gold ratings (Figure 5.31) is increasing and it indicates an increasing number of companies whose environmental management exceeds those required in the regulations.

The PROPER rating criteria are designed to encourage companies to achieve competitive advantage. The efficiency of resource use is driven by energy efficiency criteria, emission reductions, conservation and reduction of water pollution load, 3R (reduce, reuse and recycle) of hazardous waste and non-hazardous solid waste, and biodiversity protection. Taking into account the PROPER criteria, some of these criteria reflect the efforts or contributions made by companies in reducing GHG emissions. Quantitatively, some of the achievements in the improvement of environmental management performance by the business world are:

1. 919,098,110 Giga Joule efficiency on energy utilisation. A 35-fold increase from the previous year.
2. 48,076,583 ton CO_2e of emission reductions, wherein previous years the achievement were unable to be presented due to the different units applied.
3. Reduction of 9,419,229 tons non-hazardous solid waste. A 20.9% decrease from the previous year.
4. Reduction of 4,786,034 tons hazardous waste. A 49.3% increase from the previous year.



Source: Proper Secretariat, 2015

Figure 5.31 Number of companies awarded Gold and Green PROPER Rating

Green Building

Green building is one of the government programmes in the framework of sustainable development aimed at office or commercial buildings. Criteria in green building include aspects of water and energy conservation and waste management. The climate change mitigation action identified in the green building programme is linked to energy efficiency efforts. Environmentally Friendly Building policy, as an interpretation of the mandate of the Minister Regulation No. 08/2010 regarding Criteria and Certification of Environmentally Friendly Building, is implemented in the form of development of Greenhouse Gas Emission Reduction Calculation Model for Eco Friendly Building. The development of GHG emission accounting model is focused on one of the criteria of environmentally friendly building as stated in Article 4 of the Regulation No. 08/2010, which is related to energy efficiency and conservation.

In addition to programmes supporting mitigation action, Indonesia also has enabling policies that encourage the implementation of mitigation actions. The enabling policies are the Ministerial Regulation, the Governor's Regulation and the standards related to energy efficiency in the building sector, namely Minister of Energy and Mineral Resources Regulation on IKE; Building Code by SNI; Minister of Public Works and Housing Regulation on Green Building; and Governor of Jakarta Regulation on Green Building.

UTILISATION OF BIOGAS FROM PALM OIL MILL EFFLUENT

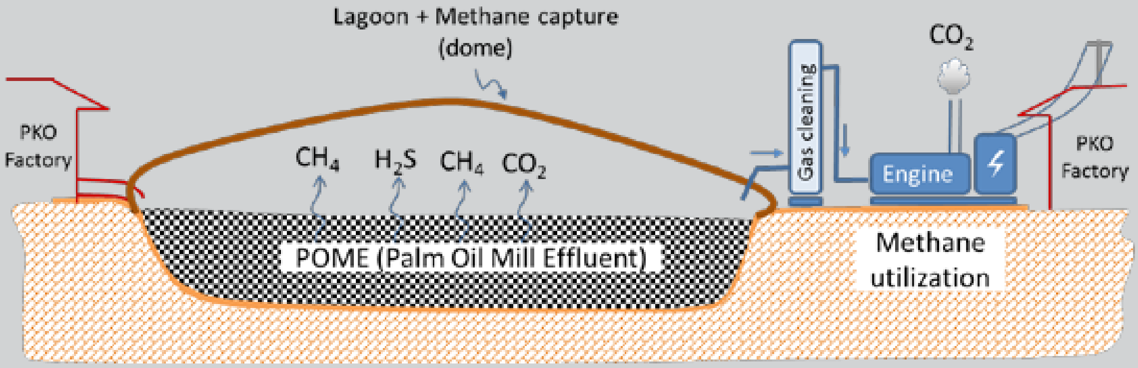


Figure A.Scheme for utilisation of biogas from POME for power generation at Palm Oil Mill PTPN V Tandun

POME treatment is the largest source of GHG emissions in the waste sector. Utilisation of POME for biogas production has benefits of (i) providing renewable energy source (b) GHG emission mitigation (methane capture) in palm oil industry. The recorded seven POM companies in Riau Province have utilized POME biogas, including PTPN V PKS Tandun (Figure 35). Since August 2012, the company has used dome technology, a type of giant membrane used to capture methane gas emitted by POME sludge (Figure 36). The gas is then processed before it is used to generate electricity in a biogas generator to supply the electricity needs of the Palm Kernel Oil (PKO) plant. (Schematic Figure 34).

Utilization of biogas POME provides an average profit of IDR 7.2 M/year due to reduced consumption of diesel oil for generator. Another benefit is the reduction of GHG emissions from methane capture and biogas utilization for power generation (replacing diesel oil). Figure 37 shows the amount of emission reduction.

The GHG emission reduction calculation uses the following assumptions.

1. MCF = 1 (AMS III H UNFCCC)
2. GHG emission calculation use Tier 1 IPCC 2006
3. Leakage excluded
4. Gas engine efficiency = 30%
5. Calorific value biogas = 480 MJ/kmol (60% CH_4)
6. GWP (CO_2=1; CH_4=21; N_2O=310) refers to 4th Assessment Report of IPCC

If the system is replicated in other CPO industries in Indonesia, the potential GHG emission reduction by 2015 would have reached 18.9 million tons of CO_2e.

Figure B for methane capture at palm oil mill PTPN V Tandun

Figure C Gas engine used to convert biogas POME into electricity

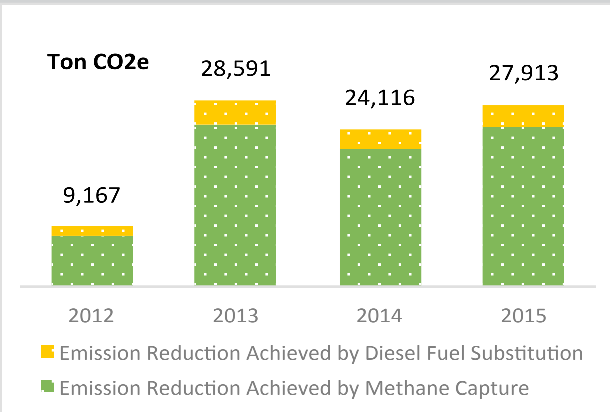


Figure D Reduction of emission from utilization of methane captured at palm oil mill PTPN V Tandun

In 2014, a performance evaluation on commercial energy sub-sector mitigation activities was conducted at Menara BCA, Central Jakarta.

Calculation of GHG emission reduction is conducted by comparing emissions level of the activity without the mitigation and the level with the implementation of mitigation action.

Baseline for BCA Tower is electricity consumption in 2008, which amounted to 25,695,417 kWh. Its mitigation actions are modification of the building's case, application of clean air conditioning, application of artificial lighting system, application of vertical transportation system, application of water management system and other electronic equipment.

After mitigation actions were implemented, the level of electricity consumption became 24,048,200 kWh in 2013. The total electricity consumption was obtained from PLN electricity bill with total operational hours higher than 2008 which is 3,172 hours. The database used for the calculation of mitigation performance is shown in Table 5.33.

Table 5.33 **Data base for estimation of emission reductions in BCA Tower in 2013**

Characteristics	Unit	Value	Notes
NLA	m^2	81,587	
Occupancy rate	%	99.30%	
NLA x occupancy	m^2	81,034	Total conditioned area
Special facility area	m^2	1,627	Server room
Service Area + Public Area	m^2	21,748	
Parking area	m^2	2,722	
Gross Area	m^2	106,056	
Occupancy and service area, Public Area	m^2	102,782	
Number of days in a year	Day	365	
Operating hours in weekdays	Hour	55	07:00-18:00
Operating hours in weekend	Hour	6	Pkl.07:00-13:00
Annual operating hours	Hour	3,172	ACE stipulate 2,000 hours/year; SNI=2,800 hours/year
Annual electricity consumption	-kWh baseline = IKE x Area with AC x operating hour/ year) - Mitigation= actual kWh/year - kWh server area	17,756,755	
Electricity consumption for main server	kWh	3,960,675	
Total annual electricity consumption with conversion to 2,008 hours/year	Electricity consumption/year x (baseline hours/actual operating hours)	24,076,542	
PLN electricity bill	IDR/year	25,112,556,382	
	kWh/year	24,084,200	
Electricity consumption from Generator	IDR/year	92,110,018	
	kWh/year	28,342	
Annual electricity cost (PLN+Generator)	IDR	25,204,666,400	
Annual electricity consumption (PLN+Generator)	**kWh**	**24,112,542**	

After activity data in the form of electricity consumption is known, baseline and mitigation emission level are calculated with the following equation:

GHG emissions = Total Electricity Consumption (kWh) x Emission Factor (EF)

Emission Factor used is the JAMALI Grid's (year 2012) of 0.814 kgCO_2e/kWh.

Emission level without mitigation action (baseline) is:

A. Baseline B. = Electricity consumption from PLN x EF of JAMALI grid 25,695,417 kWh/year x 0.814 kg CO_2e/1000

C. = **20,916.07 ton CO_2eq**

Emission level with mitigation action is:

D. Mitigation E. = Electricity consumption from PLN x EF of JAMALI grid 24,048,200 kWh/year x 0.814 kgCO_2e / 1000

F. = **19,598.30 ton CO_2eq**

Actions related to the abovementioned programmes/policies are implemented through initiatives of non-state actors. Planning for the initiatives by non-state actors are not related to the planning of national mitigation actions. From the above calculation, achievement in GHG emission reduction can be calculated from the difference between baseline emission level (2008) and the level of GHG emission after mitigation action (2013). It resulted in emission reductions of 1,318 ton CO_2eq.

Clean Development Mechanism

As of October 2014, 215 CDM projects and programmes have been approved by the Government of Indonesia. Of these, 146 have been registered at the CDM Executive Board. Since the rearrangement of Indonesian DNA to the Ministry of Environment and Forestry, no new project has been proposed yet. It is assumed that this is due to the low price of CERs, thus reducing the attractiveness of CDM. However, the approved projects and programmes on CDM EB continue and as of November 1, 2016, 1 more project has been registered on CDM EB. Of the 147 projects and programmes, 37 of them have produced CERs with a total of more than 19.6 million tons of CO_2e. Most of the Indonesian CDM projects are waste management and alternative energy generation activities, particularly from methane avoidance in agro-industry waste treatment. Despite being a country with large tropical forests, only two A/R CDM projects were proposed and approved by the government. However, due to various constraints, the two projects did not proceed to the registration stage.

Mitigation at Climate Village Programme (PROKLIM)

Calculation of GHG emission reductions in the areas of Proklim are located, is based on data collected from proponents and from the site visit by using template provided by MoEF. The results of this are Table 5.34.

Table 5.34 GHG Emission Reduction at Proklim Areas in 2013

Provinces	No. of Village	Sector	GHG Emission Reduction (ton CO_2e)
Riau	4	Waste	1,215.76
East Java	1	Forestry, agriculture, waste, energy	344.85
Central Java	2	Forestry, agriculture, waste, energy	1,456.12

5.6 Verification of Mitigation Actions

In the framework of transparency, Indonesia has developed MRV system with the main function for verification of mitigation actions. The measurement (M) and reporting (R) components are carried out by the implementer of mitigation activities, while verification is conducted by independent third party. This sub-chapter presents brief description of the MRV system and the current status of verification of national mitigation actions, as well as the constraints faced in the implementation of verification.

5.6.1 MRV System

The scope of the national MRV is limited to mitigation of GHG in forestry and peatland, agriculture, energy and transport, IPPU and waste sectors, aimed at having a reliable national MRV system for mitigation actions, both for government and non-government. MRV provides guidelines for measurement, reporting and verification, and it gives flexibility for those responsible for mitigation actions to use recognized methodologies at national and international levels.

MRV serves to track the national GHG emission levels, funding, and impact of mitigation actions implemented. MRV assesses whether a defined emission reduction target can be achieved. This creates transparency and demonstrates the sustainability of a country's actions, thus strengthening the confidence of donors and other investors. A transparent MRV approach can increase the capacity to generate and compile information needed to plan, implement and coordinate individual mitigation activities.

MoEF has the mandate to develop and manage verification of mitigation actions. Flow and institution for MRV developed by MoEF are shown in Figure 5.32.

As shown in Figure 38, the verification process follows several steps: (i) the party responsible for the action must submit a report on the planning, implementation and achievement of mitigation activities to the DGCC MoEF, (ii). The DGCC commissions the MRV Team to verify the mitigation action report, (iii) In conducting verification, the DGCC will involve experts, (iv). the MRV Team will issue an evaluation result, (v) the result will be assessed by the DGCC for approval If it is approved, the DGCC will recommend the issuance of certification and registration of climate change mitigation action to the Minister (section 5a), whereas if the report is not approved it will be returned to the party responsible for revision (section 5b).

In certain cases (e.g. REDD activities), the DGCC shall appoint an Independent Expert Team to re-evaluate the verification results to ensure the validity of the mitigation action report. DGCC, based on the verification result, will provide recommendation to MoEF to register the achievement of mitigation action into the National Registry System.

5.6.2 Current Progress

Verification process that is currently under going consists of two activities as follows:

5.6.2.1 Development of MRV team

Verification is conducted by the MRV Team established through the Decree of Director General of Climate Change No. SK.8/PPI-IGAS/2015 dated October 16, 2015 . The MRV Team, which consists of the Technical Team under the DGCC the, is presented in Figure 5.33.

5.6.2.2 Implementation of verification on mitigation action

At this time Currently, the verification process of the emission reduction report from the implementation of the new mitigation action is carried out through two stages, not yet through the stages as illustrated in Figure 5.32. These stages are:

1. **Desk review**

Desk review is carried out in two phases: (1) on the report of the implementation of climate change mitigation actions submitted by the Responsible Institution to verifiers in the RAN-GRK report's format; (2) on the data obtained during the interview with the Responsible Institution. Implementation of desk review aimed at assessing data accuracy, data consistency, data transparency, and to ensure action implemented is corresponds to the action plan documents.

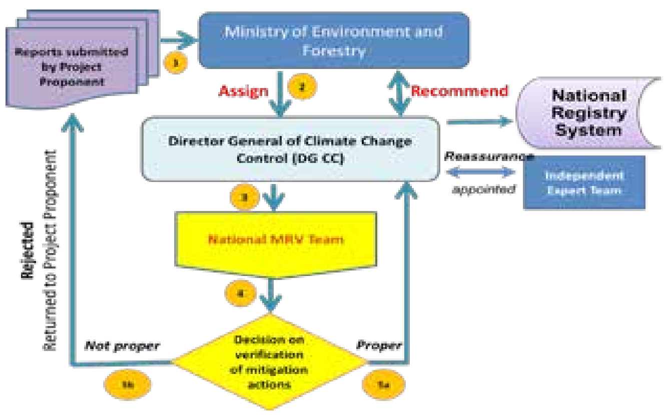


Figure 5.32 MRV Scheme

2. Clarification of Information

Clarification on the reported information is carried out through interviews with representatives of each responsible work unit in the relevant Ministries/Agencies. The scope of the interviews are, among others, managerial system, methodologies and detailed supporting data related to GHG emission reduction measurements, funding, monitoring system, and supporting action documents.

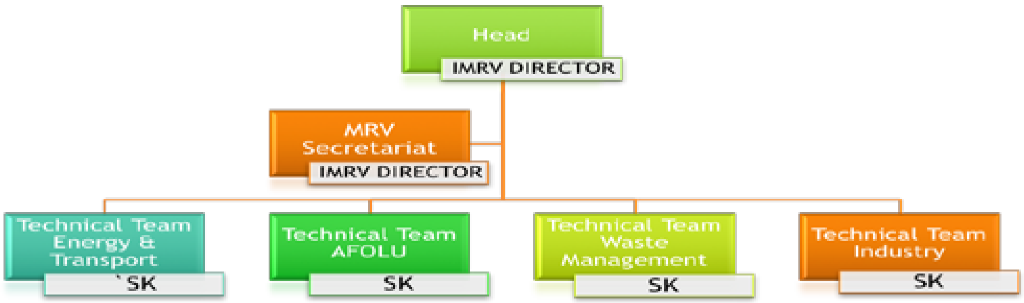


Figure 5.33 Development of MRV team

Source/Location: Directorate of Mitigation MOEF/KPH Rinjani Barat

Chapter 6

REDD+ IMPLEMENTATION

6.1 Background

REDD+ development in Indonesia is in line with the decisions resulted in COPs since COP 13 in Bali t o COP 19 in Warsaw. Indonesia has shown various progresses in support of REDD+ through the development of national instruments for REDD+ building block, including the national strategy of REDD+, National Forest Reference Emission Level, System Information for Safeguard (SIS) and MRV system, as well as related financing instruments for REDD+. With regard to policy, the Government of Indonesia has designed various policy interventions, developed regulations and actions related to REDD+.

REDD+ activities in Indonesia, has the potential to reduce the national emission reduction up to 70% for land-based sectors. In connection with the significant progress and the potential roles of REDD+ in addressing the national target of emissions reduction, it is important to report and communicate the progresses achieved by Indonesia in REDD+ implementation to the international community through formal communication channels, i.e. through National Communication. The following section will briefly describe the progress, while Appendix VI.A provides detailed information on REDD+ and Indonesia's roles in global development of REDD+ as well as the readiness process for the implementation of REDD+.

6.2 History of REDD+ in Indonesia

COP 11, conducted in 2005 in Montreal, viewed the beginning of forests as an important area for discussion and since then have been high on the COP's agenda. Related to forests, the underlying philosophy of REDD+ is to search for solutions on ways to avoid and/or lower deforestation rate in developing countries through the application of sustainable development principles. During the 2007 discussion at COP 13 in Bali, REDD+ activities were directed towards avoiding deforestation and forest degradation, carbon stock conservation, sink enhancement, and sustainable forest management.

Since 2007, the preparation for REDD+ in Indonesia has grown rapidly. At the same time, the Indonesian government through the Ministry of Forestry has released a study report by IFCA (Indonesia Forest Climate Alliance) that among others, contained an analysis on the drivers of deforestation and forest degradation and means of addressing them. The REDD+ programmes were continuously progressing with the establishment of REDD+ Task Force by the President in 2010. REDD+ Task Force worked at national level, and has appointed 11 wiprovinces as the pilot provinces and set Central Kalimantan as the pioneer province for REDD+.

Replacing the function of the REDD Task Force, the REDD+ Agency was established by the President in 2014 with and responsibility includes formulation of measurement standard and methodology, enhancement of the capacity and capability of relevant ministries, support Indonesia's position on REDD+ in international fora, coordinate law enforcement for REDD+ implementation, as well as monitoring and evaluation. REDD+ Agency has implemented five prerequisite programmes, including development of provincial strategies and actions plans, development of baseline data and cadastral map, institutionalisation at the sub national level, signing of MOUs with provincial and district levels, and development of MRV and FREL. REDD+ Agency had also implemented their 10 main programmes, including mapping, capacity building, and implementation of customary forest programme, Green Village and green school.

In 2010, Norway and Indonesia signed a USD 1 billion performance agreement to reduce GHG emissions from deforestation and forest degradation and to support sustainable development. REDD+ Agency used the support to implement their key programmes to reduce emissions from land-based sector. Since 2015, all of REDD+ programmes run by REDD+ Agency and other relevant government institutions were be coordinated and regulated by the newly established MoEF c.q. Directorate General of Climate Change.

6.3 Progress on Preparation for Full Implementation of REDD+

Decision 1/CP.16 paragraph 71 requested developing countries that are committed to REDD+ (hereinafter referred to as the REDD+ countries), to perform the REDD+ mechanism in accordance to the convention, so that they can obtain adequate and predictable support for the mechanism of payment on performance, including financial, technical and technology supports. The REDD+ countries therefore need to develop a number of elements as follows: (a) REDD+ National Strategy or Action Plan; (b) Forest Reference Emission Level/Forest Reference Level (FREL/FRL), (c) A robust and transparent National Forest Monitoring System, and (d) Safeguards Information System. Brief descriptions on the development of these four elements, are given in the following sections.

6.3.1 National REDD+ Strategy

Development of the National Strategy was expected to result in the formulation of policies that consider the participation and accommodate every stakeholder's interests, effective and easy to be implemented, as well as easy to control and evaluate, and provides fair economic incentives for the community.

The formulation of REDD+ National Strategy considered the following four basic principles:

1. Inclusiveness. The formulation of REDD+ National Strategy involves stakeholders who either will implement the policies, or directly and indirectly affected.
2. Transparency. The process adheres to the values of openness, honesty, and clarity. Public is made informed of the stages of the implementation and can monitor the development of policy formulation.
3. Credibility. The development of REDD+ National Strategy is managed by reputable institutions or individuals, and is conducted using the principles of inclusiveness, transparency, and reliability.
4. Institutionalization. The development of REDD+ National Strategy is conducted using approaches that are directed toward institutionalisation of ideas, knowledge, values, legal foundations, resources, structure and organisational mechanism, which describe the following six basic aspects: order, autonomy, adaptability, comprehensiveness, coherence, and functionality.

Many stakeholders expect that REDD+ will be able to accelerate the efforts in reducing the rate of deforestation and forest degradation, contributes to efforts in alleviating poverty of the community living adjacent to and inside the forest, and provides a stronger guarantee that forest and its biodiversity will be conserved.

The objectives of REDD+ National Strategy formulation are:

1. To prepare an effective institution which will execute REDD+ programmes;
2. To provide a basis and direction for the management system and integrated regulations to oversee the implementation of REDD+ scheme.
3. To develop a systematic and consolidated process and approach, in preserving Indonesia's natural forests along with the biodiversity.
4. To provide a reference for the development of investment in regards to forest and peatland utilisation, for forest and/or non forest commodities.

The process has begun since the Coordinating Minister of Economy mandated Bappenas to coordinate the formulation of REDD+ National Strategy. Bappenas started by formed a Steering Team, an Executing Team, and an Author Team of the REDD+ National Strategy, with the support and facilitation from UN-REDD Programme Indonesia. The Draft of REDD+ National Strategy submitted by Bappenas to REDD+ Task Force, in which established the REDD+ National Strategy through Decree No. 02/Satgas REDD+/09/2012 on 19 September, 2012,

There are 5 (five) pillars serving as the fundamental strategy for REDD+ in Indonesia as mentioned in the REDD+ National Strategy document with . the implementation status is summarized in Table 6.1.

Table 6.1 REDD+ strategy and the implementation status

Pillar of REDD+ Strategy	Status of implementation	Achievements of Outputs
Institutions and Process		
1. REDD+ Institution	Implemented	• Establishment of REDD+ Task Force in 2010, REDD+ Agency in 2013 and Directorate General of Climate Change MOEF in 2015 • REDD+ institution was established at 11 provinces (as a Working Group, Commission, or Task Force)
2. Funding Instruments	Operationalised/ Continuously progressing	• FREDDI was developed by REDD+ Agency • GoI issued a Presidential Decree regulating Environmental Financing and is currently preparing a National Financing Institution
3. MRV Institution	Implemented	• National Registry System by MoEF
Laws and Programs		
1. Land rights	Operationalised/ Continuously progressing	• Land and Forest Governance Reform is established • Customary Right is given Recognition and Protection by the national government • Agrarian Reform is on going • Acceleration of Forest area through recognition of rights • Ministerial Decrees related to Indigenous Forests are issued at five provinces and six districts: • SK.6737/menlhk-pskl/kum.1/12/2016; • Sk.6738/menlhk-pskl/kum.1/12/2016; • SK.6739/menlhk-pskl/kum.1/12/2016; • SK.6740/menlhk-pskl/kum.1/12/2016; • SK.6743/menlhk-pskl/kum.1/12/2016; • SK.6744/menlhk-pskl/kum.1/12/2016; • SK.6744/menlhk-pskl/kum.1/12/2016
2. Spatial planning	Operationalised/ Continuously progressing	• One map policy is established • Cadastral baseline database is developed • Presidential Regulation No.9/2016 on Acceleration to One Map Policy Implementation is in place
3. Review on law enforcement and corruption prevention	Operationalised/ Continuously progressing	• Road map on Law Reform is established • Conflict Resolution is carried out in six National Parks • Permit of moratorium and conflict resolution is carried out through multi-door approach.
4. Moratorium of concessions	Implemented	Indonesian forest concession/license moratorium is implemented through Presidential Instruction No.8/2015 and Ministerial Decree No. SK.2312/Menhut-VII/IPSDH/2015 (PIPIB), and is periodically reviewed
5. Data and mapping	Operationalised/ Continuously progressing	• One map policy is established • Cadastrial baseline database is developed
6. Harmonize the incentive systems	Operationalised/ Continuously progressing	• Some initiatives in result-based payment system related to emission reduction measures from deforestation and forest degradation by local community at the district level were developed • Engagement of the private sector is built, as one of the resources for REDD+ financing
Strategic Programs		
1. Sustainable management of landscape	Operationalised/ Continuously progressing	• MoUs with local governments to develop sustainable management of landscape at sub national level are established • watershed management is implemented • Forest Management Unit (KPH)-based watershed are established
2. Sustainable economic system in terms of resource utilization	Operationalised/ Continuously progressing	Low-emission development strategies at the provincial level are developed, including Provincial Conservation Strategy.
3. Conservation and rehabilitation	Implemented	• Conflict resolution in national parks are implemented • Prevention programme of peat and forest fire are implemented • Rehabilitation national movement is implemented, including replanting on burnt area, degraded land, and firebreaks • Restoration programmes are implemented, including those embedded in livelihood programme.
Paradigm and work culture		
1. Enhancement of forest management and land use	Operationalised/ Continuously progressing	• A robust and transparent National Forest Monitoring System is established • Improvement and data updating of activity from permanent sample plots at sub national level are ongoing • Web platform: REDD+ Registry System, SIGN SMART, Safeguards Information System/SIS REDD+ are developed • Forest Reference Emission Level (FREL) REDD+ Indonesia is established • Acceleration of Forest Area through right recognition is carried out

Pillar of REDD+ Strategy	Status of implementation	Achievements of Outputs
2. Empowering local economy in accordance with sustainability principle	Implemented	• Support for the development of Indicative Maps For Social Forestry • Strengthening capacity of local facilitators • Support to local communities in partnership mechanism with private sectors • Introduction of performance based payments pilot activities (payment for eco-system services) using community grants; • Submission of proposals on local community-based forest management (200,000 hectares) • Agreement on 'payment for ecosystem services' to private sectors between Nagari Malalo with PT. PLN and Nagari Sungai Buluh with PT. Angkasa Pura II are established
3. National campaign for forest saving activities	Operationalised/ Continuously progressing	Several events and programmes are carried out
Stakeholder involvement		
1. Interactions with various groups (regional government, private sectors, non-governmental organization, indigenous/ local and international community)	Operationalised/ Continuously progressing	• Capacity and local institutional building • Stakeholder engagement • Multi-stakeholder forum • MoUs with local government • Engagement of private sector is one of resources for REDD+ financing • Continuous engagement with 11 pilot provinces-especially the 6 provinces under transition program • Cooperation with universities and research institution (Climate Change and Forestry Expert Network) • Citizen journalism program
2. Development of social and environmental safeguards	Implemented	Principle, Criteria, Indicator and Assessment Tools for a System for Providing Information on REDD+ Safeguards Implementation is developed and a SIS REDD+ web platform is operational
3. Fair benefit sharing	Operationalised/ Continuously progressing	Research and studies on the benefit sharing mechanism related to emission reduction measures from deforestation and forest degradation are developed, involving local community at district level

As a follow up to the National Strategy, 11 (eleven) priority provinces have formulated REDD+ Provincial Strategy and Action Plan (*Strategi dan Rencana Aksi Provinsi*/SRAP), i.e. : Aceh, Riau, Jambi, South Sumatera, West Sumatera, East Kalimantan, West Kalimantan, Central Kalimantan, Central Sulawesi, Papua, and West Papua. It is expected that the REDD+ SRAP document serves as a reference in mainstreaming climate change issue into the regional development planning system. Incorporating SRAP into the local government plan would ensure its implementation and enable evaluation of achievements of local development activities against REDD+ target. Periodic reviews are conducted to ascertain that REDD+ document remains aligned with the social, political, and economic development.

