SOCIALIST REPUBLIC OF VIETNAM

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT

NATIONAL COMMUNICATION OF VIETNAM

THE THIRD

TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

ISBN 978-604-952-383-0

NOT FOR SALE

VIETNAM PUBLISHING HOUSE OF NATURAL RESOURCES, ENVIRONMENT AND CARTOGRAPHY

NARENCA

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Hanoi Branch: No.14 - Phao Dai Lang, Lang Thuong, Dong Da, Hanoi

Ho Chi Minh Branch: No.3 - Tran Nao, Binh An Ward, District 2, Ho Chi Minh City

THE THIRD NATIONAL COMMUNICATION OF VIETNAM TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Responsible for Publishing:

General Manager - Editorial Director: MA. Kim Quang Minh

Deputy Editor: BSc. Nguyen Van Chinh

Editor: Dao Thi Hau

Cover and Print Design: Tue Phuong Design

Number of prints: 1.000 booklets, Size: 21x29,7 cm

Printed at: Cartographic Printing Enterprise

Address: 14 Phao Dai Lang, Dong Da, Ha Noi

Licence No.: 897-2019/CXBIPH/02-218/BaĐ

Publishing Decision No.: 15/QĐ-TMBVN

Completed Print and Copyright Deposited in March 2019

ISBN code: 978-604-952-383-0

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INTERNATIONAL SUPPORTS

GEF, UNEP, GSP, GIZ and SilvaCarbon have provided financial and technical support for the development of the Third National Communication of Viet Nam to the UNFCCC.

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ABBREVIATIONS

AFD	Agence Française de Développement
AR4	IPCC's 4th Assessment Report
AR5	IPCC's 5th Assessment Report
BAU	Business As Usual
BUR	Biennial Updated Report
BUR1	The Initial Biennial Updated Report of Viet Nam to UNFCCC
BUR2	The Second Biennial Updated Report of Viet Nam to UNFCCC
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
EF	Emission factor
EUR	Euro
FAO	United Nations Food and Agriculture Organization
FIRM	Facilitating Implementation and Readiness for Mitigation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSP	United Nations Global Support Programme
GSO	General Statistics Office
GWP	Global Warming Potential
HDI	Human development index
IE	Included Elsewhere
IIP	Index of Industrial Production
IMHEN	Institute of Meteorology, Hydrology and Climate Change
INC	The Initial National Communication of Viet Nam to UNFCCC
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industry processes and product use
ISPONRE	Institute of Strategy Policy on Natural Resources and Environment
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
KP	Kyoto Protocol
LEAP	Long-range Energy Alternatives Planning
LPG	Liquefied Petroleum Gas
LULUCF	Land use, Land use change and Forestry
MARD	Ministry of Agriculture and Rural Development
MOC	Ministry of Construction
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MOT	Ministry of Transport
MPI	Ministry of Planning and Investment
MRV	Measurement, Reporting and Verification
NA	Not applicable
NAMA	Nationally Appropriate Mitigation Action
NCs	National Communications
NCCC	National Committee on Climate Change
NDC	Nationally Determined Contribution
NE	Not Estimated
NGOs	Non-governmental organizations
NIR 2014	Technical report of 2014 National GHG inventory
NMVOCs	Non-methane volatile organic compound
NO	Not Occurring
ODA	Official Development Assistance
PA	Paris Agreement
QA	Quality Assurance
QC	Quality Control
REC	Renewable Energy Certificate
REDD+	Reducing Emissions from Deforestation and Forest Degradation as well as conservation, sustainable management of forests and enhancement of forest carbon stocks
SDGs	Sustainable Development Goals
SNC	The Second National Communication of Viet Nam to UNFCCC
SP-RCC	Support Program to Respond to Climate Change
TNC	The Third National Communication of Viet Nam to UNFCCC
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VCS	Verified Carbon Standard
VND	Viet Nam Dong
VPCC	Viet Nam panel on climate change
WB	World Bank

CHEMICAL FORMULA

CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HFCs	Hydrofluorocarbons
NO_x	Oxides of nitrogen
N_2O	Nitrous oxide
NH_3	Ammonia
PFCs	Perfluorocarbons
SF_6	Sulfur hexafluoride
SOx	Sulfur Oxides

UNIT

^0C	Degree Celsius
kg	Kilogram
cm	Centimeter
m	Meter
km	Kilometer
m^2	Meter square
km^2	Kilometer square
m^3	Meter cubic
ha	Hectare
t	Tonnes
tCO_2	Tonnes of Carbon dioxide
tCO_2e	Tonnes of Carbon dioxide equivalent
kt	Thousand tonnes
Mt	Million tonnes
TOE	Tonne of oil equivalent
KTOE	Thousand tonnes of oil equivalent
kW	Kilowatt
MW	Megawatt
kWh	Kilowatt per hour
MWh	Megawatt per hour

PREFACE

In order to implement the provisions of Articles 4.1 and 12.1 of the United Nations Framework Convention on Climate Change (UNFCCC), Ministry of Natural Resources and Environment - The National Focal Point implementing the UNFCCC, the Kyoto Protocol and the Paris Agreement - has been in charge, in collaboration with relevant ministries and agencies to develop the Third National Communication of Viet Nam to the UNFCCC.

The Third National Communication of Viet Nam to the UNFCCC was prepared in accordance with UNFCCC guidelines, including 06 main chapters: (i) National circumstances; (ii) National greenhouse gas inventory; (iii) Climate change impacts and adaptation measures; (iv) Assessment of greenhouse gases mitigation measures and related policies; (v) Other information, including Transfer of technologies; Research and systematic observation; Education, training, capacity building and public awareness on climate change; Information and networking; Mainstreaming climate change issues into socio-economic development strategies, master plans and plans; and (vi) Constraints and gaps, and related financial, technical and capacity needs.

The completion of the Third National Communication of Viet Nam to the UNFCCC contributes to the affirmation that Viet Nam, one of the developing countries most affected by climate change, aims to fulfill its obligations as a Party; demonstrates the Government's proactive commitments to respond to climate change, as well as actively participates in the international community to implement the ultimate objectives of UNFCCC and the Paris Agreement.

The Ministry of Natural Resources and Environment is pleased to announce the Third National Communication of Viet Nam to the UNFCCC Secretariat and would like to thank for the active participation of relevant Ministries, The Advisory Council of the National Committee on Climate Change, the valuable contributions of national and international experts and scientists, and a number of international organizations, in particular the Global Environment Facility and the United Nations Environment has provided financial support for the preparation of the Third National Communication of Viet Nam./.

Tran Hong Ha

MINISTER OF NATURAL RESOURCES AND ENVIRONMENT OF VIET NAM

Chapter 1

NATIONAL CIRCUMSTANCES

1.1. NATURAL CONDITIONS

1.1.1. Geography

Located in Southeast Asia, the mainland territory of Viet Nam is from latitude 8°27′ to 23°23′ N and longitude 102°08′ to 109°30′ E, and borders China to the North, Lao PDR and Cambodia to the West, and the East Sea (Biển Đông) to the East, South and Southwest. Viet Nam has a coastline of 3,260 km and over one million kilometer-squared of sea waters, including two major archipelagos, the Paracel Archipelago of Da Nang city and the Spratly Archipelago of Khanh Hoa province. There are over 3,000 islands along the coastline and 10 bays, of which there are two biggest bays, Cam Ranh Bay and Ha Long Bay.

The mainland territory of Viet Nam occupies approximately 331,230.8 km^2.[1] Three quarters of Viet Nam is mountainous with the altitude mostly from 100 m to 1,000 m in the Northeast, Northwest and Central areas. The remaining areas are alluvium plains. Viet Nam has many high and extensive mountain ranges, especially the Hoang Lien Son range and the Truong Son range. The two largest plains are the Mekong Delta, covering an area of about 40,000 km^2 in the South and the Red River Delta, covering an area of about 15,000 km^2 in the North.

Ha Noi is Viet Nam's capital and political, cultural, scientific and educational centre. Ha Noi has an area of 3,358.9 km^2 and a population of 7.420 million people[2].

1. Statistical yearbook of Viet Nam 2017
2. Statistical yearbook of Viet Nam 2017

1.1.2. Climate

Viet Nam has a tropical monsoon climate. As the territory of Viet Nam stretches along many latitudes and terrains, the differences in climate between regions are significant and distinct. The northern climate has four seasons, including spring, summer, autumn, winter, while the southern climate has two seasons including the rainy season from May to November and the dry season from December to April. The average temperature of the coldest month is between 10^0C and 16^0C in the northern mountain area and 20^0C to 24^0C in the south. Averages of summer temperature range from 25^oC to 30^oC. Averages of annual rainfall range from 600 mm to 5,000 mm, most frequently from 1,400 mm to 2,400 mm. About 80-90% of the rainfall is concentrated in the rainy season. The number of rainy days in the year is about 60 to 200 days but varies among regions. Average relative humidity is around 80 to 85%. Average annual sunshine hours range from 1,700 to 2,500 hours.

1.1.3. Water resources

Viet Nam has 3,450 rivers and streams over 10km in length, including 13 major rivers; 392 inter-provincial rivers and streams; 3,045 provincial rivers and streams; 108 river basins, of which 8 major river basins are Hong-Thai Binh, Bang Giang-Ky Cung, Ma, Vu Gia-Thu Bon, Ba, Dong Nai and Cuu Long; 25 inter-provincial river basins and 75 provincial river basins.

The average annual flow of surface water is about 830-840 billion m^3, of which 57% is concentrated in the Mekong River Basin, more than 16% in the Hong-Thai Binh River Basin, with more than 4% in the Dong Nai River Basin, with the remainder in other river basins. Most of Viet Nam's major river systems are transboundary rivers. Approximately 63% of surface water (520-525 billion m^3) flows in from neighboring countries, and only about 37% of surface water (310-315 billion m^3) is from domestic sources. The total volume of water currently being exploited is about 80.6 billion m^3, accounting for approximately 10% of the country's total water volume, of which over 80% is used for agricultural purposes (approximately 65 billion m^3 per year). In addition, water is also used for energy production, daily life, aquaculture and industrial production, tourism and other services. The structure of water use is tending to increase for industry, fisheries and livelihood. Viet Nam has a relatively high average annual rainfall and a total rainfall of about 640 billion m^3 per year.

Viet Nam has a relatively large potential for groundwater resources, concentrated in the Red River and, Mekong River deltas and Tay Nguyen region. Total potential groundwater reserves are estimated at 63 billion m^3 per year. Total groundwater exploitation is about 10.53 million m^3 per day, of which the Northern Delta and the Southern Delta are the two most exploited areas with the total exploitation of both areas of about 5.87 million m^3 per day, accounting for 55.7% of the total groundwater exploitation in the country. The exploited groundwater is mainly used for daily activities and industry.

1.1.4. Biodiversity

Viet Nam is rich in biodiversity with many ecosystems, types of species, and extensive endemic genetic resources due to the diversity of terrain, soil, climatic and hydrological conditions. Typical ecosystems include forest ecosystems, mangrove ecosystems, coral reef ecosystems and seagrass ecosystems. On the diversity of species, there are nearly 16,500 species of higher plants, large fungi and moss on land, of which endemic plant species account for about 30%. There are about 10,500 terrestrial animal species. In freshwater, there are about 1,500 species of microalgae and algae; over 1,000 invertebrates and about 600 species of fish. In marine ecosystems, there are over 1,200 species of seaweed, grass, microalgae and more than 7,000 invertebrates, about 2,500 species of fish and approximately 50 species of sea snakes, sea turtles and marine mammals. Regarding diversity of genetic resources, Viet Nam is considered to be one of the 12 centers of plant origin and domesticated husbandry in the world.

However, recently, climate change along with the overexploitation of biological resources, the reduction of natural forest area due to illegal logging, wild fire, and the invasion of adventives are causing biodiversity loss in Viet Nam.

1.2. SOCIO-ECONOMIC DEVELOPMENT AND ENVIRONMENTAL PROTECTION

1.2.1. Population, society, education, human health and tourism

As of 2014, Viet Nam's population was 90.73 million, average population density was 274 persons/km^2, and average life expectancy was 73.2. Some demographic characteristics during the period of 2012-2016 are shown in Table 1.1.

Table 1.1. Some demographic characteristics during the period of 2012-2016

Year	Total population (thousand persons)	Growth rate (%)	By sex (%)		By residence (%)	
			Male	Female	Urban	Rural
2012	88,809.3	1.08	49.44	50.56	31.83	68.17
2013	89,759.5	1.07	49.43	50.57	32.17	67.83
2014	90,728.9	1.08	49.33	50.67	33.10	66.90
2015	91,709.8	1.08	49.31	50.69	33.88	66.12
2016	92,692.2	1.07	49.36	50.64	34.44	65.56

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The total expenditures for social security, hunger elimination and poverty reduction in Viet Nam increased from VND 4,304 billion in 2014 to VND 7,303 billion in 2016. As of 2016, over 18.3 million health insurance cards were issued for policy beneficiaries and the poor for free treatment. Some key social indicators achieved during the period of 2012-2016 are displayed in Table 1.2.

Table 1.2. Some key social indicators achieved during the period of 2012-2016

Indicator	Year				
	2012	2013	2014	2015	2016
Unemployment rate of the working age labor in urban areas (%)	3.21	3.59	3.40	3.37	3.23
Poverty rate (%)	11.1	9.8	8.4	7.0	5.8
Percentage of literate population at 15 years of age and above (%)	94.7	94.8	94.7	94.9	95.0
Human development index (HDI)	0.662	0.667	0.682	0.688	0.695
Life expectancy at birth (year)	73.05	73.10	73.23	73.31	73.39
Percentage of household having hygienic water (%)	91.0	-	93.0	-	93.4
Percentage of household using electricity (%)	97.6	-	98.3	-	98.8

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The national education system has been restructured, focusing on the planning of education and training facilities, human resources and infrastructure systems. The contents, educational programs and training methods at all levels have been reformed and completed to decentralize the state management of education and training activities. The number of teachers, students and universities increased during the period of 2013-2016 as shown in Table 1.3.

Table 1.3. Number of teachers, students and universities during the period of 2013-2016

Year	Teachers (thousand persons)	Students (thousand persons)	Universities (public and non-public)
2013	65.2	1,670.0	214
2014	65.7	1,824.3	219
2015	69.6	1,753.2	223
2016	72.8	1,767.9	235

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The health sector in Viet Nam has showed great efforts to focus on the development of the domestic health-care system and the people's health care in the direction of improving efficiency and quality. Disease prevention activities has been enhanced. The increase in the number of doctors, medical facilities and patient beds during the period of 2012-2016 is presented in Table 1.4.

Table 1.4. Number of doctors, establishments and patient beds during the period of 2012-2016

Year	Doctor	Number of doctors /10.000 inhabitants	Number of health establishments (excluding private facilities)	Number of patient beds
2012	65,100	7.3	13,523	275,100
2013	68,600	7.6	13,562	280,700
2014	71,800	7.9	13,611	295,800
2015	73,800	8.0	13,617	306,100
2016	77,500	8.4	13,591	315,000

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Viet Nam is a country with rich and diverse tourism potential, with more than 40,000 natural and cultural attractions; they include eight scenic sites are recognized by UNESCO as World Heritage Sites; eight World Biosphere Reserves; nine world intangible cultural heritages; three world natural heritages; 117 museums; nearly 8,000 domestic festivals; two magnificent world-class bays: Ha Long Bay and Nha Trang Bay; 125 beautiful beaches; 46 national tourist sites; 40 national tourist spots; 30 National Parks and many natural hot springs; nearly 1,000 caves, including many beautiful world-class caves, especially those in Phong Nha-Ke Bang National Park.

In 2014, the tourism sector serviced about 38.5 million domestic visitors. The total number of foreign visitors to Viet Nam in 2014 reached 7,959.9 thousand persons. The total number of foreigner arrivals in Viet Nam during the period of 2012-2016 is shown in Table 1.5.

Table 1.5. Number of foreigner arrivals in Viet Nam during the period of 2012-2016

Unit: thousand visitors

Year	Total	Of which		
		Aviation	Waterway	Road transport
2012	6,847.7	5,575.9	285.5	986.3
2013	7,572.4	5,980.0	193.3	1,399.1
2014	7,959.9	6,220.2	133.2	1,606.5
2015	7,943.7	6,271.3	169.8	1,502.6
2016	10,012.7	8,260.6	284.8	1,467.3

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

1.2.2. Industry, energy, transportation and construction

The Index of Industrial Production (IIP) increased during the period of 2012-2016, in which the electricity, gas, hot water, steam and air conditioner supply had the highest rate of increase index, as shown in Table 1.6. Some major industrial products during the period of 2012-2016 are presented in Table 1.7.

Table 1.6. IIP compared to the previous year by industrial setors during the period of 2012-2016

Unit: %

Year	Total	Mining And quarrying	Manufacturing	Electricity, gas, hot water, steam and air conditioning supply	Water supply; Sewerage and waste management and remediation activities
2012	105.8	105.0	105.5	111.5	108.2
2013	105.9	99.4	107.6	108.4	109.5
2014	107.6	102.4	108.7	112.5	106.3
2015	109.8	107.1	110.5	111.4	106.9
2016	107.4	93.2	111.3	111.5	108.0

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Table 1.7. Some major industrial products during the period of 2012-2016

Year	2012	2013	2014	2015	2016
Coal (kt)	42,083	41,064	41,086	41,664	38,735
Crude oil (kt)	16,739	16,705	17,392	18,746	17,230
Natural gas (million m^3)	9,355	9,751	10,210	10,660	10,610
Iron ores (kt)	1,506	2,495	2,719	2,691	3,056
Copper ores (t)	50,862	49,148	48,394	49,032	48,526
Clothes (million pieces)	3,144.1	3,424.0	3,706.5	4,320.0	4,530.0
Chemical fertilizers (kt)	3,205.0	3,730.8	3,829.4	3,729.1	3,536.6
NPK fertilizers (kt)	3,295.2	3,372.3	3,387.1	3,304.1	3,081.0
Cement (kt)	56,353	57,516	60,982	67,645	74,457
Steel bars (kt)	2,964.8	3,484.3	3,954.0	4,092.7	5,472.0
Steel (kt)	8,405	9,251.9	10,739.0	12,543.3	15,523.4
Mobile phone (million pieces)	109.4	132.0	181.4	235.6	193.0
Assembled television set (thousand pieces)	2,600.4	3,112.3	3,425.9	5,512.4	10,838.6
Air-conditioner (thousand pieces)	393.4	414.1	286.6	534.3	613.5
Threshing machine (thousand pieces)	12.6	14.0	12.9	13.1	13.7
Assembled automobile (thousand pieces)	86.9	101.1	134.0	192.8	254.9
Paper, cover (kt)	1,492.3	1,445.0	1,349.4	1,495.6	1,614.4

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Total primary energy supply by types of energy was 58,023 KTOE in 2012, increased to 62,894 KTOE in 2014 and final energy consumption by types of energy was 49,302 KTOE in 2012, and increased to 52,248 KTOE in 2014, as shown in Tables 1.8 and 1.9.

Table 1.8. Total primary energy consumption during the period of 2012-2014 by types of energy

Unit: KTOE

Types of energy / Year	Coal	Crude oil	Total oil products	Natural gas	Non-commercial fuels	Electricity	Total
2012	15,785	6,297	8,902	8,253	14,121	4,665	58,023
2013	17,239	6,918	7,757	8,522	13,669	5,097	59,202
2014	19,957	6,345	9,453	9,124	12,745	5,270	62,894

Sources: Viet Nam Energy Statistics 2014, MOIT, 2016; Technical report on GHG inventory in energy sector for 2013, MONRE, 2017; Technical report on GHG inventory in energy sector for 2014, MONRE, 2018

Table 1.9. Total end-use energy consumption during the period of 2012-2014 by types of energy

Unit: KTOE

Types of energy / Year	Coal	Total oil products	Natural gas	Non-commercial fuels	Electricity	Total
2012	9,678	15,036	1,438	14,086	9,064	49,302
2013	10,559	14,971	1,460	13,628	9,988	50,606

Year \ Types of energy	Coal	Total oil products	Natural gas	Non-commercial fuels	Electricity	Total
2014	11,457	15,592	1,458	12,696	11,045	52,248

Sources: Viet Nam Energy Statistics 2014, MOIT, 2016; Technical report on GHG inventory in energy sector for 2013, MONRE, 2017; Technical report on GHG inventory in energy sector for 2014, MONRE, 2018

The transport of passengers in 2014 reached 3,056.8 million passengers (an increase of 216.9 million passengers compared to 2013), of which the road transport was the most common mean of transportation with 2.863.5 million passengers. The number of passengers traveling by waterway was 156.9 million persons, by aviation was 24.4 million persons and by railway was 12.0 million persons. The total number of passengers carried during the period of 2012-2016 by types of transport is presented in Table 1.10.

Table 1.10. Number of passengers carried during the period of 2012-2016 by types of transport

Unit: million persons

Year	Total	of which			
		Railway	Road	Waterway	Aviation
2012	2,676.5	12.2	2,504.3	145.0	15.0
2013	2,839.9	12.1	2,660.5	150.4	16.9
2014	3,056.8	12.0	2,863.5	156.9	24.4
2015	3,310.5	11.2	3,104.7	163.5	31.1
2016	3,623.2	9.8	3,401.9	172.9	38.6

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The volume of freight transported in 2014 was about 1,078.6 million tonnes (an increase of approximately 68.2 million tonnes compared to 2013), of which the road transport is the dominant type with 821.7 million tonnes; inland waterway, sea, air and rail freight reached about 190.6 million tonnes, 58.9 million tonnes, 0.2 million tonnes and 7.2 million tonnes respectively. The volume of freight transported during the period of 2012-2016 by types of transport is presented in Table 1.11.

Table 1.11. Volume of freight transported during the period of 2012-2016 by types of transport

Unit: kt

Year	Total	Of which				
		Railway	Road	Inland waterway	Marinetransport	Aviation
2012	961,128.4	6,952.1	717,905.7	174,385.4	61,694.2	191.0
2013	1,010,413.9	6,525.9	763,790.0	181,212.7	58,701.6	183.7
2014	1,078,580.9	7,178.9	821,700.0	190,600.0	58,900.0	202.0
2015	1,146,895.7	6,707.0	877,628.4	201,530.7	60,800.0	229.6
2016	1,255,458.2	5,209.0	969,721.0	215,768.2	64,474.4	285.6

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The floor area of residential buildings constructed in 2014 reached 89,843 thousand m^2, an increase of 3.7% compared to 2013, in which the area of apartment buildings reached 2,326 thousand m^2, accounting for 2.6%; and the area of single detached houses reached 87,517 thousand m^2, accounting for 97.4%. The area of housing per capita in the country was 19.4 m^2 per person in 2012, which increased to 21.4 m^2 per person in 2014 and 22.2 m^2 per person in 2016.

Total floor area of residential buildings constructed during the period of 2012-2016 by types of house is shown in Table 1.12.

Table 1.12. Floor area of residential buildings constructed during the period of 2012-2016

Unit: thousand m^2

Year	Total	Of which	
		Apartment	Private house
2012	81,313	1,844	79,469
2013	86,621	3,361	83,260
2014	89,843	2,326	87,517
2015	93,422	2,324	91,098
2016	102,488	2,982	99,506

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

1.2.3. Agriculture, aquaculture and forestry

In 2014, the total area of agricultural production in the country was about 10.23 million ha, of which the total area of paddy cultivation was about 7.8 million ha. The total production of paddy in 2014 reached nearly 45 million tonnes. The total cereal production in 2014, including maize production, reached nearly 50.2 million tonnes. Viet Nam is one of the major rice exporters in the world. The planted area and production of cereals during the period of 2012-2016 is shown in Table 1.13.

Table 1.13. Planted area and production of cereals during the period of 2012-2016

Year	Planted area (thousand ha)		Production (kt)	
	Paddy	Maize	Paddy	Maize
2012	7,761.2	1,156.6	43,737.8	4,973.6
2013	7,902.5	1,170.4	44,039.1	5,191.2
2014	7,816.2	1,179.0	44,974.6	5,202.3
2015	7,828.0	1,178.9	45,091.0	5,287.2
2016	7,737.1	1,152.7	43,165.1	5,246.5

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The cultivation sector has been in line with domestic and international markets, focusing on improving product quality. Cultivation area and production of some industrial crops during the period of 2012-2016 are shown in Tables 1.14 and 1.15.

Table 1.14. Planted area of some industrial crops during the period of 2012-2016

Unit: thousand ha

Year	Rubber	Coffee	Tea	Sugarcane	Soybean	Cashew nut	Peanut
2012	917.9	623.0	128.3	301.9	119.6	335.2	219.2
2013	958.8	637.0	129.8	310.4	117.2	308.1	216.4
2014	978.9	641.2	132.6	305.0	109.4	295.1	208.7
2015	985.6	643.3	133.6	284.2	100.8	290.4	200.2
2016	973.5	650.6	133.4	267.6	99.6	293.1	184.8

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Table 1.15. Production of some industrial crops during the period of 2012-2016

Unit: kt

Year	Rubber	Coffee	Tea	Sugarcane	Soybean	Cashew nut	Peanut
2012	877.1	1,260.4	909.8	19,015.4	173.5	312.5	468.5
2013	946.9	1,326.6	936.3	20,128.5	168.2	275.5	491.9
2014	966.6	1,408.4	981.9	19,821.6	156.5	345.1	453.3
2015	1,012.7	1,453.0	1,012.9	18,337.3	146.4	352.0	454.1
2016	1,035.3	1,460.8	1,033.6	17,211.2	160.7	305.3	427.2

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The development of the livestock population during the period of 2012-2016 is presented in Table 1.16.

Table 1.16. Livestock population during the period of 2012-2016

Year	Buffaloes	Cattle	Pigs	Poultry
	Thous. heads			Mil. heads
2012	2,627.8	5,194.2	26,494.0	308.5
2013	2,559.5	5,156.7	26,264.4	317.7
2014	2,521.4	5,234.3	26,761.4	327.7
2015	2,524.0	5,367.2	27,750.7	341.9
2016	2,519.4	5,496.6	29,075.3	361.7

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Production, area of aquaculture water and the number of fishing vessels have increased during the period of 2012-2016, details are shown in Table 1.17.

Table 1.17. Production, area of aquaculture water and the number of fishing vessels during the period of 2012-2016

Year	Production (kt)		Area of water surface for the aquaculture (thousand ha)	Number of upper 90 CV offshore fishing vessels (vessels)
	Catch	Aquaculture		
2012	2,705.4	3,115.3	1,038.9	22,566
2013	2,803.8	3,215.9	1,046.4	25,456
2014	2,920.4	3,412.8	1,056.3	27,679
2015	3,049.9	3,532.2	1,057.3	28,719
2016	3,226.1	3,644.6	1,072.8	30,472

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The production of aquaculture in 2014 reached about 2.9 million tonnes, of which marine reached 2.7 million tonnes, while freshwater reached 0.2 million tonnes. Total aquaculture production in 2014 was about 3.4 million tonnes, of which marine aquaculture was 0.2 million tonnes and freshwater aquaculture was 3.2 million tonnes. The area of aquaculture water increased from 1,038.9 thousand ha in 2012 to 1,072.8 thousand ha in 2016. The number of upper 90 CV offshore fishing vessels increased from 22,566 vessels in 2012 to 30,472 vessels in 2016.

The total forest area of Viet Nam in 2014 was 13,796,500 ha, equating to a 40.4% of forest coverage, of which natural forest was 10,100,200 ha and the planted forest was 3,696,300 ha. The area of forest in Viet Nam during the period of 2012-2016 is presented in Table 1.18.

Table 1.18. Area of forest in Viet Nam during the period of 2012-2016

Unit: thousand ha

Year	Total forest area	Of which		Proportion of forest coverage (%)
		Natural forest	Planted forest	
2012	13.862,0	10.423,8	3.438,2	40,7
2013	13.954,4	10.398,1	3.556,3	41,0
2014	13.796,5	10.100,2	3.696,3	40,4
2015	14.061,9	10.175,5	3.886,4	40,8
2016	14.377,7	10.242,1	4.135,6	41,2

Sources: Statistical yearbook of Viet Nam 2013, 2014, 2015, 2016, 2017, GSO 2014, 2015, 2016, 2017, 2018

The new plantation area of newly planted forest in the whole country in 2014 reached 221,700 ha, including 198,600 ha of production forests, 21,800 ha of protection forests and 1,300 ha of specialized forests. The area of new concentrated planted forest by types of forest in Viet Nam during the period of 2012-2016 is shown in Table 1.19.

Table 1.19. Area of new concentrated planted forest by types of forest during the period of 2012-2016

Unit: thousand ha

Year	Total	Of which		
		Production forest	Protection forest	Specialized forest
2012	187.0	171.0	14.6	1.4
2013	227.1	211.8	14.1	1.2
2014	221.7	198.6	21.8	1.3
2015	250.0	225.4	23.3	1.3
2016	240.0	218.9	19.9	1.2

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

1.2.4. Economic growth, environmental protection and sustainable development

The Gross Domestic Product (GDP) of Viet Nam in 2014 was 5.98% higher than in 2013. The economic growth rate was higher than the population growth rate, GDP per capita at current prices increased from USD 1,748 per person in 2012 to USD 1,907 in 2013; USD 2,052 in 2014; USD 2,109 in 2015 and USD 2,215 per person in 2016.

GDP at current prices by economic sector increased gradually during the period of 2012-2016 and is shown in Table 1.20.

Table 1.20. GDP at current prices by economic sector during the period of 2012-2016

Unit: billion VND

Year	Total	Of which			
		Agriculture, forestry and fishing	Industry and construction	Service	Products taxes less subsidies on production
2012	3,245,419	623,815	1,089,091	1,209,464	323,049
2013	3,584,262	643,862	1,189,618	1,388,407	362,375
2014	3,937,856	696,969	1,307,935	1,537,197	395,755
2015	4,192,862	712,460	1,394,130	1,665,962	420,310
2016	4,502,733	734,830	1,473,071	1,842,729	452,103

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

The Gross National Income (GNI) at current prices of Viet Nam increased from VND 3,115,227 billion in 2012 to VND 3,750,823 billion in 2014 and VND 4,314,321 billion in 2016. GNI at current prices during the period of 2012-2016 is presented in Table 1.21.

Table 1.21. GNI at current prices during the period of 2012-2016

Year	GDP (bil. VND)	GNI (bil. VND)	Net income from abroad (bil. VND)	GNI over GDP (%)
2012	3,245,419	3,115,227	-130,192	95.99
2013	3,584,262	3,430,668	-153,594	95.71
2014	3,937,856	3,750,823	-187,033	95.25
2015	4,192,862	3,977,609	-215,253	94.87
2016	4,502,733	4,314,321	-188,412	95.82

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Export turnover in 2014 reached USD 150 billion, an increase of 13.6% compared to 2013, of which the domestic economic sector reached USD 48.4 billion, an increase of 10.4% compared to 2013 and the foreign investment sector reached USD 101.6 billion (including crude oil), an increase of 15.2% compared to 2013. Import turnover in 2014 reached nearly USD 148 billion, an increase of 12.1% compared to 2013, of which the foreign invested sector reached USD 84.5 billion, an increase of 13.6% compared to 2013. Domestic production reached USD 63.5 billion, an increase of 10.2% compared to 2013. In 2014, Viet Nam's trade surplus reached nearly USD 2.4 billion. The total exports and imports of goods during the period of 2012-2016 is shown in Table 1.22.