The SRAP document describes the problems encountered, strategy, and plan of action for REDD+ implementation based on the actual conditions of each province. SRAP document was formulated through comprehensive discussions with various provincial multi-stakeholders. The strategies and action plans were reviewed and adjusted over time to align with the provincial policies, development plan and programmes, as well as aligned with the national policies and development programmes. In order to strengthen the developed strategies and action plan, and to prepare the follow up actions for their implementation, series of review discussions were conducted in some provinces, such as in East Kalimantan and West Kalimantan Provinces, to address the political dynamics and to improve governance within the provinces.

6.3.2 Forest Reference Emission Level (FREL)

Immediately after COP 17 in Durban, Indonesia has started the development of its Forest Reference Emission Level (FREL) in 2011. The national FREL were initially constructed using three different initiatives: (1) the REDD+ Agency and the Ministry of Forestry (now Ministry of Environment and Forestry) have developed the national FRELs using land cover data of the Ministry of Forestry under the reference year 2000-2012; (2) the Indonesia SNC has established emission projection for LULUCF up to 2020 using land cover data of the Ministry of Forestry under reference period 2000-2006 (MoE, 2010); and (3) Ministry of Forestry has updated and issued FREL using the same land cover data as the

SNC, and modified with a reference period of 2000-2006 through the Minister of Forestry Decree No. 633/2014. Due to data availability, the three initiatives employed stock difference approach using historical deforestation rate.

Development of FREL has been continually carried out by the Directorate General of Climate Change MoEF by using land cover data of reference year 1990-2012. National FREL has been submitted in 2015 during the COP 21 in Paris and completed the process of technical assessment by Secretariat UNFCCC in November 2016. The report of technical assessment, up-dated FREL as well as the official document is accessible on UNFCCC website.

The objectives of Indonesia FREL submission are:

1. To present a national FREL figure for REDD+ implementation, including step-by-step analysis that has been exercised in establishing FREL for Indonesia.
2. To provide broader audience and stakeholders with clear, transparent, accurate, complete and consistent estimates of emissions projection as a basis for further discussion with other agencies who have expressed an interest in supporting Indonesia.
3. To share information and knowledge of the process undertaken by Indonesia in preparing for full REDD+ implementation based on result-based payment.

At present, the Indonesian FREL serves as a baseline for reducing emission from deforestation and forest degradation under REDD+ mechanism (performance-based payment of REDD+).

6.3.3 National Forest Monitoring System / Measurement, Reporting and Verification (NFMS/MRV)

For the purpose of data transparency in forest monitoring system, Indonesia has considered the followings: (1) The Decision 4/CP.15 paragraph 1(c), which requested parties to use the most recent IPCC guidance and guidelines, as adopted or encouraged by the COP, as the appropriate basis for estimating anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes; (2) Based on the Decision 4/CP.15 paragraph 1(d) and decision 1/CP.17 paragraph 71(c), Parties are requested to establish a robust and transparent national forest monitoring system and, if appropriate, sub-national systems as part of the national monitoring systems.

That monitoring system should (i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes *(Monitoring and Measurement)*; (ii) Provide estimates that are transparent, consistent, as accurate as possible, and that reduces uncertainties, by taking into account national capabilities and capacities *(Reporting)*; and (iii) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties *(Verification)*; (3) Further provision on the development of a robust and transparent national forest monitoring system for monitoring and reporting of REDD+ activities under decision 1/CP.16 paragraph 71 (c), includes sub-national monitoring and reporting as an interim measure, monitoring and reporting of emissions displacement at the national level, if appropriate, reporting on how displacement of emissions is being addressed, and searching for means to integrate sub-national monitoring systems into a national monitoring system.

The Indonesia's NFMS was not designed merely for the implementation of REDD+, as the system is also crucial as a source of national data and information for operational uses. The forest/land monitoring of NFMS is a system monitoring approach that was established in 2000, under the DG of Forest Planning. As a big and comprehensive system, the NFMS of Indonesia consists of several sub-systems, as shown in Figure 6.1 One of the sub-systems: the forest monitoring sub-system, is mistakenly renowned as the NFMS. It is based on a regular production of land cover maps of Indonesia, which is originally generated in three-year interval, and includes 23 land cover classes, including cloud cover and no-data.

As illustrated in Figure 6.1, the NFMS consists of four components/sub-systems: (a) forest/land monitoring to provide

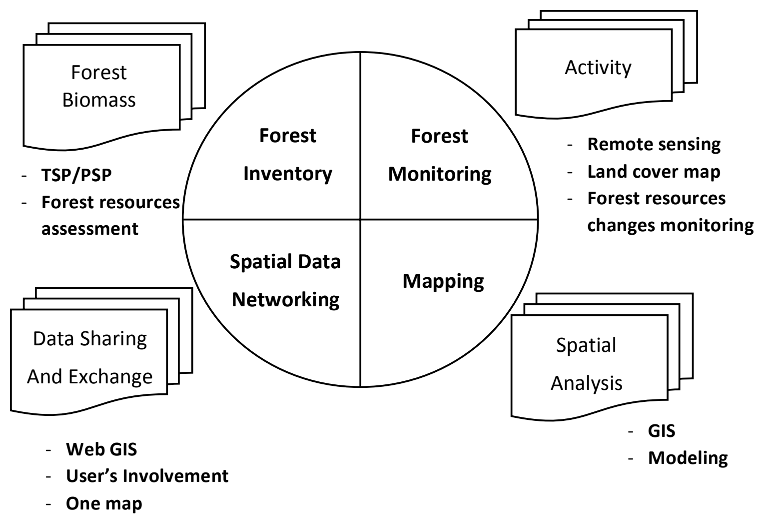


Figure 6.1 NFMS in Indonesia (Source: DG of Forestry Planning MoF)

information on land cover on regular basis and changes over time; (b) forest inventory to provide data on forest biomass estimation; (c) mapping to maintain spatial database and provide information based on spatial analysis, and (d) spatial data networking to maintain data communication, raw data providers, data sharing, data exchange and spatial data clearinghouse

In general, users only recognise two sub-systems under the NFMS of Indonesia, i.e.: (a) forest monitoring sub-system that is often called NFMS and (b) national inventory data or NFI (National Forest Inventory). Forest monitoring sub-system is crucial for various users, as data on forests and their relevant information, including forest cover changes over time, forests within designed land-use and within concessionary boundaries or other permits, need to be regularly updated and systematically

Figure 6.2 Relationship scheme between National Forest Monitoring Systems (NFMS) and the national methodological arrangements for the MRV requirements

archived. Whereas, NFI is one of the systematic data sources for forest inventory and the main provider for country biomass data under each type of land cover data. This sub-system is the operational source for national stock carbon dataset. In addition, all data and information should be made available to decision-makers in a timely manner, as well as to the public, which justify the importance of the roles of mapping and spatial data networking sub-systems.

To fit the requirements, with regard to the MRV preconditions, Indonesia has sets the NFMS as one of the main pillars for the implementation of domestic MRV as depicted in Figure 6.2. Three renowned 'pillars' (building blocks) support the development and implementation of NFMS (Decision 1/CP.16 paragraph 71(c); Decision 4/CP.15 paragraph 1(d)), with the dual functions of monitoring and MRV for REDD+ under the UNFCCC, i.e. :(1) Satellite Land Monitoring System or NFMS-Simontana (Indonesia FREL 2015, 2016, Margono et al. 2016) to collect and assess over time the Activity Data related to forest land; (2) National Forest Inventory (Revilla Liang 1992, Indonesia FREL 2015, 2016) to collect information on forest carbon stocks and changes, relevant for estimating emissions and removals as well as to provide emissions factors; and (3) SIGN-SMART as a tool for reporting on anthropogenic forest-related GHG emissions by sources and removals by sinks, to the UNFCCC Secretariat.

6.3.4 Safeguards Information System for REDD+ (SIS-REDD+)

To comply with the COP decisions related to REDD+ safeguards, Indonesia has developed a Safeguard Information System (SIS) for REDD+ (SIS-REDD+) on how the COP-16 safeguards are addressed and respected. The SIS-REDD+ aims to collect, manage and provide/display information on the implementation of REDD+ activities in Indonesia.

In agreement with the mandate from related COP Decision, and as per invitation from the Subsidiary Body for Scientific and Technological Advice at its thirty-eighth session, Indonesia submission to UNFCCC Secretariat has expressed its views on: (i) experiences, lessons learned, and challenges in the development of SIS-REDD+ and (ii) the type of information on from SIS-REDD+ that would be helpful and may be provided by developing country Parties. To follow up on this submission, the subsequent sections explain and provide information to address the issues indicated in the submission and serve as a summary of information on how REDD+ safeguards are addressed and respected.

6.3.4.1 Description of national REDD+ related policies and/or programmes and/or activities

The international "rules" for safeguarding the implementation of REDD+ is available at international scale. However, to put it into practical implementation, these regulation need to be interpreted according to national circumstances. Translation and interpretations are required in order to enable the effective implementation of REDD+ safeguards on all scales and levels. Interpretation of the international guidelines must be done within the context of national specifications such as legislation and regulations, available resources, capacity to implement, and other relevant local factors. In particular, Indonesia's legacy of policy, regulations, and practices represent a national asset of significant value as a foundation for developing a system for information provision on REDD+ safeguard implementation that is appropriate to the national context.

In 2011, the former Ministry of Forestry started a multi-stakeholder process to review the existing policy, regulatory and voluntary instruments, which are of relevance to REDD+ safeguards as defined by the COP 16 decision, as a preliminary basis for constructing a national REDD+ safeguards information system. The rationale for this process is that existing instruments have either a strong legal basis and/or are already tried and tested within the scales and contexts appropriate to REDD+ activities. The steps taken in this process include the evaluation of relevant mandatory and voluntary instruments for their appropriateness to the specific REDD+ safeguards set out in COP 16, the relative strengths and weaknesses of the instruments, acceptability to stakeholders, obstacles to effectively implementing the existing instruments, and consideration of interrelatedness of instruments in providing comprehensive coverage in all aspects.

Based on the experience during the initial steps of the translation process, it became clear that REDD+ safeguards are nothing new for Indonesian sustainable forest management. A number of existing instruments, identified as references mandated within the Indonesian legal system, or are currently practiced voluntarily, can be applied for REDD+ safeguards (COP 16 Decisions Appendix I). The identified existing instruments and policies covered and analysed are provided in the following Table 6.2

The REDD+ safeguards-related instruments and policies currently applied in Indonesia, were analysed and assessed using three criteria (relevance, limitations in scope, and effectiveness), to identify the elements which are proven effective, implementable and relevant to the seven REDD+ safeguards. Summaries of the analysis of elements from the existing instruments informed the following general results:

1. Different instruments operate well at different levels, with most operating well at the site level and less so at broader geo-political scales.
2. Existing safeguards covered here are weak, or non-existent, for ensuring the permanence of carbon stocks and preventing leakage.
3. Overall, the safeguards analysed are best at ensuring good governance, respect for indigenous people, and for ensuring appropriate stakeholder engagement.
4. With the exception of KLHS, voluntary standards tended to be rated higher than mandatory instruments.
5. Gaps in the effectiveness of safeguards by applying existing instruments are primarily related to the:
    a. Need for strengthened implementation of the existing instruments;
    b. Need for additional regulation to guide consistent implementation of the existing instruments;
    c. Need for strengthened systems to monitor impacts of instruments;
    d. Divergence in capacity/expertise at Provincial/District level compared to national level;

Table 6.2 Existing instruments and policies related to REDD+ safeguards identified and analysed during the development process of SIS-REDD+ Indonesia

Instrument	Abbreviation	Brief description
AMDAL	*Analisis Mengenai Dampak Lingkungan* (Environmental Impact Assessment)	Environmental impact assessment (based on Government Regulation No. PP.27/ 2012 on Environmental Permits)
KLHS	*Kajian Lingkungan Hidup Strategis – KLHS* (Strategic Environmental Assessment)	A mandatory control mechanism for development of policies, plans and programmes at the National, Provincial and District level (based on Act No. 32/2009, Government Regulation No. 46/2016 on Guidance for Strategic Environment Assessment
PHPL	*Pengelolaan Hutan Produksi Lestari* (Sustainable Production Forest Management)	A sustainability management system for all production forest concessions in Indonesia
SVLK	*Sistem Verifikasi Legalitas Kayu* (Timber Legality Verification System)	Timber legality verification system which is part of PHPL (sustainable forest management) certification, based on Ministerial Decree No. 30/ menlhk/Setjen/phpl.3/3/2016 on the Assessment of Performance in Sustainable Management of Production Forest and Timber Legality verification on Concession Holders
FPIC	Free Prior Informed Consent (or *Consultation, per Government of USA and WB*),	A process that provides opportunity for indigenous and/or local communities to reject or approve activities in forests to which they have rights.
FSC	Forest Stewardship Council	Related to SFM and HCVF
HCVF	High Conservation Value Forest	Also known as HCVA (High Conservation Value Area), a concept developed by the FSC in describing natural habitats where these values are considered to be of outstanding significance or critical importance
IBSAP	Indonesian Biodiversity Strategy and Action Plan	It serves as the main GoI reference to guide the development of national programmes for the utilisation and conservation of biodiversity under the National Development Plan 2004-2009.
PGI	Partnership Governance Index	A comprehensive measure and comparison of democratic governance performance of all provinces in Indonesia. PGI juxtaposes the arenas and principles of governance to derive its indicators of good governance
SEA	Strategic Environmental Assessment	Related to KLHS
SESA	Strategic Environmental and Social Assessment	A safeguard system of the World Bank that can be applied in the context of REDD+ activities including REDD+ pilot programmes
Source : PCI for SIS-REDD+ Indonesia (2011)		

e. Absence of over-arching framework to coordinate the metrics and reporting standards of diverse instruments and their actors from national to project site scales.

6. In general, adequate instruments are enshrined in mandated instruments or commonly practiced voluntary standards, to provide a basis for developing appropriate Principles, Criteria and Indicators for the COP-16 safeguards specific framework (with some exceptions).
7. A Safeguard System based on the existing instruments as assessed is possible, by the selection of specific elements from each instrument, with the caveat that strengthened standards of implementation of the instruments and stronger over-arching coordination may be necessary.

6.3.4.2 Design of the Safeguards Information System

The institutional arrangement for the SIS-REDD+ was designed based on institutional structures of Indonesian autonomous governance system (from sub national to national level), operating through phased-based approach, while maintaining consistency with the COP-guidance for SIS-REDD+. The institutional arrangement clearly determines the tasks, functions, and responsibilities of government institutions and other national and sub-national actors involved.

1. Institutional structure in SIS-REDD+

SIS-REDD+ aims to gather, process, analyse, and present necessary information on how safeguards are managed and respected in REDD+ activities. To ensure efficiency in data collection, an institutional structure and distribution of tasks and responsibilities from site to national level has been established for the information system, as described below in Figure 6.3.

For operation of the system, the institutional structure of SIS-REDD+ consists of data and information management bodies (PSIS/Pengelola Sistem informasi Safeguards) from different levels (from site, sub national, to national levels). These bodies are in charge of managing the data and information on safeguards information gathered from REDD+ implementer. They are also in charge of public awareness, provide guidance for their lower level, establish a grievance mechanism, as well as open communication channels with stakeholders and disseminate information.

At sub national levels, the management bodies also act as clearinghouses that collect, verify, consolidate, process, and store data from sites' information administrator. The consolidated information will be reported regularly to the national level and made available for public. PSIS at sub national level are also assigned with the task to provide guidance for the development of information system and periodically updating database at the lower levels.

SIS-REDD+ has also been designed to be open to inputs from various stakeholders. Therefore, SIS management bodies at sub-national and national levels can work with independent third parties. A Multi-Stakeholder Forum or Institution (L/FMP) can be established wherever necessary with members including representatives from the government, indigenous peoples, the private sector, NGOs, universities, and community leaders. L/FMP serves as a point of communication and coordination between related agencies, provides regulatory recommendations, becomes the contact centre for complaints related to the implementation of REDD+ safeguards, and conducts awareness-raising and education programs.

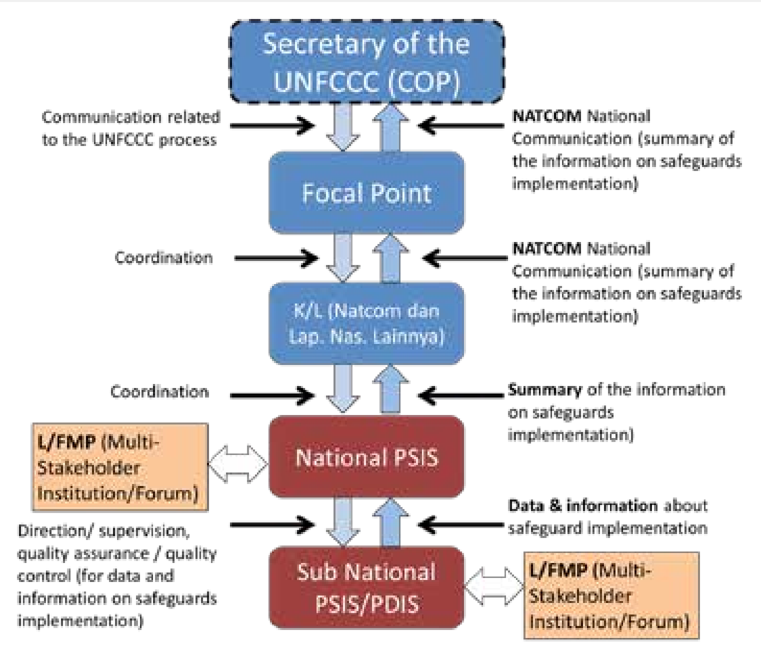


Figure 6.3 Institutional structure for SIS-REDD+ Indonesia

It is important to note that the management agencies and SIS-REDD+, both at the sub-national and national levels, do not necessarily have to be new institutions. PSIS can also utilise existing agencies and systems by strengthening the capacity and infrastructure needed to implement SIS-REDD+ efficiently.

2. Information flow in SIS-REDD+

In SIS-REDD+, the provision of safeguards implementation information is designed to be delivered throughout the levels, from the project on site to the SIS management in districts, then to the provinces, and finally to the national level. However, because REDD+ as a mechanism is still in progress, both at global and participating-country levels, the provision of safeguards information for the mean time will also be conducted in stages, in line with the capacity, resources, and phase of REDD+ development. During the readiness and preparation phases, this information will be submitted directly by REDD+ implementers to the SIS manager at the national level. When REDD+ is fully implemented, the information will be submitted from one level to the next, as designed for SIS-REDD+. If REDD+ activities are conducted in conservation forests managed by the central government, the reports can be submitted through these levels or directly to the national level. The information flow within SIS-REDD+ Indonesia is illustrated in Figure 6.4 below.

To promote transparency and ease access to safeguards information provided in SIS-REDD+, two components will be built to support each other, i.e.:

1. A database to manage data and information on safeguards implementation; and
2. Web-platform in both Bahasa Indonesia and English to present the information on safeguards implementation (http://sisredd.dephut.go.id/redd/).

On this website, REDD+ implementers will need to register as users to be able to report information on safeguards implementation in their activities. The users will fill out forms and checklists prepared by the MoEF as part of the APPS and include short descriptions about the implementation of safeguards. On this platform, users can also upload electronic documents as evidence of safeguards implementation. PSIS at the relevant level will verify the documents and fill out relevant columns to confirm the verification process upon completion. Only verified information will be displayed on the

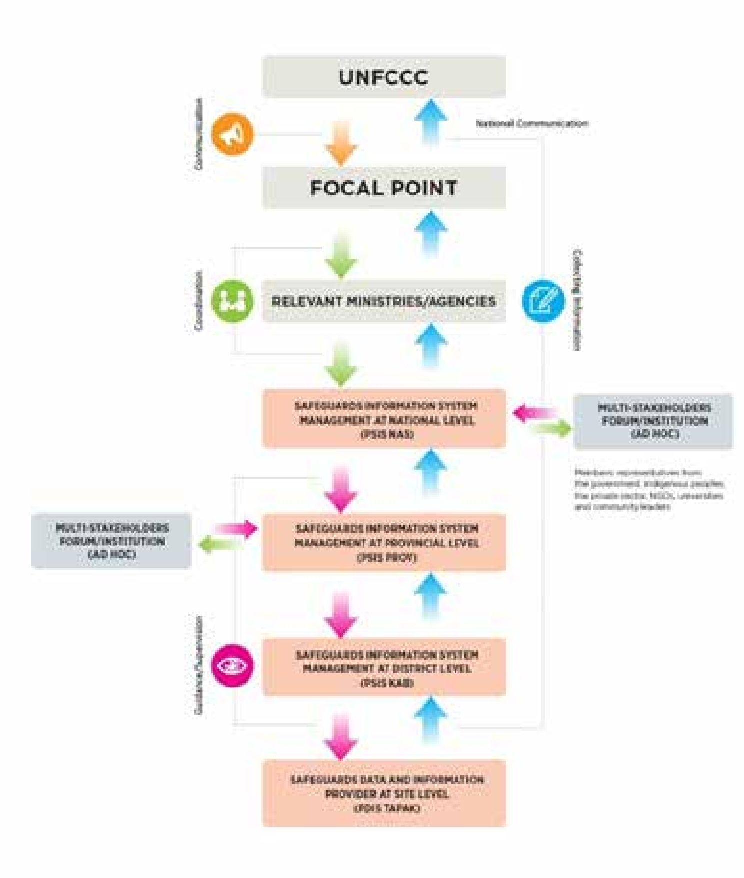


Figure 6.4 Institutional structure and information flow for SIS-REDD+ Indonesia

website and be accessible by public. When a user's classified information needs to be provided as evidence for safeguards implementation, they can make a special note to the PSIS to request that the documents not be published online.

The website is designed not only to provide information on safeguards implementation under REDD+, but also data of the REDD+ activities, such as project names, locations, implementers, partners, duration, and scope of activities. By collecting more data, the website may eventually be able to provide a summary of REDD+ activities in Indonesia in general, for example in the form of maps - both national and provincial -, graphics, and related news.

Aside from the web-platform as the main point of access for information on REDD+ safeguards, for places without reliable internet access PSIS use other communication channels to reach the public, such as routine publications or announcements at local government offices.

6.3.4.3 Description of processes in developing the system, including stakeholder participation

Indonesia's experiences have shown that the development of SIS-REDD+ provided a valuable opportunity to understand the progress of REDD+ implementation in the country, to identify obstacles early on, and to explore possibilities for future improvement. Development of SIS-REDD+, including formulation of Principle, Criteria and Indicators (PCI) for SIS-REDD+ and tools to assess safeguards implementation based on the existing system, taking into account policy and other relevant instruments, as well as setting institutional arrangements and information flow for SIS, were proven to be valuable means for capacity building through "learning by doing" processes.

A country-led development of the system through multi-stakeholder processes, supported by relevant experts and in collaboration with international partners, has proven to be an effective and acceptable approach considering the big variety of REDD+ actors in Indonesia. The involvement of multiple stakeholders in the process of SIS development promotes transparency and participation and increases the confidence of the diverse actors. It is crucial to involve various stakeholders from the beginning of system development up to operationalisation, even though it may take significant allocation of time, commitment, and resources. Such involvement will create a sense of ownership and acceptance, and ensure that the outputs fit within the national and sub-national contexts and serve as a precondition for an effective implementation (Figure 6.5).

6.3.4.4 Description of implementation approaches on how safeguards are addressed and respected

The SIS-REDD+ Indonesia was designed using the following principles: simplicity, completeness, accessibility, and accountability. The assessment and the steps in the analysis process of the existing instruments, which resulted in the initial PCI framework, are as follows:

1. Identification and prioritisation of elements contained in existing instruments relevant to safeguards as defined by the COP-16 Decision
2. Identification of clusters of elements or "common denominators" (Figure 1–6)
3. Set linkage of the emerging element clusters to COP16safeguards
4. Mapping of elements into the PC framework and referencing back the PCI to the original instruments (Figure 6–7).