Table 1.22. Exports and imports of goods during the period of 2012-2016

Unit: million USD

Year	Total	Of which		
		Exports	Imports	Balance (Exports minus imports)
2012	228,309.6	114,529.2	113,780.4	748.8
2013	264,065.5	132,032.9	132,032.6	0.3
2014	298,066.2	150,217.1	147,849.1	2,368.0
2015	327,792.6	162,016.7	165,775.9	-3,759.2
2016	351,559.2	176,580.8	174,978.4	1,602.4

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Environmental protection activities have been carried out and enhanced. The treatment of solid waste and wastewater from industrial zones and urban areas as well as the collection and treatment of common solid waste in Viet Nam during the period of 2014-2016 are presented in Tables 1.23, 1.24 and 1.25.

Table 1.23. Disposing solid waste and waste water of industrial zones

Year	Total industrial zones	Number of industrial zones disposing in accordance with corresponding defined criteria	Rate of industrial zones disposing in accordance with corresponding defined criteria (%)
2014	378	218	58.0
2015	371	235	63.3
2016	371	238	64.2

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Table 1.24. Disposing solid waste and waste water of urban areas

Year	Total urban areas	Number of urban areas disposing solid waste in accordance with corresponding defined national criteria	Number of urban areas disposing waste water in accordance with corresponding defined national criteria
2014	786	174	40
2015	787	146	42
2016	781	228	44

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Table 1.25. Average collected solid waste treated per day in whole country

Unit: t

Year	Total of collected solid waste	Total of collected solid waste treated in accordance with corresponding defined national criteria
2014	31,600	23,933
2015	32,415	24,319
2016	33,167	27,067

Sources: Statistical yearbook of Viet Nam 2015, 2016, 2017, GSO 2016, 2017, 2018

Regarding air quality, in urban areas, dust pollution tends to remain high, especially in areas near major transportation routes, while other pollutants (such as NO_2, SO_2, CO) are still within acceptable levels. In industrial zones, the concentration of suspended powder solids in many places has exceeded the regulated levels, while the concentrations of NO_2, SO_2 are generally lower than the permitted levels. In trade villages, the concentrations of NO_2 and, SO_2 tend to increase, although the level of air pollution depends on the character, scale and products of each type of production.

In general, despite the difficulties and challenges, the socio-economic situation of Viet Nam in 2014 and more generally in the period of 2012-2016 has improved and achieved some significant results. The macro-economy stable, major balances remain, and inflation is under control in the country. The money market, interest rate, and exchange rate have been stable. The business environment has improved significantly. Social security has been addressed, and the spiritual and material life of the people has been improved. Social security is addressed. The spiritual and material life of the people has been improved. The management and control of waste sources in order to prevent environmental pollution is increasingly focused and enhanced. The organizational system of state management on environmental protection has been strengthened.

Sustainable development is a requirement throughout the country's development. In order to implement the Sustainable Development Goals (SDGs) in the 2030 Agenda of the United Nations (adopted by the General Assembly of the United Nations in September 2015), the Prime Minister issued a National Action Plan to implement the 2030 Agenda for Sustainable Development under Decision No. 622/QD-TTg dated May 10th, 2017. This Action Plan has identified 17 main goals, including 115 specific objectives, in line with national development conditions and priorities, and main tasks undertaken in two phases of 2017-2020 and 2021-2030. Sustainable development has been integrated into socio-economic development strategies and programs at all levels with the highest priority. On July 16th, 2018, at the United Nations Headquarters in New York (United State of America), the head of the Viet Nam delegation presented Viet Nam's Voluntary National Report (VNR) on the implementation of the SDGs of the United Nations. The VNR highlighted the results achieved in the implementation of 17 SDGs over the past few years and identified the difficulties and challenges that need to be overcome in order to achieve these Goals in Viet Nam in the coming time.

Since 2017, Viet Nam has been participating as a partner of the "Partnering for Green Growth and the Global Goals 2030 - P4G". The main objective of P4G is to facilitate countries and other partners to implement green growth solutions, contributing to the achievement of SDGs and the Paris Agreement (PA). Green growth implementation is an indispensable direction for transforming the growth model and restructuring the country's economy in the future.

1.3. RESPONDING TO CLIMATE CHANGE

Viet Nam ratified the United Nations Framework Convention on Climate Change (UNFCCC) on November 16th, 1994; the Kyoto Protocol (KP) on September 25th, 2002 and the Doha Amendment on June 22nd, 2015 as well as approving the PA on November 03rd, 2016. To contribute to the achievement of UNFCCC objectives, Viet Nam has submitted its Intended Nationally Determined Contribution (INDC) on September 30th, 2015. The INDC of Viet Nam officially became its Nationally Determined Contribution (NDC) to the UNFCCC.

Viet Nam has considered responding to climate change to be a vital issue. Responding to climate change is the responsibility of the whole political system. In recent years, some legal documents, policies, programs, plans to proactively respond to climate change, pursuit green growth have been adopted, including:

- Resolution No. 24-NQ/TW dated June 3rd, 2013 of the Central Committee of the Party, session XI, on active response to climate change, strengthening natural resources management and environmental protection.

- Law on Environmental Protection No. 55/2014/QH13 was adopted by National Assembly of the Socialist Republic of Viet Nam, Session XIII on June 23rd, 2014, in which the particular content responding to climate change is at Chapter IV of the Law.

- Law on Meteorology and Hydrology No. 90/2015/QH13 was adopted by the National Assembly of Socialist Republic of Viet Nam on November 23rd, 2015, including contents related to monitoring, impact assessment and response to climate change.

The Government of Viet Nam approved Resolution No. 120/NQ-CP dated November 17th, 2017 on Sustainable Development of the Mekong River delta adapting to climate change and issued a comprehensive Action Plan to implement this Resolution with specific tasks, actions and timeline to be carried out by ministries, sectors and localities.

The National Climate Change Committee of Viet Nam was established in 2012 and chaired by the Prime Minister. The Vice Chairmen of this Committee are a Deputy Prime Minister and the Minister of Natural Resources and Environment. Members of this Committee are leaders, representatives of related Ministries and agencies. The Ministry of Natural Resources and Environment (MONRE) is the permanent acting agency of this Committee. The Committee Office, the assisting body for this Committee is located in MONRE and chaired by the Director

General of the Department of Climate Change. The Viet Nam panel on climate change (VPCC) was established in 2014 and is currently chaired by the Minister of Natural Resources and Environment, whose responsibility is to advise this Committee on policy, science and technology issues. Members of the VPCC are representatives, scientists from the related Ministries, agencies and organizations.

The Government of Viet Nam has designated MONRE as the National Focal Point to implement the UNFCCC, KP, PA and other relevant international treaties on climate change and to develop Biennial Updated Reports and National Communications of Viet Nam to UNFCCC. The National Steering Committee for UNFCCC, KP, and PA is chaired by the leader of MONRE, and is composed of representatives from the relevant ministries.

The institutional arrangement for the development of the Third National Communication (TNC) of Viet Nam to UNFCCC is summarized in Figure 1.1.

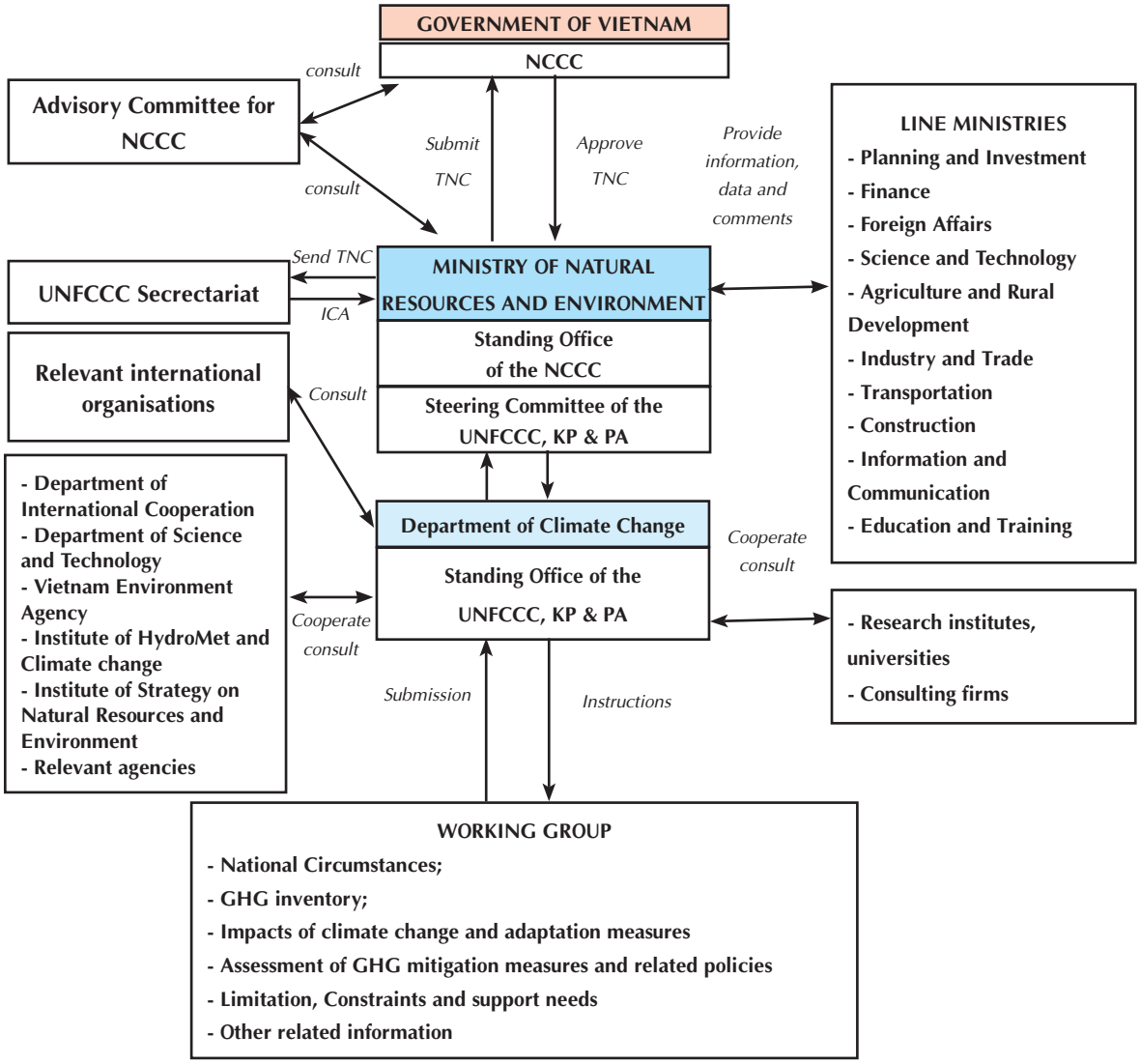


Figure 1.1. Institutional arrangement for the development of the Third National Communication of Viet Nam to UNFCCC

Chapter 2

NATIONAL GREENHOUSE GAS INVENTORY

Year 2014 is chosen to be the base year of the GHG inventory for Viet Nam's Third National Communication to the UNFCCC. The 2014 GHG inventory is carried out for five sectors which are: i) Energy; ii) Industrial Processes and Product Use (IPPU); iii) Agriculture; iv) Land Use, Land Use Change and Forestry (LULUCF); and v) Waste. The main greenhouse gases (GHGs) taken into account are CO_2, CH_4 and N_2O.

2.1. INSTITUTIONAL ARRANGEMENT FOR THE NATIONAL GREENHOUSE GAS INVENTORY IN 2014

The institutional arrangement for the National Greenhouse Gas Inventory in 2014 is outlined in the Decision No.2359/QD-TTg dated December 22nd, 2015 by the Prime Minister as in the following Figure 2.1:

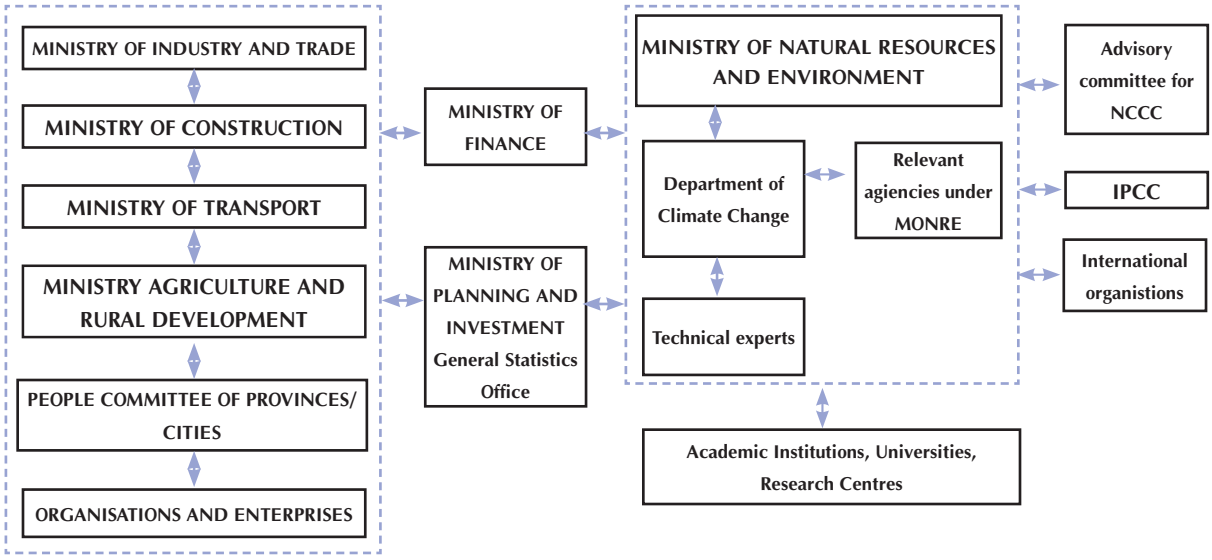


Figure 2.1. Organization of the National GHG inventory system for 2014

Source: Technical report of 2014 National GHG inventory (NIR 2014), MONRE, 2018.

2.2. METHODOLOGY

2.2.1. Intergovernmental Panel on Climate Change Guidelines

The national GHG inventory is implemented in compliance with the Intergovernmental Panel on Climate Change (IPCC) Guidelines, which includes:

- The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the Revised 1996 IPCC Guidelines);

- The IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (hereinafter referred to as the GPG (2000);

- The IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry (hereinafter referred to as the GPG-LULUCF 2003)

- The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006);

Besides, the Agriculture and Land Use Greenhouse Gas Inventory (ALU) software developed by the Colorado State University is used for GHG inventory in LULUCF sector.

2.2.2. Activity data and emission factors

Information and activity data are collected and compiled by the GSO, MPI, from national statistics data and from a number of central and local agencies. Furthermore, some data from relevant studies are referred.

The IPCC default EFs and several others in Viet Nam are used for the GHG inventory.

Table 2.1. Methods used for the 2014 national GHG inventory

Sector	Method	Data sources		
		Activity data	Emission factor	Other parameters
Energy	All sub-sectors used Tier 1 according to 1996 IPCC Guidelines.	- Statistical Yearbook 2014, General Statistics Office 2015; - Energy Balance Table in 2014, Viet Nam Energy Statistics in 2014, Institute of Energy, Ministry of Industry and Trade; - Data from scientific research and programs.	-IPCC default values for EFs; - Country-specific value for CH4 emission in coal mining in Viet Nam.	-IPCC default values; - The national calorific value of coal developed and announced by the Ministry of Industry and Trade.
IPPU	- All sub-sectors used Tier 1 according to 2006 IPCC Guidelines. - Only cement production sub-sector used Tier 1 according to 1996 IPPC Guidelines and GPG2000.	- Statistical Yearbook 2014, General Statistics Office 2015; - NAMA Cement Project, Ministry of Construction; - Cement Industry Report in 2014, Viet Nam Cement Association; - Data from scientific researches and programs.	IPCC default values for EFs.	IPCC default values.

Agriculture	- All sub-sectors used Tier 1 according to 1996 IPCC Guidelines; - Only sub-sector 4.B. on Manure Management and 4.C. on Rice cultivation used Tier 2 according to 1996 IPCC Guidelines	- Statistical Yearbook 2014, General Statistics Office 2015; - Statistical Yearbook of Agriculture and Rural Development in 2014, MARD 2015; - Data from scientific researches and programs; - United Nations Food and Agriculture Organization (FAO).	- IPCC default values for EFs; - Country-specific value for rice cultivation and manure management.	- Default value of the IPCC; - Fraction of manure handled using manure system in livestock of Viet Nam; - Fraction of Continuously Flooded Rice.
LULUCF	- All sub-sectors used Tier 1 according to 1996 IPCC Guidelines; - Only sub-sector 5.A. on Forest land and 5.B.1 on Cropland used Tier 2 according to 1996 IPCC Guidelines.	- Statistical Yearbook 2014, General Statistics Office 2015; - Statistical Yearbook of Agriculture and Rural Development in 2014, MARD 2015; - Land Use Matrix in the period of 2010-2014, General Department of Land Administration, Ministry of Natural Resources and Environment; - Data from scientific researches and programs.	IPCC default values for EFs.	- IPCC default values; -Results from studies.
Waste	- All sub-sectors used Tier 1 according to 1996 IPCC Guidelines; - Only sub-sector 6.A. on Solid waste disposal used Tier 2 according to 1996 IPCC Guidelines.	- Statistical Yearbook 2014, General Statistics Office 2015; - National Environnent Report 2011 - Solid Waste, MONRE ; - Report on environmental status of 40 provinces/cities in the period of 2011-2015; - Data from scientific research topics and programs.	- IPCC default values for EFs; - Fraction of domestic wastewater treatment according to the national environment report 2011.	- IPCC default values; - Results from studies.

Source: NIR 2014, MONRE, 2018.

2.2.3. Global warming potential

The Global Warming Potential (GWP) values of GHGs for 100 years which have been used in this inventory cycle are shown in Table 2.2.

Table 2.2. The GWP values of GHGs

Gas	GWP
CO_2	1
CH_4	25
N_2O	298
HFCs	124-14,800

Source: AR4 Report, IPCC, 2007

2.3. QUALITY CONTROL AND ASSURANCE

2.3.1. Quality control

The implementation of QC for the 2014 inventory includes:

- Re-evaluating the activity data and emission factors in different sectors;

- Checking the estimation of emissions/removals;

- Checking the conversional calculation; key categories analysis; and other related issues.

2.3.2. Quality assurance

Independent experts conducted evaluations for the following issues:

- Checking:

+ Source and value of parameters used separately and collectively between emission sources/sinks;

+ The consistency of the input data source and the dimensions of the data;

+ Records and summarization of data in the report.

- Evaluating:

+ The appropriateness of the inventory method for data available for the year of inventory;

+ Needs for improvement in the next inventory cycle.

2.4. KEY EMISSION/REMOVAL CATEGORIES

Analysis and estimation of emission from GHG emission sources/sinks were carried out to provide two results: (i) including LULUCF and (ii) excluding LULUCF in accordance with GPG 2000 and GPG-LULUCF Guidelines. Different approaches were used in order to identify sources/sinks which contributed up to 95% total emissions. Table 2.3 displays in detail the key sources/sinks of GHG with and without LULUCF. Among those key sources/sinks, the biggest source was Public Electricity and Heat Production with 52,220.70 $ktCO_2e$ while the smallest source was Rice cultivation by Rain-fed. Key categories analysis in 2014 with LULUCF are shown in Table 2.3.

Table 2.3. Key categories analysis in 2014 with LULUCF

No.	Sector/sub-sector	Gas	Emissions ($ktCO_2e$)	Source Analysis without LULUCF (%)	Source Analysis with LULUCF (%)
1	1.A.1.a. Energy industry: Public Electricity and Heat Production	CO_2	52,220.70	16.24	14.11
2	4.C.1. Rice cultivation - Irrigated	CH_4	42,717.80	29.53	25.66
3	2.A.1. Cement Production	CO_2	32,440.38	39.62	34.43
4	1.A.3.b. Transport: Road Transportation	CO_2	27,404.64	48.14	41.83
5	5.A.1. Forest Land remaining Forest Land	CO_2	-26,491.07		48.99
6	1.A.2.e.Manufacturing Industries and Construction :	CO_2	16,286.35	53.21	53.40

No.	Sector/sub-sector	Gas	Emissions ($ktCO_2e$)	Source Analysis without LULUCF (%)	Source Analysis with LULUCF (%)
7	4.D.1. Cropland: Direct Soil Emissions	N_2O	13,425.38	57.38	57.02
8	1.B.2.a. Fugitive: Oil	CH_4	13,332.70	61.53	60.63
9	4.D.3. Cropland: Indirect Soil Emissions	N_2O	10,152.84	64.69	63.37
10	6.B.2. Domestic and Commercial Waste Water	CH_4	9,609.00	67.68	65.97
11	5.A.2. Land converted to Forest Land	CO_2	-9,170.72		68.45
12	6.A. Solid Waste Disposal on Land	CH_4	8,036.90	70.18	70.62
13	1.A.4.b. Other: Residential	CO_2	6,702.75	72.26	72.43
14	1.A.2.h. Manufacturing Industries and Construction: Textile and Leather	CO_2	6,384.41	74.25	74.16
15	4.A.1.b. Enteric fermentation: Cattle	CH_4	5,507.40	75.96	75.64
16	4.B.11.a. Waste management: compost for fertilizer	N_2O	5,187.64	77.57	77.05
17	1.A.2.a.Manufacturing Industries and Construction: Steel	CO_2	5,082.79	79.15	78.42
18	1.A.2.b. Manufacturing Industries and Construction: Fertilizer	CO_2	5,011.26	80.71	79.78
19	5.B.1. Cropland remaining as cropland	CO_2	-4,757.46		81.06
20	1.A.2.d. Cement Production	CO_2	4,242.13	82.03	82.21
21	1.A.4.a. Other sectors: Commercial/ Institutional	CO_2	3,597.88	83.15	83.18
22	1.A.2.g. Food Manufacturing Industry	CO_2	3,583.41	84.27	84.15
23	4.A.2. Enteric fermentation: Buffalo	CH_4	3.466,93	85,34	85,09
24	5.F.2. Land converted to other land	CO_2	3.318,43		85,98
25	1.B.2.b. Fugitive: Natural gases	CH_4	3.313,98	86,37	86,88
26	1.A.4.b. Other: Residential	CH_4	3.198,06	87,37	87,74
27	1.A.2.c. Manufacturing and Construction: Chemicals	CO_2	3.023,88	88,31	88,56
28	1.A.2.l. Manufacturing Industries and Construction: Other	CO_2	2.862,17	89,20	89,33
29	5.B.2. Land converted to cropland	CO_2	-2.590,29		90,03
30	4.B.11.b. Manure management: aerobic treatment	N_2O	2.452,34	89,96	90,70
31	2.A.2. Construction Materials and Minerals: Lime Manufacturing	CO_2	2,442.00	90.72	91.36
32	1.B.1.a.Fugitive: Underground coal mining	CH_4	2,340.68	91.45	91.99
33	6.B. Wastewater handling: Human sewage	N_2O	1,998.70	92.07	92.53

No.	Sector/sub-sector	Gas	Emissions ($ktCO_2e$)	Source Analysis without LULUCF (%)	Source Analysis with LULUCF (%)
34	1.A.1.b. Energy industry: Petrochemical	CO_2	1,928.50	92.67	93.05
35	4.F.1. Burning by-products: Cereal	CH_4	1,925.76	93.27	93.57
36	1.A.3.d. Waterway	CO_2	1,740.84	93.79	94.02
37	2.B.1 Production Ammonia	CO_2	1,737.39	94.33	94.49
38	2.C.1. Production of steel	CO_2	1,678.02	94.87	94.96
39	4.C.2. Rice cultivation: Rain-fed	CH_4	1,576.80	95.36	95.39

Source: NIR 2014, MONRE, 2018

The number of key sources/sinks of GHG was compiled in Table 2.4. Among 39 key sources/sinks including LULUCF there are 23 key sources/sinks of CO_2, 11 key sources of CH_4 and 5 key sources of N_2O.

Table 2.4. Number of key sources/sinks in 2014

No.	Sector	Key categories analysis without LULUCF	Key categories analysis with LULUCF	CO_2*	CH_4*	N_2O*
1	Energy	18	18	14	4	0
2	IPPU	4	4	4	0	0
3	Agriculture	9	9	0	5	4
4	LULUCF		5	5	0	0
5	Waste	3	3	0	2	1
Total		**34**	**39**	**23**	**11**	**5**

**: with LULUCF*

Source: NIR 2014, MONRE, 2018

2.5. RESULT OF NATIONAL GREENHOUSE GAS INVENTORY IN 2014

2.5.1. Compilation of emission sources and sinks in 2014

Total emission of Viet Nam in 2014 was 283.965,53 $ktCO_2e$ with LULUCF sector and 321.505,71 $ktCO_2e$ without LULUCF sector.

Without LULUCF sector, there are 186,441.25 kt of CO_2, accounting for 58.0% of total GHG emissions; 99,410.02 $ktCO_2e$ of CH_4, equal to 30.92% and 35,654.46 $ktCO_2e$ of N_2O for the rest 11.08%.

The results of the 2014 inventory by gas and shares of emission by sector are illustrated in Table 2.5, Figures 2.2 and Figure 2.3.

Table 2.5. 2014 total GHG emissions/removals by gas

Unit: $ktCO_2e$

No.	Sector	CO_2	CH_4	N_2O	Total
1	Energy	147,525.44	22,977.37	1,118.26	171,621.08
2	IPPU	38,619.79			38,619.79
3	Agriculture		57,214.29	32,537.51	89,751.80
4	LULUCF	-37,675.67	115.75	19.75	-37,540.18
5	Waste	296.00	19,218.35	1,998.69	21,513.04
Total emission (without LULUCF)		**186,441.25**	**99,410.02**	**35,654.46**	**321,505.71**
Total emission (with LULUCF)		**148,765.58**	**99,525.76**	**35,674.20**	**283,965.53**

Source: NIR 2014, MONRE, 2018

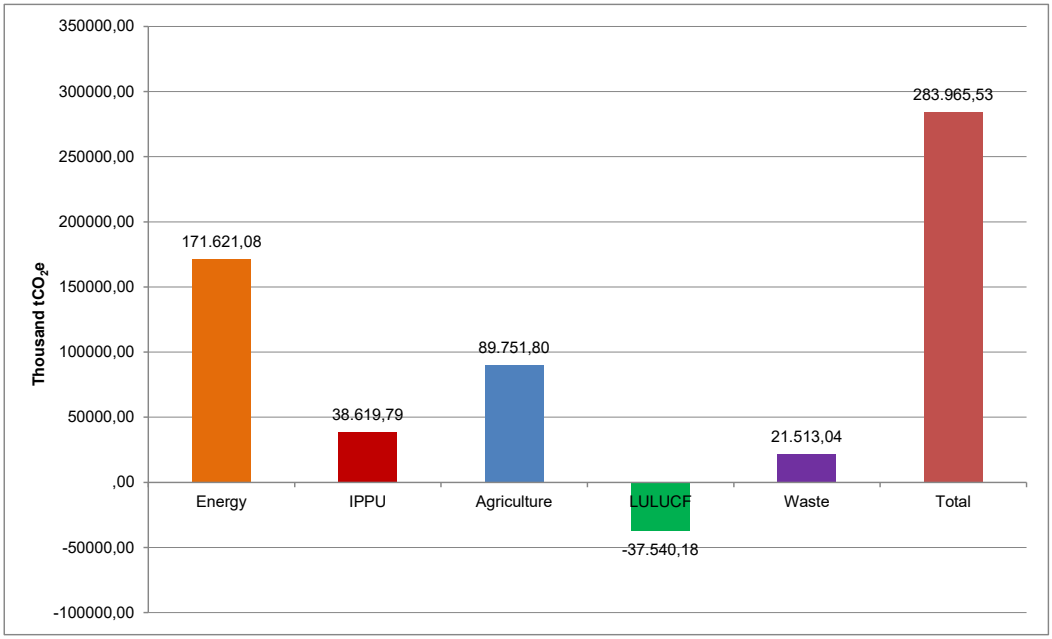


Figure 2.2. The 2014 GHG emissions and removals by sector

Source: NIR 2014, MONRE, 2018

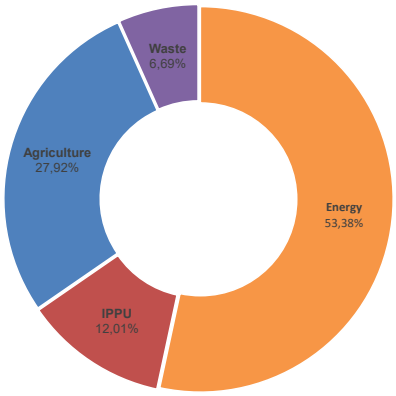


Figure 2.3. The 2014 GHG shares of emissions by sector

Source: NIR 2014, MONRE, 2018

The 2014 GHG emissions/removals not regulated by the Montreal Protocol on Ozone depletion substances is shown in Annex 1. In addition to information on GHGs, Annex 1 also aggregates information on indirect gases emissions such as CO, NOx, NMVOCs and SOx as well as fuel consumption for international aviation though not mandatory in National inventory of GHGs.

2.5.2. Results of greenhouse gas inventory by sector

a. Energy

Total emissions of the Energy sector in 2014 were 171.621,08 $ktCO_2e$, among which main sources of emission were Fuel Combustion at 87.8% and Fugitive emission at 12.2%.

Details of emissions in the energy sector and the shares of emissions among sub-sectors are provided in Table 2.6 and Figure 2.4.

Table 2.6. The 2014 GHG emissions of the Energy sector

Unit: $ktCO_2e$

Greenhouse gas sources	CO_2	CH_4	N_2O	CO_2e
Total emissions	**147,525.44**	**22,977.37**	**1,118.26**	**171,621.08**
1.A. Fuel Combustion	145,979.07	3,598.29	1,114.67	150,692.02
1.A.1. Energy Industry	54,315.10	20.88	166.41	54,502.38
1.A.2. Manufacturing Industries and Construction	48,767.80	230.05	370.44	49,368.29
1.A.3. Transport	30,351.83	124,24	76.24	30,552.31
1.A.4. Others	11,684.60	3,220.56	492.42	15,397.58
1.A.5. Non-Energy Use	859.74	2.56	9.16	871.46
1.B. Fugitive emissions	1,546.38	19,379.09	3.59	20,929.05
1.B.1. Solid fuels		2,732.40		2,732.40
1.B.2. Oil and Natural Gas	1,546.38	16,646.68	3.59	18,196.65

Source: NIR 2014, MONRE, 2018

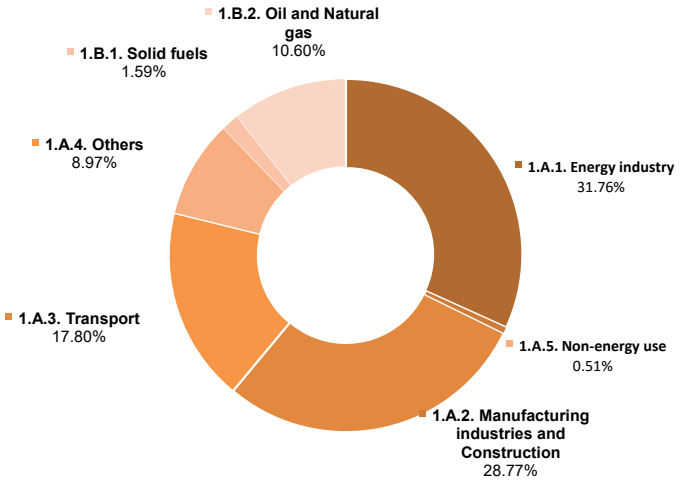


Figure 2.4. The 2014 GHG emissions shares of sub-sectors in the energy sector

Source: NIR 2014, MONRE, 2018

In order to estimate GHG emissions in fuel combustion, a reference approach is used in addition to the sectoral approach. The results of the calculation using the reference approach was 146,536 $ktCO_2e$, while the sectoral approach was 145,979 $ktCO_2e$. The difference between the two methods was 0.4%.

b. IPPU

GHG emissions of this sector are calculated from 4 sub-sectors: production of cement, production of lime, production of ammonia and production of iron.

Total GHG emission of this sector was 38,619.79 $ktCO_2e$. Emission from production of construction materials has the biggest share at 91%. Emissions from ammonia production and metallurgy were both 4%.

Emissions of IPPU sector and the shares of emissions among sub-sectors are presented in Table 2.7 and Figure 2.5.

Table 2.7. The 2014 GHG emissions of the IPPU sector

Unit: kt

Greenhouse gas source	CO_2	CH_4	N_2O	HFC, PFC, SF_6	NOx	NMVOC	CO	SO_2
Total emissions	**38,619.79**	**NE,NO**	**NE, NO**	**NE,NO**	**0.73**	**279.31**	**10.96**	**18.94**
2 A. Construction materials and minerals	35,204.38					250.86	NE	18.28
2.B. Chemical industry	1,737.39		NE, NO		NO	6.32	10.51	0.04
2 C. Metallurgical	1,678.02	NE, NO		NO	0.73	0.41	0.45	0.59

2.D. Other manufacturing industries					NE	21.72	NE	NE
2.E. Production of Halocarbons and SF6				NO				
2.F. Consume Halocarbons and SF6				NE				
Total (CO_2e)	**38,619.79**							

Source: NIR 2014, MONRE, 2018

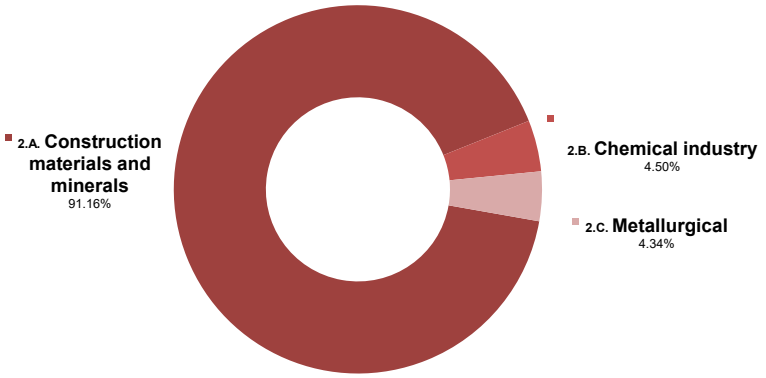


Figure 2.5. The 2014 GHG emissions shares of sub-sectors of the IPPU sector

Source: NIR 2014, MONRE, 2018

c. Agriculture

The 2014 total emission of the Agriculture sector was 89.751,8 ktCO_2e, as presented in Table 2.8. Rice cultivation is the biggest source of emission at 49.352% and smallest source is Prescribed Burning of Savannas at 0.001%.

The emissions of the Agriculture sector and the shares of emissions among sub-sectors are shown in Table 2.8 and Figure 2.6.

Table 2.8. The 2014 GHG emissions of the Agriculture sector

Unit: kt CO_2e

Greenhouse gas source	CH_4	N_2O	Total
Total emissions	**57,214.3**	**32,537.5**	**89,751.8**
4.A. Enteric Fermentation	10,200.6	0.0	10,200.6
4.B. Manure Management	704.6	8,158.7	8,863.4
4.C. Rice Cultivation	44,294.6	0.0	44,294.6
4.D. Agricultural Soils	0.0	23,955.5	23,955.5
4.E. Prescribed Burning of Savannas	0.9	0.1	1.0
4.F. Field Burning of Agricultural Residues	2,013.6	423.1	2,436.7

Source: NIR 2014, MONRE, 2018

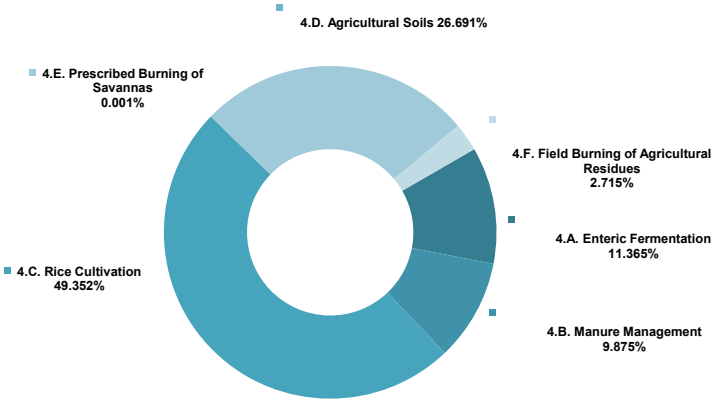


Figure 2.6. The 2014 GHG emissions shares of sub-sectors in the Agriculture sector

Source: NIR 2014, MONRE, 2018

d. LULUCF

Total GHG emission/removal of the LULUCF sector in 2014 was -37,540.18 ktCO_2e. The biggest removal came from the forest land sub-sector with -35,612.44 ktCO_2e and other land for the smallest emission with 3,371.60 kt CO_2e.

Emissions/removals of the LULUCF sector and the shares of emissions/removals among sub-sectors are shown in Table 2.9 and Figure 2.7. Further information is elaborated in Annex 1.

Table 2.9. The 2014 GHG emissions/removals of the LULUCF sector

Unit: Kt

Greenhouse gas source /removal	CO_2	CH_4	N_2O	CO	NOx
Total emissions/removals	**-37,675.67**	**4.63**	**0.07**	**40.51**	**1.14**
5.A.Forestland	-35,661.79	1.50	0.04	13.09	0.37
5.B.Cropland	-7,347.75	1.12	0.01	9.83	0.28
5.C.Grassland	IE	IE	IE	IE	IE
5.D.Wetland	959.00	0.04	0.01	0.39	0.01
5.E.Settlements	1,056.45	0.00	0.00	0.00	0.00
5.F.Other land	3,318.43	1.97	0.01	17.20	0.48
Total (CO_2e)	**-37,540.18**				

Source: NIR 2014, MONRE, 2018

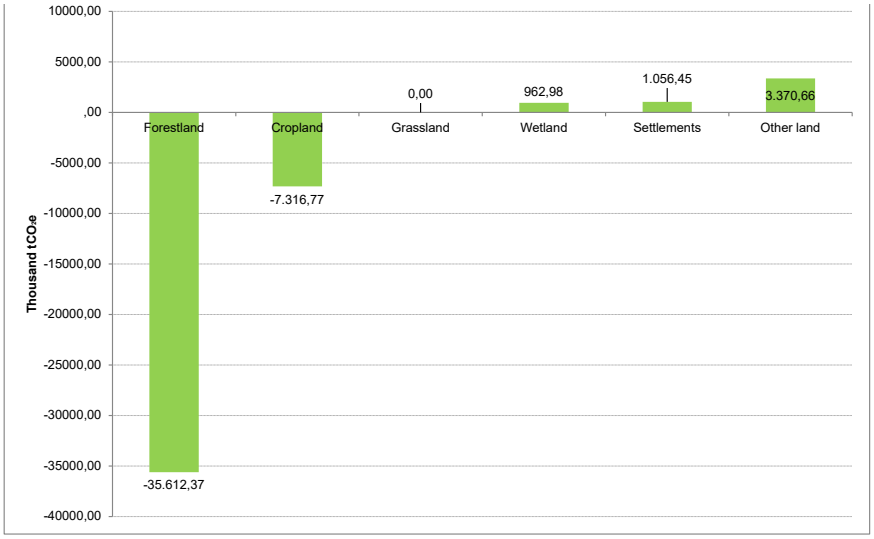


Figure 2.7. The 2014 GHG emissions/removals shares of sub-sectors of the LULUCF sector

Source: NIR 2014, MONRE, 2018

e. Waste

Total emissions in the Waste sector in 2014 was 21,513 ktCO_2e. Among all sub-sectors, domestic wastewater emitted the most with 44.67% while incineration had the least emission with 1.38%.

Emissions in Waste sector and the shares of emissions/removals among sub-sectors are described in Table 2.10 and Figure 2.8.

Table 2.10. The 2014 GHG emissions of the Waste sector

Unit: Kt CO_2e

Greenhouse gas source	CO_2	CH_4	N_2O	CO_2e
6.A. - CH_4 emission from solid waste disposal sites	NE	321.475		8,037
6.B.1. - CH_4 emission from industrial wastewater		62.901		1,573
6.B.2. - CH_4 emission from domestic wastewater		384.358		9,609
6.B.2.b. - N_2O emission from human sewage			6.707	1,999
6.C. - CO_2 emission from waste incineration	296		NE	296
Total	**296**	**768.734**	**6.707**	**21,513**

Source: NIR 2014, MONRE, 2018

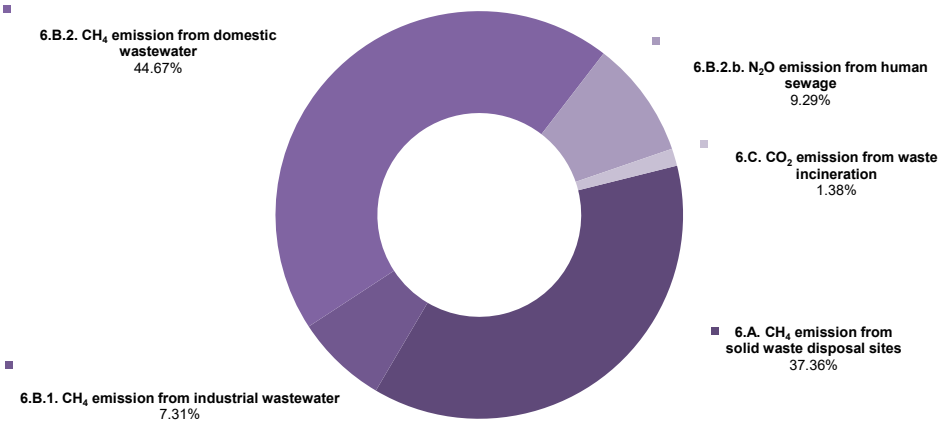


Figure 2.8. The 2014 GHG emission shares of sub-sectors in the Waste sector

Source: NIR 2014, MONRE, 2018

2.6. UNCERTAINTY RELATED TO ACTIVITY DATA AND EMISSION FACTORS

The uncertainty of GHG emissions/removals is calculated indirectly from uncertainties of ADs and EFs. Most uncertainty values for ADs and EFs in Viet Nam's GHG national inventory are default values or the range of default values of IPCC Guidelines. Uncertainty does not affect the quality of GHG inventory results but contributes for further improvement in the next inventory cycle.

Results of uncertainty assessment are illustrated in Table 2.11 and 2.12.

Table 2.11. Uncertainty of national GHG inventory in 2014

No.	Sector	Applied method	Emission/Removal ($ktCO_2e$)	Uncertainty (%)
1	Energy	Chapter 2 of GPG 2000 and Chapter 3, Volume I of IPCC 2006 GL	171,621.08	14.45
2	IPPU	Chapter 3 of GPG 2000 and Chapter 3, Volume I of IPCC 2006 GL	38,619.79	26.50
3	Agriculture	Chapter 4 of GPG 2000 and Chapter 3, Volume I of IPCC 2006 GL	89,751.80	16.47
4	LULUCF	GPG-LULUCF and Chapter 3, Volume I of IPCC 2006 GL	-37,540.18	51.38
5	Waste	Chapter 5 of GPG 2000 and Chapter 3, Volume I of IPCC 2006 GL	21,513.04	26.57
Total			**283,965.53**	**12.90**

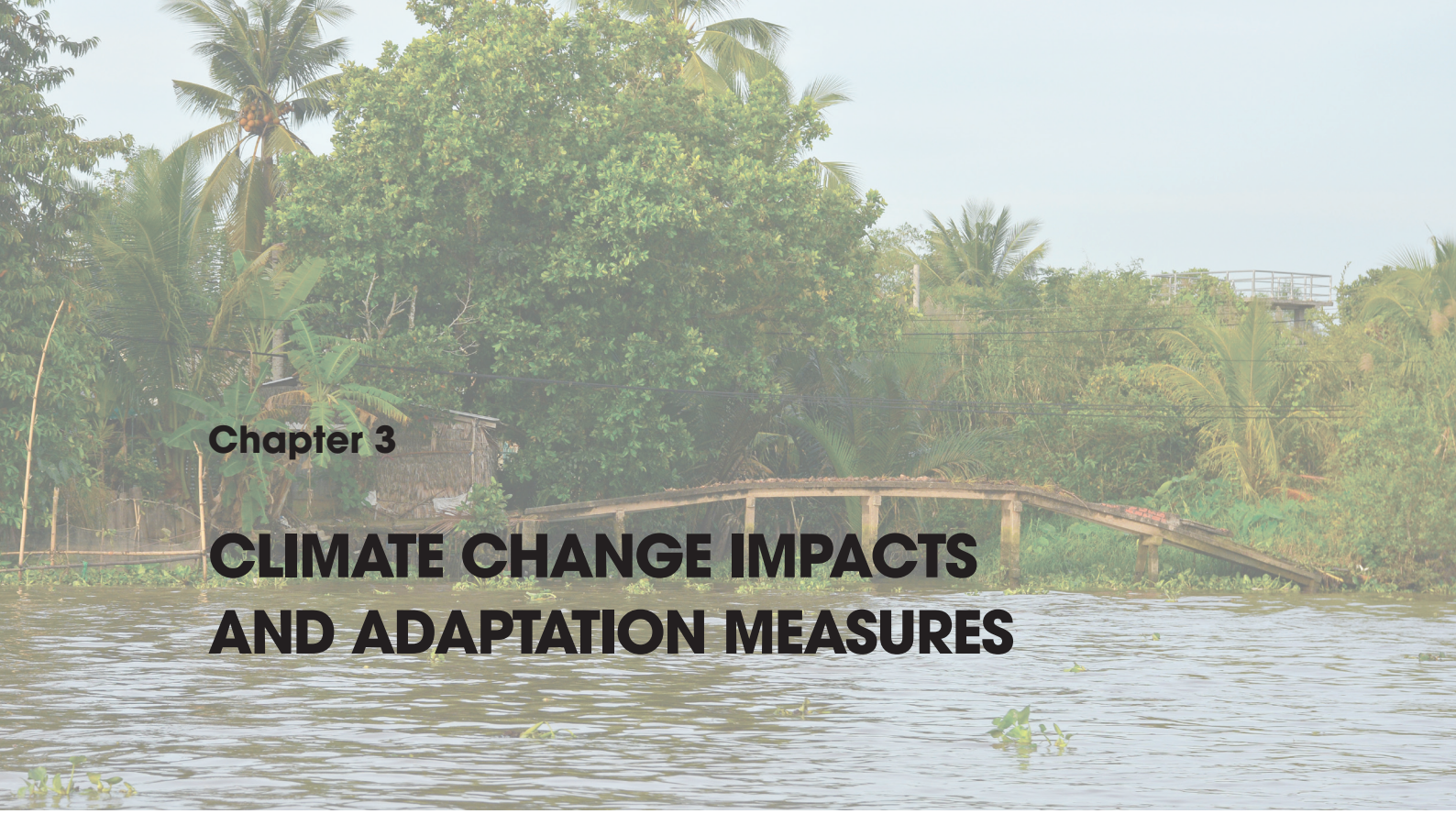
Source: NIR 2014, MONRE, 2018

Table 2.12. Uncertainty assessment of the 2014 inventory key categories with LULUCF

No.	Sector/Sub-sector	Gas	Emission ($ktCO_2e$)	Source Analysis without LULUCF (%)	Source Analysis with LULUCF (%)	Uncertainty (%)
1	1.A.1.a. Energy industry: Public Electricity and Heat Production	CO_2	52,220.70	16.24	14.02	4.47
2	4.C.1. Rice cultivation- Irrigated	CH_4	42,717.80	29.53	25.48	25.00
3	2.A.1. Cement Production	CO_2	32,440.38	39.62	34.19	30.60
4	1.A.3.b.Transport: Road Transportation	CO_2	27,404.64	48.14	41.55	11.18
5	5.A.1. Forest Land remaining Forest Land	CO_2	26,491.07		48.66	60.00
6	1.A.2.e. Manufacturing Industries and Construction: Building materials	CO_2	16,286.35	53.21	53.03	4.72
7	4.D.1. Cropland: Direct Soil Emissions	N_2O	13,425.38	57.38	56.63	51.42
8	1.B.2.a. Fugitive: Oil	CH_4	13,332.70	61.53	60.21	133.50
9	4.D.3. Cropland: Indirect Soil Emissions	N_2O	10,152.84	64.69	62.94	51.42
10	6.B.2. Domestic and Commercial Waste Water	CH_4	9,609.00	67.68	65.51	33.29
11	5.A.2. Land converted to Forest Land	CO_2	-9,170.72		67.98	73.51
12	6.A. Solid Waste Disposal on Land	CH_4	8,036.90	70.18	70.13	57.20
13	1.A.4.b. Other: Residential	CO_2	6,702.75	72.26	71.93	13.12
14	1.A.2.h. Manufacturing Industries and Construction: Textile and Leather	CO_2	6,384.41	74.25	73.65	4.72
15	4.A.1.a. Enteric fermentation: Cattle	CH_4	5,507.40	76.06	75.21	41.76
16	4.B.11.b Manure management: aerobic treatment	N_2O	5,187.64	77.67	76.60	32.31
17	1.A.2.a. Manufacturing Industries and Construction: Steel	CO_2	5,082.79	79.26	77.97	4.72
18	1.A.2.b. Manufacturing Industries and Construction: Manure	CO_2	5,011.26	80.81	79.31	4.72
19	5.B.1. Cropland remains to cropland	CO_2	-4,757.46		80.59	70.20
20	1.A.2.d. Cement Production	CO_2	4,242.13	82.13	81.73	4.72
21	1.A.4.a. Other sectors: Commercial/Institutional	CO_2	3,597.88	83.25	82.69	13.12
22	1.A.2.g. Food manufacturing industry	CO_2	3,583.41	84.37	83.66	4.72
23	4.A.2. Enteric fermentation: Buffalo	CH_4	3,466.93	85.45	84.59	41.76
24	5.F.2. Land converted to other land	CO_2	3,318.43		85.48	172.00
25	1.B.2.b. Fugitive: Natural gases	CH_4	3,313.98	86.48	86.37	188.60

No.	Sector/Sub-sector	Gas	Emission ($ktCO_2e$)	Source Analysis without LULUCF (%)	Source Analysis with LULUCF (%)	Uncertainty (%)
26	1.A.4.b. Other: Residential	CH_4	3,198.06	87.47	87.22	100.78
27	1.A.2.c. Manufacturing Industries and Construction: Chemical	CO_2	3,023.88	88.41	88.04	4.72
28	1.A.2.l. Manufacturing Industries and Construction: other	CO_2	2,862.17	89.30	88.80	15.52
29	5.B.2. Land converted to cropland	CO_2	-2,590.29		89.50	193.70
30	4.B.11.b. Manure management: aerobic treatment	N_2O	2,452.34	90.06	90.16	32.31
31	2.A.2. Construction Materials and Minerals: Lime Manufacturing	CO_2	2,442.00	90.82	90.81	101.12
32	1.B.1.a. Discharge Emission: Pit coal	CH_4	2,340.68	91.55	91.44	100.50
33	6.B. Wastewater handling: Human sewage	N_2O	1,998.70	92.17	91.98	5.39
34	1.A.1.b. Energy industry: Petrochemical	CO_2	1,928.50	92.77	92.50	4.47
35	4.F.1. Burning by-products: Cereal	CH_4	1,925.76	93.37	93.01	41.76
36	1.A.3.d. Transportation: Waterways	CO_2	1,740.84	93.91	93.48	7.28
37	2.B.1. Ammonia production	CO_2	1,737.39	94.45	93.94	11.18
38	2.C.1. Metallurgy: Manufacture of steel	CO_2	1,678.02	94.97	94.39	11.18
39	4.C.2. Rice cultivation: Rain-fed	CH_4	1,576.80	95.46	94.82	26.91

Source: NIR 2014, MONRE, 2018



Chapter 3

CLIMATE CHANGE IMPACTS AND ADAPTATION MEASURES

3.1. MANIFESTATION OF CLIMATE CHANGE AND CLIMATE CHANGE SCENARIOS FOR VIET NAM

3.1.1. Manifestation of climate change and sea level rise in Viet Nam

a) Manifestation of climate change

During the period of 1958-2014, the temperature tended to increase at most monitoring stations in Viet Nam. In the country, the average annual temperature increased about 0.62°C (about 0.10°C/10 years). Annual rainfall decreased in the North (from 5.8% to 12.5%/57 years) while increasing in the South (from 6.9% to 19.8%/57 years).[3]

Storms and tropical depressions in the East Sea that directly affected or landed in Viet Nam were less variable. However, in recent years, typhoons (the strongest typhoon-wind of scale 12 and above) have shown a slight rising trend with a later ending season and tending to head to the Southern area.

The highest (Tx) and lowest (Tm) daily temperatures showed a sharp increase, with the highest increase up to 1°C/10 years. The number of hot days (days with Tx ≥35°C) rose in most areas nationwide, especially in the North East, Red River Delta and Central Highlands, at a typical level of 2-3 days/10 years whereas they decreased at monitoring stations in the North West, South Central and the South. The number of droughts, especially severe droughts, rose across the country. Extreme and damaging cold days in the North declined, especially in the last

3. Ministry of Natural Resources and Environment (2016), Climate change and sea level rise scenarios for Viet Nam, Viet Nam Natural Resources and Environment Publishing House, Hanoi, Viet Nam

two decades. Nevertheless there were some long periods of extreme and damaging cold weather. The incidence of extreme rainfall events had a tendency to vary among different climatic zones, decreasing at most monitoring stations in the North West, North East, and the Red River Delta while increasing at stations in other climatic zones.

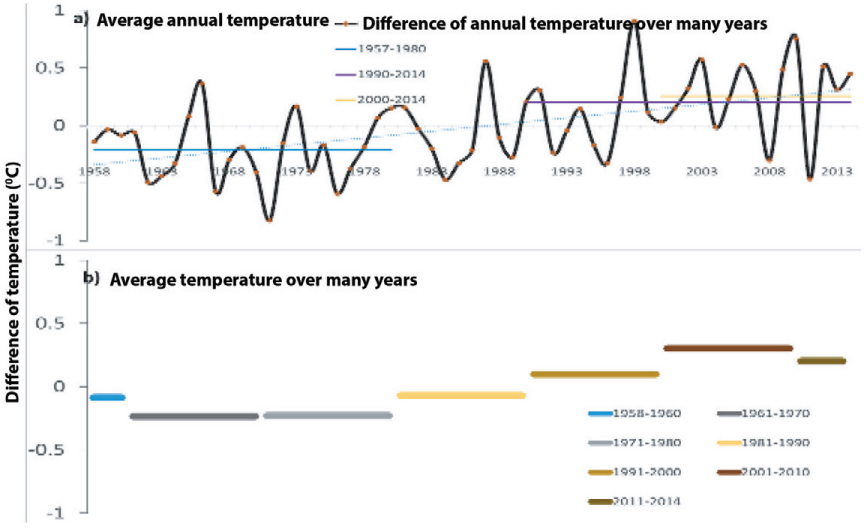


Figure 3.1. Difference of annual temperature (°C) over many years

Source: Climate change and sea level rise scenarios for Viet Nam, MONRE, 2016

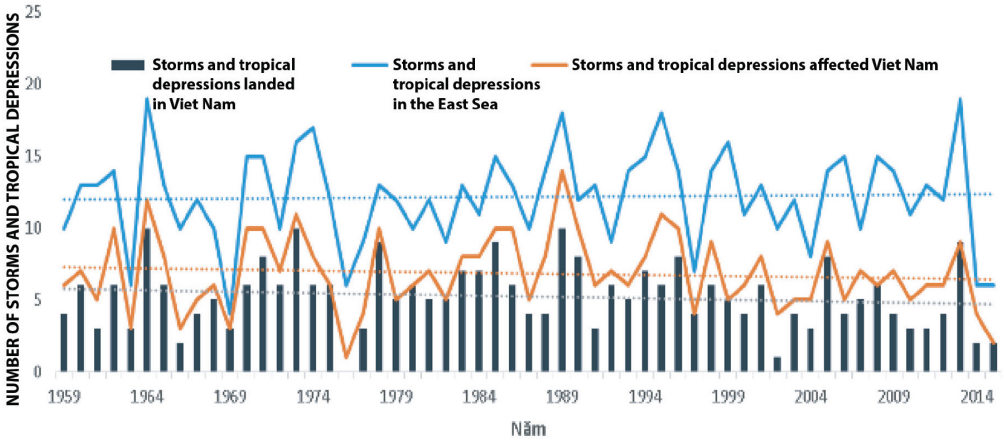
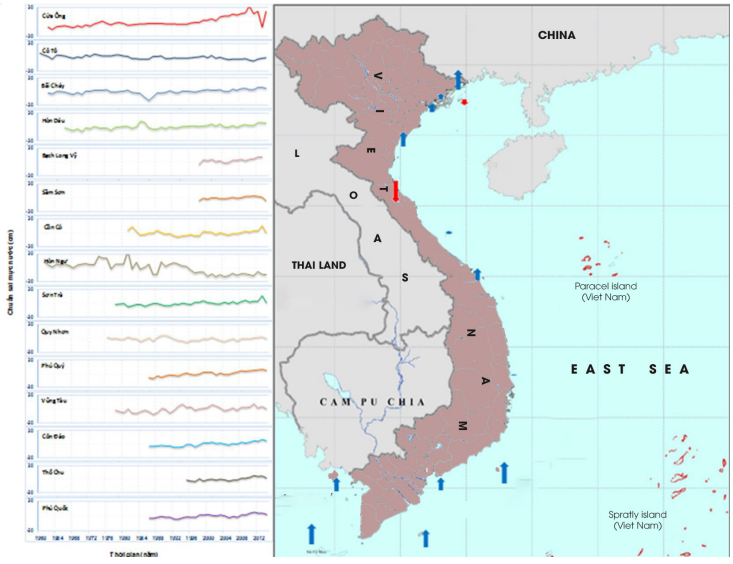


Figure 3.2. The development of storms and tropical depressions in the period of 1959-2014

Source: Climate change and sea level rise scenarios for Viet Nam, MONRE, 2016

b) Manifestation of sea level rise



Box 3.2. 3.2. Manifestation of sea level rise

Sea levels at coastal stations in Viet Nam:
- Rise about 2.45mm/year in the period of 1960-2014;
- Rise about 3.34mm/year in the period of 1993-2014;
- Rise about 3.5±0.7 mm/year in the period of 1993-2014 according to satellite data.

Figure 3.3. Trends of sea level rise

Source: Climate change and sea level rise scenarios for Viet Nam, MONRE, 2016

According to observation data at coastal and island stations of Viet Nam, water levels at stations have been rising up, in which the highest is in Phu Quy station (5.6 mm/year). The water levels at Hon Ngu and Co To stations had a downward trend (respectively 5.77 and 1.45 mm/year). Water levels at Con Co and Quy Nhon stations fluctuated. On average, for all stations, the sea level increased by 2.45 mm/year. Water levels at stations in the period of 1993-2014 increased by about 3.34 mm/year.

According to measured data using satellites during the period of 1993-2014, average water level in the East Sea rose 4.05±0.6 mm/year. Average water level in Viet Nam's coastal area increased by 3.50±0.7 mm/year. Average water level in the Central coast increased the most (4mm/year), with the highest value in the South Central (5.6 mm). Average water level in the Gulf of Tonkin increased the least (2.5 mm/year).

3.1.2. Climate change and sea level rise scenarios for Viet Nam

In 2016, MONRE announced the climate change and sea level rise scenarios for Viet Nam with the following new important viewpoints:

- To apply the latest methodologies in the IPCC's 5th Assessment Report (AR5) and use the data updated up to 2014 of 150 inland and island monitoring stations of Viet Nam's hydro-meteorological network; sea level data of 17 coastal and island marine stations; sea level data measured from satellites and terrain data of 1:2,000, 1:5,000 and 1:10,000 updated maps up to 2016.

- To develop climate change and some climatic extremes scenarios for 63 provinces/cities and sea level rise scenarios for 28 coastal provinces as well as Spratlys and Paracels Archipelago of Viet Nam.

- To assess the risk of submergence due to sea level rise in delta areas, coastal areas, islands as well as Spratlys and Paracels Archipelagos of Viet Nam.

Climate change and sea level rise scenarios for Viet Nam are summarized as below:

1) Average annual temperature: In all regions, the trend is higher than in the baseline period (1986-2005), with the largest increase in the North.

According to the low GHG concentration pathway (RCP4.5 scenario), the nationwide average annual temperature at the beginning of the century has a common rise of 0.6-0.8^{o}C; by the middle of the century, the increasing rate is 1.3-1.7^{o}C; and by the end of the century, is a jump of 1.9-2.4^{o}C in the North and 1.7-1.9^{o}C in the South (Figure 3.4).

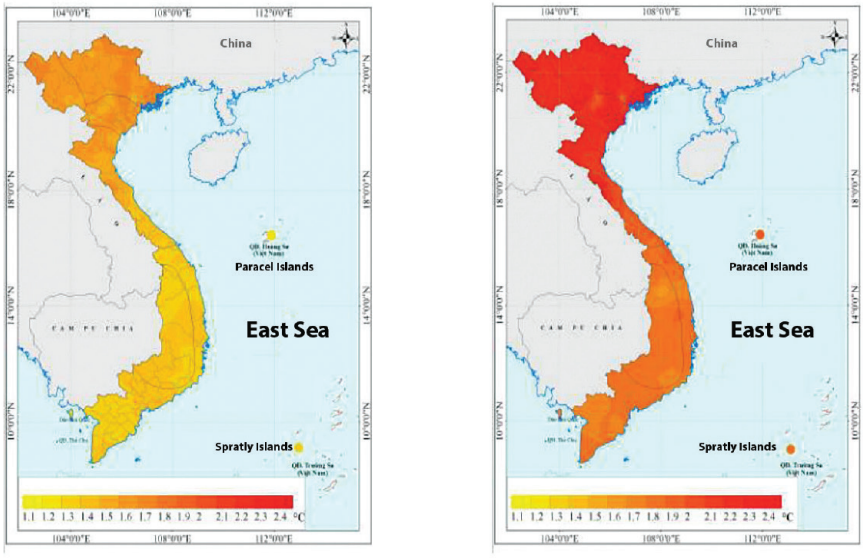
According to the high GHG concentration pathway (RCP8.5 scenario), the nationwide annual average temperature at the beginning of the century is 0.8-1.1^{o}C; by the middle of the century from 1.8-2.3^{o}C; and by the end of the century is 3.3-4.0^{o}C in the North and 3.0-3.5^{o}C in the South.

The average lowest and the highest temperatures in both scenarios have remarkable increases.

2) Annual rainfall: tends to increase nationwide.