6.3.4.5 Operationalisation of the SIS-REDD+

Since the system's development, SIS-REDD+ Indonesia has been operationalised in accordance with its initial design. The PCI and assessment tools and institutional structure followed during the operational process, in parallel with continuous awareness raising on REDD+ safeguards. SIS-REDD+ is operationalised in parallel in both centralised approach from national level and linked between national - sub national level. For the second approach, there are several sub national jurisdictions working with the central management (DGCC MoEF), namely : East Kalimantan Province, Jambi Province, and South Sumatra Province. In addition, SIS-REDD+ was also introduced to the local communities in Sarolangun District – Jambi

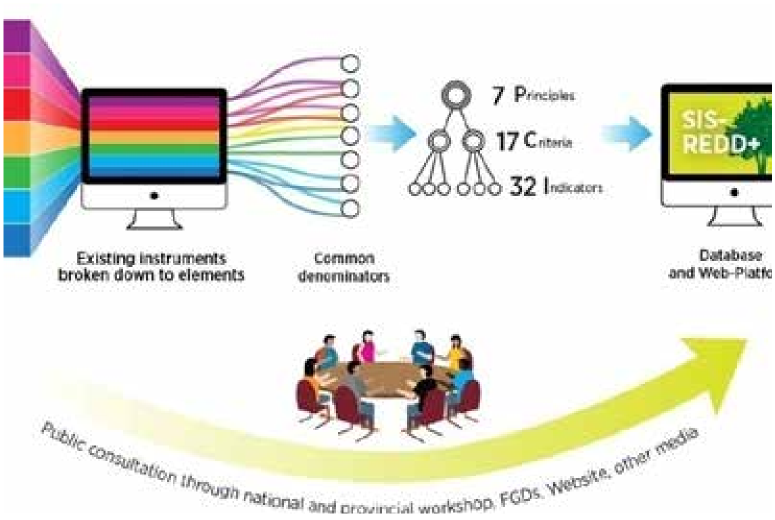


Figure 6.5 Process of formulation PCI of the Safeguard REDD+

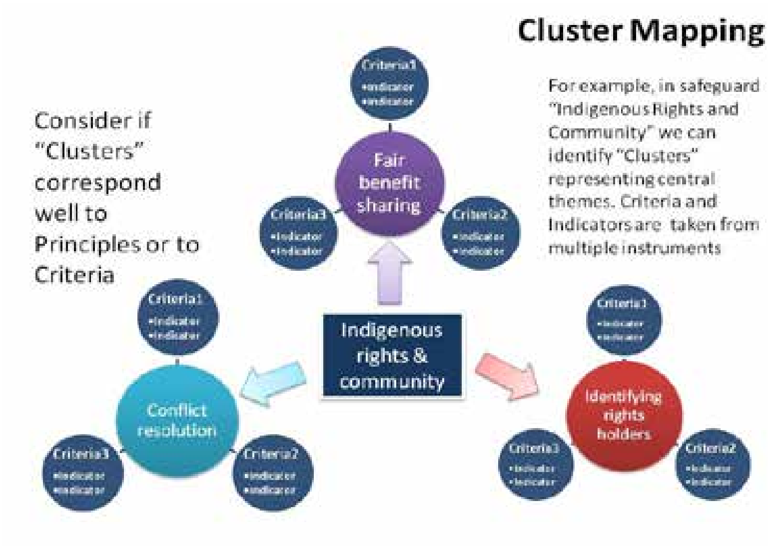


Figure 6.6 Process of Cluster Mapping to PCI

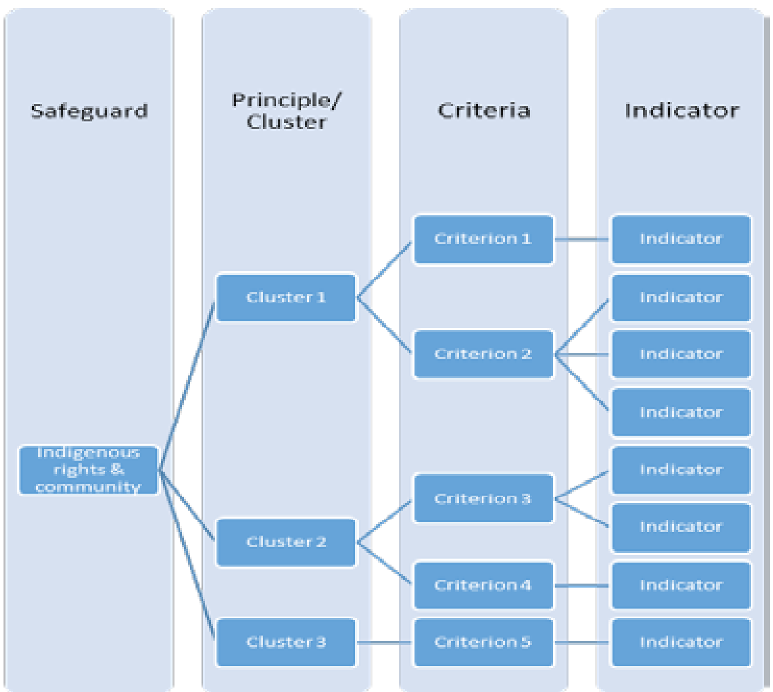


Figure 6.7 Mapping of elements into PCI

through some *Masyarakat Hukum Adat* (MHA) groups facilitated by AMAN[1].

During the operational process, some improvement steps were taken, including preparation of legal umbrella for the SIS-REDD+ operationalisation as part of MoEF regulation on REDD+ implementation. There are also some advanced discussions to obtain deeper understanding on REDD+ safeguards and how to implement the safeguards through PCI and assessment tools provided in the SIS-REDD+. To achieve the understanding, DGCC MoEF is working with some REDD+ and safeguards related initiatives, including REDD+SES in East Kalimantan and Central Kalimantan, and SESA at national level and East Kalimantan Province (within FCPF Carbon Fund scheme). SIS-REDD+ also develops collaboration with related systems, for example: with PFMIS (Provincial Forest Management Information System) developed by East Kalimantan Provincial Government supported by GIZ Forclime, and with Information System for Sustainable Land Development (INSTANT) developed for Locally Appropriate Mitigation Action in Indonesia (LAMA-i) programme in South Sumatera.

6.4 Financing REDD+ in Indonesia

6.4.1 Mandate of REDD+ financing under UNFCCC

In the COP 21 Decision of the UNFCCC, particularly on financial mechanism, the Parties recognise the importance of adequate and predictable financial resources, including financial resources dedicated for results-based payments, for the implementation of policy approaches and positive incentives for reducing emissions from deforestation and forest degradation. Article 9 of Paris Agreement states that developed country Parties shall provide financial resources to assist developing country Parties with respect to both mitigation and adaptation in continuation of their existing obligations under the Convention. The mitigation action includes reducing emission from deforestation and forest degradation. Further, paragraph 5 of Paris Agreement states Parties are encouraged to take action to implement and support, including through results-based payments, the existing framework as set out in related guidance and decisions already agreed under the Convention. This involved policy approaches and positive incentives for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. This views REDD+ as a positive incentive for developing countries to improve their forest governance.

[1] *Aliansi Masyarakat Adat Nasional* - National Alliance for Indigenous Community

6.4.2 REDD+ as a result-based payment mechanism

As mentioned earlier, REDD+ financial mechanism is a form of a result-based payment mechanism. The design of the mechanism should structure an adequate and predictable financing in a way that fosters confidence in delivery of REDD+ results, including financing for REDD+ readiness and performance. Financing for REDD+ readiness is an ex-ante payment aims at funding non-carbon activities. Result-based payment for REDD+ is payment based on performance of verified emission reduction. Market-based approach is one of the approaches that can be used in REDD+ mechanism, which has not been used by Indonesia as REDD+ countries. Non-market based finance and alternative policy approaches are the approaches currently implemented in Indonesia.

6.4.2.1 Sources of climate finance for REDD+ implementation

In line with the Paris Agreement, several developed countries (Norway, Japan, Korea, and Germany) have committed to support Indonesia in reducing emissions from deforestation and forest degradation through bilateral mechanism. For example, the Indonesia – Norway billateral partnership comprised of three phases covering preparation phase, transformation phase, and contribution-for-verified emission reduction phase. The preparation phase encompasses, inter alia, completing a national REDD+ strategy, establishing special agency for REDD+ and establishing funding instruments for REDD+, of which some of the activities have been completed in 2015. Meanwhile, Germany through GIZ Forclime project, developed sustainable payment system for emission reduction measures from deforestation and forest degradation in the Districts of Malinau, Berau and Kapuas Hulu in East Kalimantan Province. Other projects developed with support from international organizations such as The Nature Conservancy (TNC) and Fauna Flora Indonesia (FFI) have also developed result-based payment system related to emissions reduction measures from deforestation and forest degradation by local community at district level. In terms of financial support for REDD+, in total, there have been around USD 1.2 billion of various financing resources committed for REDD+ implementation in Indonesia.

Beside public finance, private finance is also a source of finance for implementing REDD+. Some private sectors in Indonesia are potential contributors of REDD+ implementation. In order to stimulate private sector engagement in climate change actions, GoI needs to establish either fiscal or non-fiscal incentives.

6.4.2.2 Climate Finance Instrument to Support REDD+

To provide an umbrela regulation for environment financing as mandated in Act No. 32/2009 on Environmental Protection and Management, the GoI has issued a Government Regulation on Economic Instruments for Environment, including funding instrument for REDD+. To address the mandate, this Government Regulation covers three main areas of development planning and economic activities, environmental financing, also incentive and disincentive systems. The regulation states that one of environmental financing management is the General Service Agency (*Badan Layanan Umum*/BLU), a national financing institution that will manage the funds, including REDD+ funds.

The sources of finance for REDD+ are from national budget, bilateral and multilateral funds, and other possible sources. The national budget is used as an initial budget to prepare the implementation of REDD+, while bilateral and multilateral grants are intended for the preparation fund and result-based payment.

In general, the distribution of REDD+ financing consists of two stages, namely input-based and result-based payment. Input-based mechanism is intended to fund non-carbon based activities covering capacity building (institutional and human resources development) and policy processes. Meanwhile, result-based payment is addressed to fund carbon and non-carbon activities involving verified carbon emission reduction and continue support for capacity building and policy strengthening.

6.5 Other related issues support the readiness for REDD+ implementation

6.5.1 Institutional Arrangement

At national level, the Directorate General of Climate Change of the MoEF is currently mandated coordinate the implementation of REDD+ in Indonesia. At sub national level, local governments contribute significantly in REDD+ implementation. Each of the eleven REDD+ pilot provinces, have set up an Ad-Hoc institution to coordinate REDD+ activities and prepare document for REDD+ implementation at provincial level.

The Ad-Hoc institution assigned to coordinate REDD+ activities in the province, take the form of a Working Group, a Task Force, or a Commission. The composition of each Ad-Hoc REDD+ institution at provincial or district levels consists of local governments and other related stakeholders, including local NGOs and academia/universities representatives. These institutions made some significant progress in REDD+ readiness preparation phase and their role is vital as a bridge between the national and the sub national levels in implementing REDD+ related policy. Maintaining the existence of these Working Groups/Task Forces/Local Commissions and their functions is essential; and should be replicated wherever possible by other provinces.

6.5.2 REDD+ Demonstration Activities/Pilots/Related Activities

One of the decisions agreed at COP-13 in Bali calls for the development of Demonstration Activities (DA) as part of REDD+ implementation preparation. The DAs are expected to deliver lessons learnt and knowledge in preparing the REDD+ implementation at all levels (national, sub-national (provincial/district/city) and site). Furthermore, REDD+ DA is also used as an exercise to fulfil one of the requirements in REDD+ implementation preparation, in accordance with international agreements, namely the preparation of REL/RL/ baseline, MRV set up and safeguards implementation.

REDD+ DA in Indonesia is defined as field activities aimed at reducing carbon emissions and/or increase carbon stocks and/or conservation of carbon stocks through LULUCF based REDD+ activities, and as a means of learning, including testing and development of methodology, technology, institutions, capacity building and implementation of the safeguards and/or result based action that resulted in the payment and/or incentives for the reduction/ prevention of emissions or enhancement of forest carbon stocks achieved. As a technical guidelines for REDD+ Demonstration Activities in Indonesia, the GoI (c.q. Ministry of Forestry) in 2013 has developed a national standard called "Indonesian National Standard (*Standard Nasional Indonesia* – SNI) 7848:2013". The standard sets common requirements (e.g. DA must be in line and support the national REDD+ strategy and forest policy), and special requirements consist of administrative requirements (proponent must obtain approval to conduct DA REDD+ from the competent authority), and technical requirements (boundaries of REDD+ DA implementation is determined based on sub-national boundaries).

By 2016 in Indonesia, there are around 37 REDD+ related DAs/pilots/projects/ activities, implemented with a variety of approaches, scales, scopes, time periods, extent and methods, and are distributed in 15 (fifteen) provinces: North Sumatra, Riau, Jambi, South Sumatra, Central Java, East Java, Central Kalimantan, East Kalimantan, North Kalimantan, West Nusa Tenggara, East Nusa Tenggara, Central Sulawesi, Gorontalo, and Papua. Out of the total 37 (thirty-seven) REDD+ DAs, two are located in protected areas (Berbak National Park in Jambi Province and Sebangau National Park in Central Kalimantan Province). Both national parks are managed by the central government through the Directorate General of Natural Resources and Ecosystem Conservation under the Ministry of Environment and Forestry.

Figure 6.8 below illustrates the locations of REDD+ DAs, deployment and actors, as well as scopes of the activities.

Various activities have been carried out by the proponents of DA/pilot/project/activity include environmental protection (biodiversity/ conservation/ restoration, ecosystem, watershed, peat, animal habitat, elephants, tigers, orangutans), welfare improvement of forests communities, carbon emissions reduction, carbon markets development,

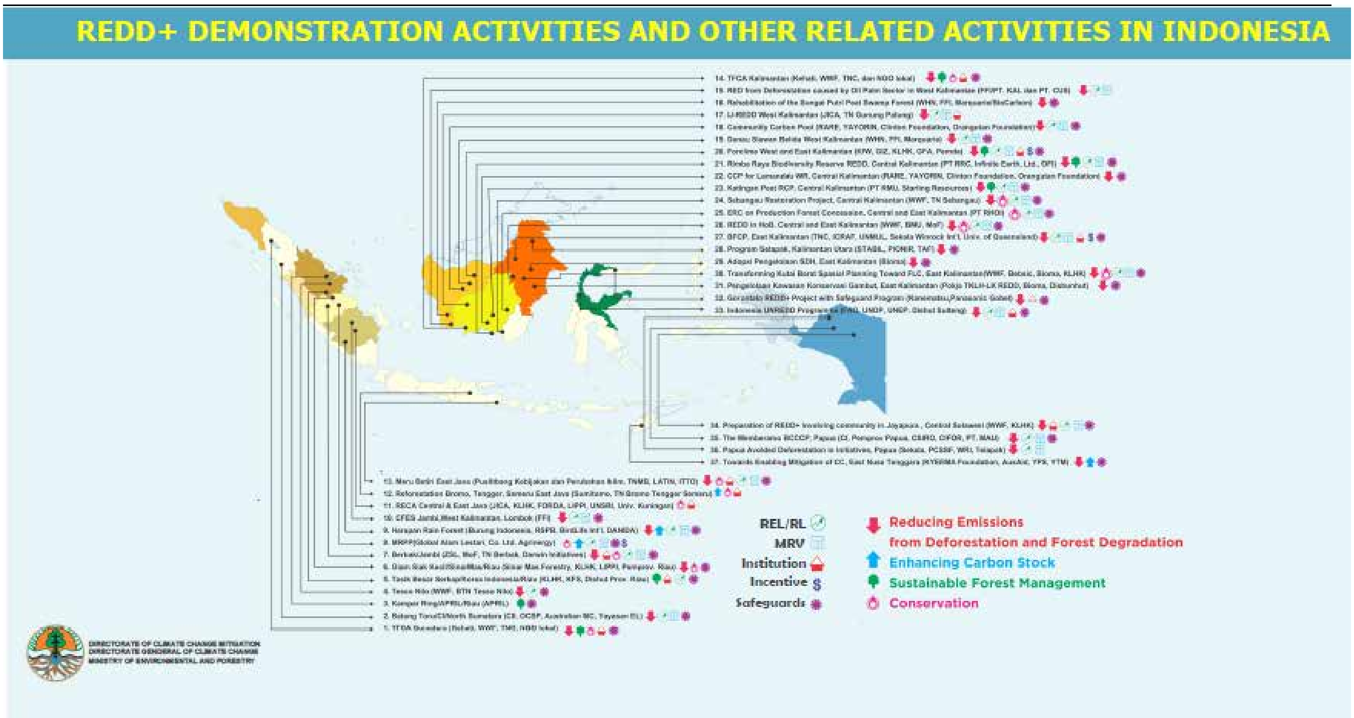


Figure 6.8 Map of the distribution of REDD Demonstration Activities and Other Related Activities in Indonesia.

sustainable forest management, stakeholders' capacity building, public and institutional arrangements, construction and management of village forest/social forestry/ agroforestry, economic development around protected areas and forest fire management.

In terms of time, the development of REDD+ DA/pilot/project/activity could be categorised as a learning period, which has the opportunity to be continued and upgraded into a full REDD+ project. The technical requirements for the REDD+ DA/ pilot/project/activity had been tested at various levels, namely the development of carbon accounting system, REL/RL, MRV system, implementation of REDD safeguards, as well as trials for payment mechanism. REDD+ DA has an important role to play in encouraging the readiness of Indonesia to enter the third phase, which is the full implementation phase. Third phase is significantly influenced by the results of the previous phases, consisted of elements of strengthening policies, instruments, capacity building and also demonstration of result-based activities implementation. There are however, specific tasks to be resolved at national level, including the need for legal protection at national and sub-national levels for setting up funding mechanism, especially for result-based payments.

Similar to its role at national level, REDD+ DA also plays key role as a learning process as well as a result-based actions at sub-national level (provincial/district/site) at the transition process to full implementation of REDD+. In order to address and record the existence of the DAs/projects/initiatives/activities related to REDD+, a REDD+ Registry System was developed by MoEF (Figure 6.9), as part of the National Registry System. The REDD+ Registry System serves as a tool in the administration, coordination and recognition of the contributions and supports provided for REDD+ DA/pilot/project/activity. Through this system, it is possible to track down the activities to assess the roles and contributions of each DA/pilot/project/activity. Figure 6.9 shows a page within the National Registry System where information on REDD+ related activities are managed.

6.6 Capacity building to support REDD+

Indonesia has conducted capacity building activities in diverse locations with the supports from various parties namely government agencies, international organizations, research institutes, individuals, etc. Capacity building targets institutions and stakeholders involved

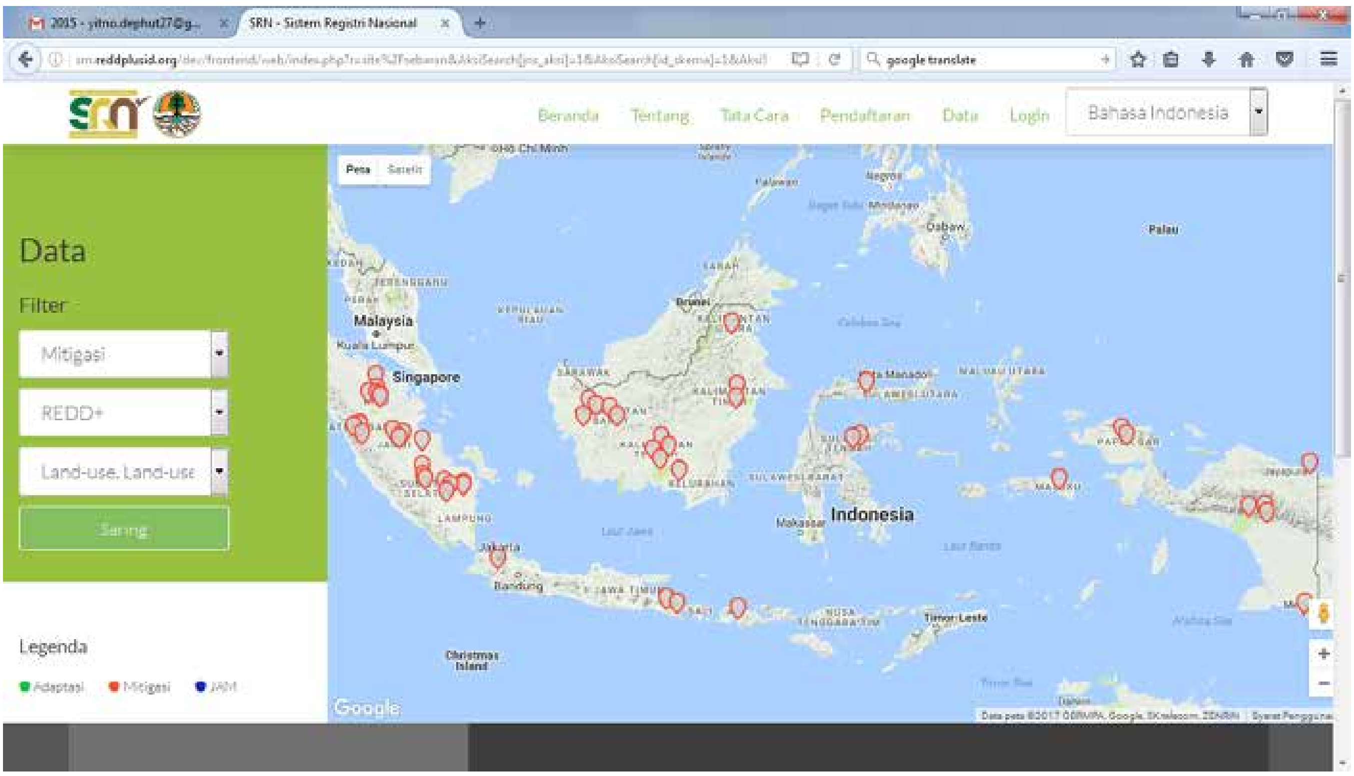


Figure 6.9 National Registry System (SRN)

in REDD+ implementation at national and sub national level and has the objectives to strengthen the technical as well as the institutional capacities such as MRV for REDD+ at national and sub national levels.

Capacity building is provided through activities such as workshops, trainings and publications, which include activities aim at enhancing the capacity to conduct carbon accounting and monitoring, mainstreaming climate policy, and financial capacity. For example, through Forest Carbon Partnership Facilities (FCPF), Indonesia has organized training of trainers to enhance the capacity to conduct carbon accounting and monitoring in several provinces (Maluku, East Java, West Sumatra, Bali, Jambi, West Nusa Tenggara). Indonesia has also established the Indonesian Expert Network on Forest and Climate Change (*Ahli Perubahan Iklim dan Kehutanan Indonesia* Network/APIKI Network) as a network to enhance the scientific capacities in addressing climate change issues, including REDD+. APIKI Network was established in 2014 involving experts from 7 (seven) regions of Indonesia (Sumatera, Java, Kalimantan, Sulawesi, Bali and Nusa Tenggara, Maluku, and Papua). The Network is engaged in conducting a diversity of climate change and forestry related-research as an important foundation for decision making in REDD+.

6.7 Communication and outreach

Understanding REDD+ is a key point in implementing REDD+, that is implemented through national policy with sub national implementation thus closely related with various stakeholders from local communities, private sectors, local government, national government as well as international community. In order to have common understanding of REDD+ and to communicate and share the information on REDD+ implementation, Indonesia has organized several workshops, discussions, public consultations and publications for various stakeholders at national and sub-national levels. These Indonesia realises that communication is important to disseminate information and raise awareness on REDD+. The communication also serves as channel to gain public acceptance and enhance the transparency.

Indonesia is actively building communication with international community, one means of building communication is through the participation as the Coordinator of ASEAN Regional Knowledge Network for Forest and Climate Change (ARKN-FCC)(currently is ASEAN Working Group on Forestry and Climate Change/AWGFCC). One of ARKN-FCC's task is responding to emerging issues on forests and climate change arising from the work programmes of ASEAN Senior Officials on Forestry (ASOF) and ASEAN Ministerial Meeting on Agriculture and Forestry (AMAF) and from regional and international processes that are relevant to ASEAN Member States. Through ARKN-FCC, Indonesia shares knowledge and information regarding climate change as well as REDD+, enhance capacity within members, and participates in joint submission for international negotiation.

Indonesia also participates in REDD+ Partnership, a global platform for organizing actions in order to enable effective, transparent and coordinated fast action on reducing greenhouse gas emissions from deforestation and forest degradation in developing countries. The core objective of the partnership is to contribute to the global battle against climate change by serving as an interim platform for the partners to scale up REDD+ actions and finance, and to take immediate action, including to improve the effectiveness, efficiency, transparency and coordination of REDD+ initiatives and financial instruments, and to facilitate among other things knowledge transfer, capacity enhancement, mitigation actions as well as technology development and transfer.

6.8 Moving Indonesian REDD+ Forward: Next Steps

Indonesia played significant roles in shaping the global establishment of REDD+ concept and its development as an international mechanism for providing positive incentives for developing countries to reduce emission from deforestation and forest degradation. Nationally, Indonesia has established a set of instruments required for REDD+ implementation in accordance with UNFCCC guidance through its COP's decisions. These instruments, as envisaged in the Indonesian REDD+ architecture, are:

REDD+ national strategy, national FREL, NFMS/MRV and REDD+ Registry System, and REDD+ Safeguards Information System. Currently, development process of funding instrument for REDD+ is still in progress and in advance it will serve as critical element to move Indonesian REDD+ towards achieving result-based financing.

In parallel, a number of sub national jurisdictions (11 pilot provinces) are involved in this preparation process, and a number of REDD+ demonstration activities/pilots/ projects/ initiatives at site-level, are providing experiences and lessons-learned for REDD+ to move forward. Cooperation and partnerships with developing partners (bilaterally and multilaterally) are in progress, providing assistance and supports in preparing Indonesian REDD+ readiness towards implementation. Piloting the result-based, an FCPF Carbon Fund programme at East Kalimantan Province is currently in progress with LoI, and a pilot on BioCarbon Fund ISFL at Jambi Province is on initial preparation.

For the future of Indonesian REDD+, some plans for improvement have been prepared by the GoI and others are ongoing. For example, the Indonesia's FREL need to be revisited and reviewed post 2020. Besides, in order to prepare the REDD+ performance-based payment (RBP), the MoEF has also initiated series of meetings aimed to develop guidelines for establishing sub-national FREL. The guidance needs to be established to maintain the appropriate use of the national FREL in sub-national implementation. This guidance is designed to be included in the regulation for REDD+ implementation, especially on the Measurement, Reporting, and Verification (MRV) of REDD+. In terms of REDD+ financing, accounting of the finance demand for REDD+ in Indonesia is to be further discussed. In addition, following up the progress on financing-related policy instruments being prepared, there is a need of capacity building for tracking the climate finance for REDD+ and for operationalisation of the funding institution. In terms of SIS-REDD+, it is important to further maintain the system to be well-operationalised and to strengthen the system through collaboration and synergy with other related system.

Furthermore, following the submission of Indonesia's First NDC and with acknowledgement and strong political signal from Paris Agreement to REDD+ implementation, REDD+ will be an important part of the national emissions reduction target in the near future. With this regards, the next important step to do is to determine the position of REDD+ activities in the Indonesian NDC. This step will enable REDD+ to play significant role in broader context of climate change in Indonesia, particularly to help the country in addressing the issue of deforestation and forest degradation.

Source/Location: Directorate of Mitigation MOEF/explosive industry, West Java

Chapter 7

OTHER INFORMATION

7.1 Transfer of Technology

In the past, much of technology transfer in mitigation activities was accomplished through the implementation of carbon projects such as the Clean Development Mechanism (CDM). Unfortunately, the numbers of such projects have declined significantly since end of 2014. However, aside from carbon projects, technology transfer also takes place through multilateral and bilateral cooperation, for example through the ASEAN-Germany cooperation program: "Promoting Innovation and Technology-ASEAN" or "PIT ASEAN" aiming at promoting the innovation and technology especially for small-medium enterprises (SMEs) in Indonesia. NGOs also play important roles in facilitating and implementing technology transfer for mitigation and adaptation activities. Based on data from SGP-GEF UNDP programme, as per 2008, there were about 18 NGOs working on climate change mitigation projects. They are predominantly centred in Java and focus their activities mostly on energy and waste sectors (Boer et al. 2008).

7.2 Research and Systematic Observation

7.2.1 Research

A number of research agencies and universities are engaged in climate-related research, including several international organizations based in Indonesia, who have recently also focus their research activities on climate change. Research activities conducted by these agencies vary (Boer et al. 2007; Perdinan et al., 2016), where some would focus their research either on adaptation or mitigation, and some on both. Research Centres/ Institutes, which are active in conducting climate change related research are: Indonesian Agroclimate and Hydrology Research Institute (BALITKLIMAT) of Ministry of Agriculture, Research Centre on Forest and Climate Change Policy of Ministry of Environment and Forestry, Research and Development Centre of BMKG, LAPAN, Research and Development Centre of the Ministry of Public Works and Housing, Agency for the Assessment and Application of Technology (BPPT), and climate change research centres under several universities such as Bogor Agricultural University (IPB), Bandung Institute of Technology (ITB), University of Indonesia (UI), and University of Palangkaraya (UNPAR).