According to RCP4.5 scenario, annual rainfall in the beginning of the century tends to increase in almost all regions of the country, mostly from 5-10%; by the middle of the century it is between range of 5-15%, potentially rising in some coastal provinces in the North, North Central and Mid-central regions by over 20%; by the end of the century, it has a similar distribution as in the middle of the century, but has more areas with more than 20% increase (Figure 3.4).

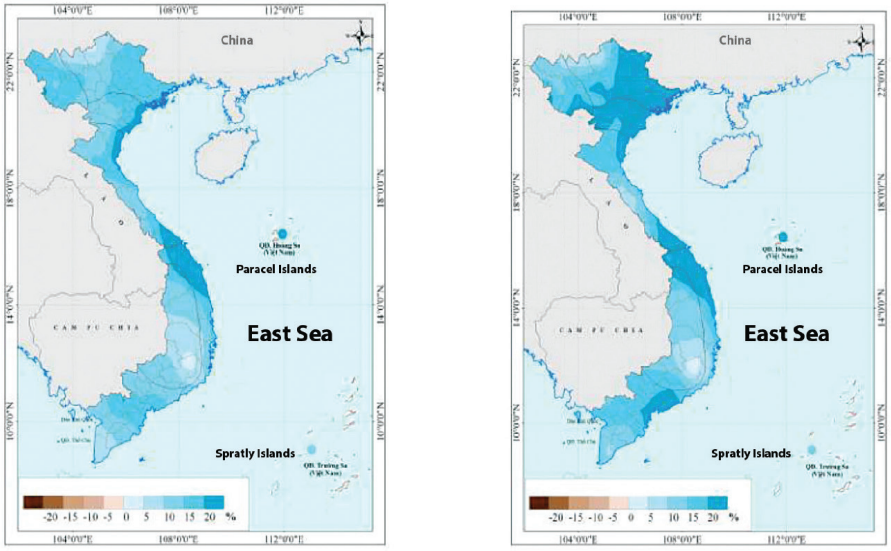
According to RCP8.5 scenario, annual rainfall in the beginning of the century rises in most areas of the country at 3-10%; by the middle of the century, the uptrend is similar to that of RCP4.5; and finally by the end of the century, the biggest increase could be over 20% in most of the North, the Mid-Central, part of the South and the Central Highlands areas.



(a) in the middle of the 21st century (b) in the end of the 21st century

Figure 3.4. Change of average annual temperature (°C) according to RCP4.5 scenario

Source: Climate change and sea level rise scenarios for Viet Nam, MONRE, 2016



(a) in the middle of the 21st century (b) in the end of the 21st century

Figure 3.5. Change of average yearly rainfall according to RCP4.5 scenario

Source: Climate change and sea level rise scenarios for Viet Nam, MONRE, 2016

3) Some climatic extremes:

The number of storms and tropical depressions might be less variable but more concentrated at the end of the storm season, which is also a major active time for storms in the South. Huge storms and typhoons tends to appear more frequently. The summer monsoon might start earlier and end later. Rainfall during the active period of monsoon will increase. The number of extreme

and damaging cold days in the Northern mountainous provinces, the Red River Delta and North Central coast will decrease. The number of hot days (the highest temperature of day Tx ≥35°C) will grow in most areas of the country, with the highest growth in the North, South Central and South. Drought may become more severe in some areas due to rising temperatures and the possibility of decreasing rainfall in the dry season as in the South Central in spring and summer, the South in spring and the North in winter.

4) Sea level rise:

Table 3.1. Sea level rise according to RCP4.5 scenario

Unit: cm

Area	21st Century milestones							
	2030	2040	2050	2060	2070	2080	2090	2100
Mong Cai-Hon Dau	13 (8÷18)	17 (10÷24)	22 (13÷31)	27 (17÷39)	33 (20÷47)	39 (24÷56)	46 (28÷65)	53 (32÷75)
Hon Dau-Deo Ngang	13 (8÷18)	17 (10÷24)	22 (13÷31)	27 (16÷39)	33 (20÷47)	39 (24÷56)	46 (28÷65)	53 (32÷75)
Deo Ngang-Deo Hai Van	13 (8÷18)	17 (10÷24)	22 (14÷32)	28 (17÷39)	33 (20÷47)	40 (24÷56)	46 (28÷65)	53 (33÷75)
Deo Hai Van-Mui Dai Lanh	13 (8÷18)	17 (10÷25)	23 (14÷32)	28 (17÷40)	34 (21÷48)	40 (25÷57)	47 (29÷66)	54 (33÷76)
Mui Dai Lanh -Mui Ke Ga	12 (8÷18)	17 (10÷25)	23 (14÷33)	28 (17÷41)	34 (21÷50)	40 (24÷59)	47 (28÷68)	54 (33÷78)
Mui Ke Ga -Mui Ca Mau	12 (7÷18)	17 (10÷25)	22 (13÷32)	28 (17÷40)	33 (20÷49)	40 (24÷58)	46 (28÷67)	53 (32÷77)
Mui Ca Mau -Kien Giang	12 (7÷18)	17 (10÷25)	23 (13÷32)	28 (17÷40)	34 (21÷49)	41 (25÷58)	48 (29÷68)	55 (33÷78)
Paracels Archipelago	13 (8÷18)	18 (12÷26)	24 (15÷34)	30 (19÷42)	37 (23÷51)	43 (27÷61)	50 (31÷70)	58 (36÷80)
Spratlys Archipelago	14 (8÷20)	19 (11÷27)	24 (14÷35)	30 (17÷44)	36 (21÷53)	43 (25÷62)	50 (29÷72)	57 (33÷83)

Source: Climate change and sea level rise scenarios for Viet Nam, MONRE, 2016.

According to scenario RCP4.5, the average sea level rise for the entire coastal zone of Viet Nam by 2050 is 22 cm (14 cm-32 cm); by 2100 is 53 cm (32 cm-76 cm) (Table 3.1).

According to scenario RCP8.5, the average sea level rise for the entire Viet Nam coastal zone by 2050 is 25 cm (17 cm-35 cm); by 2100 is 73 cm (49 cm-103 cm).

5) Risk of flooding due to sea level rise

If the sea level rises by 100 cm without any response measures, about 16.8% of the Red River Delta area, 1.5% of area of Central coastal provinces from Thanh Hoa to Binh Thuan, 17.8% of the Ho Chi Minh city area, and 38.9% of the Mekong Delta area are at risk of inundation. Van Don, Con Dao, Phu Quoc islands are in danger of flooding. Compared to the Spratly Archipelago with lower flood risk, the Paracel Archipelagos are at greater danger of flooding.

3.2. VULNERABILITY AND EXPOSURE TO INCREASING RISKS

Vulnerability and exposure to increasing risks are identified in specific contexts, linking with the sources of the risk (IPCC, 2012). Climate change is changing the level of extreme phenomena, which effects the exposure and vulnerability of natural ecosystems and human ecosystems. In Viet Nam, climate change is increasing the number of extreme phenomena and natural disasters, levels of exposure and vulnerability. Depending on the conditions of each region and impacts of different factors, subjects and levels of vulnerability vary, with the most vulnerable sectors being agriculture and food security, natural ecosystems, biodiversity, water resources, public health, shelters and technical infrastructure. The National Target Program to Responds to Climate Change evaluates all areas to be impacted by natural disasters, among which the Mekong Delta, the Red River Delta and the Central Coast are the most vulnerable areas.

In each region, groups of the poor, ethnic minorities, those who have climate-dependent income, the elderly, women, children, and the sick are the most vulnerable subjects to climate change.

The increase of risks and potential impacts of climate change for each sector, area, community and related infrastructure includes:[4]

The coastal strip of more than 3,000 km and the waters and islands of Viet Nam which will be subjected to higher risks and hazards with most potential impacts related to climate change and sea level rise.

Large deltas and urban municipalities will also be at increased risk, especially coastal cities because of the high population density and urban/spatial planning that do not integrate natural disaster risk mitigation and climate change adaptation to cover areas where most assets, infrastructure and vulnerable groups are located.

Northern Mountain and Central areas face higher risk of flash floods and landslides due to the change in rainfall patterns, increasing in frequency and intensity.

At the same time, the regions which will be at higher risk and more vulnerable to drought and water shortages, leading to increasing desertification in Viet Nam include: Central Coast and South Central Coast, Red River Delta, Midland and the Central Highlands.

Every year, Viet Nam has an average of 7 to 8 typhoons directly impacting the mainland out of 12-16 typhoons active in the East Sea. From 1990 to 2010, there were 74 floods in river

4. IMHEN and UNDP (2015), Viet Nam's Special Report on natural disaster management and extreme weather for enhancing adaptation [Tran Thuc, Koos Neefjes, Ta Thi Thanh Huong, Nguyen Van Thang, Mai Trong Nhuan, Le Quang Tri, Le Dinh Thanh, Huynh Thi Lan Huong, Vo Thanh Son, Nguyen Thi Hien Thuan, Le Nguyen Tuong), Viet Nam Natural Resources and Environment Publishing House, Hanoi, Viet Nam

systems. Together with rainstorms, short-term heavy rainfall causes downstream floods, fluvial floods, and flash floods in the mountainous areas. Severe droughts, saltwater intrusion, landslides, and other natural disasters have also been hindering the development of regions throughout the country. In particular, in recent years, occurrence of more extreme natural disasters have increased losses in terms of human lives and economic development. In 2017, most climatic extremes occurred in Viet Nam except for tsunamis.

Droughts are likely to appear more frequently in the 21st century in most climates across the country. With the rise of temperature and extreme events, the number of typhoons operating in the East Sea and affecting Viet Nam may have a lower frequency, but with higher intensity as well as number of storms. Severe cold weather days also tend to decrease, but the number of cold spells becomes unpredictable and fluctuates from year to year.

Extreme heat and dry weather create a high risk of forest fires. Statistics from the Forest Protection Department show that in the period of 1992-2013, Viet Nam lost on average 6,000 ha per year due to forest fires. The phenomena of long hoarfrost, extreme and damaging cold (for example in 2008) destroyed hundreds of hectares of acacia trees in the Northern provinces (Quang Ninh, Bac Giang, Lang Son). Storms and tropical depressions, especially powerful storms and typhoons, resulted in hundreds of hectares of damaged acacia, eucalyptus and rubber trees. Storms with high tides have caused coastal erosion and damage to mangrove forests.

3.3. IMPACTS OF CLIMATE CHANGE

3.3.1. Water resources

The impact of climate change on water resources is assessed according to the correlation of characteristics between water resources and river basin, as along with the rainfall - runoff relationship and variability of rainfall.

Average annual flow, and flows in flood and dry seasons of seven main river basins calculated in climate change and sea level rise scenarios in different times in the 21st century compared to the period of 1986-2005 are displayed in Tables 3.2, 3.3 and 3.4.

Table 3.2. Average annual flows of seven river basins

No.	River basin	Period	RCP4.5 Scenario						RCP8.5 Scenario					
		1986-2005	2016-2035		2046-2065		2080-2099		2016-2035		2046-2065		2080-2099	
		Value (mm)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)
1	Bang Giang - Ky Cung	600	823	37	828	38	938	56	731	22	839	40	965	61
2	Red	740	802	8	843	14	880	19	753	2	837	13	904	22
3	Ca	819	826	1	884	8	920	12	883	8	910	11	926	13
4	Ba	691	731	6	761	10	759	10	759	10	750	9	763	11
5	Thu Bon - Vu Gia	2,912	3,539	22	3,805	31	3,902	34	3,505	20	3,769	29	3,737	28
6	Se San	967	1,011	5	1,055	9	1,074	11	1,022	6	1,061	10	1,094	13
7	Dong Nai	1,126	1,415	26	1,511	34	1,538	37	1,390	23	1,575	40	1,574	40

Source: Center for Hydrological and Water Resources Research, IMHEN, 2018

Table 3.3. Average flows in flood season of seven river basins

No.	Rive basin	Period	RCP4.5 Scenario						RCP8.5 Scenario					
		1986-2005	2016-2035		2046-2065		2080-2099		2016-2035		2046-2065		2080-2099	
		Value (mm)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)
1	Bang Giang - Ky Cung	443	513	16	567	28	687	55	520	17	628	42	739	67
2	Red	538	563	5	584	9	602	12	546	2	585	9	619	15
3	Ca	558	538	-4	558	0	576	3	586	5	590	6	621	11
4	Ba	499	511	2	552	11	551	10	540	8	541	8	530	6
5	Thu Bon - Vu Gia	1,974	2,628	33	2,926	48	2,982	51	2,553	29	2,815	43	2786	41
6	Se San	647	689	6	726	12	739	14	711	10	736	14	727	12
7	Dong Nai	898	1,154	29	1,299	45	1,279	42	1,206	34	1,319	47	1394	55

Source: Center for Hydrological and Water Resources Research, IMHEN, 2018

Table 3.4. Average flows in dry season of seven river basins

No.	River basin	Period	RCP4.5 Scenario						RCP8.5 Scenario					
		1986-2005	2016-2035		2046-2065		2080-2099		2016-2035		2046-2065		2080-2099	
		Value (mm)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)	Value (mm)	Difference (%)
1	Bang Giang - Ky Cung	157	309	97	261	67	252	61	211	35	211	35	226	44
2	Red	202	239	18	259	28	278	38	207	2	252	25	285	41
3	Ca	261	288	10	326	25	344	32	297	14	319	22	305	17
4	Ba	192	226	18	207	8	205	7	220	15	208	8	240	25
5	Thu Bon - Vu Gia	937	911	-3	879	-6	920	-2	952	2	954	2	951	1
6	Se San	320	322	1	329	3	335	5	311	-3	325	2	367	15
7	Dong Nai	228	261	15	213	-7	259	14	184	-19	256	12	179	-21

Source: Center for Hydrological and Water Resources Research, IMHEN, 2018

After 2020, underground water levels in many areas will be significantly reduced due to the impacts of climate change. Underground water levels will decrease the most in the Northern and Southern key economic regions and the least in the Central Highland area. In the Central South and South areas, if the flow is reduced by 10-30%, the groundwater level may be lowered by about 11m compared to the current water level and be even more severe due to overexploitation of underground water for socio-economic development purposes. At the moment in the South, there are places where water levels have dropped more than 10 meters during the last 10 years from 2005 to 2015, as shown in Figure 3.6. Underground water levels in areas not affected by tides tend to be lower. The decrease in underground water level in many places in Viet Nam has changed the types and scope of exploitation.

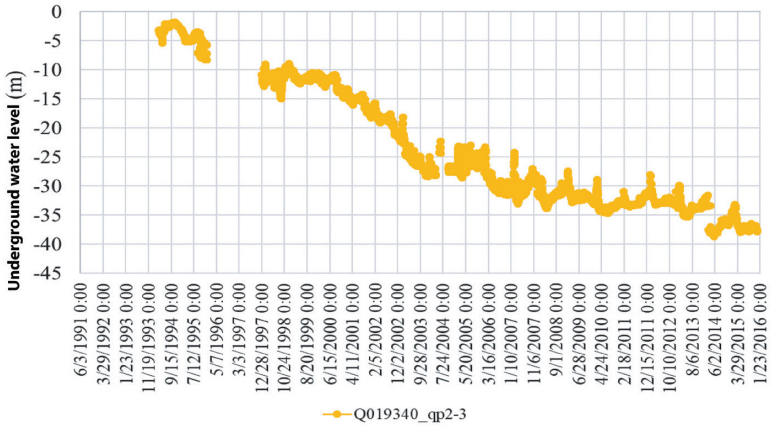


Figure 3.6. Water level in the middle of Pleistocene aquifer (Qp2-3) was observed at Q019340 point in Ho Chi Minh City

Source: Center of Hydrology and Water Resources Research, IMHEN, 2018

3.3.2. Agriculture sector

If the sea level rises by 100 cm, the Mekong Delta and Ho Chi Minh City are at risk of losing 40.5% of total rice production in the region. By 2050, according to the average scenario of climate change, the potential yield of spring paddy may be decreased by around 717 kg/ha equivalent to 2.16 million tonnes; potential yield of summer-autumn rice may drop around 795 kg/ha equivalent to 1,470 thousand tonnes of production; potential yield of maize may reduce to 782 kg/ha, equivalent to 880 thousand tonnes; potential yield of soybean may fall to 215 kg/ha, equivalent to 37,000 tonnes [5].

The lessening of crop land due to sea level rise has serious implications for cereal production, which directly threatens animal feed. Increasing temperature will make the grass grow faster, reduce quality quickly and lower nutrient contents.

Rising temperatures also can cause damage to the yield of all crops in all regions. Declines in crop yields and livestock production due to higher temperatures according to RCP4.5 and RCP8.5 scenarios are estimated and displayed in Table 3.5.

Table 3.5. Estimates of crop yield reductions and livestock production due to rising temperatures based on the RCP4.5 and RCP8.5 scenarios

Parameters	RCP4.5 Scenario			RCP8.5 Scenario		
	2016-2035	2046-2065	2080-2099	2016-2035	2046-2065	2080-2099
Average increase of temperature (°C)	0.6-0.7	1.3-1.8	1.8-2.4	0.8-1.1	1.8-2.3	3.0-4.0
Decline of crop yields (%)	1	2	3	1.5	2.5	3.5
Decline of livestock productivity (%)	1-2	2-3	3-4	1-3	3-5	5-10

Source: Report on assessing and forecasting the impacts of climate change on Viet Nam's agriculture under the climate change and sea level rise scenarios

Reduction in crop yields and livestock production due to changes in rainfall and climate change scenarios for Viet Nam in 2016 are calculated and described in Table 3.6.

Table 3.6. Estimation of crop productivity and livestock productivity due to change in rainfall

Parameters	RCP4.5 Scenario			RCP8.5 Scenario		
	2016-2035	2046-2065	2080-2099	2016-2035	2046-2065	2080-2099
Average increase of temperature (°C)	5-10	5-15	20-25	3-10	5-15	18-30
Decline of crop yields (%)	1	10	20	1	10	20-40
Decline of livestock productivity (%)	0.5-1	1-1.5	1-2.5	1-2	2-2.5	2-5

Source: Report on assessing and forecasting the impacts of climate change on Viet Nam's agriculture under the climate change and sea level rise scenarios

5. Dinh Vu Thanh, Nguyen Van Viet, 2014, Impacts of climate change on agriculture sector and response measures. Agricultural Publishing House.

Sea level rise has shrunk many lowland coastal farming areas. Damage in rice production in the Mekong Delta according to the scenario of climate change and sea level rise for Viet Nam in 2016 is estimated and presented in Table 3.7.

Sea level rises along with widespread saltwater intrusion leading to the narrowing of grasslands, and grazing areas, and reducing the number of breeding facilities in coastal lowlands, especially in the Mekong Delta as well as degrading the quality of drinking water sources for cattle and poultry and raising the cost of water supply for livestock.

Table 3.7. Estimation of losses in rice production in the Mekong Delta

Cities, provinces	Sea level rises at 70 cm				Sea level rises at 100 cm			
	Flooded area of rice cultivation (ha)	Yearly rice yield 2016 (quintal/ ha)	Estimation of rice loss/crop (tonne)	Damage value (billion VND)	Flooded area of rice cultivation (ha)	Yearly rice yield 2016 (quintal/ ha)	Estimation of rice loss/ crop (tonne)	Damage value (billion VND)
Mekong River Delta	186,000	53.6	993,000	5,460	569,000	53.6	3,180,000	17,500
Long An	1,890	53.4	10,100	55,6	43,500	53.4	232,000	1,280
Tien Giang	3,460	58.8	20,400	112	26,600	58.8	156,000	860
Ben Tre	13,500	27.7	37,500	206	11,900	27.7	33,000	181
Tra Vinh	2,390	47.7	11,400	62,7	3,720	47.7	17,700	97.5
Vinh Long	799	53.3	4,260	23,4	5,320	53.3	28,400	156
Đong Thap	243	61.6	1,500	8,23	7,510	61.6	46,300	255
An Giang	41	60.8	250	1,40	3,210	60.8	19,500	107
Kien Giang	80,600	54.3	438,000	2,410	244,000	54.3	1,330,000	7,300
Can Tho	155	58.2	900	4,95	17,900	58.2	104,000	572
Hau Giang	26,600	60.9	162,000	892	56,800	60.9	344,000	1,890
Soc Trang	28,100	59.4	167,000	917	89,800	59.4	534,000	2,930
Bac Lieu	12,600	58.4	73,400	404	53,600	58.4	313,000	1,720
Ca Mau	15,700	42.4	66,600	366	5,100	42.4	21,600	119

Source: Report on assessing and forecasting the impacts of climate change on Viet Nam's agriculture under the climate change and sea level rise scenarios

3.3.3. Fishery sector

The amount of wild fish may be reduced due to increasing temperature. Sea level rise will flood part of the Mekong Delta and the Red River Delta, affecting production and aquaculture. Flooded ponds, lakes and lagoons can cause aquatic products to escape. Climate change can cause seasonal changes, disease outbreaks, decreasing productivity, reduction in aquatic resources and degrading soil quality.[6]

Climate change can also seriously impact the infrastructure of fishing ports, storm shelters, and coastal petrol stations and fishermen boats.

Temperature is one of the significant factors that greatly affect the growth and development of

6. Dinh Vu Thanh, Nguyen Van Viet, 2014, Impacts of climate change on agriculture sector and response measures. Agricultural publisher.

aquatic products. Long-lasting heat causes shrimp to lose immunity, eat less, become susceptible, grow slowly, and even die.

Research results on the impact of climate change on the fisheries sector in 10 provinces of Bac Bo and North Central[7] (from Quang Ninh to Thua Thien Hue) state that annual economic losses (comparative prices in 2012, discount rate at 3% per year) due to changes in temperature to 2050[8] will be VND 410 billion for the fishery sector and VND 445 billion for aquaculture respectively.

When rainfall in the coastal zone increases to 100 mm (0.1 m), aquatic yield in the same year will decrease on average from 0.98% to 2.2% and be reduced by 1.5% for exploitation in the following year[9]. Annual economic losses (comparative prices in 2012, discount rate at 3% per year) of the fisheries and aquaculture sector in 10 provinces of North and North Central areas (from Quang Ninh to Thua Thien Hue) due to changes in rainfall by 2050[10] is forecasted to be about VND 35 billion and VND 60 billion respectively.

Storms and tropical depressions can destroy infrastructure of aquaculture areas such as irrigation canals, tents, supplies and equipment as well as through erosion of dikes, or greatly damage infrastructure of aquatic resource exploitation. The impact of storms on the fisheries sector will not only affect the catches produced in a year, but also affect the yields of subsequent years. Some studies show that an increase of one storm per year would reduce catches by 1.57% in the same year and decrease by 2.17% in the following year. In contrast, tropical depressions have a positive effect on fisheries outputs. If the number of tropical depressions increases by one incident per year, it will help to add 3.58% more to catches in the same year and 3.07% in the following year[11].

Annual economic losses (comparative prices in 2012, discount rate at 3% per year) of the fisheries and aquaculture sector in 10 provinces of Bac Bo and North Central (from Quang Ninh to Thua Thien - Hue) due to the typhoon by 2050[12] is estimated at about VND 115 billion and VND 60 billion (Figure 3.7).

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7. Research on "Economic Impact Assessment of Climate Change for Northern Fisheries", University of Economics, Vietnam National University, Hanoi, 2015.

8. Climate change and sea level rise scenarios for Viet Nam, 2012

9. Research on "Economic Impact Assessment of Climate Change for Northern Fisheries", Hanoi University of Economics, Vietnam National University, Hanoi, 2015, and Research "Impact of Climate Change on Vietnamese fishery "by Nguyen Viet Thanh et al., University of Economics, Vietnam National University, Hanoi, 2014.

10. Climate change and sea level rise scenarios for Viet Nam, MONRE, 2012.

11. Research on "Economic Impact Assessment of Climate Change for Northern Fisheries", University of Economics, Viet Nam National University, Hanoi, 2015.

12. Climate change and sea level rise scenarios for Viet Nam, MONRE, 2012.

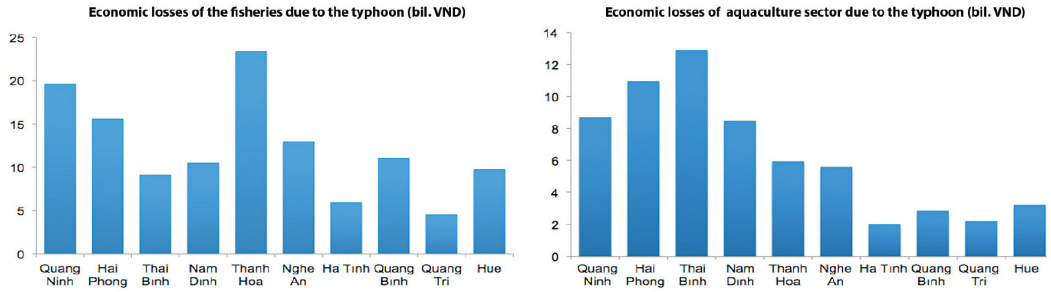

Figure 3.7. Economic losses in the fisheries and aquaculture sector due to storms

Source: University of Economics, Viet Nam National University, Hanoi, 2015

Sea level rise and salinity intrusion will cause the area of freshwater aquaculture to be reduced significantly as well as affect the quality of the ecological environment with changes to ecosystems in the estuary area. When salinity fluctuates dramatically or exceeds the threshold, aquatic species that only can adapt within a narrow range of salinity may die.

According to the study on the impact of salinity intrusion in the Mekong Delta[13], at a sea level rise of 22 cm (RCP4.5) by 2050, the area of freshwater ecosystems suitable for raising freshwater aquaculture will likely shrink by about one million ha compared to the baseline scenario in 2004.

3.3.4. Forestry sector

The impacts of climate change on forestry include increasing the risk of forest fires, changing the distribution of natural forest ecosystems, impacts on planted forests and mangroves[13].

The risk of forest fires increases in all ecological regions, however, more strongly in the North West, North Central Coast and Central Highlands areas. Although the forest area of Viet Nam has increased in recent years, the quality of forest has tended to decrease. Primary forest areas account for about 7% of the total forest area[14] whereas poor secondary forest amounts to nearly 70% of the country's total forest area. It is estimated that there are about 6 million hectares of easily-burnt forest. Forests with high risk of fire include pine, cajuput, bamboo, eucalyptus, dipterocarp forest[15].

Some natural ecosystems (dipterocarp, mangrove, semi-deciduous, evergreen broadleaf forests) are at risk of changing (narrowing and/or widening) their distribution due to climatic conditions. Changes in the distribution of dipterocarp, mangrove and semi-deciduous forest are relatively high[16].

13. Pham Minh Thoa, Assessment on impacts, identifying response measures, development and implementation of action plans to respond to climate change in Forestry sector, Hanoi, Viet Nam 2013.
14. FAO, 2012. State of the World's Forest 2012, Rome.
15. Vu Tan Phuong et al., Scientific report on First step to evaluate vulnerability due to climate change in forestry sector, MARD, Hanoi, Viet Nam, 2008.
16. Pham Minh Thoa, Assessment on impacts, identifying response measures, development and implementation of

Under the impact of climate change, the suitable zone for the distribution of dipterocarp forest will be 4.6% by 2020, but drop to about 1.5% by 2050. It is even possible that dipterocarp forest may no longer be in the Central Highlands by 2100.

In the Red River Delta, climate change and sea level rise could result in shrinking the area of the mangrove ecosystem, due to increased coastal erosion (Do Son, Hai Hau and Nghia Hung coastal areas and a part of Giao Thuy areas)[17]. Some species of mangrove may not adapt to changes in such environmental conditions as tides, salinity, and temperature. In the Southern provinces, especially in the Mekong Delta, the impact of sea level rise, salinity regimes and salinity values may lead to a reduction in mangrove forest areas. In addition, the impact of climate change may cause the loss of biodiversity as well as growth of mangroves.

Semi-deciduous forest ecosystem is strongly affected by climate change. By 2020, the distribution of this forest type is likely to decline drastically in the North Central Coast. By 2050, this forest ecosystem may no longer exist in the North Central and only appear in the South Central and Central Highlands regions. Climate change will not produce major changes in the distribution of the evergreen broad-leaved forest ecosystem. By 2020, the Central Highlands and the South Vietnam can have a favourable climate for the distribution of this type of forest ecosystem and continue to increase in the Central Highlands and Southern Vietnam in 2050 and 2100.

In the period of 2010-2050, changes in climatic conditions could have a positive impact on the expansion of climatic zones suitable for plantation. Climate change could also significantly reduce the growth of acacia plantation in the South (reduced by 10-27%), especially in the South East and Mekong Delta. However, the growth of Acacia mangium forest is likely to widen in the North, with an increase of 10-30%[18]

Rising temperatures will increase the risk of larval infestation in pine forests and for other pests in planted forests. The risk of tea tussock moth will grow by about 10% by 2020, about 13% by 2050 and especially by 2100, the risk of tea tussock moth living in pine trees will jump to 31% compared to 2000.

Other risks of climate change are the directly relate to the consequences of deforestation and forest degradation.

3.3.5. Energy sector

For the national electricity grid, when the air temperature rises, the additional load to the grid will increase accordingly leading to electricity plants, lines and stations to be operated at higher intensity. The additional loads in summer usually are 10% higher, causing more losses

action plans to respond to climate change in Forestry sector, Hanoi, Viet Nam 2013.

17. Tran Van Dat et al, Summary report on programme:"Research on impacts of sea level rise due to climate change to mangrove ecosystem and coastal resident community across Red River Delta", MARD, Hanoi, 2013.

18. Pham Minh Thoa, Assessment on impacts, identifying response measures, development and implementation of action plans to respond to climate change in Forestry sector, Hanoi, Viet Nam 2013.

in electricity transmission and distribution. For power plants using coal, oil, gas, biomass and even nuclear, when the air temperature rises, the water temperature also increases, requiring more circulating water, lowering turbine performance and fuel efficiency. Air temperature increases also lead to higher energy consumption due to the use of cooling equipment such as air conditioners, electric fans, ice cream machines, freezers and cold chambers for food storage, watering pumps for crops.

Strong tropical storms, heavy rain and floods can affect the safety of infrastructure in power plants and transmission lines, leading to higher cost for repairing and maintaining energy facilities.

Sea level rise may cause a negative impact on power plants, transmission stations, transformer stations, fuel lines, mines, coal yards and other energy facilities in the coastal zone.

3.3.6. Transport sector

Increasing temperature negatively affects transport infrastructure by deforming steel structures; reducing the life span of works; reducing the safety of traffic activities and rising the fuel consumption of vehicles.

Strong storms, heavy rain, flood, flash flood, flooding, landslide, tide and extreme weather events have seriously influenced all types of transportation.

Sea level rise may submerge some transport infrastructure in coastal lowlands such as seaports, roads, railways and airports. If the sea level rises 100 centimeters about 4% of the national rail system, more than 9% of the national highways and about 12% of provincial roads will be affected, with most heavily-affected transportation systems being in the Mekong Delta at 28% and provincial roads at 27%. Sea level rise affects the foundations of coastal ports and airports in lowland coastal areas. Saltwater intrusion has a negative impact on road infrastructure, which reduces the life expectancy of traffic works, especially steel structures due to erosion to metal and other materials by salinity. High tides affect the traffic and urban life of people, especially in the Mekong Delta.

3.3.7. Community health

Some studies have proved that when the average temperature rises by 1^0C, the hospital admission rate of children under 5 will increase by 2.6%. Within 1 to 6 days after the increase in temperature, the hospitalization rate for children aged 3-5 ranges more than those in the younger group[19].

19. "Temperature as a risk factor for hospitalization of young children in the Mekong Delta, Viet Nam", Phung Tri Dung et al., Journal of Occupational and Environmental Medicine, March 2015.