7.2.1.1 Climate Research

Research centres of various agencies/ institute and universities that carried out basic research on modelling of weather and climate are limited, mainly BMKG, LAPAN, IPB, and ITB. Some of the climate modelling research activities conducted by BMKG, include an analysis of the spatial and temporal patterns of rainfall in western Indonesia using WRF-EMS (Weather Research and Forecasting Environmental Modelling System) such as the following initiatives:

1. **SEACLID/Cordex-SEA (Southeast Asia Regional Climate Downscaling)**

SEACLID is the first cooperation project in Southeast Asia aims to downscale a number of Global Climate Model (GCM) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) for Southeast Asia. Before the founding of SEACLID, Southeast Asia is classified under the domain of Cordex-East Asia. This cooperation project was initiated by Indonesia, Malaysia, Philippines, Thailand, Vietnam, Cambodia and Lao PDR. In addition to member countries, a number of collaborators from several countries, such as Australia, Britain, South Korea, Hong Kong, Sweden, Germany, and Japan also joined this project. Currently, SEACLID/Cordex-SEA consists of 14 countries and 19 institutions. The resulting downscaling of climate change scenarios into high-resolution data (25x25 km) for Southeast Asia region, are stored and disseminated free of charge to users through the Earth System Grid Federation (ESGF) as well as the implementation of data policies by Cordex and APN. SEACLID/ Cordex-SEA also provides a platform for capacity building of human resources and training for young researchers from the region. Implementation of SEACLID/Cordex-SEA is expected to increase the understanding of scientists on climate change and the assessment of the impacts of climate change in Southeast Asia. In addition, countries in the region can formulate strategies for adaptation and mitigation of climate change based on scientific evidences.

2. SACA&D (Southeast Asia Climate Assessment and Dataset)

SACA&D is developed as a part of the *Digitisasi Data Historis* (Didah) project, which is a two-year project (2010-2011) focusing on the digitization and use of high-resolution historical climate data from Indonesia over the period 1850-present. SACA&D is the collaboration between 15 countries in Southeast Asia. It is a web oriented database of daily data from Southeast Asia, presenting not only the station data itself, but also providing information on extremes, trends, anomalies and climate indices. It comprises of 6000 daily data series from 4100 stations, in which 34% are downloadable. The parameter outputs comprises of 10 elements that are available in ASCII, namely: 1. TX (Maximum daily temperature), 2. TN (Minimum daily temperature), 3. TG (Average daily temperature), 4. RR (Daily rain rate), 5. PP (Mean daily sea level pressure), 6. SS (Sun shine duration), 7. HU (Daily humidity), 8. FX (Maximum wind speed), 9. FG (Average wind speed), and 10. DD (Wind direction).

7.2.1.2 Climate Change Impact Research

Research on the impacts of climate change on various sectors, were implemented by different agencies/institutes at local and national levels. Over the last six years, there have been at least 100 research activities undertaken by a wide range of sectors (Figure 7.1). Most of the activities were mainly on agriculture, followed by coastal and marine, water resources, forestry, urban and rural, and human health. Most of the research in agricultural sector, focused on the assessments of climate change impacts on main food crop production, i.e. rice paddy. Climate research in urban/rural and human health are still limited, in which research on health impact of climate change still directed primarily to the occurrence of dengue and malaria.

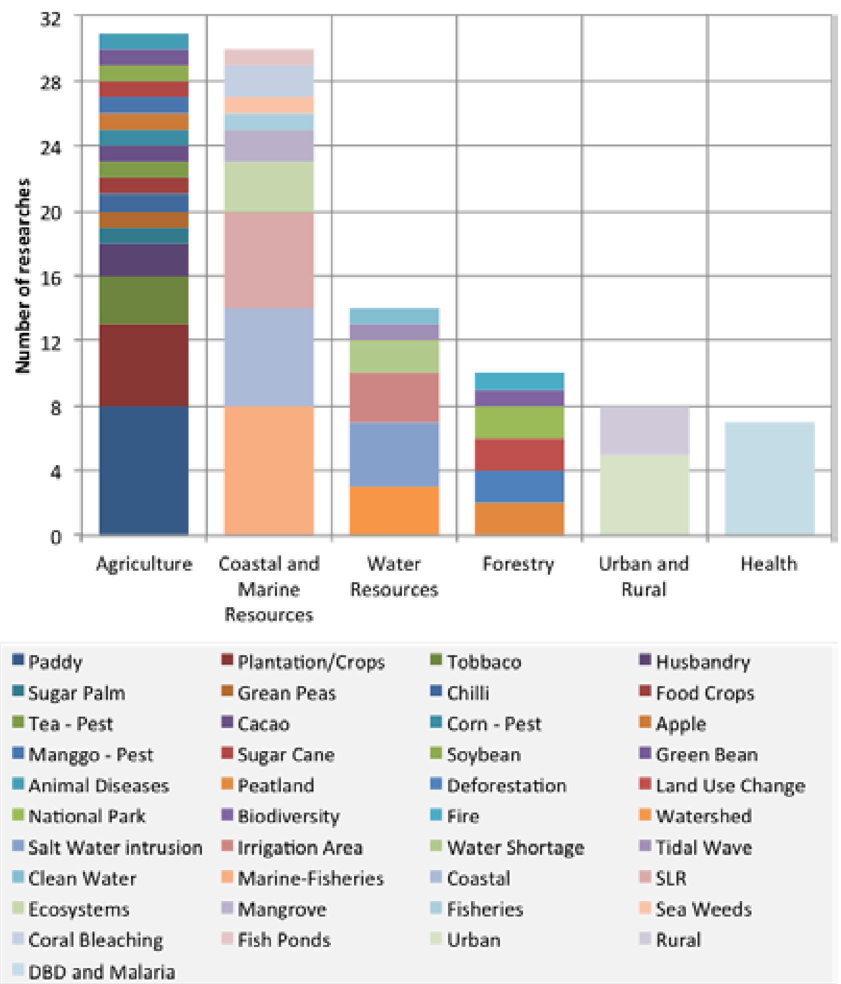


Figure 7.1 Number of climate change impacts research by sector in Indonesia in 2010-2016

7.2.2 Systematic Observations

The systematic observation of climate in Indonesia is coordinated by BMKG. Rainfall Observation Network has existed since the Dutch Colonial Era. Subsequent to independence, more rainfall stations were installed. Nevertheless, such efforts were still far from sufficient to have a representative number of stations across the country. At present, BMKG manages around 173 observation stations and around 5,000 rain gauges throughout the country as compared to the ideal number of 20,000 rain gauges to meet the WMO standard for Indonesia (Sribimawati, 1999). They are mainly located in Java, followed by Sumatra, Sulawesi, Maluku, Kalimantan and Papua. In addition to rain gauges stations, BMKG has also installed a number of automatic weather stations (AWS) and radar in several places, particularly in weather/climate hazards prone areas. In collaboration with WMO, BMKG has also established a Global Atmospheric Watch (GAW) in Bukittinggi, West Sumatra. With the presence of the GAW, Indonesia becomes a part of the global atmospheric observation under World Weather Watch.

The National Network of Agroclimatic Stations is installed in a number of agriculture research stations. The network is maintained by the National Agency for Agricultural Research and Development. There are about 59 agroclimatic stations, but only half are in good conditions (Surmaini et al., 2010). The distribution of the agroclimatic stations is presented below in Figure 7.2.

Data on daily rainfall and temperature are collected and provided by BMKG from 162 stations (Figure 7.3), portraying various record lengths with the longest temporal coverage of

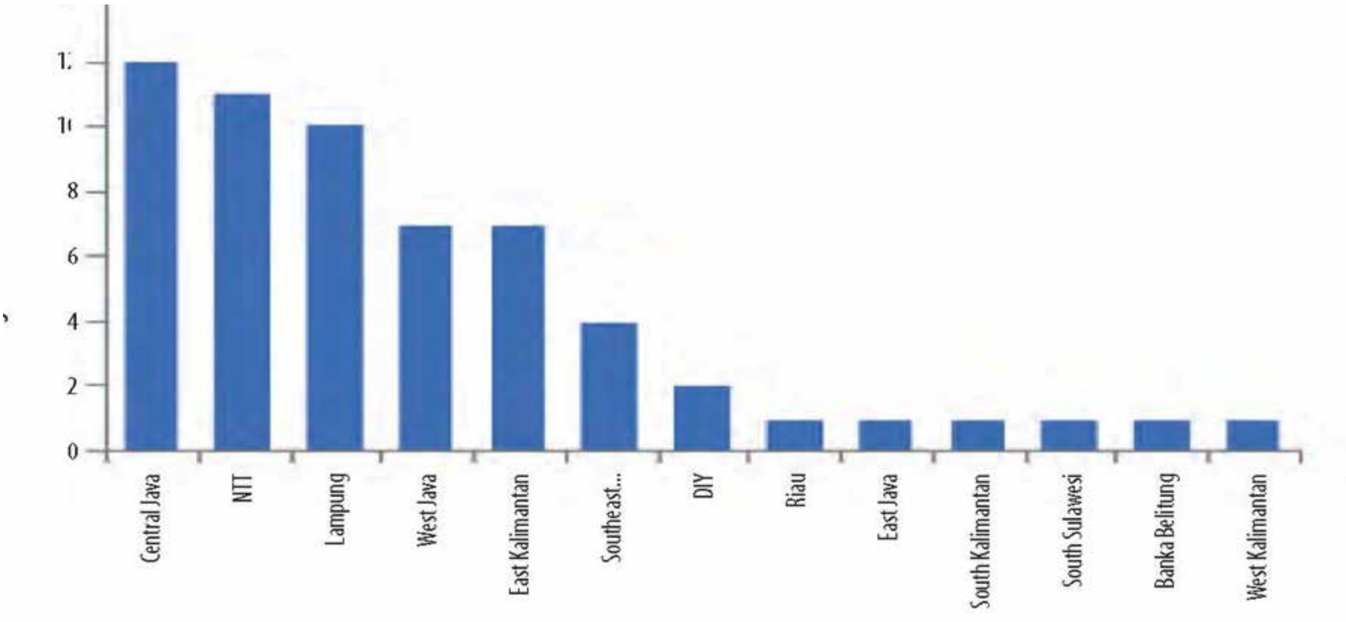


Figure 7.2 Number of agroclimatic stations by province (Surmaini *et al.*, 2010)

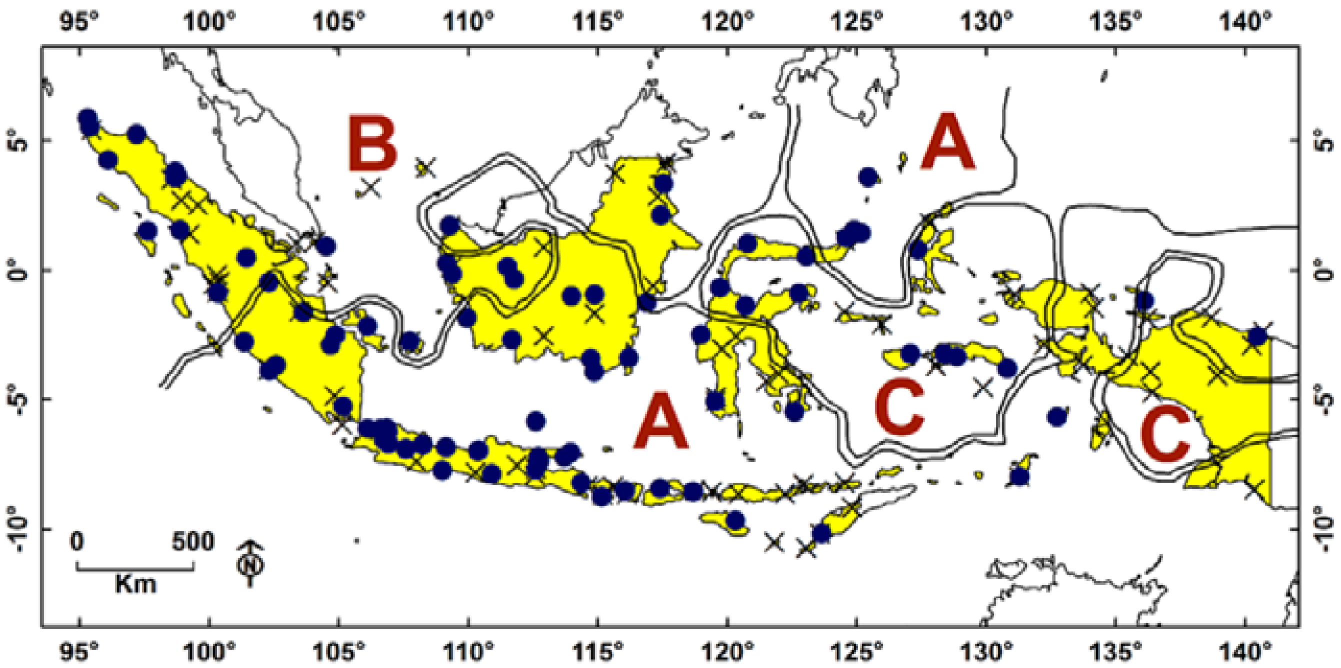


Figure 7.3 Spatial distribution of 162 weather stations

Note: For rainfall analysis, stations are grouped into the three sub-regions i.e., A,B and C (Aldrian and Susanto, 2003). Stations marked with X represent stations with poor quality with many missing observations (Supari, 2016)

43 years (i.e. 1970–2012). All records are stored in an agroclimatic format comprising of weather variables including: surface temperature, rainfall, duration of solar irradiation, relative humidity and wind speed-direction. The longest observational data is from Jakarta Observation Station with a length of record of 134-years (daily) and 114-years (hourly) (Siswanto, 2015). BMKG provides online access for public uses through http://dataonline.bmkg.go.id/home.

LAPAN also conducts climate observation and analysis using radar and satellite data. Some of their research activities include:

5. Optimation of space weather data transfer system network
6. Development of space weather information services: Development of TEC observation system, and Ionosfer Real Time Sintilation
7. Utilization of radio FM for monitoring Irregularity of Ionosfer

Indonesia has also installed a number of instruments to monitor sea level. The existing Indonesia Sea Level Monitoring Network consists of 65 operational stations (Figure 7.4). More stations will be installed through an ongoing programme called the Indonesia Tsunami Early Warning System (IndTEWS). The network will consist of 120 stations of which 80 will use real time data transmission and at least two quality sea level recordings. Solar cell power supplies for each station have been installed to ensure the availability of backup power for continuous measurements.

7.3 Capacity Building, Education, Training and Public Awareness

Climate change capacity building is increasing over the years, particularly in building the local capacities to design and implement mitigation and adaptation activities, and to conduct estimations of GHG emissions. Between 2000 and 2008, Indonesia has conducted about 91 trainings, public awareness programmes and capacity building activities, although this number might be underestimated, since many climate change capacity building activities have not been recorded by the related agencies. At present, there is no system in place to record and monitor the outcomes of the activities. However, the numbers presented in Figure 7.5 may reflect the level of participation in supporting capacity building programmes in Indonesia. Information on Figure 7.5 indicates that most capacity building activities were supported by Japan, Germany, ADB and the World Bank. It is to be noted that the number of activities does not necessarily reflect the amount of funding being provided.

Between the years 2011-2014, in total, there were 41 capacity building events on adaptation that were recorded, ranging from development of educational and training materials, to sectoral training such as for health, agriculture, and fisheries sectors. Events related to mitigation appeared more frequently as shown by the total number of 184 events, which were mostly related to forestry and energy sectors (Figure 7.6).

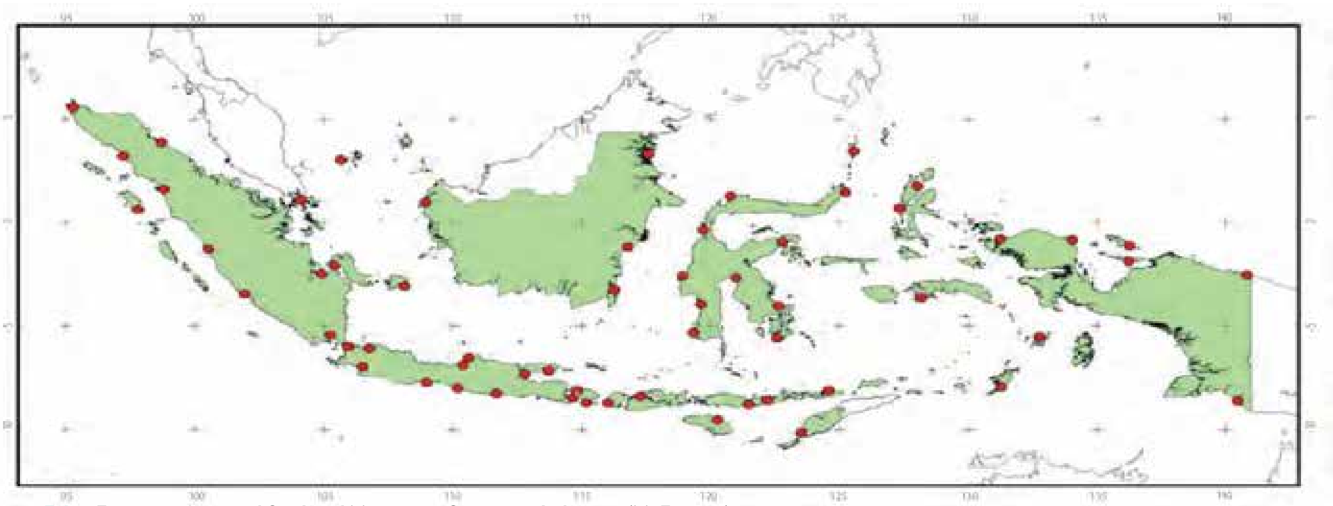


Figure 7.4 Existing operational Sea Level Monitoring Stations in Indonesia (MoE, 2008)

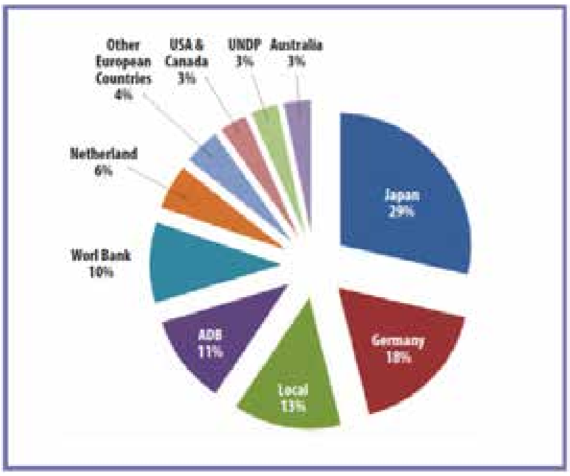


Figure 7.5 Donor countries/agencies who contribute to the implementation of climate change capacity building activities (based on data collected from the Ministry of Environment)

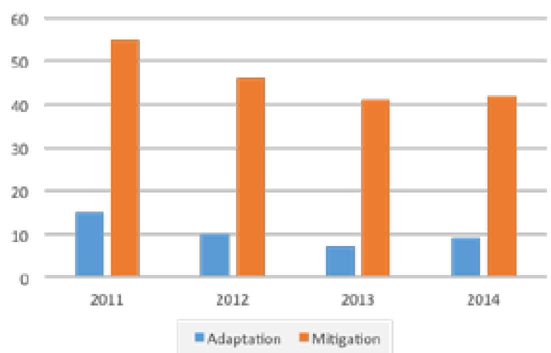


Figure 7.6 Number of capacity building events on climate change

To mainstream climate change into the development plans, capacity building activities were also targeted at decision makers and urban planners at provincial and municipal/district levels. Materials discussed, among others, were identifying and prioritizing potential programmes within the province/district/municipal's development plans that would contribute to climate change mitigation and adaptation. These capacity building activities were organised by Bappenas and MoEF with the supports from a number of development agencies including UNDP, GIZ, DANIDA, JICA, USAID, ADB, World Bank, etc.

Since 2011, climate change topic has been introduced into the school curricula for students from elementary schools to high schools. This effort was initiated by the Ministry of Education and Culture. In addition, BMKG has also developed a Climate Change Curriculum as a reference for teachers in elementary schools, junior high schools, high schools, and marine vocational high school. A number of universities also offered subjects relevant to climate change topic.

7.4 Networking and Information Sharing

7.4.1 Networking

To strengthen the research network among Indonesian scientists on climate change research, the MoEF has facilitated the formation of Indonesian Research Association on Climate Change and Forestry (APIKI). Other related ministries provide supports for research associations such as Agricultural Meteorology Society (PERHIMPI), Soil Scientist Association, Indonesian Agronomy Association (PERAGI), Agriculture Socio-Economic Association (PERHEPI) etc., to conduct joint research related to climate change. These societies/associations play significant roles in providing inputs to the governments in developing national climate change policies. In addition, many Indonesian scientists are also active in regional networkings such as LoCARNet (Low Carbon Asia Research Network).

7.4.2 Information Sharing

To facilitate sharing of information between national and local governments, as well as to communities, Government of Indonesia has developed a number of portals/information systems related to climate change. At present, there are at least 10 portals on climate change, as shown in Figure 7.7.

Ministry of Environment and Forestry established SIGN SMART (signsmart.menlhk.go.id), a portal that provides information on GHG emissions/sinks at national, sectoral and sub-national levels for 5 sectors. MoEF also established SIDIK (http://sidik.menlhk.go.id), that presents data and information on vulnerability index. At provincial to village level data across Indonesia. SIDIK utilises socio-economic, demographic, geography, and environmental infrastructure data from village potentials representing exposure, sensitivity and adaptive capacity. SIDIK will also be used to monitor the impacts of the implementation of adaptation programmes in reducing the vulnerability of the region in question.

Figure 7.7 Climate change portals coordinated by line ministries or institutions in Indonesia

Other portal is ProKlim (http://proklim.menlhk.go.id) that provides public information on various actions implemented by the communities at village level that contribute to climate change mitigation and adaptation. This system will contribute in providing inputs for the formulation of policies, strategies, and programmes related to climate change. ProKlim is expected to strengthen the partnerships of various stakeholders in the face of climate change and to facilitate the dissemination and exchange of information of best practices on climate change adaptation and mitigation. Portal of National Registry System, that is previously described in Chapter II, is provided by MoEF to register and share information on actions and supports on climate change.

RAN GRK/API portal (http://sekretariat-ranapi.org and http://www.sekretariat-rangrk.org) provides information on climate change adaptation and mitigation plans and programmes from sectors.

Ministry of Agriculture (MoA) has developed an information system called KATAM (http://katam.litbang.pertanian.go.id) that can be used by the local governments and communities in supporting planting decision that minimise climate risks. KATAM is an integrated information system providing alternative farming decisions (e.g., planting dates, amount of seeds/varieties/fertilizer, and pest) based on rainfall forecast information. In addition, the MoA also established "Standing Crop" to monitor the growth and development of rice crop as well as drought areas

Another information system is the Indonesian Ocean Forecasting System (http://maritim.bmkg.go.id) developed by BMKG. The system provides forecast information on sea surface temperature (SST) and surface currents (Current Ocean Circulation) that can be used by fishermen to determine proper fishing dates and fishing areas in Indonesia. The Research and Development Centre for Marine and Coastal Resources (P3SDLP) of the MoMAF has also developed a system to monitor fishing zone areas. For example, in estimating areas for Bigeye Tuna located within the Indian Ocean, hook rate is used as an indicator. In addition, the MoRF also have an android-based system to forecast tide.

BMKG in collaboration with GIZ called CCIS (http://ccis.klimat.bmkg.go.id). The system manages climate data and standardised climate change information in Indonesia (Figure 7.8).

BPS established a system that provides information on the environmental condition and efforts to control environmental damage (Figure 7.9).

Figure 7.8 Interface of the Climate Change Information System

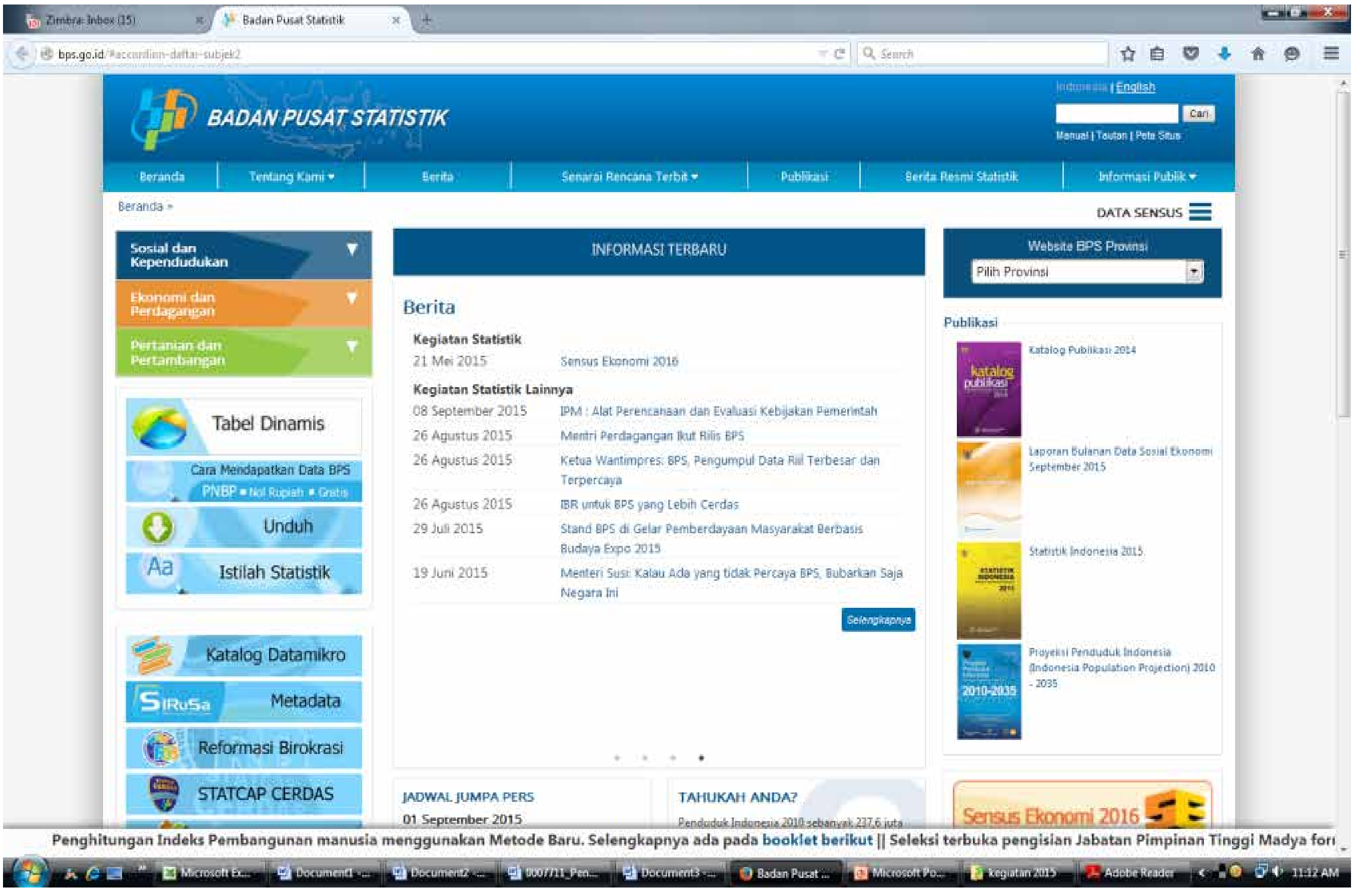


Figure 7.9 Example of BPS webpage compiling statistics in environmental data

LAPAN) has developed a Satellite Disaster Early Warning System, called SADEWA (http://sadewa.sains.lapan.go.id) that provides information on the formation and movement of cloud as well as monitoring the development of tropical cyclone. LAPAN has also developed other information system called Information System for Disaster Mitigation (*Sistem Informasi untuk Mitigasi Bencana - SIMBA*), designed to provide information on disaster management. The SIMBA utilises satellite data such as Terra/ Aqua MODIS, NOAA AVHRR, MTSAT-1R, QMorph, and TRMM to provide information on emergency responses during and after disasters. The information is daily published every 8 days in temporal resolution, and by monthly (Figure 7.10). Moreover, the National Disaster Management Agency (BNPB) developed information system that manages disasters data and presentation of disaster data analysis.