The impacts of climate change such as sea level rise, high temperature, change in rainfall patterns can increase infectious sources, which brings in the possibility of outbreaks and spread of epidemics such as influenza A (H1N1), influenza A (H5N1), influenza A (H7N9), diarrhea, cholera, dysentery, malaria, dengue fever, yellow fever, typhoid fever, viral encephalitis, Japanese encephalitis, Severe acute respiratory syndrome (SARS), plague, and Zika.

Flooding and saltwater intrusion pollute fresh water source, increase the risk of water-borne diseases such as gastrointestinal diseases and facilitate the spread of infectious diseases with such hosts as mosquitoes, mice and flies, and fleas.

Climate change affects food security, intensifies the risk of poverty, makes it difficult for the people livelihoods and affects public health.

Recent research results show that:

- Group of vector-transmitted diseases: dengue fever, malaria, Japanese encephalitis, Zika will develop complicatedly in the Mekong Delta and Southeast area. Dengue fever may develop in the Central Highlands.

- The group of gastrointestinal infections will tend to be dependent on rising air temperature, for instance dysentery, and cholera. The hospitalization rate for diarrhea in hot dry months (June-September) was 1.56 times higher than those with fewer dry days (from February to May)[20]. When average temperature increases by 1°C, the rate of hospitalization for children under 5 years of age due to infectious digestive diseases will jump to 4.4% and the incidence of catching HFMD after five days may go up to 5.6%. When the humidity increases by 1%, the rate of getting HFMD after three to six days will rise by about 1.7%[21].

- Some other diseases such as high blood pressure, heat shock, mental illness, chronic obstructive pulmonary disease, bronchial asthma, respiratory diseases, stroke, accidents etc. are at high increasing risk in the coming time. When average temperature gets 1°C more, the hospital admission rate of children under 5 years due to respiratory infections will be 3.8%[22] more and 1.1%[23] more for adults.

3.3.8. Coastal zones

The highest risk areas of flooding under the climate change and sea level rise scenarios for Viet Nam in 2016 are presented in Table 3.8.

21. "Influence of heat waves on public health in Ho Chi Minh City, Vinh, Nghe An and proposal of response model", National Institute of Occupational and Environmental Health, 2013.
21. "Time and place analysis of hand, foot and mouth disease related to climatic factors: A study in the Mekong Delta, Viet Nam, Nguyen Xuan Huong et al., Journal of Science of the Total Environment, 2016.
22. "Temperature as a risk factor for hospitalization of young children in the Mekong Delta, Viet Nam," Phung Tri Dung et al., Journal of Occupational and Environmental Medicine, March 2015.
23 . "High temperature and risk of hospitalizations, and effect modifying potential of socio-economic conditions: A multi-province study in the tropical Mekong Delta Region", Phung Tri Dung et al., Journal of Environment International, 2016.

Table 3.8. Highest risk areas of flooding under the climate change and sea level rise scenarios for Viet Nam in 2016

No.	Coastal zone	Area (ha)	Risk of flooding in relation to sea level rises (% area)					
			50cm	60cm	70cm	80cm	90cm	100cm
1	Quang Yen (Quang Ninh)	39,082	25.1	27.8	30.4	33.0	35.6	37.7
2	Kien Thuy (Hai Phong)	10,257	6.16	9.70	16.36	26.90	40.26	52.94
3	Tien Hai (Thai Binh)	4,351	67.47	72.33	76.28	79.36	81.90	83.95
4	Nghia Hung (Nam Dinh)	22,030	57.44	63.85	69.37	74.22	78.35	81.61
5	Kim Son (Ninh Binh)	17,870	50.94	59.48	65.57	70.54	74.82	78.56
6	Hoang Hoa (Thanh Hoa)	22,449	7.06	8.53	10.24	12.30	14.59	17.29
7	Dien Chau (Nghe An)	31,301	2.38	3.33	4.26	5.14	5.97	10.49
8	Loc Ha (Ha Tinh)	11,605	3.36	5.04	7.16	9.75	13.18	15.59
9	Le Thuy (Quang Binh)	140,374	5.76	5.99	6.21	6.58	6.61	6.79
10	Phu Vang (Thua Thien-Hue)	27,815	4.43	8.46	14.17	20.22	25.61	42.58
11	Lien Chieu (Da Nang)	7,991	3.27	3.71	4.08	4.39	4.67	4.92
12	Hoi An (Quang Nam)	6,150	3.75	3.85	3.94	4.04	4.13	4.32
13	Tuy Phuoc (Binh Dinh)	22,059	2.88	3.62	4.28	5.00	5.67	6.56
14	Dong Hoa (Phu Yen)	26,960	2.94	3.74	4.75	5.65	6.52	7.28
15	Cam Ranh (Khanh Hoa)	31,640	2.65	2.87.	3.37	3.78	4.07	4.27
16	Vung Tau (Ba Ria-Vung Tau)	13,482	9.78	11.45	13.65	15.96	19.42	22.78
17	Binh Thanh (Ho Chi Minh City)	2,081	59.58	63.58	67.75	72.07	76.30	80.78
18	Ben Luc (Long An)	28,752	1.04	4.28	10.50	26.26	45.56	80.11
19	Go Cong Tay (Tien Giang)	19,075	0.20	0.78	2.84	10.72	26.88	42.44
20	Ba Tri (Ben Tre)	36,014	10.01	12.18	17.63	22.86	34.53	45.91
21	Cang Long (Tra Vinh)	29,438	1.60	1.79	2.19	2.96	6.46	46.02
22	Vung Liem (Vinh Long)	31,164	7.98	8.92	9.89	11.09	15.58	22.88
23	Lai Vung (Dong Thap)	23,914	0.89	0.98	1.12	1.58	4.25	11.72
24	Thoai Son (An Giang)	46,806	0.01	0.04	0.16	0.63	2.45	8.75
25	Giang Thanh (Kien Giang)	42,358	17.70	54.21	76.81	86.21	98.23	98.93
26	Thoi Lai (Can Tho)	27,717	0.53	0.63	1.00	2.74	12.28	39.82
27	Long My (Hau Giang)	40,950	5.82	19.98	39.37	59.41	73.93	96.94
28	Nga Nam (Soc Trang)	24,259	10.80	31.38	56.60	73.29	88.54	96.54
29	Hong Dan (Bac Lieu)	44,050	10.70	22.48	41.24	59.51	72.66	90.78
30	Tran Van Thoi (Ca Mau)	71,507	16.05	25.87	41.40	57.96	73.86	90.02

Source: Climate change and sea level rise scenarios for Viet Nam, MONRE, 2016

If the sea level rises by 57cm, about 8% of the forest area and natural vegetation in the coastal zones will be at risk of flooding. The mangrove forest areas in Ca Mau, Ba Ria - Vung Tau, Nam Dinh provinces and Ho Chi Minh City will be the highest affected areas. In addition, coastal ecosystems those are under the influence of current tides will likely move gradually into inland areas, particularly for coastal ecosystems in the Red River and the Mekong River Deltas.

Climate change will cause coastal biodiversity to decline; coastal ecosystems will be degraded and narrowed. Animals and plants will tend to move further away from shore due to changes in coastal circulation patterns, changing river-coast interactions in coastal estuaries, and loss of about 60% of their habitats. of course. If there is a 100-centimeter sea level rise, 78

natural habitats, 46 protected areas and 9 areas of major biodiversity will be severely impacted. Increased salinity intrusion due to sea level rise will greatly affect freshwater ecosystems.

Sea level rise may cause higher waves, which directly hit beach and may cause beach erosion, degrade or destroy mangrove forests - our natural "green belt" to the waves. The decline in mangroves has led to increased vulnerability of coastal ecosystems and structures to the effects of natural disasters.

Climate change affects coastal infrastructure. Coastal infrastructure is not designed to take into account factors of climate change and sea level rise. Therefore, sea level rise will cause inundation, greatly affecting the sustainability and safety of infrastructure, affecting people.

Solid waste collection and treatment systems in many coastal zones will be affected by flooding due to sea level rise. Dumping sites and landfills will be inundated at risk of flooding, causing landfill leaks and spills waste to surrounding areas, polluting the environment and adversely affecting public health, increasing vulnerability of coastal communities.

Sea level rise and strong storms threaten the safety of ports, marine constructions, maritime activities as well as coastal and island tourist resorts.

Buildings, houses and public works in coastal zones and towns are strongly affected by climate change and sea level rise in vulnerable regions in Viet Nam. When the public buildings and houses are flooded or destroyed causing severe damages and losses to people, property and increasing costs for repairing and reconstruction. Coastal landslides will become more serious.

Climate change affects coastal communities. Sea level rise has reduced the area of agricultural cultivation land, aquaculture area and saline land area of coastal communities. The area of residential land of coastal residential areas will also be narrowed. If the sea level rises 100 cm and no effective response solutions, about 17.8% of Ho Chi Minh City and 38.9% of the Mekong River Delta will be at risk of flooding (Figure 3.8) and about 10-12% of the country's population will be directly affected, damaging about 10% of GDP. Typhoons, floods, salinity intrusion and other extreme weather events will cause a great deal of damage to the coastal people.

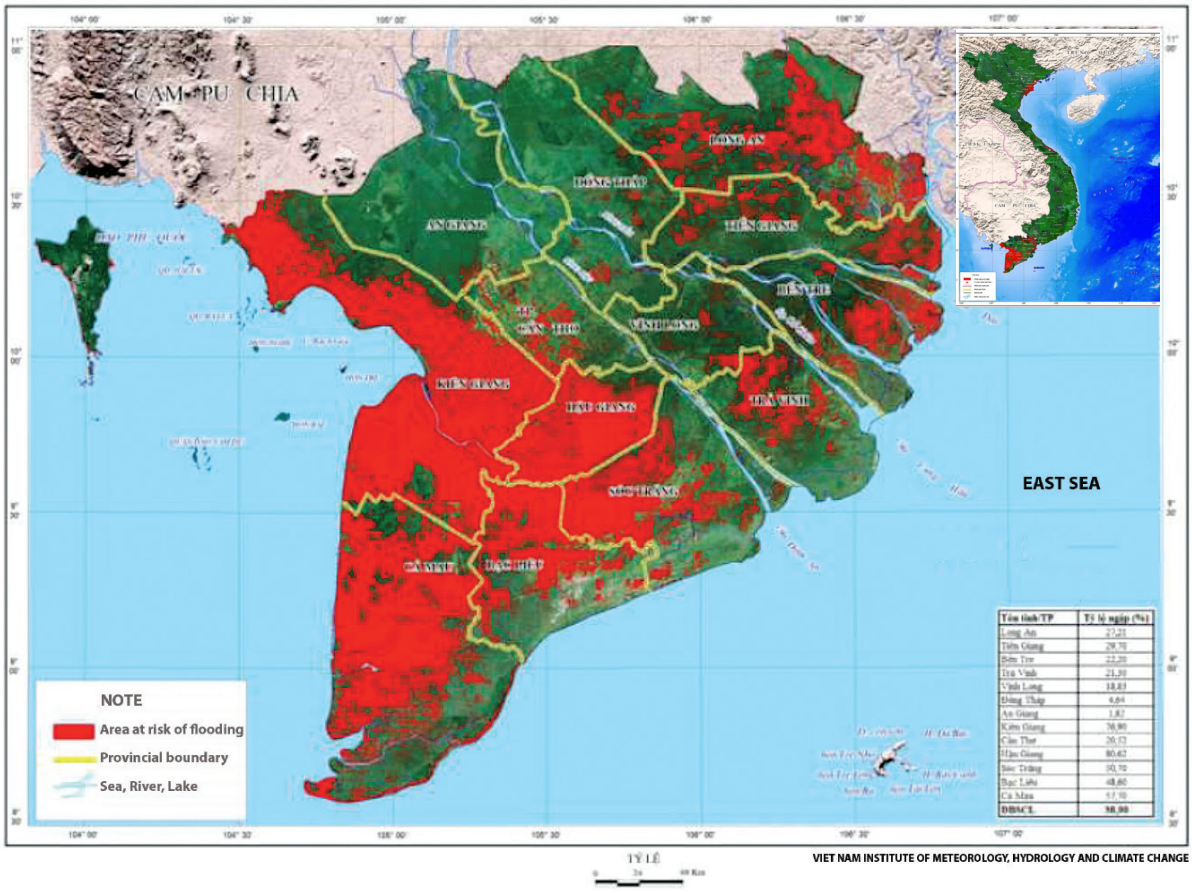

Figure 3.8. Map of flood risk corresponding to sea level rise of 100 cm, Mekong Delta

Source: Climate change and sea level rise scenarios for Viet Nam, MONRE, 2016

3.3.9. Gender equality

In 2017, females accounted for 50.64% of the total population of Viet Nam[24]. Females are one of the most vulnerable people to climate change.

In addition to social work, females play a major role in housework, health care, education of the children. In rural areas, most female is attached to agricultural production, including cultivation, livestock and post-harvesting work. Climate change may cause the poverty of many rural households; therefore, their work is harder, harder, and their daily working time is longer.

Females also have to do a lot of household chores, their working time may go up to 12 hours a day, while males mostly work less than 8 hours a day[25]. In the context of climate change, the weather of extreme weather increases, the work of females in Northem mountainous areas is

24. Statistical yearbook of Viet Nam 2017

25. Impact of climate change on the role of gender in agricultural production: case study in Giao Loi, Giao Thuy, Nam Dinh. Nguyen Tat Thang et al., Journal of Science and Development

more difficult to prevent the cold for pets in the heavy cold weather[26].

Climate change has a negative impact on health, increasing the prevalence of the disease among females, especially pregnant females, girls, females with chronic diseases, elderly females, and at the same time increasing the number of deaths. Casualties, and disappearances of females.

Droughts, lack of water and sanitation will also impact on a woman's health, causing illnesses and water-related illnesses.

Climate change detrimental to the economic life of the family, reducing income will lead to increased risk of poverty. It is also one of the main causes for increased migration. The number of female migrating from rural and mountainous areas to central cities and industrial parks has increased, may be much higher than males. In the context of migration and away from home, female have to struggle, face greater risks, difficulties and challenges in life. The living conditions of migrant female are often difficult, not only in terms of income, but also in terms of living conditions such as housing and environmental sanitation, especially for unstable laboring females.

3.3.10. Impacts on achieving sustainable development goals

Climate change can affect the achievement of sustainable development goals, reflected in the following processes:

- Gradual processes, including factors such as increasing temperature and, sea level rise.

- Rapid processes through the rise of extreme phenomena, including storms; floods, flash floods, heavy rains, urban flooding, droughts, heat wave, damaging cold and saltwater intrusion.

To determine the impact of each factor on each objective of sustainable development, an impact matrix is constructed, in which the impact index of a factor is determined by the following levels: 4 = High impact; 3 = major impact; 2 = average impact; 1 = little impact and 0 = no impact. These indicators are based on expert consultation on the impact of each factor on sustainable development [27].

The total impact of the above mentioned phenomena on each objective of sustainable development is determined as the sum of impact of each factor.

The magnitude of the impacts of climate change on sustainable development goals are illustrated in Figure 3.9 and shown in percentages.

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26. The impact of natural disasters and climate change on the ethnic minorities in the north under the gender lenses. Pham Thu Hien, Journal of Family and Gender Studies No. 2-2013

27. Huynh Thi Lan Huong, Nguyen Thi Lieu, Tran Thi Thanh Thuy, Tran Van Tra, Vu Duc Dam Quang, Tran Tien Dung - Impacts of climate change on sustainable development in Viet Nam, Journal of Climate Change Science Vol. 6, 2018

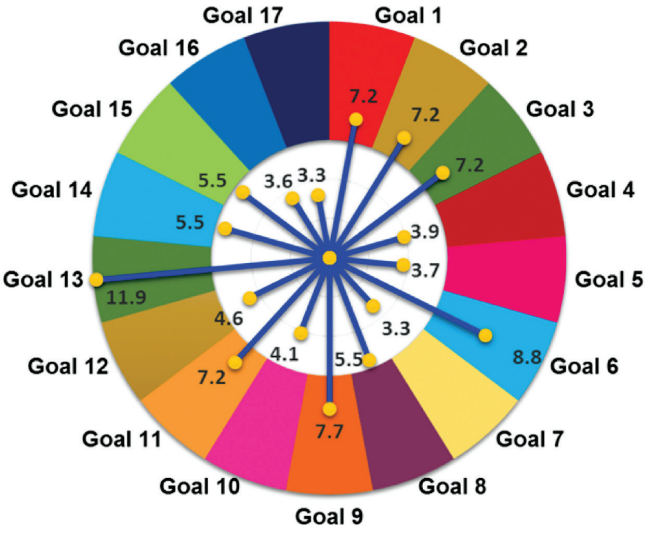

Figure 3.9. The impact of climate change on Viet Nam's sustainable development goals

Source: Impacts of climate change on sustainable development of Viet Nam, Journal of Climate Change Science, Huynh Thi Lan Huong et al., 2018.

The results of assessing the impact of climate change on the objectives of sustainable development are presented in Table 3.9.

Table 3.9. The impact of climate change on sustainable development goals

Target No.	Target name	Level of impact (%)
1	End to all forms of poverty everywhere.	6.8
2	Eradicate hunger, ensure food security, enhance nutrition and promote sustainable agricultural development.	5.1
3	Ensure healthy living and increased welfare for people of all ages.	6.8
4	Guarantee a quality, fair, comprehensive education and promote lifelong learning opportunities for all people.	3.8
5	Achieve gender equality, empowerment and make opportunity for women and girls.	6.8
6	Conduct adequate and sustainable management of water and sanitation for all people.	10.6
7	Give access to sustainable, reliable and affordable energy sources for all.	5.1
8	Achieve sustainable, comprehensive and continuous economic growth; Create full employment, productivity and good jobs for everyone.	5.9
9	Building high-resilience infrastructure, promoting inclusive and sustainable industrialization, and enhance innovation.	6.8
10	Reduce inequality in society.	7.6
11	Develop sustainable, sustainable urban and rural areas; Ensure living environment and work safety; allocate reasonable population and labor by region.	5.9
12	Have a sustainable production and consumption.	4.7
13	Respond timely and effectively with climate change and natural disasters.	8.9

Target No.	Target name	Level of impact (%)
14	Conserve and use sustainably ocean, seas and marine resources for sustainable development.	3.8
15	Obtain sustainable forest development and protection, biodiversity conservation, ecosystem services development, anti-desertification, prevention of deterioration and restoration of land resources.	5.1
16	Promote a peaceful, democratic, equitable, equitable, civilized society for sustainable development; Enable access to justice for all people; Establishing effective, accountable and participatory institutions at all levels.	3.4
17	Strengthen implementation and promotion of global partnerships for sustainable development.	3.0
Total		**100**

Source: Impacts of climate change on sustainable development of Viet Nam, Journal of Climate Change Science, Huynh Thi Lan Huong et al., 2018.

3.4. EFFORTS OF VIET NAM IN CLIMATE CHANGE ADAPTATION

3.4.1. National programs, plans on adaptation

Policies related to adaptation issued and implemented by the Government of Viet Nam include:

- Resolution on active response to climate change, strengthening natural resources management and environmental protection[28].

- Target program to respond to climate change and Green Growth for the period of 2016-2020[29].

- Implementation plan of Paris Agreement[30].

- Supporting Program to respond to climate change (SPR-CC) for the period of 2016-2020[31].

- Investment policy for the Target Programs in the period of 2016-2020[32].

- Resolution on Sustainable Development of the Mekong River delta adapting to climate change[33].

- Provinces and cities have updated their action plans to respond to climate change as well as identify and carry out their plans for PA implementation and the national action plan on green growth for the period of 2016-2020.

28. Resolution No.24-NQ/TW dated June 3rd, 2013 of the Central Committee of the Party, session XI
29. Decision No.1670/QD-TTg dated October 31st, 2017 of the Prime Minister
30. Decision No.2053/QD-TTg dated October 28th, 2016 of the Prime Minister
31. Decision No.2044/QD-TTg dated October 27th, 2016 of the Prime Minister
32. The Government of Viet Nam's Resolution No.73/NQ-CP dated August 26th, 2016
33. The Government of Viet Nam's Resolution No.73/NQ-CP dated August 26th, 2016

3.4.2. Sectoral programs, projects on adaptation

Parallel to national programmes, various action plans on climate change response are also being developed and implemented at the ministerial and local levels, with a focus on vulnerable sectors and areas. The main climate change adaptation programmes and projects are as follows:

1) Water resources

Many climate change adaptation measures have been implemented as part of the national and ministerial programmes, including:

- Mekong River Delta water supply planning and safe water supply projects;

- Red River Delta programme on water resource management and climate change adaptation, jointly implemented by relevant ministries and provinces;

- Response to climate change programme for large cities in Viet Nam, with priority given to projects to prevent inundation in Ho Chi Minh City, Hanoi, and Can Tho;

In addition to the framework programmes and large-scale projects, detailed assessments of climate change impacts on water resources and adaptation measure are conducted.

2) Agriculture

Climate change adaptation measures in agriculture are mainly aimed at developing a commodity agriculture sector that is clean, diversified, and sustainable with easy access to new scientific and high-tech applications and the ability to compete in local and international markets; developing new rural areas with modernized technical infrastructure and a reasonable economic structure based on agriculture, industries and services; ensuring enough jobs, reducing poverty, and improving the quality of life among rural communities; and ensuring food security and eco-agricultural development.

MARD has developed an action plan in response to climate change that includes 54 tasks, requiring a total of VND 402 billion in funding. So far, only 21 tasks have been implemented with a total funding of VND 47,180 billion. The focus was on the development and improvement of legal normative documents to ensure consistency between laws and bylaws to protect clean, diverse and sustainable agriculture; the revision and improvement of policies and mechanisms to support the application of new technologies and modern technical solutions to restructure the mix of crop and husbandry, as well as new farming techniques in line with climate change mitigation; the development and implementation of scientific and technological instruments for climate change adaptation in the agricultural sector; planning for the effective use of agricultural land and aquatic water surfaces while taking into account the immediate and potential impacts of climate change to ensure the stable and sustainable agricultural production of commodities; and planning for the effective use of water sources in irrigation systems while considering climate change impacts.

MARD has also developed and submitted a sea dyke programme spanning Quang Ngai to Kien Giang provinces, taking into considerations climate change and sea level rise, to the Prime Minister for his approval. The programme would include protection afforestation in front of dykes that are 500-1,000 meters wide. In addition, it includes transport systems inside the dykes, a system of culverts to prevent tides and saltwater spilling over, and an area of unoccupied land to elevate the dykes when sea level rises. Other programmes that have been developed and implemented include a programme to upgrade river dykes given the new context, a water resource management system master plan for the Mekong River Delta, Red River Delta and the central region in the context of climate change and sea level rise, and a project to prevent saline intrusion and sea level rise for northern Ben Tre Province.

One of the adaptation measures employed by the agricultural sector is the creation and use of hybrid varieties of crops that have the potential to adapt to changing climatic conditions. Apart from rice varieties for the intensification of rice farming, new sets of rice varieties have been developed that are adaptive to inundation conditions. Although still limited in quantity, acid and salt tolerant varieties will serve as the basis for further research to create new varieties that can adapt to a changing climate.

Moving forward, the agricultural sector will continue to implement the tasks set out in MARD's action plan and other national strategies and programmes on climate change. The main tasks include assessing the impacts of climate change and sea level rise on sub-sectors of agriculture and rural development; developing programmes and projects for agricultural sub-sectors in line with local contexts, including responses to climate change and the creation of development opportunities; mainstreaming climate change and sea level rise into action plans, policies, strategies for sectoral and provincial development; and others.

3) Forestry

Forests are heavily impacted by climate change. They also play an important role in climate change mitigation. Viet Nam has developed a number of policies for sustainable forest development and responses to climate change.

The National Action Programme on Reducing Emissions from Deforestation and Forest Degradation and sustainable management of forests and the conservation and enhancement of forest carbon stocks (REDD+).

Payment for forest ecosystem services (PFES) (Government of Viet Nam, 2010a): Since 2011, this policy aims at providing payments for forest ecosystem services across Viet Nam. According to Decree No. 99/2010/ND-CP on PFES, beneficiaries of ecosystem services that can receive payments include hydropower plants, clean water suppliers and eco-tourism operators. This policy generates revenues of approximately USD 50 million per year, which is used for forest protection to ensure these ecosystem services stay available.

In addition, the Government of Viet Nam is implementing a national target programme for new rural development in 2010-2020 (Government of Viet Nam, 2010b) and a programme to support accelerated and sustainable poverty eradication for 61 poorer districts (Government of Viet Nam, 2008b). These programmes put an emphasis on agro-forestry development, improved agricultural yields, value-added forestry production, and sustainable forest resource management.

Forest protection and development plan for 2011-2020: This is a follow-up of the original programme to plant 5 million ha of new forests, which ended in 2010. The goal of the new plan is to sustainably manage 13,4 million ha of forest, with subsequent increases of 14,3 million ha by 2015 and 15,1 million ha by 2020 (Government of Viet Nam, 2012c).

Project to protect and develop coastal protection forests in response to climate change for 2015-2020: The objective of this project is to protect the existing 310 ha of coastal forest area and plant 46,058 ha of new forests, thereby increasing the total coastal forest area to 356,753 ha by 2020 and coastal forest coverage from 16,9% in 2014 to 19,5% by 2020, The total funding requirement for this project for 2014-2020 is VND 5,415 billion (or USD 258 million), 70% of which is mobilized from the Government budget, 26% from ODA, and 4% from other sources (Government of Viet Nam, 2015).

Project to recover and manage protection forests sustainably: The project is aimed at managing and protecting protection forests sustainably, recovering and preserving biodiversity, and supporting poverty reduction in mountainous areas. The project will be implemented from 2012-2021 in 11 provinces (i.e, Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua-Thien Hue, Quang Ngai, Binh Dinh, Phu Yen, Ninh Thuan, and Binh Thuan Provinces). Funding for the project is provided by Japan's ODA loans.

Viet Nam Forests and Deltas Programme: The programme is aimed at promoting Viet Nam's transformation in the context of sustainable development, GHG mitigation and climate change. The project consists of three components: sustainable landscapes, adaptation and coordination, and policy support at the central level. The project will focus on promoting the development of livelihoods that can adapt to changing climatic conditions, mitigation and adaptation solutions, and mitigation and adaptation policies.

3.4.3. Overall assessment

The above-mentioned programmes demonstrate the Government of Viet Nam's determination to respond to climate change. Although they do not directly respond to climate change, some programmes are ultimately aimed at increasing forest coverage, managing forests sustainably, improving yields in agricultural and forestry production and reducing poverty. Sources of funding for these action programmes and plans have been identified, in which 30-35% will be provided from Government budgets (at the central and local level) while the remainder will need to be provided via other funding avenues, such as ODA or the private sector.

The action programmes and plans to respond to climate change at the national and sectoral level are mainly set out until 2020. Longer-term policies are included in the National Strategy on Climate Change, However, very few programmes and plans currently have a long-term perspective. Therefore, only a limited number of adaptation programmes and actions have been proposed for the period of 2020-2030. Moreover, there is no clear and committed funding source for the implementation of adaptation measures. Currently, the post-2020 period is only mentioned in the Action Plan with reference to responding to climate change in the agricultural and rural development sector for 2011-2015 and sets out a vision for 2050, but even this document does not include specific tasks and budget for this period.

3.5. CLIMATE CHANGE ADAPTATION FOR THE PERIOD OF 2021-2030

Viet Nam has clearly identified adaptation targets for the period of 2021-2030 in its NDC which include: (i) To analyze the potential impacts of climate change and the needs of vulnerable sectors and areas in Viet Nam; in adapting to climate change, especially for 2021-2030; (ii) To identify prioritized action for climate change adaptation for sectors and areas, thereby identifying Viet Nam's ability to contribute, as well as international support needs to close the gaps post-2020 and especially during 2021-2030. The climate change adaptation priority actions for 2021-2030 include:

3.5.1. Responding proactively to natural disasters and improving climate monitoring

Need to modernize the hydro-meteorological observatory and forecasting system to ensure the timely forecasting and early warning of weather events. Develop the assessment and monitoring system on climate change and sea level rise; produce Socio-Economic Development Plans based on climate change scenarios, with a focus on key sectors and regions; implement disaster prevention plans and measures, protect peoples' lives, and ensure national defense and security; consolidate and develop prioritized and urgent disaster prevention projects; strengthen the capacity of search and rescue forces; develop infrastructure and make plans for residential areas; relocate and resettle households and communities from areas affected frequently by storm surges, floods, riverbank and shoreline erosion, or areas at risk of flash floods and landslides; allocate and mobilize resources for community-based climate change adaptation and disaster management; raise awareness and build capacities for climate change adaptation and disaster risk management.

3.5.2. Ensuring social security

Need to review, adjust and develop livelihoods and production processes that are appropriate under climate change conditions and are linked to poverty reduction and social justice; develop mechanisms, policies, and strengthen the insurance system and share climate and disaster risks;

improve regulations and technical standards for infrastructure, public facilities and housing, that are appropriate under climate change conditions; implement ecosystem-based adaptation through the development of ecosystem services and biodiversity conservation, with a focus on the preservation of genetic resources, species at risk of extinction, and important ecosystems; implement community-based adaptation, including using indigenous knowledge, prioritizing the most vulnerable communities; implement integrated water resources management in river basin systems; ensure reservoir safety; strengthen international cooperation in addressing transboundary water issues; ensure water security; ensure food security through protecting, sustainably maintaining and managing agricultural land; restructuring of crops and livestock; create new climate change resilient varieties; complete the disease control and prevention system; implement sustainable forest management; improve the quality of poor natural forests; implement afforestation and reforestation measures, focusing on large timber plantations; and prevent forest deforestation and degradation; protect, restore, plant and improve the quality of coastal forests, including mangroves, especially in coastal estuaries and the Mekong and Red River deltas.

3.5.3. Responding to sea level rise and urban inundation

Need to implement integrated coastal zone management; use sea level rise scenarios in urban and land use planning for infrastructure, industrial parks, coastal and island resettlement areas; implement anti-inundation measures for large coastal cities; construct climate change resilient urban infrastructure; strengthen and build new large urban drainage infrastructure; consolidate, upgrade and complete crucial sea and river dykes; control saline water intrusion in the most severely affected areas.

Chapter 4

ASSESSMENT OF GHG MITIGATION MEASURES AND RELATED POLICIES

4.1. OVERVIEW

With regard to actively responding to climate change, Viet Nam has developed and promulgated several policies related to GHG mitigation, including national-, ministerial- and local-level policies. Several GHG mitigation options have been developed and prepared for implementation in accordance with the NDC of Viet Nam.

The main contents of this Chapter are (1) Policies related to GHG mitigation, (2) GHG mitigation options in the NDC, (3) GHG mitigation actions and (4) Preparation for setting up the Measuring, Reporting and Verification (MRV) system for GHG mitigations.

4.2. POLICIES RELATED TO GHG MITIGATION

4.2.1. Inter-sectoral policies

Viet Nam has identified that actively responding to climate change is one of the most important tasks of the whole political system. The Central Committee of Party, the National Assembly, the Government and the Prime Minister have promulgated a number of policies to create important legal bases for the research, development and implementation of mitigation activities, as follows:

- Resolution No. 24-NQ/TW dated 03rd, June 2013 issued by the 11th Central Committee of the Party on actively response to climate change, improvement of natural resource management and environmental protection has identified climate change adaptation as an opportunity to

promote growth pattern transformation towards sustainable development and simultaneously to conduct adaptation and mitigation actions.

- Law on Environment Protection No. 55/2014/QH13 (The 13th National Assembly, dated June 23rd, 2014) provides statutory provisions on response to climate change, including assessing climate change mitigation and adaptation measures, managing GHG emission and regulating the roadmap and modality for participation in reducing global GHG in conformity with socio-economic conditions and commitments made in the international treaties to which the Socialist Republic of Viet Nam is a party.

- Decision No. 2139/QD-TTg dated December 05th, 2011 of the Prime Minister approving the national strategy for climate change has set the overall objective as to mobilize national capacity; and to carry out simultaneously measures of climate change adaptation and GHG emissions reduction to ensure safety for people and properties for the sustainable development goals toward low-carbon economy and green growth.

- Decision No. 1183/QD-TTg dated August 30th, 2012 of the Prime Minister approving the National Target Program to respond to climate change in the period of 2012-2015 aims at reducing GHG emissions, developing a low carbon economy, participating in the international community to protect the Earth's climate system. The program piloted GHG mitigation models in priority areas, namely agriculture, forestry, land use, water, energy, transportation, construction.

- Decision No. 1393/QD-TTg dated September 25th, 2012 of the Prime Minister approving the National Strategy on Green Growth for the period of 2011-2020 with a vision to 2050 with the overall objective of achieving a low carbon economy, reduction in emissions and increase in the possibility to absorb GHG sets mandatory and important targets in socioeconomic development.

- Decision No. 1775/QD-TTg dated November 21th, 2012 of the Prime Minister approving the Plan on GHG emission management and the management of carbon credit business activities in the world market with the general target to manage GHG emissions aims to implement the United Nations Framework Convention on Climate Change (UNFCCC) and other international agreements in which Viet Nam is a party, and at the same time take advantage of the opportunity to develop a low carbon economy with green growth.

- Decision No. 403/QD-TTg dated March 20th, 2014 of the Prime Minister approving the National Action Plan on Green Growth in Viet Nam for the period of 2014-2020, including: (1) Setting up institutions and formulating green growth action plans at the local level; (2) Reducing the intensity of GHG emissions and promoting the use of clean and renewable sources of energy; (3) Greening production; (4) Greening lifestyles and promoting sustainable consumption.

- Decision No. 2053/QD-TTg dated October 28th, 2016 of the Prime Minister approving the Action Plan for Implementation of the Paris Agreement on climate change for the period of 2016-2020 aims to: 1) review existing regulations and develop a Decree on the roadmap and

modality for GHG emission mitigation; (2) develop a carbon market within the country; piloting the system, policies and market tools for mitigation of GHG emissions in potential sectors; and (3) develop and implement GHG mitigation and green growth proposals in accordance with national conditions for implementation of NDC.

- Decision No. 1670/QD-TTg dated October 31st, 2017 of the Prime Minister approving the Target Program for climate change adaptation and green growth for the period of 2016-2020. One of the main objectives of the program is to reduce GHG emissions, contributing to the implementation of NDC after 2020.

- Resolution No. 08/NQ-CP dated January 23rd, 2014 of the Government of Viet Nam promulgating an Action Program for the implementation of Resolution No.24-NQ/TW, which stipulates that one of the key tasks of responding to climate change is to mitigate GHG emissions, while increasing the capacity of the ecosystem to absorb GHG.

- Resolution No. 120/NQ-CP dated November 17th, 2017 of the Government of Viet Nam on sustainable development in the Mekong River Delta region with the vision to 2050. The Mekong Delta region will be on a more advanced development level compared to the country as a whole, with advanced social structure; with per capita income higher than the national average, and with people's livelihood secured; the proportion of ecological agriculture and high-technology agriculture to be 80% and proportion of forest coverage to be increased to over 9% (compared to 4.3% now), along with efforts to preserve and develop important natural ecosystems.

- Decision No. 1085/QD-BKHDT dated July 16th, 2018 of the Minister of Planning and Investment promulgating the guidelines on classification of public investment for climate change and green growth.

4.2.2. Sectoral policies

a) Energy

* Energy Efficiency and Conservation:

- Decree No. 21/2011/ND-CP dated March 29th, 2011 of the Government of Viet Nam detailing the Law on Economical and Efficient Use of Energy and measures for its implementation, including energy labeling for energy-consuming devices and equipment and measures to promote economical and efficient use of energy.

- Decision No. 68/2011/QD-TTg dated December 12th, 2011 of the Prime Minister on promulgating the list of energy-saving devices that may be purchased by the agencies funded by State budget.

- Decision No. 1427/QD-TTg dated October 01st, 2012 of the Prime Minister on the approval of the national targeted program on Economical and Efficient Use of Energy for the period of

2012 - 2015 aims to form a network of law enforcement on Economical and Efficient Use of Energy , implementing energy efficiency programs at the central and local levels. The specific goal is to save between 5% and 8% of total energy consumption compared to the projections for energy development and socio-economic development under the Business-as-Usual (BAU) scenario.

- Decision No. 04/2017/QD-TTg of March 09th, 2017 of the Prime Minister on the list of equipment and appliances to which the mandatory energy labeling and minimum energy efficiency standards are applied, and the roadmap to their implementation.

- Decision No. 1305/QD-TTg dated September 03rd, 2017 of the Prime Minister promulgating the list of key energy users in 2016.

* Renewable energy:

- Decision No. 24/2014/QD-TTg dated 24 March 2014 of the Prime Minister on support mechanism for development of biomass power projects in Viet Nam.

- Decision No. 31/2014/QD-TTg dated May 05th, 2014 of the Prime Minister on supporting mechanisms for development of power generation projects using solid waste in Viet Nam.

- Decision No. 2068/QD-TTg dated November 25th, 2015 of the Prime Minister approving the development strategy of renewable energy of Viet Nam by 2030 with a vision to 2050. One of the objectives of the strategy is to develop and utilize renewable energy sources in a way that contributes to fulfilling the objectives of sustainable environment and development of green economy

- Decision No. 428/QD-TTg dated March 18th, 2016 of the Prime Minister approving the Revised Master Plan of National Power Development for the period of 2011-2020 with the Vision to 2030 (Master Plan VII-revised), in which the proportion of renewable energy (namely small hydropower, wind power, solar power, biomass power) in total electricity output is projected to reach 6.5% by 2020, 6.9% by 2025 and 10.7% by 2030.

- Decision No. 13443/QD-BCT dated December 08th, 2015 of the Minister of Industry and Trade approving the Green Growth Action Plan for the industry and trade sector for the period of 2015-2020, which concretizes the key tasks in the industry and trade sector to implement the objectives and mandates of the National Green Growth Strategy and National Green Growth Action Plan for the period of 2014-2020.

- Decision No. 11/2017/QD-TTg dated April 11st, 2017 of the Prime Minister on mechanisms for encouragement of development of solar power in Viet Nam.

- Decision No. 39/2018/QD-TTg dated September 10th, 2018 of the Prime Minister amending several articles of Decision No.37/2011/QD-TTg dated June 29th, 2011 of the Prime Minister on the provision of assistance in the development of wind power projects in Viet Nam.

* Transportation:

- Decision No. 855/QD-TTg dated June 6th, 2011 of the Prime Minister approving the project on controlling environmental pollution in transportation activities. One of the main objectives of the project is to manage the emission of gaseous pollutants and GHG caused by transportation activities.

- Decision No. 1456/QD-BGTVT dated May 11st, 2016 of the Minister of Transport promulgating the Action Plan to respond to climate change and green growth of the Ministry of Transport in the period of 2016-2020. It has an overall objective of actively developing transportation toward a uniform, sustainable, environmentally-friendly direction and reducing GHG.

- Decision No. 4206/QD-BGTVT dated December 28th, 2016 of Minister of Transport promulgating action plans to reduce CO_2 emissions in civil aviation in Viet Nam for the period of 2016-2020.

- Circular No. 48/2017/TT-BGTVT dated December 13rd, 2017 of the Minister of Transport regulating the statistical indicators and statistical reporting system of the transport sector, including the integration of statistical indicators for calculating GHG emissions in the transport sector.

* Construction:

- Decision No. 2127/QD-TTg dated November 30th, 2011 of the Prime Minister approving the national strategy on housing development through 2020, with a vision toward 2030 aims to ensure safety and meet the requirements of construction quality, architecture, landscape, facilities and environment, capability to cope with climate change, natural disasters and energy saving.

- Decision No. 2623/QD-TTg dated December 31st, 2013 of the Prime Minister approving the Plan on Urban development of Viet Nam responding to climate change in the period of 2013-2020 aims to actively respond to climate change, and use natural resources rationally in improving, upgrading and developing urban areas.

- Decision No. 811/QD-BXD dated August 18th, 2016 of Minister of Construction on introduction of the Climate Change Action Plan applicable to the Construction Industry for the period of 2016-2020. Objectives of the Plan are to strengthen the response capacity of the construction sector to the impacts of natural disasters, climate change and sea level rise; to use resources and energy efficiently, and hence contribute to climate change mitigation; and to develop the construction industry in a green and sustainable manner.

- Decision No. 419/QD-BXD dated May 11st, 2017 of the Minister of Construction promulgating the Green Growth Action Plan of Construction sector by 2020, with vision to 2030, with objectives to concretize the tasks and objectives of the construction industry as

stated in the National Green Growth Strategy. The specifc tasks of this Action Plan include urban planning adjustment, technical infrastructure improvement, construction technology and techniques reform, development of green buildings and green building materials and energy efficiency and saving in the construction sector.

- Decision No. 802/QD-BXD dated July 26th, 2017 of the Ministry of Construction promulgating the Action Plan to reduce GHG emissions in the cement industry until 2020, with vision to 2030 aims to reduce 20 million tonnes of CO_2 equivalent by 2020 and 164 million tonnes of CO_2 equivalent by 2030 compared to BAU.

- Decision No. 84/QD-TTg dated January 19th, 2018 of the Prime Minister approving the Plan of development of Viet Nam's green growth urban areas until 2030 with the objective of creating and developing green cities in Viet Nam to improve the capacity of the urban system to cope with climate change, contributing to the national commitment to reduce GHG emissions.

b) Agriculture, Land Use, Land Use Change and Forestry

- Law on Forestry No. 16/2017/QH14 dated November 15th, 2017 of the National Assembly of Viet Nam regulates the management, protection, development and use of forests; forest products processing and trade. One of the important contents of the Law is to assess the GHG emissions reduction to find solutions to limit forest loss and degradation, manage forests sustainably, conserve and increase forest carbon reserves.

- Decision No. 3119/QĐ-BNN-KHCN dated December 16th, 2011 of the Minister of Agriculture and Rural Development approving the programme of GHG emissions reduction in the agriculture and rural development sector up to 2020 aiming to promote green, safe and low-carbon agriculture production towards sustainable development, ensuring national food security and contributing to poverty reduction and an effective response to climate change.

- Decision No. 819/QD-BNN-KHCN dated March 14th, 2016 of the Minister of Agriculture and Rural Development approving the Action Plan to Respond to Climate Change of Agriculture and Rural Development sector for the period of 2016-2020 with vision to 2050 was developed based on the positive results following the implementation of the previous Action Plan to Respond to Climate Change in agriculture and rural development sector for the period of 2011-2015, aiming to: improve the integration and mobilization of all resources, integrate CC adaptation and mitigation, and restructure projects and schemes to reduce GHG emissions in agriculture and rural development to 2020.

- Decision No. 923/QD-BNN-KH dated March 24th, 2017 of the Minister of Agriculture and Rural Development promulgating the Green Growth Action Plan of Agriculture and Rural Development sector up to 2020 aims to achieve by 2020 a 20% reduction of GHG emissions from the agriculture and rural development sector, compared to 2010.

- Decision No. 419/QD-TTg dated April 05th, 2017 of the Prime Minister approving the National Action Programme on the Reduction of GHG Emissions through the reduction of Deforestation and Forest Degradation, Sustainable Management of Forest Resources, and Conservation and Enhancement of Forest Carbon Stocks (REDD+) by 2030, which contributes to the implementation of sustainable forest development, national strategies on responding to climate change, national strategies on green growth, linking to sustainable development, ensuring national environmental security and poverty reduction and Viet Nam's commitment to the Paris Agreement on climate change.

c) Waste

- Decision No. 491/QD-TTg dated May 07th, 2018 of the Prime Minister approving adjustments to national strategy for general management of solid waste to 2025 with vision towards 2050. One of the objectives of this strategy is to apply advanced and environmentally friendly solid waste treatment technologies and select technologies for solid waste treatment in accordance with energy recovery and GHG emission reduction.

- Decision No. 985a/QD-TTg dated June 01st, 2016 of the Prime Minister approving the national action plan on air quality management up to 2020, with a vision toward 2025 has set a target that 80% of steel, chemical and fertilizer production facilities will have treated dust, SO_2, NO_x and CO emissions to meet with national regulations.

4.2.3. Local policies

In order to achieve the objectives of the National Target Program to respond to climate change, Ministries, agencies and localities have developed their action plans to respond to climate change. The development of action plans has been carried out in a step-by-step manner, ensuring quality, feasibility and effectiveness. To date, all provinces and cities across the country have developed and issued their Action Plans to respond to climate change. Most provinces and cities have reviewed the implementation of their Action Plans to respond to climate change in the period of 2010-2015 and have updated them for the next phase.

By October 2018, 50 out of 63 provinces and cities throughout the country have developed their Implementation Plans for the Paris Agreement and 26 out of 63 provinces and cities have issued their Green Growth Action Plans to implement the National Green Growth Strategy.

Aiming to carry out the above-mentioned plans, many provinces and cities have implemented GHG inventory activities to identify GHG emission sources in the locality, creating the basis for develop their mitigation targets as well as researching, developing and implementing their potential mitigation activities. Some provinces and cities have studied and proposed the GHG inventory procedures and their MRV processes for local mitigation activities.

4.3. MITIGATION UNDER THE SCOPE OF NATIONALLY DETERMINED CONTRIBUTION

4.3.1. Mitigation target under Nationally Determined Contribution of Viet Nam

Viet Nam's NDC has set a target of a reduction of 8% of total GHG emissions by 2030 compared to BAU, equivalent to 62.65 $MtCO_2e$, with domestic resources. This target could be increased to 25%, equivalent to 197.94 Mt CO_2e, if international support is received through bilateral and multilateral cooperation, as well as through the implementation of new mechanisms under the Paris Agreement.

4.3.2. Mitigation options in the Nationally Determined Contribution

To achieve the above objectives, Viet Nam has developed 45 GHG mitigation options, of which 25 options are to be implemented using domestic resources and 20 options requiring international support. The mitigation options have been developed for four sectors as follows:

- The energy sector consists of 17 options with the total mitigation potential of 65.93 $MtCO_2e$.

- The agricultural sector consists of 15 options with a total mitigation potential of 45.78 $MtCO_2e$.

- The LULUCF field consists of nine options with total GHG absorption potential of 66 $MtCO_2e$.

- The waste sector consists of four options with a total mitigation potential of 20.23 $MtCO_2e$.

In order to prepare for the global effort assessment in 2018 and to update the new policies related to climate change, Viet Nam is reviewing and updating the NDC, which is expected to be completed in 2019 with the following contents:

- To review policies related to energy, agriculture, waste and LULUCF;

- To update BAU and develop potential GHG mitigation options for energy, agriculture, waste and LULUCF for the period of 2020-2030;

- To analyze, compare and evaluate national efforts to achieve the mitigation target of 2030 in case of conditional contribution (25%) and unconditional contribution (8%) compared with BAU.

By February, 2018, Viet Nam had completed a low-carbon technology assessment contributing to NDC implementation. It had taken the following steps:

- Identifying suitable technologies for each NDC mitigation option;

- Using criteria to evaluate and identify the prioritized technologies;

- Recommending prioritized technologies for NDC implementation.

Technology assessment results for 45 mitigation options in the NDC and 100 additional mitigation options for the energy, agriculture, LULUCF and waste sectors are presented in Annex 2.

4.4. IMPLEMENTATION OF MITIGATION MECHANISMS

4.4.1. Nationally Appropriate Mitigation Actions

In total, there are 12 NAMA proposals reported in the BUR1 and BUR2 of Viet Nam to UNFCCC. Among those, two NAMA proposals have reported updated activities, which are:

- NAMA in the transport sector: "Low-carbon Bus NAMA" in Viet Nam has been developed and submitted to the NAMA Facility Fund for the final time in March 2018. At present, the proposal is still in the process of finalizing and seeking funding.

- NAMA in the cement sector: "Supporting Up-scaled Climate Change Mitigation Action in Viet Nam's Cement Sector", also called the Cement NAMA, is funded by the Nordic Development Fund (NDF). To further complete this NAMA according to the criteria of the NAMA Facility Fund, the United Nation Development Programme (UNDP) provides financial support for energy audits at three to five cement plants and finalizing the NAMA proposal.

Two NAMA proposals which have been developed recently include:

- NAMA in the building sector: "Promoting the use of high performance air conditioners and solar hot water boiling systems in residential and commercial buildings in Viet Nam", funded by United Nations Environment Programme (UN Environment).

- NAMA in the industry sector: "energy-saving for the textile industry", also called the Textile NAMA funded by GIZ.

Some basic information about these NAMAs are provided in Annex 3.

4.4.2. Clean Development Mechanism

As of June 2018, Viet Nam had 255 CDM projects and 10 Program of Activities under CDM (PoAs) registered by CDM Executive Board (EB) with the total estimated annual GHG reduction of 17,970,981 tCO_2e and 1,998,173 tCO_2e respectively. To date, 70 CDM projects and 1 PoA have been certified by EB with 21,729,539 Certified Emission Reductions (CERs) issued, of which 3,936,507 CERs was issued between April 2017 and June 2018.

The proportion of projects receiving CERs by type is shown in Figure 4.1 below:

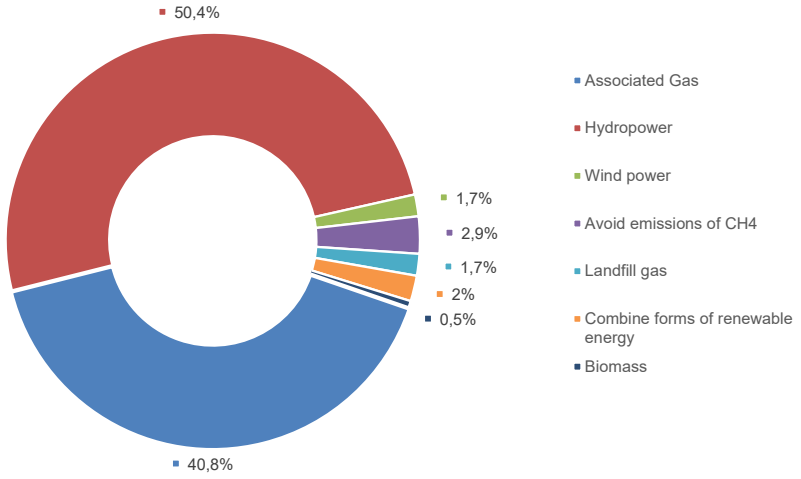

Figure 4.1. Proportion of CDM projects receiving CERs by type

Source: Department of Climate Change, 2018

4.4.3. Other mechanisms

a) Joint Crediting Mechanism

As of June 2018, five projects under the Joint Crediting Mechanism (JCM) were registered by the Joint Committee, of which two projects were issued emission reduction certificates. Information on JCM projects are shown in Table 4.1.

Table 4.1. List of JCM projects
(from April 2017 to June 2018)

Unit: tCO_2e

No.	Project name	Emission reduction potential/year	Amount of credits issued
1	Eco-Driving by Utilizing Digital Tachograph System	292	230
2	Promotion of green hospitals by improving efficiency / environment in national hospitals in Viet Nam	515	
3	Low carbon hotel project in Viet Nam: Improving the energy efficiency of commercial buildings by utilization of high efficiency equipment	272	
4	Introduction of amorphous high-efficiency transformers in power distribution systems in the southern part of Viet Nam	610	76
5	Introduction of high-efficiency air-conditioning in hotels	792	
Total		**2.481**	**306**

Source: https://www.jcm.go.jp/vn-jp/projects/registers

b) Gold Standard

As of June 2018, there were 20 projects registered under the Gold Standard (GS), of which two projects were registered within the period from April 2017 to June 2018. Details of these two new projects are shown in Table 4.2.

Table 4.2. Lists of recently registered GS projects (from April 2017 to June 2018)

Unit: tCO_2e

No.	Project name	Emission Reduction Potential/year
1	Nam Ngan Hydropower Project	29.322
2	Nam Gion Hydro-power Project	41.156
Total		**70.478**

Source: https://www.goldstandard.org/

Among the 20 projects registered under the GS, there are nine projects which have been successfully verified and certified. From April 2017 to June 2018, the total amount of carbon credits certified with the GS labels is 1,949,270 tCO_2e, of which 1,072,197 tCO_2e comes from the Viet Nam Biogas Programme.

c) Verified Carbon Standard

As of June 2018, 17 projects were registered under the Verified Carbon Standard (VCS), of which two new projects were registered between April 2017 and June 2018. Information on these two new projects is presented in Table 4.3.

Table 4.3. List of recently registered VSC projects (from April 2017 to June 2018)

Unit: tCO_2e

No.	Project name	Emission Reduction Potential/year
1	Nam Mo 3 Hydropower Project	21.817
2	Song Chung Hydropower Project	8.561
Total		**30.378**

Source: http://verra.org/project/vcs-program/

d) Renewable Energy Certificates

As of June 2018, there were four projects registered for the Renewable Energy Certificate (REC) with 192,045 units issued in total. Information on the REC projects is presented in Table 4.4.

Table 4.4. List of REC projects (as of June 2018)

Unit: REC (MWh of electricity)

No.	Project name	Amount of Renewable Energy Certificates (RECs)
1	Khe Dien Hydropower Project	53.301
2	Nam Pia Hydropower Project	63.115

3	Chieng Cong Hydropower Project	50.033
4	Nam Soi Hydropower Project	25.596
Total		**192.045**

Source: http://www.internationalrec.org/

4.5. MEASUREMENT, REPORTING AND VERIFICATION FOR MITIGATION ACTIVITIES

4.5.1. Measurement, Reporting and Verification at national level

Decision No. 2053/QD-TTg dated October 28th, 2016 of the Prime Minister approving the Plan for Implementation of the Paris Agreement has stipulated the tasks to be executed in the period of 2016-2020, in which the establishment of the MRV system is one of the key tasks in the period of 2018-2010.

The proposed national MRV system is described in Figure 4.2.

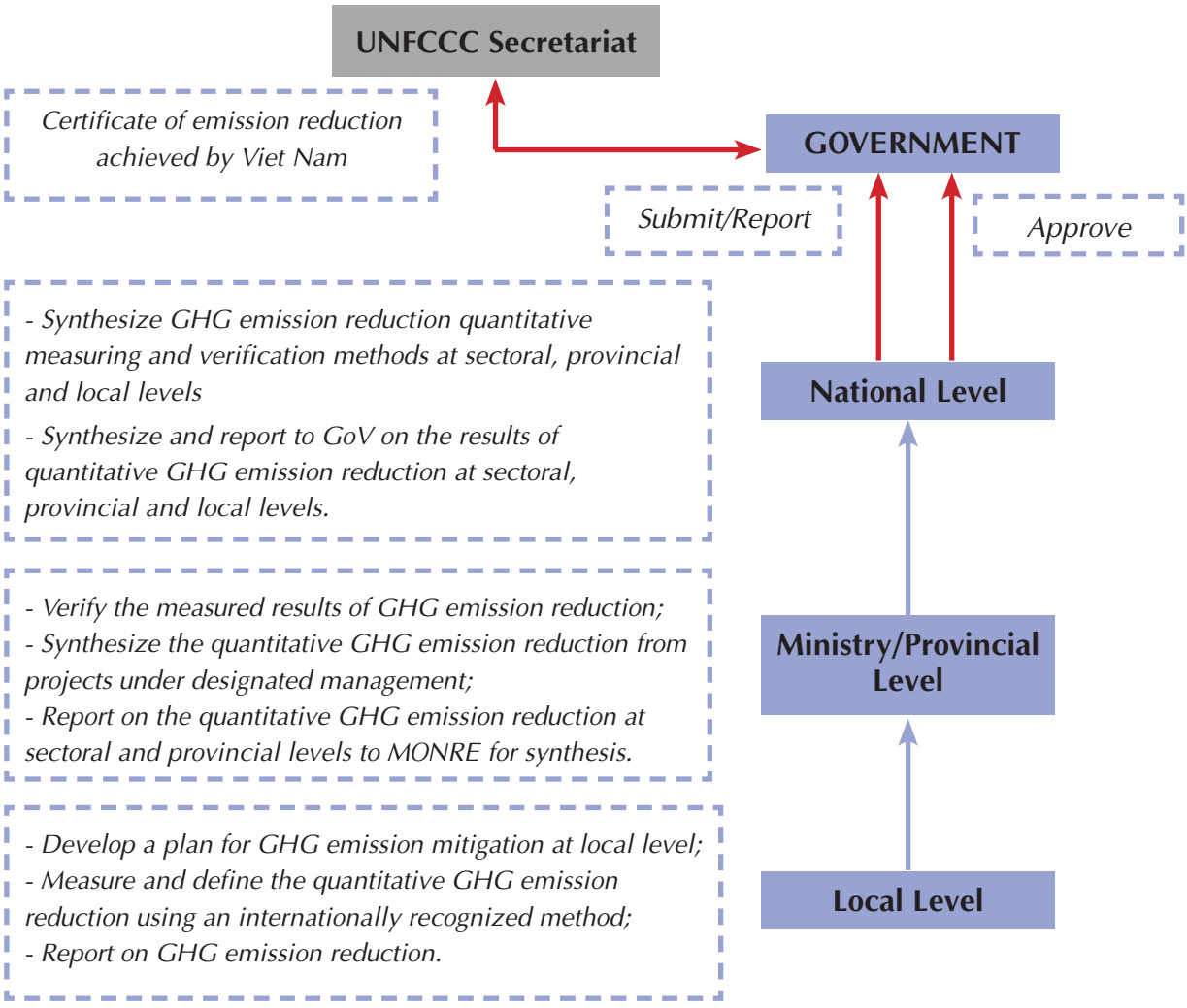

Figure 4.2. The proposed national MRV system

Source: MONRE, 2018

4.5.2. Measurement, Reporting and Verification at sectoral level

To implement Decision No.2053/QD-TTg dated October 28th, 2016 of the Prime Minister, one of the key tasks is to establish the MRV system for GHG mitigation actions at sectoral level in the period of 2018-2020.

Figure 4.3 below illustrates an example of the MRV system designed for a NAMA in the cement sector, developed by the Ministry of Construction and other related ministries and agencies.

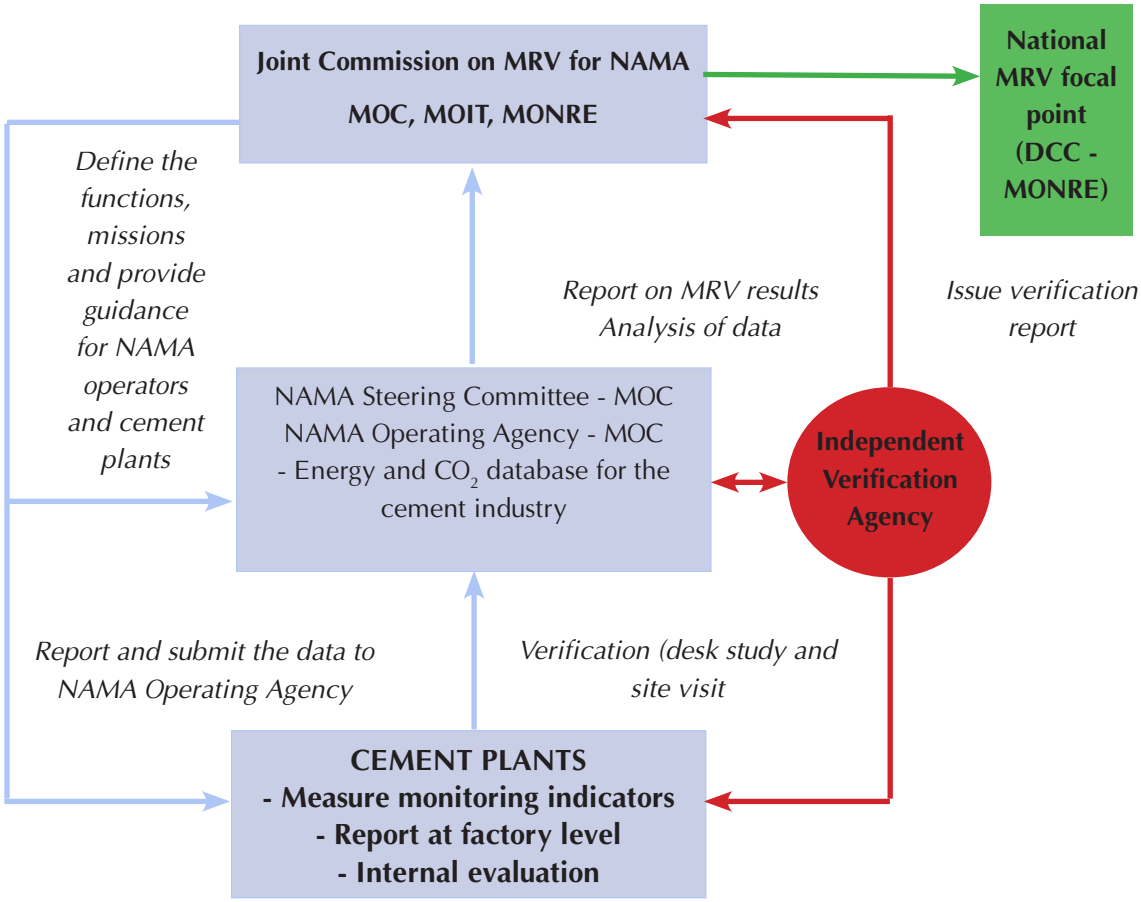

Figure 4.3. The proposed MRV system for the Cement NAMA

Source: Capacity Building and Support to Development of GHG Emission Reduction Action Plan for Cement Production in Viet Nam, 2016

In order to actively respond to climate change and steer the economy towards a low-carbon model, Viet Nam has developed and implemented numerous GHG mitigation actions. The NDC of Viet Nam was submitted to the UNFCCC Secretariat in September 2015 and is currently being reviewed and updated. However, to enhance the implementation of GHG mitigation actions, Viet Nam needs to overcome a number of difficulties and limitations and seeks to receive the necessary support from international organizations for effective implementation of NDC. These points will be presented in Chapter 6.

Chapter 5

OTHER INFORMATION

5.1. TRANSFER OF TECHNOLOGIES

In recent years, the transfer of climate change technologies has been implemented in a number of key areas such as energy, industry and waste. However, technology transfer has not been up-scaled and developed in depth. In order to enhance the transfer of climate change technologies, Viet Nam has had a number of priority policies on research, application and development of climate change technologies such as:

- Law on Technology Transfer No.07/2017/QH14 passed by the National Assembly of the Socialist Republic of Viet Nam on June 19, 2017 stipulates: Advanced technologies, new technologies, and clean technologies suitable to Viet Nam socio-economic conditions are encouraged to transfer from abroad to Viet Nam, given that they satisfy the requirements, including environmental protection, adaptation to climate change, and reduction of GHG emissions.