In addition, there are a number of early warning information systems under development and might soon be adopted by the government. These include EWARS system (early warning system) for monitoring dengue, malaria, diarrhea, pneumonia, and ILI (Athena and Anwar, 2012), and Fire Risk System (FRS; http://kebakaranhutan.or.id; Boer et al. 2017).

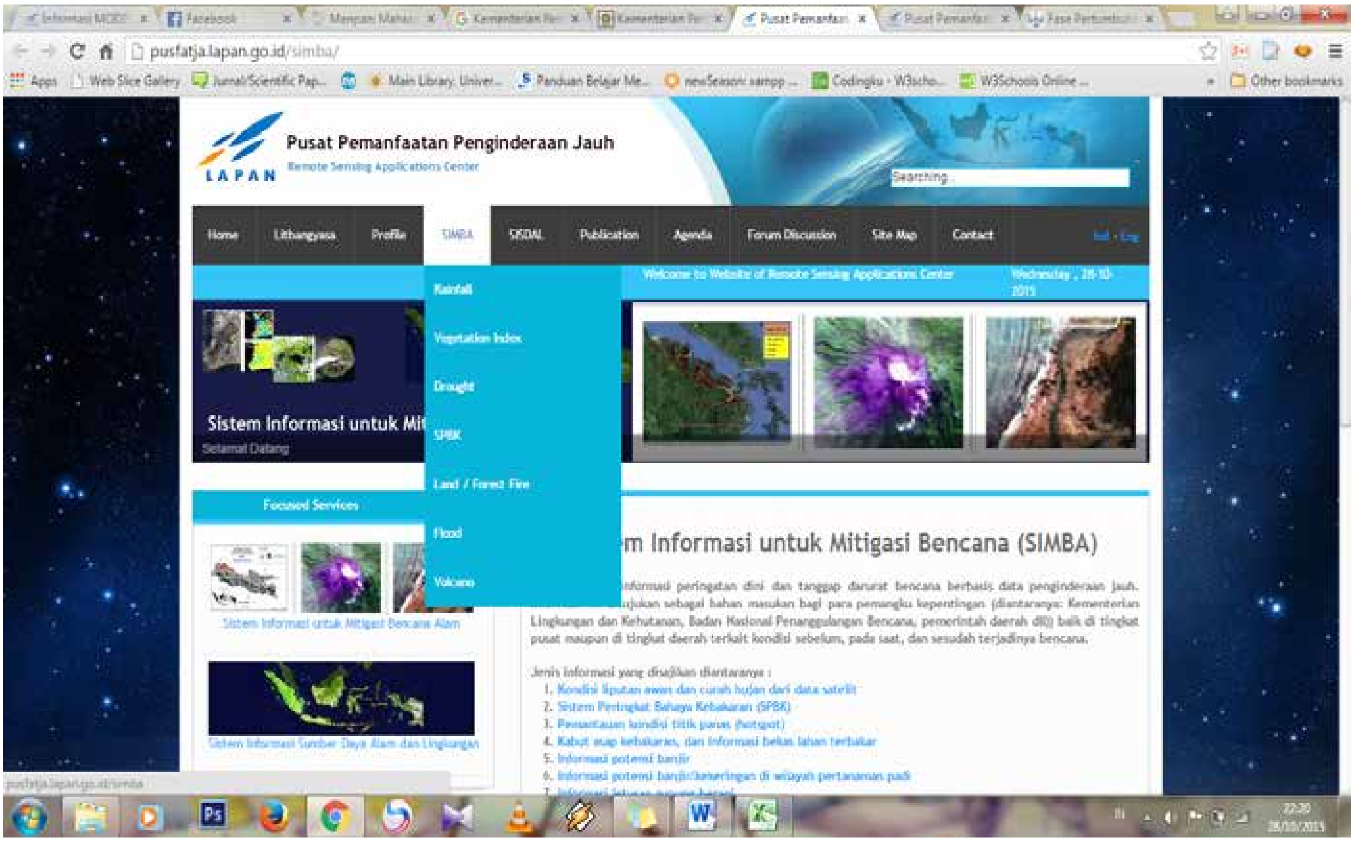


Figure 7.10 Information system for Disaster Mitigation (SIMBA) provided by LAPAN

Source/Location: Directorate of Mitigation MOEF/Waste disposal site, Piyungan, Province of D.I. Yogyakarta

Chapter 8

FINANCE, TECHNOLOGY, AND CAPACITY-BUILDING NEEDS AND SUPPORT RECEIVED

This chapter presents information on finance, technology and capacity-building needs and support received for activities relating to climate change in Indonesia. All three components are instrumental in implementing the country's commitments to improve its resilience from the catastrophic impacts of climate change and to shift toward a low carbon and climate change-resilient development pathways through reducing GHG emissions by 29% compared to the business as usual scenario by 2030, with domestic efforts and up to 41% with international supports, as stated in the Indonesia's Nationally Determined Contribution (NDC) document.

8.1 Financial Needs

Some constraints related to climate finance have resulted from the decreased in the international and domestic climate finance in Indonesia after the fast-start finance period from 2010 through 2012 (Halimanjaya, 2016). Moreover, the enabling conditions for an effective management of climate change, still need to be strengthened, including the institutional setting of climate change landscape..

Other constrains related to climate finance are: (i) lack of capacity to access climate change fund; (ii) lack of coordination and oversight; (iii) absence of country programme and consolidated project pipeline; (iv) lack of private sector involvement, (v) less robust governance and coherence of climate funds in Indonesia, and (vi) lack of capacity for data management to enhance the transparency of climate finance flows. Gaps related to international climate finance are mainly related to its volume and the availability of required matching fund, which is considered too demanding.

Related to climate change mitigation, the financial needs for national supports were identified for the implementation of 13 out of the 22 climate change mitigation projects totalling to USD 4.5 billion for the period of 2015 – 2020. Figure 8.1 and Annex 8.1 indicate that the existing energy and transportation projects are much more ready than agriculture, industry, and forestry and peatland projects. Most of these projects (around 78%) are classified under energy sector, with attached co-financing conditionality, and are faced with various stages challenges related to the financial supports tied to the conditionalities. The financial needs for the other eight mitigation actions listed in the Annex 8.1 have not been determined. Moreover, land based activities particularly forestry, which accounts for the largest emissions reduction target in the RAN-GRK, requires around USD 4 billion investment for the initial 5-Year Phase of REDD+ Related Investment Program in addition to its technical assistance component (IFCA, 2008). The estimation for forestry sector needs is not included in Figure 8.1.

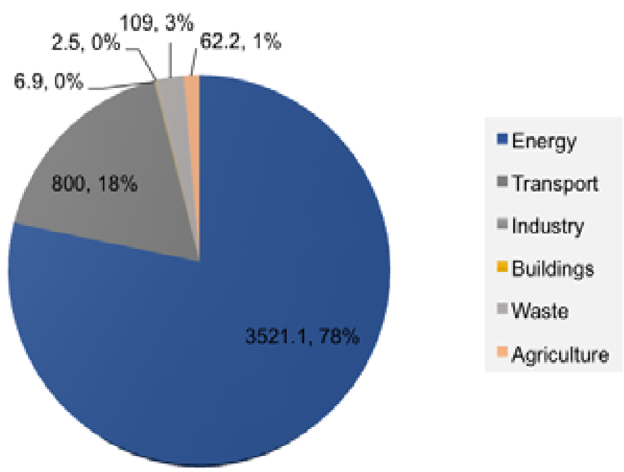


Figure 8.1 **Identified financial needs based on proposed mitigation projects**

Note: The amounts are the accumulated figures from 13 of 22 project proposals or concept notes. This has not fully reflected the need for land based sectors (i.e. forestry and peatland, agriculture)

The estimated funding needs for climate change adaptation activities reached up to IDR 840 trillion (eq. USD 64 billion), which was much higher than the needs for mitigation activities, which is stated in RAN-GRK at IDR 225 trillion (eq. USD 17 billion). Apart from small pilot projects, finance for adaptation activities is still sourced from government budget. Some international financing opportunities for adaptation such as the Adaptation Fund were still not fully utilised. Out of the total USD 10 million allocated to Indonesia by the Adaptation Fund, only around USD 4 million that was allocated, and this allocation was made for the Coastal Resilience Village project. Meanwhile, to access the other USD 6 million, the Directorate General for Climate Change of MoEF, acting as the Adaptation Fund's National Designated Agency and the accredited national implementing entity, *Kemitraan*, is creating an umbrella programme. In addition to the Adaptation Fund, other funding sources for adaptation include the Green Climate Fund as well as other bilateral supports.

Indonesia has implemented several pilot adaptation projects through ICCTF and other channels. The first ICCTF adaptation project was carried out by BMKG in five districts/municipalities across five provinces to improve public awareness on the general impacts of climate change (Halimanjaya and Barnard, 2014). The second ICCTF adaptation project was implemented by the Ministry of Health to assess health vulnerability and conduct community-based adaptation activity. This project was intended to improve the communication and coordination among the national and district level's agency/institutions associated with the Ministry of Health in five provinces, as well as coordination with the Ministry of Education (*ibid*).

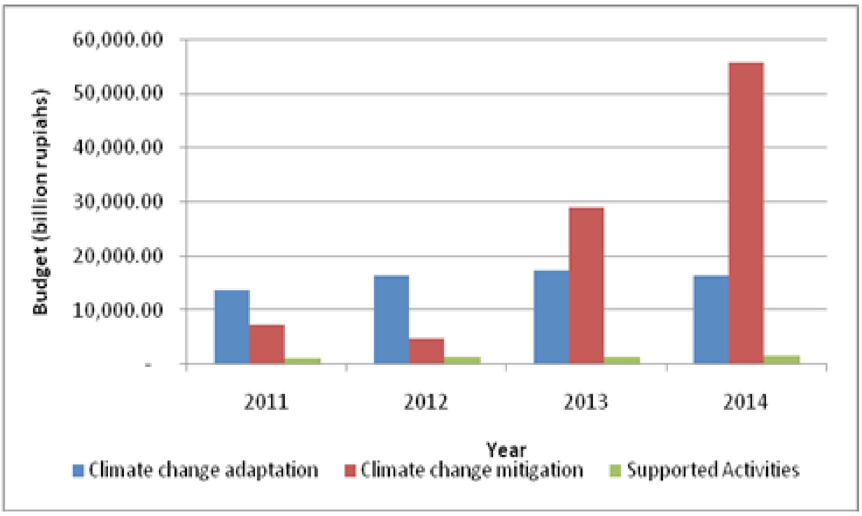


Figure 8.2 **Budget realisation related to climate change in 2011-2014 (BAPPENAS, 2014a)**

8.2 Domestic and International Supports

Financial resources that can be used to implement climate change activities come from both international and domestic funding sources. Funding sources for domestic activities are mainly provided by the government, while international funding sources are provided through multilateral climate finance and bilateral cooperation.

Based on the Government Regulation No. 10/2011 on procedure for obtaining loans and grants, all grants received should be recorded by Bappenas. Thus, the available records for this document to analyse only include the supports received in accordance with the regulations. As Government of Indonesia has committed voluntarily to reduce its emissions using domestic sources, this report will also report the funding sources used for the implementation of mitigation actions.

For the implementation of mitigation actions and development of National GHG inventory as regulated under the Presidential Regulations No. 61/2011 and No. 71/2011, Figure 8.2 shows that Indonesia has significantly increased its expenses for mitigation actions especially after 2012. The funding sources were originated from the State Budget (APBN), of which some were channelled through Government Investment Agency (PIP), the Indonesia Climate Change Trust Fund (ICCTF), and the Millennium Challenge Account Indonesia (MCAI).

In addition to APBN, mitigation actions at local level were implemented using the Local Government Budget (APBD). Similar to APBN, the local government expenses for mitigation actions across sectors, show significant increases after 2011 (Table 8.1). According to Bappenas (2014a), in 2012, most of the financial resources were used to fund forestry activities (Table 8.2). Ministry of Finance (2012) had estimated the amount of funding needed to achieve the voluntary emission reduction target in 2020, including possible contributions from private sectors, in forestry, peatland, energy and transportation sectors would reached a total of IDR 140 billion per annum.

Table 8.1 Number of Activities for GHG emissions Reduction and Budget Realization for RAD-GRK

Sector	2010		2011		2012		TOTAL	
Core Activities								
	Number of Activity	Budget (Billion IDR)	Number of Activity	Budget (Billion IDR)	Number of Activity	Budget (Billion) IDR	Number of Activity	Budget (Billion IDR)
Forestry	150	123	143	150	163	2,701	456	2,974
Agriculture	55	33	101	76	142	43	298	151
Energy	59	70	72	104	78	143	209	317
Transportation	37	62	32	60	37	240	106	362
Waste Management	37	128	209	216	276	589	522	934
TOTAL	338	417	557	606	696	3,716	1,591	4,738
Supporting Activities								
All Sectors	236	80	314	4	249	118	899	4,205

Source: Source: BAPPENAS (2014a)

Table 8.2 Budget contribution for emission reduction and indicative costs

Sources of emission reduction	Emission reduction (tCO2) in 2020	Indicative costs (billion IDR/year)		
		Public	Pri-vate	Total
Maintenance of RAN GRK expenditures based on the year 2012	116	16	0	16
Additional expenditure for RAN GRK according to GDP	31	4	0	4
Improvement of budget's effectiveness from the existing expenditures	78	1-2	0	1-2
Emissions from power plants 26% lower, including geothermal	104	15-45	15-45	40-70
Policy to limit deforestation up to 450,000 ha/year	260	1-2	20-30	21-32
Emission reduction needed from new initiative	121	6	11	17
RAN GRK target for forestry, peatland, energy and transportation	710	45-75	45-85	100-140
Emission reductions from agriculture, industry, and waste	57	Is not included in the report		
RAN GRK's total target	767			

Source: Source: Ministry of Finance (2012)

Over the period of 2011 – 2014, the Government of Indonesia has spent IDR 8.7 billion or approximately USD 655 million for forestry projects, development of pre-conditions for REDD+, and carbon stock enhancement namely forest management unit development; development plan for the improvement of forest enterprises; development of environmental services, establishment of forest boundaries; development of social forestry, forest fire control; investigation and forest security; development of protected areas; ecosystems and capacity building; and improvement of forest plantations (MoEF, 2017). Through the Ministry of Environment and Forestry, the Government of Indonesia has allocated approximately IDR 5.9 billion for the implementation of mitigation supporting activities in forestry for the period of 2018-2019.

Meanwhile, the volume of grants received during 2011-2014 from bilateral and multilateral public climate finances, was channelled through the arrangements recognised by UNFCCC and recorded by the country. The total grant was USD 202.1 million[1] with greater allocation for supporting mitigation activities than adaptation activities (Figure 8.3), although in total, the figure is still far below the financial requirement.

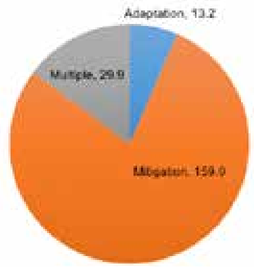


Figure 8.3 Approved climate finance in Indonesia during 2011-2014 (in USD million)

Note: Data only covers grants. Data sources: the Ministry of Environment and Forestry and the Ministry of Finance.

[1] The amount may be underestimated, as not included in this report, are other climate finance such as loan, equity and grants provided by international NGOs that are directly channeled to beneficiaries without being reported to the Ministry of Finance.

Financial supports from the international community came in various forms, e.g. grant, soft loan, mix of grants and performance-based grant. The latter is currently applied for REDD+ activities under bilateral cooperation with Norway. To manage the supports received, Government of Indonesia has established institutional arrangements such as ICCTF and PIP. Aside from these, there are also direct bilateral arrangements between donors and sectors.

1. Indonesia Climate Change Trust Fund

The Indonesia Climate Change Trust Fund (ICCTF) was established in 2009 and was formalised through a multi-stakeholder engagement process to discuss various policy-level issues, including reviews of progress and determination of resource allocations and project selection (Halimanjaya 2014). Since its establishment, ICCTF has managed USD 21.1 million: USD 11.4 million to conduct 6 large pilot projects and several small projects during its preparation phase (2010-2014) and EUR 4.5 million from GIZ in the form of technical assistance, USD 224,000 from DANIDA, USD 5.3 million from USAID, and USD 4.2 million pledge from the UK's International Climate Fund in the period of 2015-2016. To improve its governance and fiduciary standards, the ICCTF requires further capacity building so that it would be able to channel funding from international climate funds such as Adaptation Fund and Green Climate Fund.

2. Global Environment Facility

The Global Environment Facility (GEF) is the longest-standing multilateral climate change fund. Indonesia joined the GEF in 1991 and since then has work closely with the UNDP, UNEP, ADB, WB, and UNIDO as multilateral implementing agencies. Since 2011, the Government of Indonesia has received USD 29 million from the GEF, of which USD 4.5 million is to support national communication to the UNFCCC over the period of 2013-2016. The GEF support for national communication has been valuable in improving Indonesia's capacity to conduct monitoring, reporting and verification of GHG emissions and conduct assessments related to climate change adaptation. The project has made achievements despite its limited resources and wide coverage of activities. In parallel with the USD 4.5 million GEF grant and a USD 61,000 UNDP grant, the Government of Indonesia and the UNDP have both supported the activities in the form of in-kind contributions, jointly performed with some other bilateral grants from GIZ (USD 150,000) and JICA (USD 6.1 million).

3. Green Climate Fund

The National Designated Authority (NDA) of Green Climate Fund is placed under the Fiscal Policy Agency of the Ministry of Finance since early 2016. Since its appointment, the NDA has been preparing the process of no-objection procedure and the nomination of national implementing entity as suggested by the GCF and in accordance with best practices provided by the GCF. The NDA has received a bilateral assistance from the UK government through the Climate Development Knowledge Network as part of its readiness process. This covers capacity gap assessment, recommendations for institutional set up of the NDA secretariat, governance, legal basis, website, an interim no-objection procedure to endorse project proposals seeking funding from the GCF, and an interim procedure to nominate institutions to be accredited as the GCF's national implementing entity, with the right to channel funding from the GCF.

From 2008 to 2014, a grant totalling to IDR 1.178 trillion was received. This amount is much less than the announced global level at USD249.79 million (eq. IDR3.04 trillion). This discrepancy may be due to the global announcement by the donor prior to entering an agreement with the Government of Indonesia. In addition, funding from donours might go directly to non-government organizations without being recorded by the GoI.

In addition to the grants, loans are also provided by international funding agencies to support the implementation of climate change activities. It was reported that the loans allocated for Indonesia amounted to USD 323 million (www.climatefundsupdate.org/data). However, detailed information on loans is not provided in this document, as the GoI does not consider loans as support since the government has the obligation to pay back the loans.

Considering that transparency is an important tool for climate finance, the Directorate General of Climate Change of the Ministry of Environment and Forestry, has built a National Registry System (NRS) that has been operating since mid 2016. In parallel, the Ministry of Finance has developed budget tagging system and marking exercise for climate finance.[2] The budget tagging and marking exercise have been conducted since 2014 in addition to a climate finance mapping exercise with the support of Climate Policy Initiative (CPI). Both initiatives aimed at tracking government expenditures for climate change purpose.

The Budget Tagging Application System is developed as the result of the on-going support from UNDP. The system is regulated under the Minister of Finance Regulation (PMK) Number 136 of 2014. Although the exercise is regulated, but it is done voluntarily, hence it has resulted in some inconsistencies over the years. The Ministry of Finance is currently underway to engage all lines ministries and some pilot provinces in budget tagging and marking exercise. Some activities such as tracking private climate financing would remained as a gap, since tracking private financing is often challenging due to the large market and scope of Indonesia and the confidentiality of financial data of the private sectors.

On July 2017, the Ministry of Finance disseminated information on the process of tagging on budgets for climate change mitigation and adaptation, through a system called KRISNA (*Kolaborasi Perencanaan dan Informasi Kinerja Anggaran* – Collaboration in Planning and Information on Budget Performance). The trial of the tagging was conducted using year 2006 and 2017 budgets. One of the challenges that emerged during the tagging process was lack of definition of activities that would be classified as supporting mitigation and adaptation actions. Therefore, further support to develop identifiers is required.

8.3 Technology Needs

The Republic of Indonesia has submitted the Second Technology Needs Assessment (TNA), under the Global Technology Needs Assessment (Global TNA), UNEP in 2012, consisted of Mitigation and Adaptation Reports. Under the Mitigation Report, it was concluded that the Global TNA comprised of the three major contributing sectors, i.e. (1) forestry-including peat, (2) energy, and (3) waste (Republic of Indonesia, 2012a). Following the mitigation TNA, technology prioritisation was listed from which the highest values of technology from each sector were then selected (see Table 8.3). The identified main constraints for the transfer of technology include the lengthy time that was required to procure components from abroad, and the existing limited monitoring capacity for low carbon technology.

Table 8.3 List of technology prioritisation based on mitigation TNA

Sector	Technology Needs
Forestry	1. Technology for measurement and monitoring of carbon sequestration and emission technology 2. Technology for peatland re-mapping 3. Technology for water management
Energy	1. Technology for photovoltaic 2. Technology for efficient electric motor 3. Technology for Mass Rapid Transit (MRT)
Waste (Municipal Solid Waste Treatment)	1. Technology for Mechanical-Biological Treatment 2. In-vessel composting technology and low-solid anaerobic digestion

Source: Source: Republic of Indonesia (2012a)

Technology needs for adaptation have also been identified for each sector as presented in Table 8.4 Since climate change impacts vary both temporally and spatially, adaptation needs also vary across locations. The identified adaptation needs are listed in Annex 8.2.

[2] Budget tagging and marking initiative involved 6 key ministries namely Ministry of Environment and Forestry, Ministry of Agriculture, Ministry of Energy and Mineral Resources, Ministry of Transport, Ministry of Industry, and Ministry of Public Works and Housing, on a voluntarily basis. All participating ministries have tagged and marked their budgets to generate data for the period of 2014-2017. Each output is tagged when it contributes to the (1) reduction of GHG emissions, (2) capacity improvement for reducing GHG emissions, and (3) stabilisation and the conservation of carbon stocks (MoF, 2017).

Table 1.1 List of technology prioritisation based on adaptation TNA

No.	Sector	Technology Needs
1.	Agriculture	Crop insurance, food diversification, modification of planting media, crop replanting, development of tolerant varieties, simulation technology, utilisation of superior varieties, forecasting of planting and harvesting time (adjustment of growing season), increasing crop productivity, development of irrigation technology
2.	Water Resources	Sea water desalination, water use efficiency, building dams, building new water treatment plant, rehabilitation of damaged watershed, rainwater harvesting, building water storage system, water purchase, protection of water source, deepening wells, water allocation and supply, storage improvement
3.	Forestry	Agroforestry system, ecotourism development, environmentally agricultural technology, control of pests and diseases, plant type adjustment
4.	Urban	Mitigation disaster, water resources management, yard management, promotion of sustainable development, early warning system, media communication

Supports for technology development and provision have come from various multilateral agencies and through bilateral cooperation. Table 8.5 below shows examples of assistance received in meeting country-specific technology needs.

8.4 Capacity Building Needs

Capacity building is required for the implementation of mitigation actions such as those developed by sectoral ministries, privates as well as the communities. Capacity is needed not only to strengthen the skills to implement the technologies, but also to monitor GHG emissions and to measure the achievement in emission reduction. Therefore, capacity building ought to be directed towards: (i) increasing sectoral capacity in developing sectoral and sub-sectoral baseline/reference emission level as the basis for measuring the achievement of mitigation actions; (ii) enhancing the capacities of agencies responsible for collecting and understanding data and in developing templates to facilitate data collection; and (iii) developing functional database for tracking information on GHG emissions, effects of mitigation actions, financial flows from donour countries/funds, capacity building and technology transfer activities. Targets for this capacity building are the divisions or bodies within ministry/institution who are responsible for developing, coordinating and monitoring the implementation of sub-sectoral mitigation actions as well as agencies responsible for data collection on implemented mitigation programme/activities. In addition, awareness rising activities need to be implemented in an integrated way, not only for the government agencies, but also for private sectors who have the potential to participate in the implementation of mitigation actions.

The sectoral ministries have identified the types of capacity building activities necessary for the implementation of NAMA activities. The activities spanned from capacity strengthening to develop mitigation strategies and supporting regulations, application of mitigation technologies, to development of MRV system. At least there were 13 capacity building activities required by the sectoral ministries (see Annex 7.3 for detail) of which 7 had association funding estimations, which comes to a total of about USD 25 millions (Table 8.6).