- Decision No.2612/QD-TTg dated December 30, 2013 of the Prime Minister on the Clean Technology Strategy for the period up to 2020 with a vision to 2030. The objective of this strategy is to use clean technologies that are environmentally friendly, energy- and resources-efficient, and low-emission in industrial production to promote green growth, mitigate climate change and improve social welfare.

- Decree No.76/2018/ND-CP dated May 15, 2018 detailing and guiding the implementation of a number of articles of the Law on Technology Transfer has identified the list of technologies encouraged for transfer. Of the 143 identified technologies, some of the key technologies involved in responding to climate change include:

+ The technology of electricity production using solar, wind, biomass, domestic waste, industrial biogas;

+ The technology of manufacturing and production of electric vehicles on an industrial scale, using renewable energy, clean energy;

+ The advanced technology of selecting and breeding of crops, livestock and aquacultures with high productivity, high quality, disease-resistance and capacity to adapt to climate change;

+ The advanced technology of recycling and reuse of waste;

+ The technologies of processing and recycling domestic solid waste, and industrial solid waste in combination with energy recovery without generating by-products and toxic waste;

+ The technologies for treatment and re-use of industrial wastewater that do not produce toxic substances;

+ The technologies for carbon capture and storage;

+ The technologies for automated transfer of hydrometeorology and climate change data to users;

+ The technologies for monitoring and measuring of greenhouse gas emission.

Up until now, technology transfer related to greenhouse gas emission mitigation in Viet Nam has been mainly conducted through the implementation of projects under Clean Development Mechanism (CDM), Joint Credit Mechanism (JCM), Gold Standard (GS) and other international projects.

5.2. RESEARCH AND SYSTEMATIC OBSERVATION

5.2.1. Climate change research

Over the past years, Viet Nam has carried out many research projects related to climate change. Climate change activities are conducted by state agencies, research institutes, universities, research centers and non-governmental organizations. Climate change research in Viet Nam focuses on: i) Studying the scientific basis for identifying the impacts of climate change and changes in common climate phenomena for the assessment of climate change in Viet Nam; ii) Developing and enhancing a climate change monitoring system and greenhouse gas emissions mitigation in line with Viet Nam' needs, ensuring international integration; proposing solutions and models for responding to climate change, rational usage of natural resources and ensuring non-traditional security in some key areas; iii) Studying and proposing suitable active adaptation measures for sectors, domains, regions, especially in coastal, mountainous and vulnerable areas;

iv) Restructuring, changing plant and animal varieties, seasonal adjustment, and agricultural production adapting to climate change[34].

In order to strengthen research activities on climate change, Viet Nam has completed 48 tasks under the Science and Technology Program for the National Target Program to respond to Climate Change in the period of 2011-2015 and is currently implementing 17 tasks under the Program of Science and Technology for Responding to Climate Change, Natural Resources and Environment Management for the period of 2016-2020. Some key studies of the State-level Program for Science and Technology for the period of 2011-2015 include: (i) Research on application and development of energy technology - Code: KC.05/11-15; (ii) Scientific research and technology for disaster prevention, environmental protection and rational use of resources - Code: KC.08/11-15; (iii) Research on application and development of advanced technologies for community health care and protection - Code: KC.10/11-15.

The results of the research are highly regarded, ready to be applied immediately and able to provide the basis for the development of policies and measures to respond to climate change.

Climate change and sea level rise scenarios for Viet Nam and the Viet Nam Special Report on Managing the Risks of Extreme Events and Disasters to enhance climate change adaptation (SREX Viet Nam) developed by Viet Nam Institute of Meteorology, Hydrology and Climate Change (IMHEN) are the key products of scientific research on climate change in Viet Nam.

The SREX Viet Nam report analyzes and evaluates climatic extremes, their impacts on the natural environment, and on socio-economic and sustainable development of Viet Nam; the change of future climatic extremes due to climate change; the interaction between climate, environment and human factors in order to promote climate change adaptation and disaster risk management and climatic extremes in Viet Nam.

5.2.2. Systematic observation

a) National meteorological and hydrological monitoring network

As of January, 2016, the national meteorological and hydrological monitoring network consisted of:

- National meteorological and hydrological monitoring network consisting of 194 stations on the ground, including 14 solar radiation observation stations, 29 agricultural meteorological observation stations, with an average coverage of 1,930 square kilometer/station

- Rainfall monitoring network nationwide, including 1,303 points; of which 548 points

34. https://thuvienphapluat.vn/van-ban/Bo-may-hanh-chinh/Quyet-dinh-172-QD-BKHCN-khoa-hoc-cong-nghe-ung-pho-bien-doi-khi-hau-quan-ly-tai-nguyen-moi-truong-303389.aspx

are located within the meteorological and hydrological stations and 755 points are outside the meteorological and hydrological stations. With an average coverage of 280 square kilometer/ station.

- The network of high-altitude weather meteorological stations in Viet Nam consisting of eight weather radar stations, six radio-obscured stations, eight high-altitude wind stations using optical telescopes (PILOT telescopes), three ozone and ultraviolet radiation monitoring stations.

- The network of hydrological stations has 354 stations. The average coverage of stations on nine major river systems is 4,140 km^2 per station, and 4,090 km^2 per station on small rivers. The stations are mainly located on major rivers and large branches.

- The network of marine station has 27 stations, including 12 island stations, 9 coastal stations and five stations on the oil rig.

- The network of specialized hydro-technical works includes 117 stations under the management of two ministries and 24 provinces and municipalities.

b) Global climate monitoring station

Viet Nam has installed a global climate monitoring station at Pha Đin Meteorological Station under the Northwest Meteorological Station.

c) Development plan for monitoring network

The Prime Minister issued Decision No. 90/QD-TTg dated January 12th, 2016 approving the National Plan for the Network of Natural Resources and Environment Monitoring for the period of 2016-2025 with a vision to 2030 with the objective to develop a logical, united, synchronous, modern national and regional monitoring system of natural resources and environment, meeting or exceeding the highest levels in Southeast Asia and Asia overall; to meet the demand for basic survey information in service of the State management of water resources, land, sea and island resources, hydroelectricity, environmental protection and socio-economic development requirements; to provide forecast, warning, prevention and mitigation of damages caused by natural disasters and environmental pollution, and to respond to climate change. Information on the monitoring network for the period of 2016-2025, vision to 2030 is presented in Table 5.1.

Table 5.1. Number of meteorological and hydrological monitoring stations for the period of 2016-2025, vision to 2030

Station	2016-2020		2021-2025		2026-2030		Total		
	New	Upgraded	New	Upgraded	New	Upgraded	By 2030	in which	
								New	Upgraded
Meteorology	92	0	97	0	71	0	454	260	0
Hydrology	96	39	99	17	91	14	640	286	70
Marine	20	8	17	8	17	6	77	54	22
Rainfall	2,723	414	478	0	348	0	4,304	3,549	414
Salinity	25	35	22	33	25	23	163	72	91
Total	**2,956**	**496**	**713**	**58**	**552**	**43**	**5,638**	**4.221**	**597**

Source: Decision No. 90/QD-TTg dated January 12, 2016 of the Prime Minister approving the National Plan for the Network of Natural Resources and Environment Monitoring for the period of 2016-2025 with a vision to 2030

5.3. EDUCATION, TRAINING, CAPACITY BUILDING AND PUBLIC AWARENESS ON CLIMATE CHANGE

To implement Article 6 of the UNFCCC and contribute to the achievement of climate change adaptation goals in Viet Nam, the content of education, training and awareness-raising on climate change in the country focuses on the following activities:

- Raising the awareness and responsibility of public officers, civil servants and citizens on climate change;

- Developing appropriate methods for society to access and utilize information on climate change; diversifying forms of production and dissemination of information on the impacts, risks and opportunities of climate change, especially to communities and key areas;

- Integrating basic knowledge of climate change into programs, education and training; developing and adopting policies to train high-quality human resources related to climate change adaptation and greenhouse gas emissions reduction;

- Raising awareness, personal responsibility and community responsibility in preventing, avoiding and overcoming the consequences of natural disasters; promoting climate-friendly consumption patterns and lifestyle for all members of the community; encouraging and replicating good examples in responding to climate change.

The activities related to education, training, capacity building and awareness raising on climate change have witnessed a number of positive changes. Capacity building, awareness

raising on climate change have been implemented through training courses, seminars, forums, events, etc. Public information and mobilization activities responding to climate change have been implemented through mass media. Many universities and research institutes already provide doctoral, master and bachelor programs relating to climate change. A typical example is the PhD program of Viet Nam Institute of Meteorology, Hydrology and Climate Change[35], Master program of Hanoi National University[36], Viet Nam Japan University[37], Bachelor program of Hanoi[38] and Ho Chi Minh[39] University of Natural Resources and Environment. Some universities and colleges have introduced climate change courses. Many secondary schools, and elementary schools have organized seminars, and organized contests to learn about climate change and the ozone layer protection.

Training courses on capacity-building and awareness-raising on climate change for different target groups have been implemented nationwide and at all levels, with major contributions by non-governmental organizations (NGOs).

In Viet Nam, NGOs have been actively participating in capacity-building and awareness-raising activities on climate change for local communities. To date, the network of NGOs in Viet Nam has 136 members, including 49 in the North; 35 in the Central; 52 in the South. Some key achievements of the NGO Network on Climate Change include:

- Development of training materials on climate change media;

- Training the trainers on climate change;

- Training members of organizations working on climate change issues (research assessment, media, integration, development of climate change response plans);

- Development of materials on models for responding to climate change.

In addition, with support from other countries and international organizations, many officials from ministries, sectors and localities have been trained in short-term and long-term training courses on climate change in foreign countries.

5.4. INFORMATION AND NETWORKING

5.4.1. Information sharing

In recent years, many specialized websites on climate change have been set up to share updated information and data on national and international activities responding to climate change.

35. http://www.imh.ac.vn/dao-tao/cat120/441/Chuyen-nganh-dao-tao-cua-Vien-KHKTTVBDKH
36. http://sis.vnu.edu.vn/category/dao-tao/chuong-trinh-dao-tao-2/
37. http://vju.vnu.edu.vn/vn/menu/academics/climate-change-and-development
38. http://hunre.edu.vn/hre/d16097
39. http://www.hcmunre.edu.vn/hcmunrechitiet/trang-chu-tnmt/bien-oi-khi-hau-va-phat-trien-ben-vung

The UNFCCC focal point in Viet Nam has established a website[40] providing updated information on climate change policies and responses, negotiation activities at national and international conferences.

The database on climate change[41] is also integrated in the website including data on national and international policies; climate trends; climate change and sea level rise scenarios for Viet Nam; programs, projects; results of greenhouse gas inventory for base years[42].

The results of scientific researches and projects on climate change have been widely published on the websites of many universities and research institutes, and scientific organizations. In addition, many websites of different agencies and organizations have set up a category on climate change. Social networks are also used as an effective channel for public information.

In addition to disseminating information on the website, the UNFCCC focal point in Viet Nam has published a biennial newsletter on climate change response; this is distributed to related agencies, organizations, scientists, and experts.

5.4.2. Participation in and contribution to networks

Viet Nam has actively participated in activities of international climate change networks such as the NDC Partnership - a group of countries and organizations established to support the implementation of the climate targets in the NDCs; The Climate Technology Center and Network (CTCN), which connects the world's public and private climate technology stakeholders, provides technology solutions, enhances capacity and provides consultancy to implement measures to respond to climate change for developing countries.

Viet Nam is an active founding member of the Global Partnership on Low Emission Development Strategy (LEDS GP) and the Asia Forum on Low-Emission Development Strategy (Asia LEDS) with the participation of more than 200 members from the donor community, development organizations and businesses. Since 2017, Viet Nam has been participating in the Partnering for Green Growth and the Global Goals 2030 (P4G), which aims to create favorable conditions for participating countries to implement the SDGs and PA.

Some cities in Viet Nam have also joined the networks of cities responding to climate change in the world:

- The cities of Hanoi and Ho Chi Minh City have joined the Cities Climate Leadership Group (C40) focusing on addressing climate change and promoting urban action to mitigate GHG emissions and climate risks. It also promotes health, well-being and economic opportunities for urban citizens.

40. http://dcc.gov.vn/
41. http://csdl.dcc.gov.vn/
42. http://kkknk.dcc.gov.vn/

- The cities of Da Nang, Can Tho and Quy Nhon have joined the Asian Cities Climate Change Resilience Network (ACCCRN).

Many NGOs in Viet Nam have also joined the Climate Change Action Network South East Asia (CANSEA) to support the Government's actions and encourage the private sector to contribute to climate change response and sustainable development.

Viet Nam Climate Innovation Center (VCIC), established in 2015, is a member of the Global CIC network, which is dedicated to supporting innovative businesses responding to climate change from incubation to commercialization and in accessing international markets, transforming climate change challenges into opportunities for sustainable development and green growth.

In addition, many agencies, organizations and individuals have participated in many networks for sharing information and experience in specialized activities on climate change response.

5.5. MAINSTREAMING CLIMATE CHANGE ISSUES INTO SOCIO-ECONOMIC DEVELOPMENT STRATEGIES, MASTER PLANS AND PLANS

Viet Nam has considered that the integration of climate change into socio-economic development strategies and plans is an important task for all levels and sectors in order to respond to climate change and ensure sustainable development. The integration of climate change must be based on proactive principles and ensure harmony with socio-economic development strategies, and plans with priorities, in line with the basic principles of sustainable development.

The task of integrating climate change into strategies, and plans has been specified in the documents of the Party, the National Assembly and the Government. Resolution No. 24-NQ/TW on actively responding to climate change, enhancing resource management and environmental protection has identified this as one of the key tasks. This issue has also been stipulated in the Law on Environmental Protection in 2014 (Article 40), the Law on Meteorology and Hydrology in 2015 (Article 31) as well as the key tasks of the Target Program to Respond to Climate Change, and National Strategy on Climate Change.

The content of mainstreaming climate change into the strategies, master plans and plans in the above documents is summarized as follows:

- Using hydrological and meteorological information, and climate change monitoring data in the assessment of natural and environmental conditions for planning, and strategy areas;

- Using the results of analyzing and evaluating the status and impacts of climate change on natural disasters, natural resources, environment, ecosystems, living conditions, socio-economic activities and cross-cutting inter-regional and inter-sectoral issues, to identify the long-term goals

of the strategies, master plans and plans;

- Using the results of analyzing and evaluating the climate change measures to identify the socio-economic criteria of the strategies, master plans and plans.

To date, the task of integrating climate change into new strategies, master plans and development plans is at an early stage of implementation. Key areas, which are being encouraged to integrate and implement climate change policies, are policy and administration, and science technology development. Some main results are:

- The Ministry of Industry and Trade has integrated climate change into a number of strategies and plans in the field of energy, and energy efficiency.

- The Ministry of Transport has integrated climate change into the Transport Development Strategy of Viet Nam, the Development Strategy of rail transportation, the Master Plan for development of inland waterways transport, the planning of aeronautical transport, the Development Plan for the Highway network, and Transport Development Planning in the key economic region of the Mekong Delta.

- The Ministry of Agriculture and Rural Development has integrated climate change in the process of formulation and implementation of strategies, master plans, plans, programs, and projects for development of agriculture and rural development in the period of 2011-2015 (Directive No. 809/CT-BNN-KHCN dated March 28th, 2011). In addition, the implementation of REDD+ is also a key activity of integrating climate change into the agriculture and rural development sector.

- The Ministry of Construction has integrated climate change in developing the Green Construction Strategy as well as activities related to capacity-building to respond to climate change; energy efficiency; urban development planning (especially in urban areas in the Central Coast and in the Mekong Delta); and solid waste management.

- The Ministry of Natural Resources and Environment has integrated climate change into the national action plan to strengthen the effectiveness of water resources management, protection and utilization. In addition, three regional irrigation schemes and master plans for irrigation have used a system of updated climate change scenarios.

- The Ministry of Planning and Investment has requested the activities of mobilizing investment and direct investment from abroad to meet the target of responding to climate change. The Ministry of Planning and Investment is developing a Decree guiding the implementation of the Law on Planning in line with the development of integrated planning taking into account environmental issues and climate change. The Ministry of Planning and Investment has issued the Framework for Climate Change Adaptation Priorities in Socio-Economic Development Planning and the Public Sector Classification Guidelines for Climate Change and Green Growth. In

addition, the Ministry of Planning and Investment has been studying and integrating sustainable development goals in the annual socio-economic development plan and the Socio-Economic Development Strategy for the period 2021-2030 as well as developing and completing the set of monitoring indicators and frameworks for action plans responding to climate change at all levels as a basis for integrating monitoring and evaluation activities into annual and periodic plans of sectors and localities; MPI continues to support and promote an early improvement in the institutional structure, policies and laws related to the integration.

- The Ministry of Science and Technology has integrated climate change in the national science and technology development strategy, and into state level programs. Particularly, the Ministry of Science and Technology has submitted to the Government for approval the implementation of the State-level Program for Science and Technology for the National Target Program on Response to Climate Change in the period of 2011-2015 and many integrated activities in other scientific and technological master plans and plans.

Chapter 6

CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

6.1. CONSTRAINTS AND GAPS

Constraints and gaps identified in the development of the National Communications, the Biennial Updated Reports and in the implementation of activities to respond to climate change in Viet Nam have been partially overcome.

Most constraints and gaps still exist because of the lack of information and data; lack of experienced officials and experts; lack of specialized equipment; lack of financial resources; and lack of implementation guidelines. Information on the remaining constraints and gaps related to the GHG inventory, assessment of climate change impacts, implementation of measures to respond to climate change, technology transfer, and climate change monitoring and research is presented in Table 6.1.

Table 6.1. Constraints and gaps in the implementation of climate activities in Viet Nam

No.	Constraints/gaps	Impacts/ Influences
I. GHG Inventory		
1	- Lack of sources of primary data. - Inconsistent data from different sources.	- Dependent on consultants' expertise. Must refer to data sources of some international organizations. Relatively high uncertainty.
2	Some specific national emission factors are unavailable.	In most cases, Tier 1 is applied to calculate GHG emissions, so the uncertainty of GHG inventory results is high.

3	Coordination to share information and data among stakeholders is limited.	Some data from Ministries/ sectors are not consistent and difficult to synthesize.
II. Assessment of the impacts of climate change and development, implementation of adaptation measures		
1	Lack of information to assess comprehensively the impacts of climate change in the inter-sectoral and inter-regional scopes.	- Difficulties in assessing and quantifying losses and damage caused by climate change within the inter-sectoral and inter-regional scopes. - There are constraints on the development and implementation of feasible and effective adaptation mearsures.
2	Some specialized, intentive studies are limited.	Difficulties in formulating policies, developing programs and projects to respond to climate change and analyse disaster risks at different levels.
3	Shortage of experienced staff and experts	The reliability of the forecast of climate change impacts is still limited.
4	Lack of specialized equipment for monitoring and measuring to set up databases for climatic models	Difficulties in establishing highly reliable scenarios of climate change and assessment of the impacts of climate change on socio-economic sectors.
III. Development and implementation of GHG mitigation options		
1	There is no technical guideline or model that is appropriate to the national conditions to assess and develop GHG mitigation options for a number of sectors.	- Difficulties in developing appropriate GHG mitigation options. - Constraints in developing GHG mitigation plans, programmes and projects.
2	MRV systems at all levels and sectors have not been set up formally.	- Difficulties in implementing MRV at all levels, sectors and localities. - Lack of coordination and collaboration mechanism for MRV practices.
3	Lack of financial resources and financial mechanisms to encourage the implementation of GHG mitigation actions.	- Difficulties in mobilizing and ensuring financial resources for the implementation of GHG emission reduction activities, especially in mobilizing private funds. - NAMAs have not been implemented timely.
IV. Transfer of climate change technology		
1	Lack of appropriate standards and policy frameworks to promote technology transfer.	Climate change technology transfer is not common, especially for adaptation technologies.
2	Lack of expertise to receive and apply advanced technology.	- Technology transfer and effective application is time-consuming. - Lack of specialized engineers, operational and maintenance workers.
3	Lack of global guidelines on establishing the monitoring system for technology transfer.	Difficulties in assessing and implementing climate change technology transfer from other countries and international organizations.
V. System monitoring and climate change research		
1	Lack of resources to effectively implement the hydro-meteorology monitoring network as planned.	The hydro-meteorology monitoring system does not meet the requirements for climate change monitoring and natural disaster risk management.

6.2. SUPPORT NEEDS

6.2.1. Technology and capacity building needs

a) Needs for developing GHG inventory

- Developing detailed QA/QC guidelines and strengthening the capacity of QA/QC units.

- Strengthening the capacity of relevant agencies and units in the National GHG inventory System to ensure the update of activity data for the inventories.

- Identifying, developing and implementing a research plan to develop some national specific emission factors for some identified major GHG emission sources.

- Integrating research activities to develop national specific emission factors in the international-funded programs and projects related to climate change.

b) Needs relating to assessment of the impacts of climate change and development and implementation of adaptation measures

- Developing a set of criteria for monitoring and evaluation of climate change adaptation actions for all levels, sectors and guidelines.

- Organizing research, survey and data collection in service of the establishment of a database on climate change for all levels and branches.

- Capacity-building in the development and implementation of climate change impact assessment and NAP development.

- Enhancing investment in intensive research on climate change for all levels and sectors.

- Strengthening human resource training and enhancing international cooperation.

- Planning and implementing step-by-step investment in specialized equipment for monitoring and measurement.

- Receiving technologies on: (i) Real-time forecasting, early warning, sharing of real-time monitoring information systems for meteorology and hydrology sectors; (ii) Impact assessment, vulnerability, exposure to hazards and adaptation measures; (iii) Sustainable use of water resources, prevention of water pollution, urban water supply and drainage; (iv) Erosion control and coastal and river bank protection; and (v) Sustainable agricultural, forestry and fishery production, biotechnology to create new varieties that are resilient to climate change.

c) Needs for developing and implementing mitigation options

- Studying the application of suitable models for developing mitigation options.

- Establishing MRV systems for all levels and sectors; developing the MRV implementation manual.

- Studying and developing a financial mechanism to encourage the implementation of mitigation options with the active participation of the private sector.

d) Needs for technology transfer to respond to climate change

- Studying and developing standards and policies appropriate for Viet Nam's conditions.

- Strengthening human resource training, especially of the contingent of qualified experts and technical workers to meet the requirements for receiving technology.

- Collecting relevant information, exchanging experiences and carrying out research to monitor and supervise technology transfer activities implemented through programs and projects in the coming time.

e) Needs for climate change research and monitoring

- Supplementing, upgrading and completing the meteorology and hydrology monitoring network.

- Modernizing technologies and equipment for monitoring, analyzing and processing hydro-meteorological information toward digitization and automation.

- Planning for effective connection between hydro-meteorological observation networks and related monitoring networks to exploit and utilize existing technical facilities.

6.2.2. Financial needs

Total financial needs for climate change by 2020, financial need to implement the Target Program to Respond to Climate Change and Green Growth in the period of 2016-2020 and to achieve the mitigation targets in the NDC during the period of 2021-2030 had been summarized in detail in BUR2 of Viet Nam to UNFCCC in 2017.

Viet Nam has researched and developed seven NAMAs. These NAMAs are seeking funding for implementation. The financial needs for the implementation of NAMA in Viet Nam are presented in Table 6.2.

Table 6.2. Financial need for the implementation of NAMA in Viet Nam

No.	NAMA	Total budget (million USD)	Domestic (million USD)		International (million USD)
			State budget	Others	
1	Support program for wind power development in Viet Nam	34			
2	Implementing GHG emission reduction initiatives in the chemical fertilizer industry in Viet Nam	144.1	14.70	129.40	
3	Capacity-building and support for development of GHG emission reduction action plan for cement production in Viet Nam	922			
4	Low-carbon bus NAMA	4.100		3.772	328

5	Waste to resources NAMA	110-747/year (1,651-11,208 for the whole NAMA)		88	22
6	NAMA on biogas for on-site power generation for medium/large pig farms	62	23,76	10,80	27,44
7	Climate and livelihoods transformation through low-emission beef production in Viet Nam	21,6 (*)	10,6 (*)	5,6 (*)	5,2 (*)

Note: ☐ *information not available*

** - million Euro*

For the component on adaptation to climate change in the NDC of Viet Nam, the expected state budget for the adaptation activities of all ministries/ ministerial-level agencies is approximately of 0.21% GDP. If the country opts for the expenditure option of 1.5% GDP for adaptation to climate change in the period of 2021-2030, an average extra-budgetary funding of USD 3.5 billion per year is required, equivalent to USD 35 billion for the whole period.

Finance for adaptation is mainly for maintaining and repairing the existing infrastructure, to build new important constructions to prevent natural disasters and to serve the country's socio-economic development in the context of climate change. Viet Nam encourages and creates favorable conditions for the private sector to invest in adaptation activities.

6.3. INTERNATIONAL SUPPORT FOR THIRD NATIONAL COMMUNICATION PREPARATION

Table 6.3 summarizes international support activities for Viet Nam to prepare its Third National Communication to UNFCCC.

Table 6.3. Support for TNC preparation

Support source	Assistance type	Activity	Time	Assistance
GEF	Financial	TNC preparation	2016-2018	Collect and synthesize information and data, and study to prepare TNC
Australia, Singapore, UN Global Support Programme (GSP)	Capacity building	Technical workshop	2016-2018	- Capacity-building for NC and BUR preparation; - Capacity-building for MRV under UNFCCC.
Information Matters Project, GIZ		Technical workshop	2018	Collect, synthesize and analyze information for relevant subjects to prepare for the TNC
SilvaCarbon		Training workshop	2016	Transfer the ALU tool to conduct GHG inventory in agricultural and LULUCF sectors

The TNC of Viet Nam to UNFCCC is prepared in the period of 2016-2018 with the support of GEF through UN Environment and technical assistances of some international organizations such as GIZ, SilvaCarbon, etc. Viet Nam highly appreciates their valuable assistance and looks forward to further support for the preparation of next National Communications.

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6. Decision No. 114/KH-DCT dated July 19th, 2016 of the Presidium of the Viet Nam Women's Union promulgating Action Plan for the prevention and mitigation of natural disasters and adaptation to climate change for the period of 2017-2022.

7. Decision No. 1183/QD-TTg dated August 30th, 2012 of the Prime Minister approving the National Target Program to respond to climate change in the period of 2012-2015.

8. Decision No. 1326/QD-BVHTTDL dated April 06th, 2016 of the Ministry of Culture, Sports and Tourism promulgated the Action Plan to respond to climate change of the Ministry of Culture, Sports and Tourism in the period of 2016-2020.

9. Decision No. 13443/QD-BCT dated December 8th, 2015 of Ministry of Industry and Trade promulgating the Action Plan on Green Growth of the Industry and Trade sector for the period of 2015-2020.

10. Decision No. 1393/QD-TTg dated September 25th, 2012 of the Prime Minister approving the National Green Growth Strategy for the period of 2011-2020 and vision to 2050.

11. Decision No. 1427/QD-TTg dated October 2nd, 2012 of the Prime Minister approving the National Target Program on Energy Efficiency and Conservation for the period of 2012-2015.

12. Decision No. 1456/QD-BGTVT dated May 11st, 2016 of Ministry of Transport promulgating the Action Plan for Responding to Climate Change and Green Growth of the Ministry of Transport in the period of 2016-2020.

13. Decision No. 1488/QD-TTg dated August 29th, 2011 of the Prime Minister approving the Master plan for the development of the cement industry in Viet Nam for the period of 2011-2020 and vision to 2030.

14. Decision No. 1621/QD-TTg dated September 18th, 2013 of the Prime Minister approving the Master plan on development of Viet Nam's chemical industry up to 2020, vision to 2030.

15. Decision No. 1670/QD-TTg dated October 31st, 2017 of the Prime Minister approving the Target Programto Respond to Climate Change and Green Growth in the period of 2016-2020.

16. Decision No. 1696/QD-TTg dated October 2nd, 2015 of the Prime Minister approving the National Program of Action on Gender Equality in the period of 2016-2020.

17. Decision No. 172/QD-BKHCN dated January 29th, 2016 of the Ministry of Science and Technology approving the National Program on Science and Technology for Responding to Climate Change, resources management and environment for the period of 2016-2020.

18. Decision No. 1775/QD-TTg dated November 21st, 2012 of the Prime Minister approving the Plan on Greenhouse Gas emissions management; Management of carbon trading activities to the world markets.

19. Decision No. 2053/QD-TTg dated October 28th, 2016 of the Prime Minister approving the Implementation Plan of Paris Agreement in Viet Nam.

20. Decision No. 2068/QD-TTg dated November 25th, 2015 of the Prime Minister approving Viet Nam's Renewable Energy Development Strategy up to 2030 with a vision to 2050.

21. Decision No. 2127/QD-TTg dated November 30th, 2011 of the Prime Minister approving the National Strategy for State Development to 2020 with a vision to 2030.

22. Decision No. 2139/QD-TTg dated December 5th, 2011 of the Prime Minister approving the National Climate Change Strategy.

23. Decision No. 2351/QD-TTg dated December 24th, 2010 of the Prime Minister approving the National Strategy on Gender Equality for the period of 2011-2020.

24. Decision No. 2359/QD-TTg dated December 22nd, 2015 of the Prime Minister approving the National Greenhouse Gas Inventory System.

25. Decision No. 2623/QD-TTg dated December 31st, 2013 of the Prime Minister approving the Plan on the development of Viet Nam's urban centers in response to climate change for the period of 2013-2020.

26. Decision No. 3119/QD-BNN-KHCN dated December 16th, 2011 Ministry of Agriculture and Rural Development approving the GHG emission reduction Plan in agriculture and rural development sector by 2020.

27. Decision No. 403/QD-TTg dated March 20th, 2014 of the Prime Minister approving the National Green Growth Action Plan for the period of 2014-2020.

28. Decision No. 4103/QD-BCT dated August 3rd, 2010 of the Ministry of Industry and Trade promulgated Minitrial Action Plan responding to climate change.

29. Decision No. 419/QD-BXD dated May 11st, 2017 of Ministry of Construction promulgating the Green Growth Action Plan of Construction sector by 2020, with vision to 2030.

30. Decision No. 419/QD-TTg dated April 5th, 2017 of the Prime Minister approving the National program on reducing greenhouse gas emissions through forest loss and degradation, conservation and enhancement of carbon and sustainable management of forest resources to 2030.

31. Decision No. 4206/QD-BGTVT dated December 28th, 2016 of Ministry of Transport promulgating the Action Plan to reduce CO2 emissions in civil aviation in Viet Nam in the period of 2016-2020.

32. Decision No. 428/QD-TTg dated March 18th, 2016 of the Prime Minister approving the adjustment of the National Power Development Plan for 2011-2020 with a vision to 2030.

33. Decision No. 491/QD-TTg dated May 7th, 2018 of the Prime Minister approving the revision of the national strategy on integrated management of solid waste up to 2025 with a vision to 2050.

34. Decision No. 622/QD-TTg dated May 10th, 2017 of the Prime Minister promulgating the National Action Plan to implement the 2030 Agenda for Sustainable Development.