Table 8.4 Examples of Technology Supports Received

No.	Country-specific technology needs	Assistance received from developed country parties	Time Frame	Institution
1	• Environmentally friendly, for example electric car • Renewable Energy Fuel, for example Bio-diesel • Low budget and environmentally friendly Carbon Capture Storage (CCS)	Asian Development Bank for CCS	2011-2012 2016-2016	Centre For Research and Technology Development of Oil and Gas, Ministry of Energy and Mineral Resources (PPPTMGB LEMIGAS, KESDM)
		World Bank for CCS	2014-2015	
		MHI and JCOAL Japan for CCS	2012-2011	
		UK Government	2013-present	
2	• GHG mitigation technology on paddy field and paddy variety	USA; for research on paddy variety, testing of efficient nitrogen fertilizer for paddy field	2014-present	Environmental Research Center, The Ministry of Agriculture
3	• Amelioration and fertilizer utilization to improve efficiency and GHG emission reduction	Japan; for research on emission reduction technology with intermittent irrigation method from NIAES.	2013-present	

Table 8.5 Number of capacity building activities and support needs

Types of capacity building	No. of Activities	Total funding (million USD)	Support required (million USD)
Development of mitigation strategies including supporting regulations	4	18.25	18.25
Application of mitigation technologies	1	2.54	NC
	4	NC	NC
Development and implementation of MRV system	2	4.25	4.25
	2	NC	NC
Total	13	25.04	22.50

Note: NC = Not communicated

Annex 8.1 List of climate change mitigation projects

No.	Data/Information	Total Amount (USD/ IDR)	Remarks	Sector	Period	Proponent
1	Sustainable Urban Transport Initiative*	USD 800m	USD 16.2 m funded	Transport	2013 – 2021	Ministry of Transport
2	Small and medium scales renewable energy installation in North Sumatra	1st phase USD 9m, 2nd phase US$ 200m, implementation phase for 1.8GW requires USD 2.65bn	No data	Energy	N/A	No data
3	Efficient cooling and air conditioning in industry and business	No data	EUR 4.1m financed	Energy	2014-2018	Ministry of Energy and Mineral Resource
4	Renewable energy *	No data	None	Energy	N/A	Ministry of Energy and Mineral Resources
5	Cement Industry*	EUR 2.2m (USD 2.4m eq.) In 2016, USD199k was spent on developing criteria and standards	Proposal is waiting for MOI approval	Industry	N/A (until 2020)	Ministry of Industry
6	Solar PV Pilot Project in Government Buildings of DKI Jakarta	USD 2.5m	Funded	Buildings	2015-2019	No data
7	Debottlenecking project finance for least cost renewable in Indonesia*	EUR 200m (USD 218m eq.)	Funded	Energy	2016-2020	Directorate General of New, Renewable Energy and Energy
8	Solid waste management *	EUR 100m (USD 109m eq.)	No data	Waste	2014-2019	Ministry of Environment, Ministry of Public Works, Ministry of Home Affairs
9	Utilization of Used- Cooking Oil Biodiesel in Commercial Building in Bogor City*	USD 0.5m	Seek for financing	Energy	2015-2020	Bogor City
10	Community Forest Partnership for Wood Biomass Based Energy	No data	Not known	Energy	2015-2020	Directorate of Social Forestry , MoEF
11	Smart Street Lighting Initiative (SSLI)*	USD 294m	US$ 19m	Energy	2014-un-known	Ministry of Energy and Mineral Resources, ICCTF
12	Energy Efficiency Measures in City Hall/DPRD DKI Jakarta Office	USD 4m; Rp. 217m (USD 16.6k eq.) for the cost of Green Building certification; IDR 1 bn for the cost of building management system (USD76m)	Seek for financing	Energy	2015-2019	No data
13	Green Chillers and Industrial Energy Efficiency Program in Indonesia*	EUR 4.1m (USD 4.5m)	Not known	Industry	2014-2018	Directorate General of New Renewable Energy and Energy Conservation, Directorate of Energy Conservation, MEMR
14	Common Accounting Framework for Energy*	No data	£335k funded	Energy	2014-2016	Ministry of Energy and Mineral Resources
15	TransJabodetabek*	No data		Transport	N/A	Government of DKI Jakarta
16	Smart Paddy Agriculture*	No data		Agriculture	N/A	Ministry of Agriculture
17	LAMA MORRE (Mining for Rural Renewable Power – Locally Appropriate Mitigation Action)*	EUR 22m (USD 24m eq.)	Seek for financing	Energy	2016-2021	Ministry of Energy and Mineral Resources, Ministry of Environment and Forestry, PT PLN, Government of East Kalimantan
18	POME LAMA (Palm Oil Mill Effluent - Locally Appropriate Mitigation Action)*	EUR 33.1m (USD 36m eq.)	Seek for financing	Energy	2017-2021	Government of East Kalimantan
19	Sustainable Wood Energy and Enhanced Technology*	No data		Energy	N/A	ICCTF; Ministry of Environment and Forestry
20	Dynamic Cocoa Agroforestry*	EUR 57.1m (USD 62.2m eq.)	Seek for financing	Agriculture	N/A	Ministry of Environment and Forestry
21	Pulp and Paper project*	No data		Industry	2016-un-known	Ministry of Industry
22	Fertilizer project*	No data		Industry	2016-unknown	Ministry of Industry
	Financial needs to achieve NDCs					

No.	Data/Information	Total Amount (USD/ IDR)	Remarks	Sector	Period	Proponent
	Energy					
	• Electrification in the period of 2016-2025 excluding private investment by independent power producers**	USD76.5m		Energy		PT PLN
	• Non-electrification					
	LULUCF	Not aggregated				
	• Forestry					
	• Non-forestry					
	Financial needs to implement RAN API	No data***	No data*	Various		No data***

Source: NAMA database http://www.nama-database.org/index.php/Indonesia, *** RAN – API lists of strategies and action plans for climate change adaptation but points out the gap that no policies on funding of adaptation to climate change that have specifically been developed for supporting the implementation of the action plans in Indonesia. This will be further discussed in the section below. ** RUPTL (2016-2025) using the estimate of RUKN of investment for 1MW in average is about USD1.5m. * identified in RAN-GRK http://www.sekretariat-rangrk.org/images/documents/RAN-GRK_Laporan_Tahun_2015.pdf. The projects may not yet be implemented and only at the study phase.

Annex 8.2 List of technology needs for climate change adaptation in various sectors

Sector	Adaptation Needs	Proposed Technology Adaptation	Source	Year
Coastal - marine and fisheries	Diversification of revenues/ Extensification of job creation		Rindayati, Susilowati, and Hendrarto	2013
	Application of a variation of fishing gear	Application of modern technology for fishing gear variation		
	Expansion of fishing area during fishing season	Development of transportation technology weapons use mapping engine boat and catch fish with Global Positioning Systems (GPS)		
	Mangrove zoning	Dike Building (on impacts flooding/*rob*) and Beach Nourishment (for the effects of erosion)	Elizabeth Mcleod, Robert J. Nicholls, Jochen Hinkel, Nick Harvey, Athanasios T. Vafeidis, Rodney Salm	2010
	Ability to withhold sea level rise; Ability to improve productivity of fisheries	• Detached Breakwater • Water Gate and Tidal Barriers • Floodwalls System • Groyne • Artificial Sand Dunes • Coastal Restoration • Beach Reclamation • Beach Protection • (Seawall and Revetment)	Bappenas	2012
Agriculture	Food diversification	Development of technology for manufacture of high-yielding varieties	Elza Surmaini, Eleonora Runtunuwu and Irsal Las	2010
	Modification of planting media	Implementation of TOT technology (Without Land – *Tanpa Olah Tanah*)	Zainal Lamid	2011
	Increasing crop productivity			
	Crop replanting			
	Improvement of farming activities	Adaptation technology in cashew: development of varieties, development of water-saving technology; water drip irrigation technology	Handi Supriadi and Nanana Heryana	2011
	Utilisation of superior varieties	Cultivation technology (tolerant and superior varieties)	Silvana Maulidah, Heru Santoso, Hadi Subagyo and Qiki Rifqiyyah; KLH (Riminta and Handoko)	2012
	Simulation technology	Technology of replanting crops; modelling and forecasting agricultural productivity and crop losses		
	Forecast of harvest time	Development of dynamic cropping calendar	Hannah Forster, Marta Moneo-Lain, Rizaldi Boer, Till Sterzel, Christian A. Pape, Insa Niemeyer, Jurgen P. Kropp	2011
Food Security	Climate Prediction : · Information technology for climate forecasting · Fast and accurate information technology on climate · Information technology of early warning system for flood	Well distribution of climate forecasting	Bappenas	2012
Water Resource	Sea water desalination	Sea water desalination technology (separating salt from seawater)	Amalia, Bunga Irada and Agung Sugiri	2014
	Efficiency of water use	Water recycle by treatment plants dan *greywater recycling*	Dewi G. C. Kirono, Anne Leitch, Roland Barkey, Silva Larson, Luis Neumann, Amran Achmad, Grace Tjandraatmadja, Shiroma Maheepala, Mary Selintung	2014
	Establishment of a new water treatment plant	Fresh water management technology based industry		
	Establishment of water storage system	Ground water recharge and infiltration technology	Wiwin Widiyanti, Andrea Dittmann	2014
	Harvesting of rainwater	Rainwater harvesting and storage through Pamsimas	Amalia, Bunga Irada dan Agung Sugiri; USAID dan IUWASH	2014
Land and water conservation	• Land reclamation • Land optimization • SRI • Intermittent irrigation Cultivation	• Agricultural land and water conservation • Adaptive technology for agriculture infrastructure and facilities	Bappenas	2012

Sector	Adaptation Needs	Proposed Technology Adaptation	Source	Year
Forestry	Agroforestry System	• Development of agroforestry technology and as an ecotourism area • Wood selection	Herry Purnomo & Hety Herawati & Heru Santoso; Rina Laksmi Hendrati, Asri Insiana Putri, Dedi Setiadi	2012
	Ecotourism development			
	Environmental friendly technologies			
Special Region (Urban/ Rural)	Development of ecotourism	Disaster management through the application of technology and spatial mapping	Mochamad Chazienul Ulum	2013
	Proper spatial planning			
	Management of natural resources			
	Management of dry land			
	Efficiency in energy	Energy-efficient and environmentally friendly	Oot Hotimah	2013
	Early Warning System	Weather modification for disaster management of land and forest fire smoke	Budi Harsoyo	2013
	Promotion of sustainable development	Communication technologies and efficient campaign through social media		
	Communication media			
Health	Promotion of health programs	Software development and surveillance model/system on the health impacts of climate change	Athena, D. Anwar M	2013
	Training of health workers	Early warning system: Surveillance and EWORD (early warning outbreak recognition system)	Dharma Susanto	2011

Annex 8.3 Capacity building needs

Types of Capacity Building	Capacity Building Activities	Status (Identified/ Planned/on-going/ completed)	Cost for Overall capacity-building needed (a)	Support received (b)	Additional Support needed (c)
Development of mitigation strategies including supporting regulation	1. Capacity building in NAMAs development for public and private sectors (strategy development, identification of NAMAs candidates, training in NAMAs development)	Planned (2015 – 2020)	USD 10 million	-	USD 10 million
	2. Development of Low-Emission Development strategy in energy intensive industries	Planned (2015 – 2020)	USD 5 million	-	USD 5 million
	3. Development of strategy for regulating GHG emissions from high-emitting entities (industries, commercial sector)	Planned (I2015 – 2020)	USD 2 million	-	USD 2 million
	4. **NAMA's Agriculture:** Capacity building on participatory planning for synergizing adaptation and mitigation actionS **Contact:** Fahmudin Agus Email: fahmudin@yahoo.com	Identified by Research and Development staff	IDR 15 Billion (USD 1.25 Million)	Seeking Support	IDR 15 Billion (USD 1.25 Million)
Application of mitigation technologies	5. **NAMA's Agriculture:** Capacity building programme for low carbon farming empowerment of Indonesia coffee farmers	Identified by the letter of Planning Bureau of Agriculture (Sep 2014)	IDR 30.5 Billion (USD 2.54 Million)	Seeking Support	Not communicated
	6. **Peat water management:** National capacity building for peatland water management technology	Identified from TNA (2012)	Not communicated	Seeking Support	Not communicated
	7. **Photovoltaic (PV) Technology:** Capacity building for human resources capability to: Develop national PV Industry at 50 MWp capacity (minimum) Increase of testing capacity of PLTS system Improvement of PV cell manufacturing laboratories (crystalline)	Identified from TNA (2012)	Not communicated	Seeking Support	Not communicated
	8. **Regenerative Burning Combustion System (RBCS) Technology:** Capacity building for improvement of human resources capabilities in the construction, operation, and maintenance of RBCS in selected steel industries, Capacity building for improvement of local human resources in RBCS and control room design.	Identified from TNA (2012)	Not communicated	Seeking Support	Not communicated
	9. **Technology for waste management**, i.e. Mechanical Biological Treatment (MBT), In-Vessel Composting (IVC), Low Solid Anaerobic Digestion (LSAD). Capacity building for improving the capacity of Indonesian researchers and users by foreign experts through training, tutoring and knowledge transferring during practical work at the plant. Technology innovation during MBT operation should be accompanied by an agreement, especially related to Intellectual Property Rights (IPR).	Identified from TNA (2012)	Not communicated	Seeking Support	Not communicated
MRV (including mapping)	10. **Capacity building in MRV** (strategy development, benchmarking with other countries, training in MRV)	Planned (2015 – 2020)	USD 3 million	-	3 million US$
	11. **NAMA's Agriculture** Capacity building on agricultural carbon accounting at district level **Contact**: FahmudinAgus Email: fahmudin@yahoo.com	Identified by Research and Development staff	IDR 15 Billion (USD 1.25 Million)	Seeking Support	IDR 15 Billion (USD 1.25 Million)
	12. **Prioritized Technology on Forestry Sectors:** National capacity building on technology for forest-peat carbon measurement and monitoring	Identified from TNA (2012)	Not communicated	Seeking Support	Not communicated
	13. **Prioritized Technology on Forestry Sectors identified**: National capacity building on technology for forest, Unified peat re-mapping technology	Identified from TNA (2012)	Not communicated	Seeking Support	Not communicated

References

Abdurahman, Oman, Iman, Munib Ikhwatul, Riawan, Edi, Setiawan, Budhi, Puspita, Norma, & Fad, Zamsyar Giendrha. (2012). Climate risk and adaptation asessment for the water sector- South Sumatera: Kementerian Lingkungan Hidup.

ADB, Center, Worldfish, & PRIMEX. (2014). Coastal and marine resources management in the coral triangle: Southeast Asia (RETA 7813). Philippines: PRIMEX.

ADB, Initiative, Coral Triangle, & GEF. (2014). State of the coral triangle : Indonesia (1 ed., Vol. 1, pp. 1-57). Philippines: ADB, Coral Triangle Initiative, GEF.

Adiatma, Ira , Bambang, Azis Nur, & Purnaweni, Hartuti. (2013). *Adaptasi Nelayan Terhadap Perubahan Iklim dalam Pemanfaatan Ruang Pesisir (Studi Kasus: Desa Batu Belubang, Bangka)*. Paper presented at the Prosiding Seminar Nasional Pengelolaan Sumberdaya Alam dan Lingkungan, Universitas Diponegoro, Semarang.

AF (2016) http://www.adaptation-fund.org/wp-content/uploads/2015/09/Full-proposal-WFP-Indonesia-to-AFB_with_reconfirmation_reduced.pdf

Agency for the Assessment and Application of Technology of Indonesia. 2015. Indonesia Energy Outlook 2015. Jakarta: Agency for the Assessment and Application of Technology of Indonesia.

Alam, M (2013). Climate Change: Technology Transfer under the UNFCCC. Link: http://www.unep.org/climatechange/Portals/5/documents/RoapFocalPoints/001%20Climate%20Change%20%20A%20Perspective%20post%20COP%2015.pdf (13.01.2017)

Aldrian, E., & Susanto, R.D. (2003). Identification of three dominant rainfall regions within Indonesia and their relationship to sea surface temperature. *International Journal of Climatology, 23*, 1435-1452. doi: 10.1002/joc.950

Amalia, Bunga Irada, & Sugiri, Agung. (2014). Ketersediaan Air Bersih dan Perubahan Iklim: Studi Krisis Air di Kedungkarang Kabupaten Demak. *Jurnal Teknik PWK, Volume 3*(2), 295-302.

Anggraini, Nanin, & Trisakti, Bambang. (2011). Kajian Dampak Perubahan Iklim terhadap Kebakaran Hutan dan Deforestasi di Provinsi Kalimantan Barat. *Jurnal Penginderaan Jauh, Volume 8*, 11-20.

Anita, Juarni , & Latief, Hamzah. (2013). *Coastal Flooding Adaptation by Housing Adjustment in Coastal Settlements Case Studies : Muara Angke, North Jakarta and Tambak Lorok, Semarang*. Paper presented at the The Second Planocosmo Conference, Bandung. Paper retrieved from

Antara (2014). LSM Teknologi Indonesia diundang pelatihan ke Swedia. Link: http://www.antarabogor.com/berita/10500 (06.03.2017)

Ariyanto, Shodiq Eko (2010). Kajian Dampak Perubahan Iklim terhadap Produktivitas Kacang Hijau (Phaseolus Radiatus L.) di Lahan Kering.

Arsana, I Made Andi (2013). The Sinking of Sovereignty and Sovereign Rights ? Mitigating the Impacts of Climate Change to Maritime Jurisdiction and a Proposal for Solutions. *INDONESIA Law Review, Volume 2*, 125-149.

Asner, Gregory P., Loarie, Scott R., & Heyder, Ursula. (2010). Combined effects of climate and land-use change on the future of humid tropical forests. *Conservation Letters, 3*(6), 395-403. doi: 10.1111/j.1755-263X.2010.00133.x

Athena, & M, D. Anwar. (2013, 04-09-2013). PENELITIAN/PENGEMBANGAN MODEL/SISTEM SURVEILANS DAMPAK KESEHATAN PERUBAHAN IKLIM. *Buletin Penelitian Kesehatan, Volume 42*, 46-58.

ATTC, 2017. What is Technology Transfer? (http://www.attcnetwork.org/about/techtransfer.aspx (31.01.2017)

Bachtiar, Huda , & Novico, Franto. (2010). ANALISIS SPASIAL POTENSI BAHAYA

DAERAH PANTAI TERHADAP PERUBAHAN IKLIM (STUDI KASUS: PULAU BALI). *Kolokium Hasil Penelitian dan Pengembangan Sumber Daya Air*, 1-14.

Badan Pusat Statistik (BPS) Indonesia. 2000 - 2015. *Statistik Industri Manufaktur Indonesia 2000-2015*, Jakarta.

Bahri, Sjamsul, & Syafriati, T. (2011). Mewaspadai Munculnya Beberapa Penyakit Hewan Menular Strategis di Indonesia Terkait Dengan Pemanasan Global Dan Perubahan Iklim. *Jurnal Wartazoa, Volume 21*(1), 25-39.

Bakker, Laurens (2014). *Permasalahan Kehutanan di Indonesia dan Kaitannya dengan Perubahan Iklim Serta REDD+* (L. Bakker & Y. Fristikawati Eds. 1 ed.). Yogyakarta: PENERBIT POHON CAHAYA (Anggota IKAPI).

Balai Penelitian dan Pengembangan Pertanian. (2011). *Pedoman umum adaptasi perubahan iklim sektor pertanian*. Indonesia: Balai Penelitian dan Pengembangan Pertanian

Banu, Shahera, Hu, Wenbiao, Hurst, Cameron, & Tong, Shilu. (2011). Dengue transmission in the Asia-Pacific region: impact of climate change and socio-environmental factors. *Tropical Medicine & International Health, 16*(5), 598-607. doi: 10.1111/j.1365-3156.2011.02734.x

Bappenas, 2017, http://www.sdgsindonesia.or.id/index.php/sdgs-di-indonesia

BAPPENAS. 2010. *Policy Scenarios of Reducing Carbon Emission from Indonesia's Peatland*. National Development Planning Agency, UK-Aid and British Council, Jakarta.

Barnett, Jon. (2010). Adapting to climate change: three key challenges for research and policy–an editorial essay. *Wiley Interdisciplinary Reviews: Climate Change, 1*(3), 314-317.

Benestad, R. E. (2005). Climate change scenarios for northern Europe from multi-model IPCC AR4 climate simulations. *Geophysical Research Letters, 32*, 17704. doi: 10.1029/2005GL023401

Bergant, K., & Kajfez-Bogataj, L. (2005). N PLS regression as empirical downscaling tool in climate change studies. *Theoretical and Applied Climatology, 81*, 11-23.

BMKG, & JICA. (2013). Pembuatan peta perubahan iklim terhadap sektor pertanian di Bali (Pertanian, Trans.). Jakarta: Pusat Perubahan Iklim dan Kualitas Udara Deputi Bidang Klimatologi BMKG.

Boer, R. 2012. *Sustainable Forest Management, Forest Based Carbon, Carbon Stock, CO_2 Sequestration and Green Product in Order to Reduce Emission from Deforestation and Forest Degradation*. International Timber Trade Organization and Indonesian Ministry of Forestry, Jakarta.

Boer, Rizaldi, & Subbiah, A.R. (2005). Agriculture drought in Indonesia. In V. K. Boken, A. P. Cracknell & R. L. Heathcote (Eds.), *Monitoring and predicting agriculture drought: A global study*. New York Oxford University Press.

Boer, Rizaldi, Faqih, Akhmad, Ardiyansyah, M., Kolopaking, Lala, Rakhman, Adi, Nurbaeti, Beti, . . . Impron. (2013). Rencana aksi mitigasi dan adaptasi perubahan iklim dalam kerangka pengelolaan sumberdaya air di DAS Citarum di Kabupaten Bandung (Vol. 1). Indonesia: Kementerian Lingkungan Hidup CCROM-SEAP AECOM ADB IPB Pemda Jabar.

BPS - Statistics Indonesia, Ministry of National Development Planning, and UNFPA. 2013. Indonesia Population Projection 2010-2035. [WWW] Statistics Indonesia. Available at:https://www.bps.go.id/website/pdf_publikasi/watermark_Proyeksi%20Penduduk%20Indonesia%202010-2035.pdf [Accessed 12/02/2017]

BPS - Statistics Indonesia. 2015. Statistical Yearbook of Indonesia. Jakarta: BPS – Statistics Indonesia.

BPS – Statistics Indonesia. 2016. National Income of Indonesia 2010-2014. Jakarta: BPS – Statistics Indonesia.

Broich, Mark, Hansen, Matthew C., Potapov, Peter, Adusei, Bernard, Lindquist, Erik, & Stehman, Stephen V. (2011). Time-series analysis of multi-resolution optical imagery for quantifying forest cover loss in Sumatra and Kalimantan, Indonesia. *International Journal of Applied Earth Observation and Geoinformation, 13*(2), 277-291. doi: 10.1016/j.jag.2010.11.004

Brooks, N., & Fisher, S. (2011). *Tracking adaptation and measuring development*. (J. Ayers & H. Reid, Eds.)*Change*. London: International Institute for Environment and Development (IIED). Retrieved from http://pubs.iied.org/pdfs/10031IIED.pdf

Buchori, Damayanti , Rizali, Akhmad, & Sari, Adha. (2010). *Perubahan Komunitas Semut Pada Pertanaman Kakao Serta Implikasinya Terhadap Keberadaan Hama Dan Penyakit: Adakah Pengaruh Iklim?* Paper presented at the Seminar Hasil - Hasil Penelitian IPB, IPB.

Budiastuti, MTh. Sri (2010). Fenomena Perubahan Iklim Dan Kontinyuitas Produksi Pertanian: Suatu Tinjauan Pemberdayaan Sumberdaya Lahan The Climate Change Phenomenon And Continuity Of Agriculture Production: Study Of Land Agriculture Empowerment. *Jurnal Ekosains, Volume 2*(1), 33-39.

Businessdictionary.com, 2017. Link: http://www.businessdictionary.com/definition/technology-transfer.html

Butarbutar, Tigor. (2012). Agroforestri untuk adaptasi dan mitigasi perubahan iklim. *Analisis kebijakan kehutanan, 9-1*(Perubahan iklim), 1-10.

Butler, J. R. A., Suadnya, W., Puspadi, K., Sutaryono, Y., Wise, R. M., Skewes, T. D., . . . Ash, A. (2014). Framing the application of adaptation pathways for rural livelihoods and global change in eastern Indonesian islands. *Global Environmental Change-Human and Policy Dimensions, 28*, 368-382. doi: 10.1016/j.gloenvcha.2013.12.004

Carter, T.R., Jones, R.N., Lu, X., Bhadwal, S., Conde, C., Mearns, L.O., Zurek, M.B. (2007). New assessment methods and the characterisation of future conditions. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. v. d. Linden & C. E. Hanson (Eds.), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 133-171). Cambridge, UK: Cambridge University Press.

Chang, C. P., Wang, Zhuo, McBride, John, & Liu, Ching-Hwang. (2005). Annual Cycle of Southeast Asia-Maritime Continent Rainfall and the Asymmetric Monsoon Transition. *Journal of Climate, 18*(2), 287-301.

Chave, J., Kira, T., Lescure, P., Nelson, B.W., Ogawa, H., Puig, H., Rira, B., Amakura, T., Andalo, C., Brown, S., Cairns, M.A., Chambers, J.Q., Eamus, D., FIster, H., Fromard, F., Higuchi, N. 2005. *Tree Allometry and Improved Estimation of Carbon Stocks and Balance in Tropical Forests*. Oecologia 145, 87-99.

Colacino, F.M., 2013. Technology Transfer, University of Birmingham, UK: Birmingham. Link: http://www.slideshare.net/mds-web/what-is-technology-transfer (31.01.2017)

Collins, W. J., Bellouin, N., Doutriaux-Boucher, M., Gedney, N., Halloran, P., Hinton, T., Woodward, S. (2011). Development and evaluation of an Earth-System model – HadGEM2. *Geosci. Model Dev., 4*(4), 1051-1075. doi: 10.5194/gmd-4-1051-2011

Collins, William D., Rasch, Philip J., Boville, Byron A., Hack, James J., McCaa, James R., Williamson, David L., . . . Zhang, Minghua. (2006). The Formulation and Atmospheric Simulation of the Community Atmosphere Model Version 3 (CAM3). *Journal of Climate, 19*(11), 2144-2161.

D'Arrigo, R. , & Wilson, R. (2008). El Nino and Indian Ocean influences on Indonesian drought: Implications for forecasting rainfall and crop productivity. *International Journal of Climatology, 28*(5), 611–616 doi: 10.1002/joc.1654.

Dasanto, Bambang Dwi (2010). Penilaian Dampak Kenaikan Muka Air Laut pada Wilayah Pantai: Studi Kasus Kabupaten Indramayu. *Jurnal Hidrosfir Indonesia, Volume 5*(2), 43-53.

Data Processing Center, Ministry of Public Works 2012. Public Works Statistics (Buku Informasi Statistik Pekerjaan Umum).

Delworth, Thomas L., Broccoli, Anthony J., Rosati, Anthony, Stouffer, Ronald J., Balaji, V., Beesley, John A., Zhang, Rong. (2006). GFDL's CM2 Global Coupled Climate Models. Part I: Formulation and Simulation Characteristics. *Journal of Climate, 19*(5), 643–674. doi: 10.1175/JCLI3629.1

Directorate General of NRE&EC. 2013. *Statistik Energi Baru dan Terbarukan 2013*. Jakarta: Ministry of Energy and Mineral Resources.

Directorate General of NRE&EC. 2014. *Statistik Energi Baru dan Terbarukan 2013*. Jakarta: Ministry of Energy and Mineral Resources.

Directorate General of NRE&EC. 2015. *Statistik Energi Baru dan Terbarukan 2013*. Jakarta: Ministry of Energy and Mineral Resources.

Direktorat Jenderal Hukum dan Perjanjian Internasional, Kementerian Luar Negeri. 2014.at: http://treaty.kemlu.go.id/index.php/treaty/index?fullPage=1&sort=treaty_title, [Accessed 28/02/2016]

Donner, L.J., Wyman, B.L. , Hemler, R.S. , Horowitz, L.W. , Ming, Y. , Zhao, M., Zeng, F. (2011). The dynamical core, physical parameterizations, and basic simulation characteristics of the atmospheric component AM3 of the GFDL global coupled model CM3. *Journal of Climate, 24*, 3484-3519. doi: DOI: 10.1175/2011JCLI3955.1

Dufresne, J. L., Foujols, M. A., Denvil, S., Caubel, A., Marti, O., Aumont, O., Vuichard, N. (2013). Climate change projections using the IPSL-CM5 Earth System Model: from CMIP3 to CMIP5. *Climate Dynamics, 40*(9-10), 2123-2165. doi: 10.1007/s00382-012-1636-1

Dunne, J. P., John, J. G. , Adcroft, A. J. , Griffies, S. M. , Hallberg, R. W. , Shevliakova, E. N., Zadeh, N. . (2012). GFDL's ESM2 global coupled climate-carbon Earth System Models Part I: Physical formulation and baseline simulation characteristics. *Journal of Climate, 25*(19). doi: DOI:10.1175/JCLI-D-11-00560.1. 10/12

Dunne, John P., John, Jasmin G. , Shevliakova, Elena , Stouffer, Ronald J. , Krasting, John P. , Malyshev, Sergey L. , Zadeh, Niki (2013). GFDL's ESM2 Global Coupled Climate–Carbon Earth System Models. Part II: Carbon System Formulation and Baseline Simulation Characteristics. *J. Climate, 26*, 2247–2267. doi: doi: http://dx.doi.org/10.1175/JCLI-D-12-00150.1

EBTKE, 2013. Statistik EBTKE, Direktorat Konservasi Energi, Direktorat Jenderal Energi Bartu Terbarukan dan Konservasi Energi. Kementrian Energi dan Sumber Data Mineral.

EBTKE, 2014. Statistik EBTKE, Direktorat Konservasi Energi, Direktorat Jenderal Energi Bartu Terbarukan dan Konservasi Energi. Kementrian Energi dan Sumber Data Mineral.

EBTKE, 2016. Data dan Informasi Program Konservasi Energi, Direktorat Konservasi Energi, Direktorat Jenderal Energi Bartu Terbarukan dan Konservasi Energi. Kementrian Energi dan Sumber Data Mineral.

Efendi, Muchar, Sunoko, Henna Rya, & Sulistya, Widada. (2012). Kajian Kerentanan Masyarakat terhadap Perubahan Iklim Berbasis Daerah Aliran Sungai (Studi Kasus Sub-Das Garang Hulu). *Jurnal Ilmu Lingkungan, Volume 10*(1), 8-18.

Efendi, Muchtar, Sunoko, Henna Rya, & Sulistya, Widada. (2012, 11 September 2012). *Analisis Kriteria dan Indikator Kerentanan Masyarakat Terhadap Perubahan Iklim Berbasis Das (Studi Kasus Sub Das-Garang Hulu).* Paper presented at the Prosiding Seminar Nasional Pengelolaan Sumberdaya Alam dan Lingkungan, Semarang.

Fahriyah, Santoso, Heru, & Sabita, Sherley. (2011). Dampak Perubahan Iklim Terhadap Produksi dan Pendapatan Usahatani Apel (Malus Sylvestris L.). [Climate Change Impacts on Production and Income Of Apples Farmings (Malus sylvestris L.)]. *Jurnal Agrise, Volume 11*(3), 189-194.

Foerster, Hannah, Sterzel, Till, Pape, Christian A., Moneo-Lain, Marta, Niemeyer, Insa, Boer, Rizaldi, & Kropp, Juergen P. (2011). Sea-level rise in Indonesia: on adaptation priorities in the agricultural sector. *Regional Environmental Change, 11*(4), 893-904. doi: 10.1007/s10113-011-0226-9

Folland, C. K., Renwick, J. A., Salinger, M. J., & Mullan, A. B. (2002). Relative influences of the Interdecadal Pacific Oscillation and ENSO on the South Pacific Convergence Zone. *Geophysical Research Letters, 29*(13). doi: 10.1029/2001GL014201

FORCLIME (2017) *FORCLIME's Self Assessment Form for the Implementation of REDD + activities and REDD + related activities in Indonesia*. The Ministry of Environment and Forestry. Jakarta, Indonesia.

Ford, J. D., Berrang-Ford, L., Biesbroek, R., Araos, M., Austin, S. E., & Lesnikowski, A. (2015). Adaptation tracking for a post-2015 climate agreement. *Nature Clim. Change, 5*(11), 967–969. Retrieved from http://dx.doi.org/10.1038/nclimate2744

Fuel wood. http://faostat3.fao.org

Funk, C.C., Peterson, P.J., Landsfeld, M.F., Pedreros, D.H., Verdin, J.P., Rowland, J.D., . . . Verdin, A.P. (2014). A quasi-

global precipitation time series for drought monitoring. *U.S. Geological Survey Data Series, 832, 4 p*. doi: http://dx.doi.org/110.3133/ds832.
Funk, Chris, Peterson, Pete, Landsfeld, Martin, Pedreros, Diego, Verdin, James, Shukla, Shraddhanand, . . . Michaelsen, Joel. (2015). The climate hazards infrared precipitation with stations-a new environmental record for monitoring extremes. *Scientific Data, 2*(150066). doi: doi:10.1038/sdata.2015.66 2015
Fyfe, J. C., Merryfield, W. J. , Kharin, V. , Boer, G. J. , Lee, W. S. , & von Salzen, K. . (2011). Skillful predictions of decadal trends in global mean surface temperature. *Geophys. Res. Lett., 38*(L22801).
Gent, P. R., & Danabasoglu, G. (2011). Response to increasing Southern Hemisphere winds in CCSM4. *J. Clim., 24*, 4992–4998.
Gilland, B. (2002). World population and food supply - Can food production keep pace with population growth in the next half-century? *Food Policy, 27*(1), 47-63. doi: 10.1016/s0306-9192(02)00002-7
GIZ, 2015. Low-Carbon Technology Transfer in Indonesia, An Exploration into Actors, questions and potential requests to the climate Technology Centre and Network, Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ), Germany:Bonn. Link: https://www.google.co.id/url?sa=t&rct=j&q=&esrc=s&source=web&cd=8&cad=rja&uact=8&sqi=2&ved=0ahUKEwiYn6XXzezRAhUJo48KHXJ-B5MQFghPMAc&url=http%3A%2F%2Fwww.paklim.org%2Findex.php%2Fnews-events%2Fitem%2Fdownload%2F96_93b4d6ab68fdd1881c9c8eeb4a4c93bf.html&usg=AFQjCNFIsv4c5CkoFJI8GYjuKzkSeEfoCw&sig2=VrZoKgASu7MC8nCO_plksw&bvm=bv.145822982,d.c2I (31.01.2017)
Graham, L. P., Andréasson, J. , & Carlsson, B. . (2007). Assessing climate change impacts on hydrology from an ensemble of regional climate models, model scales and linking methods: A case study on the Lule River basin. *Clim. Change, 81(S1)*, 293–307.
Gullison, R.E., Frumhoff, P.C., Canadell, J.G., Field, C.B., Nepstad, D.C., Hayhoe, K., Avissar, R., Curran, L.M., Friedlingstein, P., Jones, C.D., Nobre, C., 2007. Tropical forests and climate policy. Science 316: 985–6.

Hadi, T.W. (2011). Climate Change Adaptation Planning With Disaster Risk Reduction Approach: Indonesian Experiences. Center for Climate Change. Bandung Institute of Technology. Link: http://www2.ir3s.u-tokyo.ac.jp/icssasia2011/pdf/presentation_paralel/tri.pdf
Halimanjaya, A. (2016). Allocating climate mitigation finance: a comparative analysis of five major green donors. *Journal of Sustainable Finance & Investment*, *0*(0), 1–25. doi:10.1080/20430795.2016.1201412
Halimanjaya, A. (2016). GCF Capacity assesssment. Climate and Development Knowledge Network. The Ministry of Finance, Jakarta, Indonesia.
Halimanjaya, A., & Barnard, S. (2014). *A review of the Indonesia Climate Change Trust Fund*. London, UK. Retrieved from http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/8898.pdf
Hamada, J.I. , Yamanaka, M.D., Matsumoto, J. , Fukao, S., Winarso, P.A. , & Tien, S. . (2002). Spatial and temporal variations of the rainy season over Indonesia and their link to ENSO. *Journal of the Meteorological Society of Japan, 80*, 285-310.
Harris, I., Jones, P. D., Osborn, T. J., & Lister, D. H. (2014). Updated high-resolution grids of monthly climatic observations – the CRU TS3.10 Dataset. *Int. J. Climatol., 34*(3), 623–642 doi: doi:10.1002/joc.3711
Harris, J. Berton C., Putra, Dadang Dwi, Gregory, Stephen D., Brook, Barry W., Prawiradilaga, Dewi M., Sodhi, Navjot S., Fordham, Damien A. (2014). Rapid deforestation threatens mid-elevational endemic birds but climate change is most important at higher elevations. *Diversity and Distributions, 20*(7), 773-785. doi: 10.1111/ddi.12180
Haylock, M., & McBride, J. (2001). Spatial coherence and predictability of Indonesian wet season rainfall. *Journal of Climate, 14*(18), 3882-3887. doi: 10.1175/1520-0442(2001) 014<3882:SCAPOI>2.0.CO;2
Hendon, H. H. (2003). Indonesian rainfall variability: Impacts of ENSO and local air-sea interaction. *Journal of Climate,*

16(11), 1775-1790. doi: 10.1175/1520-0442(2003)016<1775: IRVIOE>2.0.CO;2

Hendrati, Rina Laksmi, Putri, Asri Insiana, & Setiadi, Dedi. (2012). Seleksi Spesies Adaptif pada Daerah Kering Untuk Antisipasi Perubahan Iklim Global. *Jurnal Analisis Kebijakan Kehutanan, Volume 9*(1), 23-35.

Heru Santoso H., A., Tatiek Koerniawati, & R., Nur Layli. (2011). Dampak Perubahan Iklim Terhadap Produksi dan Pendapatan Usahatani Jagung (Zea Mays L). *Jurnal Agrise, Volume 11*(3), 151-163.

Hidayat, Rahmat , & Kizua, Shoichi. (2010). Influence of the Madden-Julian Oscillation on Indonesian rainfall variability in austral summer. *Int. J. Climatol., 30*, 1816-1825. doi: 10.1002/joc.2005

Hosang, Peter Rene , Tatuh, J., & Rogi, Johannes E. X. (2012). Analisis Dampak Perubahan Iklim Terhadap Produksi Beras Provinsi Sulawesi Utara Tahun 2013 – 2030. *Jurnal Eugenia, Volume 18*(3), 249-256.

Hotimah, Oot (2013). Perubahan Iklim Dan Pembangunan Kota yang Berkelanjutan. *Jurnal Region, Volume 5*(1), 1-10.

Houghton, R.A., 2005. Tropical deforestation as a source of greenhouse gas emissions in Tropical Deforestation and Climate Change, in: P. Moutinho and S. Schwartzman (eds.), pp. 13-21, Amazon Institute for Environmental Research, Belém, Pará, Brazil.

Hukom, Edison, Limantara, Lily Montarcih, & Andawayanti, Ussy. (2012). Pengaruh Perubahan Iklim terhadap Optimasi Ketersediaan Air di Irigasi Way Mital Propinsi Maluku. *Jurnal Teknik Pengairan, Volume 3*(1), 24-32.

Hurrell, J., et al. (2013). The Community Earth System Model: A framework for collaborative research. *Bull. Am. Meteorol. Soc*. doi: doi:10.1175/BAMS-D-12–00121

ICCTF, UI, RCCC, & KEMENKES. (2014). Kajian kerentanan kesehatan akibat perubahan iklim : penilaian, proyeksi, dan pemetaan terhadap penyakit demam berdarah dengue dan malaria (Provinsi Bali) (Kesehatan, Trans.). Provinsi Bali.

IESR (2015) Focus Group Discussion on Enhancing Direct Access to Green Climate Fund, Jakarta, Indonesia. Retrieved from http://iesr.or.id/2015/11/focus-group-discussion-on-enhancing-direct-access-to-green-climate-fund/?lang=en

IFCA (2008) Reducing Emissions from Deforestation and Forest Degradation. IFCA Consolidation Report. Retrieved from: http://www.unredd.net/documents/un-redd-partner-countries-181/asia-the-pacific-333/a-p-partner-countries/indonesia-187/national-un-redd-programme-management-including-tors-2778/studies-publications-resources-by-other-initiatives-1543/studies-and-publications-on-redd-1676/1027-indonesia-2008-ifca-consolidation-report-1027.html

IGES, ICLEI (2012), Climate Change Adapatation and Technology: Gaps and Needs in Southeast Asia. Hayama: Institute for Global Environmental Strategies. Link: http://www.asiapacificadapt.net/sites/default/files/resource/attach/iclei-apan-report-cca-tech-gaps-needs-sea.pdf (31.01.2017)

Indarsih, Wahyu., et al. 2016. *Statistic of Large and Medium Industry of Indonesia Data* [Powerpoint document]. Retrieved from Delegated Speaker of Center of Statistical Bureau at the meeting on Industrial data and information Provission for The Third National Communication Report Year 2016.

Intergovernmental Panel on Climate Change. 2006. *IPCC-2006 Guidelines for National Green House Gas Inventories: Energy*, Volume 2.

Intergovernmental Panel on Climate Change. 2006. *IPCC-2006 Guidelines for National Green House Gas Inventories: Industrial Process and Product Use (IPPU)*, Volume 3.

Intergovernmental Panel on Climate Change. 2006. *IPCC-2006 Guidelines for National Green House Gas Inventories: Agriculture, Forestry and Other Land Use (AFOLU)*, Volume 4.

Intergovernmental Panel on Climate Change. 2006. *IPCC-2006 Guidelines for National Green House Gas Inventories: Waste*, Volume 5.

Intergovernmental Panel on Climate Change. 2013. *Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*.

IPCC. (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change In T. F. [Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)] (Ed.). Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

IPCC. 2006. *IPCC Guidelines for National Greenhouse Gas Inventories Prepared by the National Greenhouse Gas Inventories Programme*, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

IPCC, 2003. Good Practice Guidance for Land Use, Land-Use Change and Forestry. Institute for Global Environmental Strategies, Japan.

Irvani, Harvy, Bisri, Mohammad, & Soetopo, Widandi. (2010). Studi Optimasi Pola Operasi Waduk Sutami Akibat Perubahan Iklim.

Iswati, Sri, Atmojo, Suntoro Wongso, & Budiastuti, M.Th. Sri. (2013). Kajian Perubahan Pola Tutupan Lahan Gambut Terhadap Anomali Iklim di Wilayah Kabupaten Kubu Raya Propinsi Kalimantan Barat. *Jurnal Ekosains, Volume 5*(2), 40-46.

Iversen, T., Bentsen, M., Bethke, I., Debernard, J. B., Kirkevåg, A., Seland, Ø, Seierstad, I. A. (2013). The Norwegian Earth System Model, NorESM1-M – Part 2: Climate response and scenario projections. *Geosci. Model Dev., 6*(2), 389-415. doi: 10.5194/gmd-6-389-2013

Jaggard, K. W., Qi, A. M., & Ober, E. S. (2010). Possible changes to arable crop yields by 2050. *Philosophical Transactions of the Royal Society B-Biological Sciences, 365*(1554), 2835-2851. doi: 10.1098/rstb.2010.0153

Jiafeng, Wang, & Xuebin, Zhang. (2008). Downscaling and Projection of Winter Extreme Daily Precipitation over North America. *Journal of Climate, 21*(5), 923-937.

Kartikasari, Kiki, Estiningtyas, Woro, & Perdinan. (2015). Crop insurance based on weather index for climate risk management in indonesia: Towards a strategic research agenda: GIZ.

Kementerian Kehutanan, Republic of Indonesia, 2012. "Memahami Konsep Ekonomi Hijau dan Kontribusi Sektor Kehutanan dalam Implementasinya di Indonesia"; in "Prosiding Pertemuan Stakeholder tentang Penanganan Isu Perubahan Iklim".

Kementerian Lingkungan Hidup. 2012. *Pilot Project JICA-KLH-ITB dan BLH Sumatera Utara dan BLH Sumatera Selatan Tahun 2011 dalam Pedoman Penyelenggaraan Inventarisasi Gas Rumah Kaca Nasional Buku II Volume 4 Pengelolaan Limbah*. Kementerian Lingkungan Hidup Republik Indonesia, Jakarta.

Kementerian Lingkungan Hidup dan Kehutanan (2015). *Rencana Strategis Direktorat Jenderal Pengelolaan Hutan Produksi Lestari* 2015 - 2019.

Kementerian Lingkungan Hidup dan Kehutanan (2015). *Statistik Bidang Planologi Kehutanan Tahun 2014*.

Kementerian Lingkungan Hidup dan Kehutanan (2017). Summary of Performance Accountability Report (LAKIP) of the Ministry of Environment and Forestry 2010-2011, 2012, 2013 and 2014. Jakarta Indonesia.

Kementerian Lingkungan Hidup dan Kehutanan (2017). *Strategi Implementasi NDC* (Indonesian version), October 2017.

Kemitraan (2016) The Partnership receives adaptation fund accreditation. Jakarta, Indonesia. Accessed at 22 November 2016. http://www.kemitraan.or.id/id/partnership-receives-adaptation-fund-accreditation

Kencono, A. W., et al. 2013. *Handbook of Energy Economic and Statistic of Indonesia 2013. Center for Data and Information Ministry of Energy and Mineral Resources of Indonesia*, Jakarta.

Kencono, A. W., et al. 2014. *Handbook of Energy Economic and Statistic of Indonesia 2014. Center for Data and Information Ministry of Energy and Mineral Resources of Indonesia*, Jakarta.

Kirono, Dewi G. C., Larson, Silva, Tjandraatmadja, Grace, Leitch, Anne, Neumann, Luis, Maheepala, Shiroma, . . . Selintung, Mary. (2014). Adapting to climate change through urban water management: a participatory case study in Indonesia. *Regional Environmental Change,* *14*(1), 355-367. doi: 10.1007/s10113-013-0498-3

Krisnawati, H., Adinugroho, W.C., Imanuddin, R. and Hutabarat, S. 2014. *Estimation of Forest Biomass for uantifying CO2 missions in Central Kalimantan: a comprehensive approach in determining forest carbon emission factors*. Research and Development Center for Conservation and Rehabilitation, Forestry Research and Development Agency, Bogor.

Kusmana, Cecep (2010). *Lokakarya Nasional Peran Mangrove dalam Mitigasi Bencana dan Perubahan Iklim*. Respon Mangrove terhadap Perubahan Iklim Global: Aspek Biologi Dan Ekologi Mangrove. Kuliah Kerja Praktek (KKP). Departemen Silvikultur Fakultas Kehutanan IPB. Jakarta.

Kusuma, Sonia Vianitya, & Setyono, Jawoto Sih. (2013). Adaptasi Masyarakat dalam Menghadapi Kerentanan Air Bersih Akibat Perubahan Iklim di Kelurahan Tandang, Kecamatan Tembalang, Semarang. *Jurnal Teknik PWK, Volume 2*(3), 840-850.

Lamid, Zainal (2011). Integrasi Pengendalian Gulma dan Teknologi Tanpa Olah Tanah pada Usaha Tani Padi Sawah Menghadapi Perubahan Iklim. *Jurnal Pengembangan Inovasi Pertanian, Volume 4* (1), 14-28.

Lassa, Jonatan A. , Mau, Yosep Seran, Li, Dominggus Elcid, & Frans, Nike. (2014). Impact of Climate Change on Agriculture and Food Crops: Options for Climate Smart Agriculture and Local Adaptation in East Nusa Tenggara, Indonesia. *Working Paper No. 8*.

Latief, Hamzah, Sunendar, Haris, Ismoyo, Dominic Oki, Fitriyanto, M. Suhardjono, & Bisri, Mizan Bustanul Fuady. (2012a). Climate risk and adaptation assessment for the coastal sector - South Sumatera. Indonesia: Kementerian Lingkungan Hidup.

Latief, Hamzah, Sunendar, Haris, Ismoyo, Dominic Oki, Fitriyanto, M. Suhardjono, & Bisri, Mizan Bustanul Fuady. (2012b). Climate risk and adaptation assessment for the coastal sector- Tarakan. Indonesia: Kementerian Lingkungan Hidup.

Lubis, Rachmat Fajar , & Delinom, Robert. (2010). Perubahan Iklim dan Pemanasan Global di Indonesia; Dampaknya Terhadap Kondisi Bawah Permukaan Studi Kasus : DKI Jakarta (LIPI Pusat Penelitian Geoteknologi, Trans.) (pp. 65-70): Pusat Penelitian Geoteknologi, Lembaga Ilmu Pengetahuan Indonesia.

Makassar, Pemda Kota, UNDP, Habitat, UN, & UNEP. (2013). Climate Change Vulnerability (S. Ekonomi, Trans.) *Climate Change Vulnerability Makassar*. Makassar: UNDP

Manez, Kathleen Schwerdtner, Husain, Sainab, Ferse, Sebastian C. A., & Costa, Maria Manez. (2012). Water scarcity in the Spermonde Archipelago, Sulawesi, Indonesia: Past present and future. *Environmental Science & Policy, 23*, 74-84. doi: 10.1016/j.envsci.2012.07.004

Mantua, N.J., Hare, S.R., Zhang, Y., Wallace, J.M., & Francis, R.C. (1997). A pacific interdecadal climate oscillation with impacts on salmon production. *Bull. Amer. Meteor. Soc., 78*, 1069-1079.

Manuri, S., Brack, C., Nugroho, N.P., Hergoualc'h, K., Novita, N., Dotzauer, H., Verchot, L., Putra, C.A.S., & Widyasari. 2014. *Tree Biomass Equations for Tropical Peat Swamp Forest Ecosystems in Indonesia*. For. col. Manage. 334: 241-253.

Margono B. A., Potapov P. V., Turubanova S., Fred Stolle F., Matthew Hansen C. M. 2014. *Primary Forest Cover Loss in Indonesia Over 2000-2012*. Nature Climate Change 4, 730 735 (2014) doi:10.1038/ nclimate2277.

Marlier, Miriam E., Defries, Ruth, Pennington, Derric, Nelson, Erik, Ordway, Elsa M., Lewis, Jeremy, Mickley, Loretta J. (2015). Future fire emissions associated with projected land use change in Sumatra. *Global Change Biology, 21*(1), 345-362. doi: 10.1111/gcb.12691

Martin, G. M. , Bellouin, N., Collins, W. J., Culverwell, I. D., Halloran, P. R., Hardiman, S. C., . . . Wiltshire, A. (2011). The HadGEM2 family of Met Office Unified Model climate configurations. *Geosci. Model Dev., 4*(3), 723-757. doi: 10.5194/gmd-4-723-2011

Maulidah, Silvana , Santoso, Heru, Subagyo, Hadi, & Rifqiyyah, Qiki. (2012). Dampak Perubahan Iklim Terhadap Produksi dan Pendapatan Usaha Tani Cabai Rawit (Studi Kasus di Desa Bulupasar, Kecamatan Pagu, Kabupaten Kediri). *Jurnal SEPA, Volume 8*(2), 137-144.

McBride, John L., Haylock, Malcolm R., & Nicholls, Neville. (2003). Relationships between the Maritime Continent Heat Source and the El Niño-Southern Oscillation Phenomenon. *Journal of Climate, 16*, 2905-2914.

McLeod, Elizabeth, Hinkel, Jochen, Vafeidis, Athanasios T., Nicholls, Robert J., Harvey, Nick, & Salm, Rodney. (2010). Sea-level rise vulnerability in the countries of the Coral Triangle. *Sustainability Science, 5*(2), 207-222. doi: 10.1007/s11625-010-0105-1

Mehrotra, R., & Sharma, A. (2005). A stochastic downscaling framework for multi-point daily rainfall for catchment scale climate change impact assessment. *AGU Fall Meeting Abstracts, 31*, 07.

Merriam-Webster, 2017. Networking. Link: https://www.merriam-webster.com/dictionary/networking (31.01.2017)

Meteorological, Climatological, and Geophysical Agency of Indonesia. 2015. *Atlas Proyeksi Iklim Wilayah Indonesia* 2015. Jakarta: Meteorological, Climatological, and Geophysical Agency of Indonesia.

Ministry of Agriculture of Indonesia. 2015. Agriculture Statistics. Jakarta: Ministry of Agriculture of Indonesia.

Ministry of Enviroment (2007). Climate Variability and Climate Change, and their implication. In R. Boer, Sutardi & D. Hilman (Eds.), *Indonesia Country Report*. Jakarta: Ministry of Environment, Republic of Indonesia

Ministry of Environment. 2010. *Indonesia Second National Communication Under The United Nations Framework Convention on Climate Change (UNFCCC),* Jakarta.

Ministry of Environment of Indonesia. 2012. State of Environment Report of Indonesia 2012. Jakarta: Ministry of Environment of Indonesia.

Ministry of Environment and Forestry. (2015). Ministry of Environment and Forestry Statistics 2014. .

Ministry of Environment and Forestry, Republic of Indonesia, 2015. National Forest Reference Emission Level for Deforestation and Forest Degradation: In the Context of Decision 1/CP.16 para 70 UNFCCC (Encourages developing country Parties to contribute to mitigation actions in the forest sector), Directorate General of Climate Change. The Ministry of Environment and Forestry, Indonesia.

Ministry of Environment and Forestry. 2015. Indonesian 1st Biennial Update Report (BUR) under United National Framework Convention on Climate Change. Ministry of Environment and Forestry, Republic of Indonesia.

Ministry of Environment and Forestry (2016). *First Nationally Determined Contribution*. November 2016.

Ministry of Energy and Mineral Resources. 2015. Handbook of Energy and Economic Statistic of Indonesia 2015. [WWW] Ministry of Energy and Mineral Resources. Availableat:http://prokum.esdm.go.id/Publikasi/Handbook%20of%20Energy%20&%20Economic%20Statistics%20of%20Indonesia%20/Buku%20Handbook%202015.pdf [Accessed 12/02/2017

Ministry of Finance (2017). Fiscal Policy for Input: Third National Communication to UNFCCC. Jakarta Indonesia.

Ministry of Forestry, Republic of Indonesia, 2014. National Forest Monitoring System (NFMS) http://nfms.dephut.go.id

Ministry of National Development Planning of Indonesia, Ministry of Environment and Forestry of Indonesia and Indonesian Institute of Science. 2016. Indonesia Biodiversity Strategy and Action Plan 2015-2020. Jakarta: Ministry of National Development Planning of Indonesia..

Mondal, Pinki, & Tatem, Andrew J. (2012). Uncertainties in Measuring Populations Potentially Impacted by Sea Level Rise and Coastal Flooding. *Plos One, 7*(10). doi: 10.1371/journal.pone.0048191

Moron, Vincent, Robertson, Andrew W., Ward, M. Neil, & Ndiaye, Ousmane. (2008). Weather Types and Rainfall over Senegal. Part II: Downscaling of GCM Simulations. *Journal of Climate, 21*(2), 288-307.

Moss, Richard H., Edmonds, Jae A., Hibbard, Kathy A., Manning, Martin R., Rose, Steven K., Vuuren, Detlef P. van, Wilbanks, Thomas J. (2010). The next generation of scenarios for climate change research and assessment. *Nature, 463*. doi: doi:10.1038/nature08823

Moss, Richard, Babiker, Mustafa, Brinkman, Sander, Calvo, Eduardo, Carter, Tim, Edmonds, Jae, Zurek, and Monika. (2008). Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies (pp. 132 pp). Geneva: Intergovernmental Panel on Climate Change.

Mujtahiddin, Muhamad Iid. (2014). Analisis spasial indeks kekeringan kabupaten Indramayu. *Meteorologi dan Geofisika, 15-2*(Perubahan Iklim), 99-107.