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ANNEXES

ANNEX 1. RESULTS OF THE 2014 NATIONAL GREENHOUSE GAS INVENTORY

The 2014 GHG emissions/removals not controlled by Montreal Protocol

Unit: kt

GHG Sources and Sink Categories	CO_2	CH_4	N_2O	CO	NO_x	$NMVOC_s$	SOx
Total emissions/ removals	**148,765.58**	**3,981.03**	**119.71**	**1,743.80**	**53.21**	**279.31**	**18.91**
1. Energy	**147,525.44**	**919.09**	**3.75**				
1.A. Fuel Combustion Activities (Sectoral Approach)	145,979.07	143.93	3.74				
1.A.1. Energy Industries	54,315.10	0.84	0.56				
1.A.1.a. Public Electricity Plants	52,220.67	0.75	0.54				
1.A.1.b. Petroleum Refinery	1,928.50	0.08	0.02				
1.A.1.c. Gas processing plants	165.93	0.00	0.00				
1.A.2. Manufacturing Industries and Construction	48,767.80	9.20	1.24				
1.A.2.a. Iron and steel	5,082.79	0.48	0.07				
1.A.2.b. Fertilizer	5,011.26	0.49	0.04				
1.A.2.c. Chemical and petroleum	3,023.88	0.28	0.03				
1.A.2.d. Cement	4,242.13	1.73	0.23				
1.A.2.e. Building materials	16,286.35	1.67	0.23				
1.A.2.f. Drinks	579.10	0.03	0.01				
1.A.2.g. Foods	3,583.41	3.61	0.49				
1.A.2.h. Textile and Leather	6,384.41	0.64	0.09				
1.A.2.i. Paper	1,131.36	0.11	0.02				
1.A.2.j. Pulp and Printing	569.15	0.05	0.01				
1.A.2.k. Plastic	11.77	0.00	0.00				
1.A.2.l. Other	2,862.17	0.12	0.03				
1.A.3. Transport	30,351.83	4.97	0.26				
1.A.3.a. Airway	1,089.04	0.03	0.01				
1.A.3.b. Road	27,404.64	4.81	0.23				
1.A.3.c. Rail	117.30	0.01	0.00				

GHG Sources and Sink Categories	CO_2	CH_4	N_2O	CO	NO_x	$NMVOC_s$	SOx
1.A.3.d. Waterway	1,740.84	0.12	0.01				
1.A.4. Other Sectors	11,684.60	128.82	1.65				
1.A.4.a. Commercial/Service	3,597.88	0.47	0.04				
1.A.4.b. Residential	6,702.75	127.92	1.60				
1.A.4.c. Agriculture/Forestry/ Fishing	1,383.97	0.43	0.01				
1.A.5. Other (non-energy use)	859.74	0.10	0.03				
1.B. Fugitive emissions	1,546.38	775.16	0.01				
1.B.1. Solid fuels		109.30					
1.B.1.a. Underground coal mining		93.63					
1.B.1.b. Surface coal mining		15.67					
1.B.2. Oil and natural gas	1,546.38	665.87	0.01				
1.B.2.a. Oil	803.12	533.31	0.01				
1.B.2.b. Natural gas	743.26	132.56	0.00				
2. Industrial processes	**38,619.79**	**NE, NO**	**NE, NO**	**11.02**	**0.73**	**279.30**	**18.91**
2.A. Building material and mineral	35,204.38			NE		250.86	18.28
2.A.1. Cement production	32,440.38						18.28
2.A.2. Lime production	2,442.00						
2.A.3. Limestone and Dolomite use	NE						
2.A.4. Soda Ash Production and Use	NE						
2.A.5. Asphalt Roofing	NE			NE		NE	
2.A.6. Road Paving with Asphalt						242.74	
2.A.7. Production of building glass	322.02					8.12	
2.B. Chemical industry	1,737.39	NE, NO	NE, NO	10.51	NO	6.32	0.04
2.B.1. Ammonia production	1,737.39			10.51		6.32	0.04
2.B.2. Nitric Acid production			NO		NO		
2.B.3. Adipic Acid production			NO	NO	NO	NO	
2.B.4. Carbide production	NE	NE		NE			NE
2.C. Metal production	1,678.02	NE, NO	NE, NO	0.45	0.73	0.41	0.59
2.C.1. Iron and Steel production	1,678.02	NE		0.45	0.73	0.41	0.59
2.C.2. Ferroalloys production	NE	NE				NE	
2.C.3. Aluminium production	NO	NO		NO	NO		NO

GHG Sources and Sink Categories	CO_2	CH_4	N_2O	CO	NO_x	$NMVOC_s$	SOx
2.C.4. SF6 Used in Aluminium and Magnesium Foundries				NO	NO	NO	NO
2.D. Other Production				NE	NE	21.72	NE
2.D.1. Pulp and Paper				NE	NE	NE	NE
2.D.2. Food and Drink						21.72	
2.E. Production of Halocarbons and SF6							
2.E.1. By-product emissions							
2.E.2. Fugitive emissions							
2.F. Consumption of Halocarbons and SF6							
2.G. Other	NE	NE	NE				
3. Solvents and other products	**NE**			**NE**	**NE**	**NE**	**NE**
4. Agriculture		**2,288.57**	**109.19**	**1,692.33**	**51.34**		
4.A. Enteric Fermentation		408.02					
4.A.1. Cattles		233.04					
4.A.2. Buffalos		138.68					
4.A.3. Sheep		0.34					
4.A.4. Goat		8.00					
4.A.5. Horse		1.20					
4.A.6. Swine		26.76					
4.A.7. Poultry		0.00					
4.B. Manure Management		28.19	27.38				
4.B.1. Cattles		4.76					
4.B.2. Buffalos		4.52					
4.B.3. Sheep		0.01					
4.B.4. Goat		0.30					
4.B.5. Horse		0.11					
4.B.6. Swine		12.01					
4.B.7. Poultry		6.47					
4.B.8. Anaerobic			NO				
4.B.9. Liquid systems			NO				
4.B.10. Solid Storage and Dry Lot			NO				
4.B.11. Other			27.38				
- Fertilizer composting			17.41				
- Anaerobic treatment			8.23				
- Anaerobic Digester			0.16				

GHG Sources and Sink Categories	CO_2	CH_4	N_2O	CO	NO_x	$NMVOC_s$	SOx
- Biological padding poultry manure			1.58				
4.C. Rice Cultivation		1,771.78					
4.C.1. Irrigated		1,708.71					
4.C.2. Rain-fed		63.07					
4.D. Agricultural Soils			80.39				
4.D.1. Direct emission			45.05				
4.D.2. Emissions from pasture and grazing field			1.27				
4.D.3. Indirect emission			34.07				
4.E. Prescribed Burning of Savannas		0.04	0.00	0.92	0.02		
4.F. Field Burning of Agricultural Residues		80.54	1.42	1,691.41	51.32		
4.F.1. Cereals		76.63	1.26	1,609.24	45.62		
4.F.2. Pulse		0.84	0.04	17.71	1.42		
4.F.3. Tuber and root		2.16	0.10	45.42	3.77		
4.F.4. Sugar cane		0.91	0.01	19.04	0.51		
4.G. Other		NO	NO	NO	NO		
5. LULUCF	**-37,675.67**	**4.63**	**0.07**	**40.51**	**1.14**		
5.A. Forest Land	-35,661.79	1.50	0.04	13.09	0.37		
5.A.1. Forest Land Remaining Forest Land	-26,491.07	1.50	0.04	13.09	0.37		
5.A.2. Land Converted to Forest Land	-9,170.72	IE	IE	IE	IE		
5.B. Cropland	-7,347.75	1.12	0.01	9.83	0.28		
5.B.1. Cropland Remaining Cropland	-4,757.46	NA	NA	NA	NA		
5.B.2. Land Converted to Cropland	-2,590.29	1.12	0.01	9.83	0.28		
5.C. Grassland	IE	IE	IE	IE	IE		
5.C.1. Grassland Remaining Grassland	IE	IE	IE	IE	IE		
5.C.2. Land Converted to Grassland	IE	IE	IE	IE	IE		
5.D. Wetlands	959.00	0.04	0.01	0.39	0.01		
5.D.1. Wetlands Remaining Wetlands	561.03	NA	NA	NA	NA		
5.D.2. Land Converted to Wetlands	397.97	0.04	0.01	0.39	0.01		
5.E. Settlements	1,056.45	0.00	0.00	0.00	0.00		
5.E.1. Settlements Remaining Settlements	NA	NA	NA	NA	NA		
5.E.2. Land Converted to Settlements	1,056.45	0.00	0.00	0.00	0.00		
5.F. Other Land	3,318.43	1.97	0.01	17.20	0.48		

GHG Sources and Sink Categories	CO_2	CH_4	N_2O	CO	NO_x	$NMVOC_s$	SOx
5.F.1. Other Land Remaining Other Land	NA	NA	NA	NA	NA		
5.F.2. Land Converted to Other Land	3,318.43	1.97	0.01	17.20	0.48		
5.G. Other	NE	NE	NE	NE	NE		
6. Waste	**296.00**	**768.73**	**6.71**				
6.A. Solid Waste Disposal on Land	NE	321.48					
6.B. Wastewater Handling		447.26	6.71				
6.B.1. Industrial Wastewater		62.90					
6.B.2. Domestic and Commercial Wastewater		384.36	7.71				
6.B.3. Other							
6.C. Waste Incineration	296.00		NE				
6.D. Other							
7. Other	**1,740.71**	**0.01**	**0.05**	**NE**	**NE**	**NE**	**NE**
Memo items							
International Bunkers	1,740.71	0.01	0.05	NE	NE	NE	NE
Aviation	1,740.71	0.01	0.05	NE	NE	NE	NE
Water-borne Transport	NE	NE	NE	NE	NE	NE	NE
CO_2 emission from biomass	IE						

THE 2014 GHG EMISSIONS/REMOVALS IN THE LULUCF SECTOR

Unit : kt

Emissions/removals sources							CH_4	N_2O	CO	NO_x
Land-use change		IPCC Guidelines	Annual Change in Carbon Stocks (CO_2)							
Before change	After change		Living Biomass A	Dead Organic Matter B	Soils C	CO_2 Emission/Removals D=(A+B+C)*(-1)				
Forestland	Forestland	5A	-26,605.68	NA	114.61	-26,491.07	1.50	0.04	13.09	0.37
Cropland	Forestland	5A, 5C, 5D	-604.81	NE	NE	-604.81	IE	IE	IE	IE
Grassland	Forestland	5A, 5C, 5D	IE	NE	NE	NE	IE	IE	IE	IE
Wetland	Forestland	5A, 5C, 5D	-62.25	NE	NE	-62.25	IE	IE	IE	IE
Settlements	Forestland	5A, 5C, 5D	100.94	NE	NE	-100.94	IE	IE	IE	IE
Other land	Forestland	5A, 5C, 5D	8,402.72	NE	NE	-8,402.72	IE	IE	IE	IE
	Sub-Total for Forestland		-35,776.40	NE	114.61	-35,661.79	1.50	0.04	13.09	0.37
Cropland	Cropland	5A, 5D	-4,803.85	NA	46.39	-4,757.46	NA	NA	NA	NA
Forestland	Cropland	5B, 5D	601.45	151.20	NE	752.66	1.12	0.01	9.83	0.28
Grassland	Cropland	5B, 5D	IE	NE	IE	NE	NE	NE	NE	NE
Wetland	Cropland	5D	-43.35	NE	NE	-43.35	NE	NE	NE	NE
Settlements	Cropland	5D	-200.18	NE	NE	-200.18	NE	NE	NE	NE
Other land	Cropland	5D	-3,099.42	NE	NE	-3,099.42	NE	NE	NE	NE
	Sub-Total for Cropland		-7,545.34	151.20	46.39	-7,347.75	1.12	0.01	9.83	0.28
Grassland	Grassland	5A, 5D	IE	NE	NE	0.00	NA	NA	NA	NA
Forestland	Grassland	5B, 5D	IE	0.00	NE	0.00	IE	IE	IE	IE
Cropland	Grassland	5B, 5D	IE	NE	NE	0.00	NE	NE	NE	NE
Wetland	Grassland	5C, 5D	IE	NE	NE	0.00	NE	NE	NE	NE
Settlements	Grassland	5C, 5D	IE	NE	NE	0.00	NE	NE	NE	NE
Other land	Grassland	5C, 5D	IE	NE	NE	0.00	NE	NE	NE	NE
	Sub-Total for Grassland		0.00	0.00	NE	0.00	0.00	0.00	0.00	0.00

Emissions/removals sources							CH_4	N_2O	CO	NO_x
Wetland	Wetland	5A, 5E	NE	NE	561.03	561.03	NA	NA	NA	NA
Forestland	Wetland	5B	25.68	5.92	NE	31.60	0.04	0.00	0.39	0.01
Cropland	Wetland	5E	366.37	NE	NE	366.37	NE	NE	NE	NE
Grassland	Wetland	5B	IE	NE	NE	0.00	NE	NE	NE	NE
Settlements	Wetland	5E	NE	NE	NE	0.00	NE	NE	NE	NE
Other land	Wetland	5E	NE	NE	NE	0.00	NE	NE	NE	NE
	Sub-Total for Wetland		392.05	5.92	561.03	959.00	0.04	0.00	0.39	0.01
Settlements	Settlements	5A	NE	NA	NA	0.00	NA	NA	NA	NA
Forestland	Settlements	5B	0.19	0.05	NE	0.24	0.00	0.00	0.00	0.00
Cropland	Settlements	5E	1,056.21	NE	NE	1,056.21	NE	NE	NE	NE
Grassland	Settlements	5B	IE	NE	NE	0.00	NE	NE	NE	NE
Wetland	Settlements	5E	NE	NE	NE	0.00	NE	NE	NE	NE
Other land	Settlements	5E	NE	NE	NE	0.00	NE	NE	NE	NE
	Sub-Total for Settlements		1,056.40	0.05	NE	1,056.45	0.00	0.00	0.00	0.00
Other land	Other land	5A	NE	NE	NE	0.00	NA	NA	NA	NA
Forestland	Other land	5B	1,143.30	264.58	NE	1,407.88	1.97	0.01	17.20	0.48
Cropland	Other land	5E	1,910.55	NE	NE	1.910.55	NE	NE	NE	NE
Grassland	Other land	5B	IE	NE	NE	0.00	NE	NE	NE	NE
Wetland	Other land	5E	NE	NE	NE	0.00	NE	NE	NE	NE
Settlements	Other land	5E	NE	NE	NE	0.00	NE	NE	NE	NE
	Sub-Total for Other land		3,053.85	264.58	NE	3,318.43	1.97	0.01	17.20	0.48
Sub-total by gases			-38,819.44	421.75	722.02	-37,675.67	4.63	0.07	40.51	1.14
Total (in CO_2e)			-37,540.17							

ANNEX 2. RESULTS OF THE LOW CARBON TECHNOLOGY ASSESSMENT FOR NATIONALLY DETERMINED CONTRIBUTION

No.	Sector/ Sub-sector	Option/Technology	Priority Ranking*
I. Energy saving			
1	Residential and Commercial	High-efficiency household air-conditioning	A
2		LED, CFL	A
3		Solar water heaters	A
4		High-efficiency residential refrigerators	B
5	Cement	Cement-making technology (Kiln Shell Heat Loss Reduction)	A
6		Cement-making technology (VFD Installation)	A
7		Cement-making technology (Vertical Roller Mill)	B
8		Cement-making technology (Combustion Optimization)	B
9		Cement-making technology (Waste Heat Recovery from Cement)	B
10		Cement-making technology (Dry Kilns with Multistage PreHeaters and PreCalcination)	C
11	Brick	Brick-making technology improvements (Vertical Shaft brick kilns)	B
12	Steel	WHR-based power generation	A
13		Sintering plant heat recovery	A
14		BOF gas sensible heat recovery	A
15		Hot charging in rolling mill	A
16		Variable speed drives in steel making	A
17		Coke Dry Quenching	B
18		Heat recuperation from hot blast stoves	B
19		Natural gas injection in BF	B
20		Pulverized coal injection (PCI) in blast furnace	B
21		Continuous casting	B
22		Installation of top pressure recovery turbine	B
23	Refinery	Online furnace cleaning	A
24		Optimization of power consumption in utility boiler drives and auxiliaries	A
25		Steam savings by trap management	A
26		Condensate recovery	A
27		Flare gas recovery and utilization for process heating requirements	A
28		Installation of low excess air burner	A
29		Oil recovery from crude tank bottom sludge by chemical treatment	A

30	Fertilizer	Calcium Silicate Insulation of High Pressure Steam Pipe Line	A
31		High Conversion Rate Synthesis Reactor	A
32		Installation of Variable Speed Drives for Cooling Tower Fans in Fertilizer	A
33		Steam Trap Management	A
34		Heat Recovery from MP Decomposer Vapors in Urea Plant by Installation of PreConcentrator	B
35		Isothermal CO Conversion Reactor	B
36	Pulp and paper	Waste heat recovery from paper drying	A
37		Black liquor gasification	A
38		Heat recovery in thermomechanical pulping	B
39		RTS pulping	B
40		Extended nip press	B
41		Increased use of recycled pulp	C
II. Energy			
42	Power generation	Coal power generation (USC)	A
43		Solar PV generation	A
44		Natural gas power generation	A
45		High efficiency power generation transmission line	A
46		High efficiency transformer	A
47		Biomass power generation	B
48		Biogas power generation	B
49		Small hydro power generation	C
50		Wind power generation	C
III. Transportation			
51	Mode shift	Passenger - Urban railway (Metro, LRT, monorail)	A
52		Freight - Shift from road to railway (Introduction of new freight car, large size container)	A
53		Freight - Shift from road to railway (Renovation of rail tracks)	A
54		Passenger - Bus (Bus route development/improvement)	A
55		Passenger - Inter-city railway (Renovation of rail tracks)	B
56		Passenger - Inter-city railway (High speed railway)	B
57		Passenger - Bus (BRT)	B
58		Passenger - Inland waterway (River bus/boat)	B
59		Passenger - Promotion of public transportation (IC card, automatic ticket gate)	B
60		Passenger - Promotion of public transportation (Bus location system)	B

61	Mode shift	Passenger - Promotion of public transportation (Park & Ride (e.g. Mechanical parking tower))	B
62		Freight - Shift from road to railway (Development/improvement of railway freight terminal/ ICD and set up necessary equipment, e.g. hightop lifter at rail freight terminals)	B
63		Shift from road to waterway (Development/improvement of port and related equipment)	B
64		Freight - Shift from road to waterway (Development of harbor road)	B
65		Passenger - Multimodal promotion (Connection between different mode of transportation (Combination of multiple measures))	C
66		Freight - Shift from road to railway (Development of access railways to ports)	C
67		Freight - Shift from road to waterway (Development/improvement of canals)	C
68		Freight - Multimodal promotion	C
69	Energy efficiency	Road - Improve fuel efficiency of vehicle (Low emission vehicle (High fuel economy vehicles, not including Hybrid/ Electric/ CNG/ LPG))	A
70		Road - Improve fuel efficiency of vehicle (Eco-driving for drivers (safety and environmental friendly driving and maintenance/technology to improve fuel efficiency such eco-tire))	A
71		Road - Improve fuel efficiency of vehicle (Eco-driving for freight vehicle (safety and environmental friendly driving and maintenance/ technology to improve fuel efficiency such eco-tire))	A
72		Road - Improve traffic flow (ITS (Traffic control center, Intelligent traffic signals (including LED), ETC), IOT)	A
73		Road - Improve traffic flow (Parking management)	A
74		Road - Improve traffic flow (Infrastructure (Road (bypass, ringroad), pavement utilizing recycled material, fly-over, bridges, tunnels))	A
75		Road - Others (LED lights for highways)	A
76		Road - Others (High efficiency transformer for electricity supply for tunnel (at construction and operation))	A
77		Railway - Intercity railway (Engine and locomotive renovation)	A
78		Inland waterway and Maritime - Port (Energy efficient cargo handling machinery)	A
79		Inland waterway and Maritime - Port (Renewable energy, e.g. PV system)	A
80		Aviation - Airport (Renewable energy, e.g. PV system)	A
81		Aviation - Airport (Electric vehicles)	A
82		Aviation - Airport (LED lights)	A
83		Road - Improve fuel efficiency of vehicle (Fuel car labeling)	B
84		Road - Others (Promotion of bicycle use (e.g. bicycle Lane))	B
85		Railway - Urban and inter-city railway (Energy efficient appliances and renewable energy for stations/depots (e.g. LED, PV system))	B
86		Inland waterway and Maritime - Port (Onshore power supply system)	B

87	Energy efficiency	Inland waterway and Maritime - Port (Energy efficiency chiller container)	B
88		Inland waterway and Maritime - Vessels (Technical renovation, transformation waterway vehicles, utilize vessels)	B
89		Inland waterway and Maritime - Vessels (Improve energy efficiency in ship building yard)	B
90		Aviation - Airport (APU (Auxiliary Power Unit) -> GPU (Ground Power Unit))	B
91		Aviation - Air craft (Modernize aircraft)	B
92		Road - Improve traffic flow (Traffic management (Truck ban, road pricing))	C
93		Road - Others (Freight Exchange Centre)	C
94		Railway - Urban and inter-city railway (Energy efficient railway vehicle (Light weight vehicle, VVVF, regenerative braking system, electricdiesel hybrid railway vehicles))	C
95		Railway - Inter-city railway (Improve fuel economy)	C
96		Railway - Inter-city railway (Electrification)	C
97	Fuel switching	Gaseous fuel - CNG, LPG (CNG for buses, trucks, taxis and waterways)	A
98		Biofuel - Ethanol	B
99		Biofuel - Biodiesel	B
100		Electricity - Hybrid (Hybrid buses/taxis/ bikes)	B
101		Electricity - Electricity (Electric buses/taxis/ bikes)	C
IV. Agriculture			
102	Agriculture	Increased Use of biogas (Biogas digester (small scale use for pigs, cattle, chickens and buffalos)	A
103		Reuse of agricultural residue as organic fertilizer (On-farm composting from agricultural residues)	A
104		Introduction of biochar (Small scale) (Biochar Manufacturing Equipment)	A
105		Introduction of biochar (Large scale) (Biochar Manufacturing Equipment)	A
106		Integrated Crop Management (ICM) in upland annual crop cultivation (Biochar Manufacturing Equipment)	A
107		Reuse of upland agricultural residue (On-farm composting for upland crop residues)	A
108		Alternate wetting and drying and Improved rice cultivation system (Small and Large scale) (Alternate Wetting and Drying)	B
109		Alternate wetting and drying and Improved rice cultivation system (Small and Large scale) (Solar pump for drainage system, coffee irrigation)	B
110		Integrated Crop Management (ICM) in rice cultivation (High Efficiency Pump)	B

111		Substitution of urea with SA fertilizer (Sulfate Amon (NH4)2SO4) (Energy Efficient Gas-based production unit)	B
112		Improvement of livestock diets (Lipid supplements for ruminants, feed-use amino acid (Lysine) for pigs and chickens	B
113		Improvement of quality and services available for aquaculture, such as inputs and foodstuff (Effluent treatment for livestock wastewater, food processing wastewater including aquaculture)	B
114		Improvement of technologies in aquaculture and waste treatment in aquaculture (Biomethanation and Power generation)	B
115		Improved irrigation for coffee (Drip irrigation)	B
116		Improved technologies in food processing and waste treatment in agriculture, forestry and aquaculture (High efficiency cooling for chilling and freezing facilities in cold chain process)	B
117		Improvement of processing technology and reuse of waste of livestock husbandry production for organic fertilizer (Biomethanation and Power generation)	B
118	Agriculture	Mid-season drainage (Solar pump for drainage system, coffee irrigation)	B
119		Improvement of Fishing vessel structure and planning/methods (LED lighting for squid fishing vessel)	B
V. LULUCF			
120	LULUCF	Protection of Natural Forest (1 million ha)	A
121		Protection of Natural Forest (2.2 million ha)	A
122		Rehabilitation of Mangrove (10,000ha)	A
123		Rehabilitation of Mangrove (30,000 ha)	A
124		Protection of Coastal Forest (100,000ha)	A
125		Natural forest regeneration (200,000ha)	A
126		Natural forest regeneration (400,000ha)	A
127		Regeneration of natural forests and production forests (400,000ha)	A
128		Long Rotation	A
129		Protection of Coastal Forest (100,000 ha)	A
130		Reducing emissions from forest degradation and deforestation (REDD+)	A
131		Scattered tree planting	B
132		CO_2 isolation by large scale plantation	C
VI. Waste			
133	Waste	Semi-aerobic landfill operation	A
134		Production of organic fertilizers from organic waste (composting)	B
135		Landfill gas (LFG) capture/recovery and energy utilization	B
136		Anaerobic treatment of organic waste with methane recovery for power and heat generation	B
137		WTE	B

138	Waste	Conversion to low-carbon fuel trucks for waste collection/haulage vehicles	B
139		Construction station of waste transfer	B
140		Recycling of solid waste	C
VII. F-gas			
141	F-gas destruction	Destruction of F-gas at Cement Kiln	A
142	Maintenance	Leakage inspection (Maintenance) of Refrigerator, Cold Storage and Air Conditioner of Commercial	A
143	Change Low GWP Refrigerant	Residential Refrigerator	B
144		Commercial Refrigerator	B
145		Air Conditioner	B
146		Automobile Air Conditioner	B

A: Options/technologies are of relatively higher priority and early deployment is recommended..

B: Options/technologies can be deployed when barriers are removed by arranging the deployment environment to some extent.

C: Long time may be required for technology deployment in order to arrange appropriate environment.

Source: Low Carbon Technology Assessment Contributing to Implementation of Viet Nam's NDC, The Project to Support the Planning and Implementation of NAMAs in a MRVable Manner (SPI-NAMA), 2018.

ANNEX 3. BRIEF INFORMATION OF SOME NATIONALLY APPROPRIATE MITIGATION ACTIONS IN VIET NAM

1. Readiness Plan for mitigation in the cement production sub-sector in Viet Nam (NAMA in cement production sub-sector)

Background:

- This NAMA is developed under the project on capacity building and support for development of GHG emission action plan for cement production supported by the Nordic Development Fund (NDF) and managed by the MOC.

- Key activities of the project include: 1) Development of a database and MRV system; 2) Develop baseline scenarios and GHG reduction options/ measures; 3) Establish a legal framework and implementation arrangement; 4) Financial arrangement; 5) Consultation and capacity-building for stakeholders.

Target:

Implement energy saving measures in the production of clinkers and cement to reduce electricity and fuel consumption.

Contents:

- To improve operational efficiency and introducing energy efficiency practices.

- To modern automation and monitoring system; improve the clinker coolers; improve the modern multi-channel combustion chamber; mixing process: coal slag as cement substitute; mixing process: ash as cement substitute; waste-heat recovery system for power generation; the best technologies available for other fuels to replace fossil fuels.

Quantitative goals/targets:

Estimated emissions reduction of 20 million tCO_2e by 2020 and 164 million tCO_2e by 2030.

Budget:

Budget for developing Action plan for GHG mitigation action in cement production sub-sector: USD 1.41 million from the NDF and USD 0.1 million from government counterpart co-financing for the capacity-building activities.

Expected budget for readiness stage: USD 3 million.

Expected budget for piloting the carbon-credit trade scheme: USD 10 million.

Annual operational cost up to 2030: USD 0.3 million.

Duration: 2016-2030

2. The project on low-carbon bus transportation in Viet Nam (NAMA in transport sector)

Background:

The NAMA was developed under the project "Creation of an overarching framework for NAMAs and MRV in Viet Nam" (GIZ/IMHEN NAMA Project) supported by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) together with Viet Nam Institute of Meteorology, Hydrology and Climate change (IMHEN), MONRE and the Department of Environment, MOT.

Targets:

Significantly reduce urban transport GHG and pollutant emissions in Viet Nam and contribute to sustainable development in the transport sector through:

- Apply of higher efficiency low-carbon buses.

- Increase frequency of bus use.

- Switch from private to public transport.

By 2025 all newly acquired buses in major cities of Viet Nam will be LCBs including diesel hybrid, plug-in hybrid and electric buses.

Contents:

- Provide financial and technical support to pilot hybrid buses in three major cities, then replicate in other provinces. From 2025, introduce hybrid electric buses and electric buses.

- Improvements in bus efficiency through measures such as efficient tyres, Eco Drive, idle-stop devices and telematics and improvement in operational efficiency of bus operators through measures such as route optimization and bus dispatch.

- Contribute to the improvement of public transport through measures such as improving bus services on existing routes; develop new routes; Integrated intelligent ticketing system linking buses and other public transportation facilities under construction such as metro, sky-train; measurement of GHG emissions of buses; and support national policy formulation.

Quantitative goals/targets:

Estimated emissions reduction of 10 $MtCO_2e$ by 2030.

Budget:

Expected budget for the first phase is Euro 20 millions to implement first phrase of NAMA.

Duration: 2019-2030

3. Promoting the use of Solar Water Heaters (SWH) and EE Air- Conditioners (AC) in residential and commercial buildings in Viet Nam (NAMA in building sector)

Background:

The NAMA proposal is developed under the International Climate Initiative (ICI) funded by the German Ministry of Environment (BMU) and the United Nations Environment Program (UN Environment) to support four Asia-Pacific countries including Indonesia, Philippines, Thailand and Viet Nam to implement mitigation actions for the building sector,

Targets:

- By 2020, convert 10% of existing air conditioning and heating systems to high performance air conditioning and solar water heating systems; capture and destruct 50% of refrigerant from air conditioners replaced.

- By 2025, convert 50% of existing air conditioning and heating systems to high performance air conditioning and solar water heating systems; capture and destruct 50% of refrigerant from air conditioners replaced.

- By 2030, convert 100% of existing air conditioning and heating systems to high performance air conditioning and solar water heating systems; capture and destruct 50% of refrigerant from air conditioners replaced.

Contents:

- Apply the labelling system, Energy Saving Company (ESCO) model to promote the use of high performance air conditioning and solar water heating systems.

- Convert and destruct high GWP refrigerant.

- Strengthen and raise public awareness.

Quantitative goals/targets:

Reduction of 20-25% of electricity consumption, estimated emissions reduction of 0.57 $MtCO_2e$ by 2030.

Budget:

USD 1,187 billion including: USD 1.184 billion for equipment investment and USD 3 million for capacity building activities.

Duration: 2018-2030

4. The project on energy saving for textile industry (NAMA textile)

Background:

- The NAMA was developed under the project "Creation of an overarching framework for

NAMAs and MRV in Viet Nam" (GIZ/IMHEN NAMA Project) supported by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) together with Institute of Meteorology, Hydrology and Climate change (IMHEN), MONRE and Department of Environment, MOT of Viet Nam.

- The textile industry is one of the sectors that consume more energy and cause many potential negative impacts on the environment and climate change.

- According to the requirements of potential customers, international brands increasingly concern on their responsibility on mitigation and the potential environmental risks from textile and cotton production enterprises. That context is putting a pressure on the textile industry in Viet Nam to comply with international trade agreements and commitments on export products.

Targets:

- Reduce GHG emission from textile industry by using of energy saving measures and the production of electricity from solar panels on the roof.

- Strengthen the competitiveness of the textile industry in the international market by enhancing the sustainability of the supply chain.

Contents:

- Address existing barriers to the adoption of energy saving measures and electricity generation from solar panels installed on the roofs of textile factories.

- Introduce policy measures to promote energy efficiency and electricity generation from solar panels in the textile industry.

- Establish a sustainable financing mechanism to support the implementation of the NAMA, such as the promotion of the ESCO model and the linkage between textile enterprises and third party investors.

Quantitative goals/targets.

- Save energy, reduce electricity consumption.

- Generate electricity from solar panels on the roof of the factories.

- GHG mitigation potential: 6.3 $MtCO_2e$.

Budget:

The total expected budget is USD 438.1 million, of which USD 2.6 million is expected for technical assistance and USD 435.5 million is from enterprises and third party investors to implement NAMA.

Duration: expected for the period of 2019-2030