Mulyana, Wahyu , Setiono, Ivo, Selzer, Amy Kracker, Zhang, Sainan, Dodman, David, & Schensul, Daniel. (2013). Urbanisation, Demographics and Adaptation to Climate Change in Semarang, Indonesia. *Urbanization and Emerging Population Issues Working Paper 11*.

Mulyani et al. 2012. *Basis Data Karakteristik Tanah Gambut di Indonesia*. in Prosiding Seminar Nasional Pengelolaan Lahan Gambut Berkelan utan 4 Mei 2012. http://balittanah.litbang.deptan.go.id

Murdiyarso, D., Donato, D., Kauffmann, .B., Kurnianto, S., Stidham, M. and Kanninen, M. 2009. *Carbon Storage in Mangrove and Peatland Ecosystems: A Preliminary Accounts from Plots in Indonesia*. CIFOR Working Paper 48.

Muslim, Chairul (2013). Mitigasi Perubahan Iklim dalam Mempertahankan Produktivitas Tanah Padi Sawah (Studi kasus di Kabupaten Indramayu). *Jurnal Penelitian Pertanian Terapan, Volume 13* (3), 211-222.

Mustadjab, M. Muslich , Fahriyah, & Hana, Ifta. (2012). Dampak Perubahan Iklim terhadap Pendapatan Petani Tebu (Studi Kasus Pada KPTR (Koperasi Petani Tebu Rakyat) "Tani Mulya" di Kabupaten Sidoarjo, Jawa Timur). [The Impact of Climate Change Toward Sugarcane Farmers' Income (Case Study on Farmer Member of Sugarcane Farmer Cooperation "Tani Mulya" In Sidoarjo Regency]. *Jurnal Agrise, Volume 12*(1), 74-85.

Naylor, R. L. , Falcon, W, Rochberg, D. , & Wada, N. (2001). Using El Nino/Southern Oscillation climate data to predict rice production in Indonesia. *Climate Change, 50*, 255-265.

Naylor, R. L., Battisti, David S., Vimont, Daniel J., Falcon, Walter P., & Burke, Marshall B. (2007). Assessing risks of climate variability and climate change for Indonesian rice agriculture. *PNAS, 104*(19), 7752–7757.

Nirdayana, Khori , Priminingtyas, Dina Novia, & Hadi, Heru Santoso. (2011). Dampak Perubahan Iklim terhadap Produksi dan Pendapatan Usaha Tani Mangga (Mangifera spp.). *Jurnal Habitat, Volume 22*(2), 145-173.

Parry, Martin, Rosenzweig, Cynthia, & Livermore, Matthew. (2005). Climate change, global food supply and risk of hunger. *Philosophical Transactions of the Royal Society B-Biological Sciences, 360*(1463), 2125-2138. doi: 10.1098/rstb.2005.1751

Parura, Tezario Chandra Putra , Kartini, & Yuniarti, Erni. (2010). Analisis Dampak Perubahan Iklim Terhadap Tingkat Kesejahteraan Nelayan Di Desa Sungai Kakap Kabupaten Kubu Raya.

Patriana, Ratna, & Satria, Arif. (2013). Pola Adaptasi Nelayan terhadap Perubahan Iklim: Studi Kasus Nelayan Dusun Ciawitali, Desa Pamotan, Kecamatan Kalipucang, Kabupaten Ciamis, Jawa Barat. [Adaptation Pattern of Fishers in Addressing Climate Change: A Case Study of Fishers in Ciawitali, Pamotan Village, Province Kalipucang Subdistrict, Ciamis Regency of West Java]. *Jurnal Sosek KP, Volume 8*(1), 11-23.

Pekalongan, Pemerintah Kota, & Tengah, GIZ PAKLIM Jawa. (2011). Profil Resiko Perubahan Iklim Kota Pekalongan (P. Iklim, Trans.). Kota Pekalongan: Pemerintah Kota Pekalongan GIZ PAKLIM Jawa Tengah.

Pemerintah Republik Indonesia. 2011. *Peraturan Presiden Nomor 71 Tahun 2011 tentang Penyelenggaraan Inventarisasi Gas Rumah Kaca Nasional*. Kementerian Lingkungan Hidup. Jakarta.

Perdinan, Atmaja, Tri, & Adi, Ryco Farysca. (2016). Adaptasi perubahan iklim dan ketahanan pangan: telaah inisiatif dan kebijakan. Jakarta: IESR.

Perdinan, Boer, Rizaldi, Rakhman, Adi, Situmorang, Anter Parulian, Zulaikha, Mirna, & Nurbaeti, Betty. (2015). Pilihan adaptasi perubahan iklim. Indonesia: Kementerian lingkungan hidup dan kehutanan

Perdinan, Kartikasari, Kiki, & Malahayati, Marissa. (2014). Climate Resilience in Rice and Other Crops National Studies: Indonesia. Indonesia: ASEAN network on promoting climate resilience of rice and other crops.

Piani, C., Haerter, J.O., & Coppola, E. (2010). Statistical Bias Correction for Daily Precipitation in Regional Climate Models Over Europe. *Theor. Appl. Climatol., 99*, 187–192.

Prabowo, Susetyo., et al. 2015. *Handbook of Energy Economic and Statistic of Indonesia 2015*. Center for Data and Information Ministry of Energy and Mineral Resources of Indonesia, Jakarta.

Pranowo, Widodo (2015). [Penyusunan country report: state of the art of climate change vulnerability, impact and adaptation studies].

Pujiraharjo, Alwafi, Rachmansyah, Arief, Wijatmiko, Indradi, & Anwar, M. Ruslin. (2015). Pengaruh Perubahan Iklim terhadap Ketersediaan Air Baku di Malang Raya. *Jurnal Rekayasa Sipil, Volume 9*(1), 1-8.

Pujiraharjo, Alwafi, Rachmansyah, Arief, Wijatmiko, Indradi, Suharyanto, Agus, Zaika, Yulvi, Pudyono, & Hasyim, M. Hamzah. (2014). Pengaruh Perubahan Iklim terhadap Ketersediaan Air Baku di Kabupaten Mojokerto. *Jurnal Rekayasa Sipil, Volume 8*(1), 55-64.

Purnomo, Herry, Herawati, Hety, & Santoso, Heru. (2011). Indicators for assessing Indonesia's Javan rhino National Park vulnerability to climate change. *Mitigation and Adaptation Strategies for Global Change, 16*(7), 733-747. doi: 10.1007/s11027-011-9291-0

Pusat Data dan Informasi Kementerian ESDM. 2015. *Handbook of Energy & Economic Statistics of Indonesia*. Kementerian Energi dan Sumber Daya Mineral Republik Indonesia, Jakarta.

Rachmiati, Yati , Karyudi, Sriyadi, Bambang, Dalimoenthe, Salwa Lubnan, Rahardjo, Pudjo, & Pranoto, Eko. (2014). *Teknologi Pemupukan dan Kultur Teknis Yang Adaptif Terhadap Anomali Iklim pada Tanaman Teh*. Paper presented at the Seminar Nasional Upaya peningkatan produktivitas di perkebunan dengan teknologi pemupukan dan antisipasi anomali iklim, Hotel Crown Plaza Jakarta. Makalah Seminar retrieved from

Rahardjo, Parino (2013). Pengembangan Kota Pesisir Mitigasi dan Adaftif terhadap Perubahan Iklim dengan Pendekatan Ekosistem. *Jurnal Kajian Teknologi, Volume 9*(3), 207-218.

Ramdani, Fatwa, & Setiani, Putri. (2014). Spatio-temporal analysis of urban temperature in Bandung City, Indonesia. *Urban Ecosystems, 17*(2), 473-487. doi: 10.1007/s11252-013-0332-1

Ramdhan, Muhammad , & Riadi, Bambang. (2015). Korelasi Perubahan Iklim terhadap Produksi Rumput Laut di Kabupaten Lombok Timur Provinsi Nusa Tenggara Barat. Paper presented at the Seminar Nasional Peran Geografi dalam Mendukung Ketahanan Pangan 2015. Conference Paper retrieved from http://www.researchgate.net/publication/274375907

Republic of Indonesia (2012a). Indonesia's Technology Needs Assessments for Climate Change Mitigations. Link: http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNR_CRE/e9067c6e3b97459989b2196f12155ad5/621d32b1f9704764be63a9e8004d176e.pdf (31.01.2017)

Republic of Indonesia (2012b). Indonesia's Technology Needs Assessments for Climate Change Adaptations. Link: http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNR_CRE/e9067c6e3b97459989b2196f12155ad5/eb57eb84801249d6ab4a9beb937cbd5d.pdf (31.01.2017)

Republika, 2015. Indonesia Jadi Contoh Program Transfer Teknology ASEAN. Link: http://www.republika.co.id/berita/nasional/umum/15/03/06/nkseua-indonesia-jadi-contoh-program-transfer-teknologi-asean (31.01.2017)

Rimba, A. Besse , Campbell, Stuart, Maina, Joseph, As-syakur, Abd. Rahman, & Pardede, Shinta. (2012, 7 Juni 2012). Pengaruh *Climate Stress* terhadap Ikan dan Terumbu Karang di Pulau Weh dan Pulau Aceh Indonesia. Paper presented at the Pertemuan Ilmiah Tahunan MAPIN XIX, Makassar.

Rindayati, Heni , Susilowati, Indah, & Hendrarto, Boedi. (2013). Adaptasi Nelayan Perikanan Tangkap Pulau Moro Karimun Kepulauan Riau terhadap Perubahan Iklim. Paper presented at the Seminar Nasional Pengelolaan Sumberdaya Alam dan Lingkungan, Semarang.

Rizqiyah, Firzah (2010). Dampak Pengaruh Perubahan Iklim Global terhadap Produksi Kedelai (Glicine max L Merril) di Kabupaten Malang.

Rochmayanto, Yanto, & Kurniasih, Perbriyanti. (2012). Peranan gender dalam adaptasi perubahan iklim pada ekosistem pegunungan di Kabupaten Solok, Sumatera Barat. *Analisis kebijakan kehutanan, 10-3*, 203-213.

Romadhon, Agus (2014). Analisis Kerentanan dan Adaptasi Masyarakat Pulau Gili Labak terhadap Perubahan Iklim Berbasis Ekosistem Terumbu Karang. Paper presented at the Konferensi dan Seminar Nasional Pusat Studi Lingkungan Hidup XXII, Surabaya.

Rosenzweig, C., & Parry, M. L. (1994). Potential Impact of Climate-Change on World Food-Supply. *Nature, 367*(6459), 133-138.

Rositasari, Ricky , Setiawan, Wahyu B., H.Supriadi, Indarto, Hasanuddin, & Prayuda, Bayu. (2011). Kajian dan Prediksi Kerentanan Pesisir terhadap Perubahan Iklim: Studi Kasus di Pesisir Cirebon. Jurnal Ilmu dan Teknologi Kelautan Tropis, Volume 3(1), 52-64.

Rotstayn, L. D. , Jeffrey, S. J. , Collier, M. A., Dravitzki, S. M. , Hirst, A. C. , Syktus, J. I. , & Wong, K. K. . (2012). Aerosol- and greenhouse gas-induced changes in summer rainfall and circulation in the Australasian region: A study using single-forcing climate simulations. *Atmos. Chem. Phys., 12*, 6377–6404.

Ruminta, & Handoko. (2012). Climate risk dan adaptation assessment for the agriculture sector- Greater MALANG. Indonesia: Kementerian Lingkungan Hidup.

Saji, N. H., & Yamagata, T. (2003). Structure of SST and surface wind variability during Indian Ocean Dipole Mode events: COADS observations. *Journal of Climate, 16*(16), 2735-2751.

Sakuntaladewi, Niken, & Sylviani. (2014). Kerentanan dan Upaya Adaptasi Masyarakat Pesisir Terhadap Perubahan Iklim. [Vulnerability and Adaptation of Community at the Coastal Area to Climate Change]. *Jurnal Penelitian Sosial dan Ekonomi Kehutanan, Volume 11*(4), 281-293.

Sakya, Andi Eka, & Mahardhika, Ressa. (2010). Perspektif Penelitian dan Pengembangan Kecuacaan dan Keikliman untuk Mendukung Langkah Ketahanan Pangan dan Adaptasi Perubahan Iklim di Indonesia.

Schmidhuber, J., & Tubiello, F. N. (2007). Global food security under climate change. *Proceedings of the National Academy of Sciences of the United States of America, 104*(50), 19703-19708. doi: 10.1073/pnas.0701976104

Schmidt, Gavin A., Ruedy, Reto, Hansen, James E., Aleinov, Igor, Bell, Nadine, Bauer, Mike, . . . Yao, Mao-Sung. (2006). Present-Day Atmospheric Simulations Using GISS ModelE: Comparison to In Situ, Satellite, and Reanalysis Data. *Journal of Climate, 19*(2), 153-192. doi: 10.1175/jcli3612.1

Serang, Rudi. (2012). Pengaruh Perubahan Iklim Terhadap Optimasi Ketersediaan Air Di Daerah Irigasi Golek Kecamatan Pakisaji Kabupaten Malang Dengan Mempergunakan Program Linier. *Jurnal Teknik Pengairan, Volume 3*(1), 15–23.

Setiawan, Budhi, Abdurahman, Oman, Riawan, Edi, Puspita, Norma, & Iman, Munib Ikhwatul. (2012). Climate risk and adaptation assessment for teh water sector. Indonesia: Kementerian Lingkungan Hidup.

Sihombing, Lintong, et al. 2016. *Industrial Data and information Provission for The Third National Communication Report* [Powerpoint document]. Retrieved from Delegated Speaker of Ministry on Industry at the meeting on Industrial data and information Provission to arrange Third National Communication Report Year 2016, Bogor.

Sudarso. (2010). Perubahan iklim dan pengaruhnya terhadap peningkatan gangguan kesehatan. *Jurnal Damianus, Volume 9*(1), 12-22.

Suhelmi, Ifan R , Fahrudin, Achmad, & Triwibowo, Ferdinand Hariyanto. (2014). Potential Economic Losses Due to Tidal Inundation and Flood at Semarang City. *Journal of Forum Geografi, Volume 28*(2), 113-118.

Suhelmi, Ifan Ridlo (2013). Pemetaan Kapasitas Adaptif Wilayah Pesisir Semarang dalam Menghadapi Genangan Akibat Kenaikan Muka Air Laut dan Perubahan Iklim. Jurnal Forum Geografi. Kuliah Kerja Praktek (KKP). Balitbang Kelautan dan Perikanan. Pusat Penelitian dan Pengembangan Sumberdaya Laut dan Pesisir Balitbang Kelautan dan Perikanan.

Sumaryanto. (2012). Strategi Peningkatan Kapasitas Adaptasi Petani Tanaman Pangan Menghadapi Perubahan Iklim. *Jurnal Forum Penelitian Agro Ekonomi, Volume 30*(2), 73-89.

Supriadi, Handi , & Heryana, Nana. (2011, 1 Juni 2011). Dampak Perubahan Iklim terhadap Produksi Jambu Mete dan Upaya Penanggulangannya. *Buletin Ristri, Volume 2,* 175-186.

Surbakti, Indra M., Idroes, Izhar C., A., Hendricus, Simarmata, & Firman, Tommy. (2010). Jakarta City Report (K. Pesisir, Trans.) *Information related to Climate Change in Jakarta City*. Jakarta: BPS

Surmaini, Elza , Runtunuwu, Eleonora, & Las, Irsal. (2010). Upaya Sektor Pertanian dalam Menghadapi Perubahan Iklim. *Jurnal Litbang Pertanian, Volume 30*(1), 1-7.

Suroso, Djoko Santoso Abi, Hadi, Tri Wahyu, Latief, Hamzah, & Riawan, Edi. (2011). Pola Kerentanan Pesisir Indonesia Terhadap Dampak Perubahan Iklim Sebagai Basis Perencanaan Adaptasi. [Coastal Vulnerability Patterns Of Indonesia for The Climate Change Impact As Planning Adaptation Basis]. *Jurnal Tata Loka, Volume 13*(2), 108-118.

Susilowardhani, Arry. (2014). The Potential of Strategic Environmental Assessment to Address The Challenges of Climate Change to Reduce The Risks of Disasters: A Case Study From Semarang, Indonesia. *Resilient Cities: Beyond Mitigation, Preparedness, Response, and Recovery (Cities 2013 International Seminar), 135*, 3-9. doi: 10.1016/j.sbspro.2014.07.317

Sutanto, Dharma. (2011). EL-NINO untuk early warning demam berdarah dengue di Indonesia. *Penanggulangan bencana, 2-1*(Perubahan iklim), 33-40.

Sutijastoto., et al. 2010. *Handbook of Energy Economic and Statistic of Indonesia 2010*. Center for Data and Information Ministry of Energy and Mineral Resources of Indonesia, Jakarta.

Syahbuddin, Haris (2015). [Pengembangan teknologi terpadu adaptasi untuk pengelolaan risiko iklim sektor pertanian].

Syahrial, Ego., et al. 2011. *Handbook of Energy Economic and Statistic of Indonesia 2011*. Center for Data and Information Ministry of Energy and Mineral Resources of Indonesia, Jakarta.

Syahrial, Ego., et al. 2012. *Handbook of Energy Economic and Statistic of Indonesia 2012*. Center for Data and Information Ministry of Energy and Mineral Resources of Indonesia, Jakarta.

Syaukat, Yusman (2011). The Impact of Climate Change on Food Production and Security and Its Adaptation Programs in Indonesia. *Journal of ISSAAS, Volume 17*(1), 40-51.

Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *Proceedings of the National Academy of Sciences of the United States of America, 108*(50), 20260-20264. doi: 10.1073/pnas.1116437108

Timmermann, A., Oberhuber, J., Bacher, A., Esch, M., Latif, M., & Roeckner, E. (1999). Increased El Nino frequency in a climate model forced by future greenhouse warming. *Nature, 398*(6729), 694-697.

Tjiputra, J. F., Roelandt, C., Bentsen, M., Lawrence, D. M., Lorentzen, T., Schwinger, J., Heinze, C. (2013). Evaluation of the carbon cycle components in the Norwegian Earth System Model (NorESM). *Geosci. Model Dev., 6*(2), 301-325. doi: 10.5194/gmd-6-301-2013

Tokairin, Takayuki, Sofyan, Asep, & Kitada, Toshihiro. (2010). Effect of land use changes on local meteorological conditions in Jakarta, Indonesia: toward the evaluation of the thermal environment of megacities in Asia. *International Journal of Climatology, 30*(13), 1931-1941. doi: 10.1002/joc.2138

UNFCCC, 1992a. "UNFCCC Article 4 – Commitments" link: https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf (12.01.2017)

UNFCCC, 1995. The United Nations Framework Convention for Climate Change. FCCC/INFORMAL/84. United Nations Framework Convention on Climate Change, Bonn, Germany.

UNFCCC, 2007a. Decision 1/13. Bali Action Plan. United Nations Framework Convention on Climate Change, Bonn, Germany.

UNFCCC, 2007b. Decision 2/13. Reducing emissions from deforestation in developing countries: approaches to stimulate action. United Nations Framework Convention on Climate Change, Bonn, Germany.

UNFCCC, 2009. Decision 4/CP.15. Methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries. United Nations Framework Convention on Climate Change, Bonn, Germany.

UNFCCC, 2010. Decision 1/CP.16. Cancun Agreements. United Nations Framework Convention on Climate Change, Bonn, Germany.

UNFCCC, 2011. COP 16; Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010. (p. 12). UN.

UNFCCC, 2012. COP 17; Report of the Conference of the Parties on its seventeenth session, held in Durban from 28 November to 11 December 2011, Part Two: Action taken by the Conference of the Parties at its seventeenth session. (p. 16 - 19). UN.

UNFCCC, 2016. Technology and the UNFCCC: Building the foundation for sustainable development

UNFCCC, 2017b. "Technology Transfer Framework". Link: http://unfccc.int/ttclear/tec/tech-transfer-framework.html (12.01.2017)

USAID. (2012). Climate Change & Development Strategy Clean Resilient Growth. USAID: USAID.

Van der Werf, G.R., Dempewoll,, Trigg, S.N., Randerson, T., Kasibhatla, R.S., Giglio, L., Murdiyarso, D., Peter, W., Morton, D.C., Collatz, G., Polman, A., and DeFries, R.S. 2008. *Climate Regulation of Fire Emission and Deforestation in Equatorial Asia*. PNAS 105: 20350- 20355.

W. Hatmoko et al. 2012. Neraca Ketersediaan dan Kebutuhan Air pada Wilayah Sungai di Indonesia Puslitbang SDA Bandung (Water Balance of Water Availability and Water Demand in Indonesia River Basins, Water Resources Research Agency, Bandung)

Watanabe, Masahiro, Suzuki, Tatsuo, O'ishi, Ryouta, Komuro, Yoshiki, Watanabe, Shingo, Emori, Seita, Kimoto, Masahide. (2010). Improved Climate Simulation by MIROC5: Mean States, Variability, and Climate Sensitivity. *Journal of Climate, 23*(23), 6312-6335. doi: 10.1175/2010jcli3679.1

Watanabe, Satoshi, Kanae, Shinjiro , Seto, Shinta , Yeh, Pat J.-F. , Hirabayashi, Yukiko , & Oki, Taikan (2012). Intercomparison of bias-correction methods for monthly temperature and precipitation simulated by multiple climate models. *Journal of geophysicsal research, 117*(D23114).

WFP. (2016). Adaptation Fund Project - Submission for Cancellation (unpublished). Jakarta, Indonesia

Wibowo, Ari. (2012). Konversi hutan menjadi tanaman kelapa sawit pada lahan gambut: Implikasi perubahan iklim dan kebijakan. *Sosial dan Ekonomi Kehutanan, 7-4*(Perubahan iklim), 251-260.

Widiyanti, Wiwin, & Dittmann, Andreas. (2014). Climate Change and Water Scarcity Adaptation Strategies in the Area of Pacitan, Java Indonesia. *4th International Conference on Sustainable Future for Human Security Sustain 2013, 20*, 693-702. doi: 10.1016/j.proenv.2014.03.083

Widodo and Donan. (2010). The Important of Open Green Space (RTH) Development in Yogyakarta Municipality, Indonesia.

Widyati, Enny. (2011). Kajian Optimasi Pengelolaan Lahan Gambut dan Isu Perubahan Iklim. [Overview on Optimizatin of Peat Lands Management and Climate Change Issues]. *Jurnal Tekno Hutan Tanaman, Volume 4*(2), 57-68.

Wijaya, Nurrohman (2015). Climate Change Adaptation Measures in the Coastal City of Semarang, Indonesia: Current Practices and

Performance. *Jurnal Perencanaan Wilayah dan Kota, Volume 26*(1), 28-42.
Wilby, R. L., Troni, J., Biot, Y., Tedd, L., Hewitson, B. C., Smith, D. M., & Sutton, R. T. (2009). A review of climate risk information for adaptation and development planning. *International Journal of Climatology, 29*(9), 1193-1215.
Wirawan, I. Made Ady. (2010). Public Health Responses to Climate Change Health Impacts in Indonesia. *Asia-Pacific Journal of Public Health, 22*(1), 25-31. doi: 10.1177/1010539509350912
Wirayoga, Mustazahid Agfadi (2013). Hubungan Kejadian Demam Berdarah Dengue dengan Iklim di Kota Semarang Tahun 2006-2011. *Unnes Journal of Public Health, Volume 2*(4), 1-9.
Wit, Francisca, Muller, Denise, Baum, Antje, Wameke, Thorsten, Pranowo, Widodo Setiyo, Muller, Maritz, & Rixen, Tim. (2015). The impact of distrubed peatlands on river outgassing in Southeast Asia. *Natural Communications*(Peatland), 1-9. doi: 10.1038/NCOMMS10155
Wu, P., Hara, M., Fudeyasu, H., Yamanaka, M.D. , Matsumoto, J., Syamsuddin, F.,. Djajadihardja, YS. . (2007). The impact of Trans-equatorial monsoon flow on the formation of repeated torrential rains over Java Island. *Sola, 3*, 093-096. doi: doi:10.2151/sola.2007-024.
Wu, T. (2012). A mass-flux cumulus parameterization scheme for large-scale models: Description and test with observations *Clim. Dyn., 38*, 725–744.
Wulandari, Marina Ayu , & Sunarti. (2012). Tipologi Kerentanan Permukiman Kumuh Kawasan Pesisir Terhadap Perubahan Iklim Di Kota Tegal. *Jurnal Teknik PWK, Volume 2*(1), 85-93.
Xin, X., Wu, T., Li, J. , Wang, Z., Li, W. , & Wu, F. . (2012). How well does BCC_CSM1.1 reproduce the 20th century climate change over China? *Atmos. Ocean. Sci. Lett., 6*, 21–26.
Xin, X., Zhang, L., Zhang, J., Wu, T., & Fang, Y.. (2013). Climate change projections over East Asia with BCC_CSM1.1 climate model under RCP scenarios. *J. Meteorol. Soc. Jpn., 91*, 413–429.
Yamashita, T. , Bambang, H., Teti, K., & Hendri. (2013, September 24-26, 2013). Tropical Coastal Engineering in Indonesia Adapting to Near-Term Ocean-Climate Changes. Paper presented at the International Conference on Asian and Pacific Coasts (APAC 2013), Bali, Indonesia.
Yukimoto, S., Yoshimura, H. , Hosaka, M. , Sakami, T., Tsujino, H. , Hirabara, M,.Kitoh, A. . (2011). Meteorological Research Institute - Earth System Model v1 (MRI-ESM1) - Model Description. In T. R. o. MRI (Ed.), (Vol. 64, pp. 83 pp): Ibaraki, Japan.
Yukimoto, Seiji, Adachi, Yukimasa, Hosaka, Masahiro, Sakami, Tomonori, Yoshimura, Hiromasa, Hirabara, Mikitoshi, Kitoh, Akio. (2012). A New Global Climate Model of the Meteorological Research Institute: MRI-CGCM3 —Model Description and Basic Performance&mdash. *Journal of the Meteorological Society of Japan. Ser. II, 90A*, 23-64.
Yulianisa, Rizky , & Susilowati, Indah. (2010). Economic Valuation on Climate Change in The Marine Fisheries In Cilacap, Central Java.
Zed, Farida., dkk. 2007. *Handbook of Energy Economic and Statistic of Indonesia 2007*. Center for Data and Information Ministry of Energy and Mineral Resources of Indonesia, Jakarta.
Zed, Farida., dkk. 2008. *Handbook of Energy Economic and Statistic of Indonesia 2008*. Center for Data and Information Ministry of Energy and Mineral Resources of Indonesia, Jakarta.
Zubaidah, Tien (2012). Dampak perubahan iklim terhadap kejadian penyakit demam berdarah dengue di Kota Banjarbaru, Kalimantan Selatan selama tahun 2005-2010. *Jurnal Buski, Volume 4*(2), 59-65.

Published by:
Directorate General of Climate Change
Ministry of Environment and Forestry
Republic of Indonesia
Manggala Wanabakti Building, Block VII, 12th Floor
Jl. Jend. Gatot Subroto, Senayan Jakarta 10220, INDONESIA
Phone: +62-21-5730144, Facs: +62-21-5733336