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ACRONYMS

ACI	Adaptive Capacity Index
ADB	Asian Development Bank
ASEAN	Association of South East Asian Nations
BOD	Biochemical Oxygen Demand
CaC03	Calcium carbonate
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CH4	Methane
CNG	Compressed Natural Gas
CO	Carbon monoxide
C02	Carbon dioxide
COP	Conference of the Parties
CSR	Corporate Social Responsibility
DNA	Designed National Authority
DNDMCC	Department of National Disaster Management and Climate Change
DSMIEE	Demand-Side Management/Energy Efficiency
EDL	Electricity Authority of Lao PDR
ENSO	El Nino Southern Oscillation
FNC	First National Communication
GCM	Global Circulation Models
GEF	Global Environment Facility
GDP	Gross Domestic Product
GIO	Greenhouse Gas Inventory Office
GISTDA	Geo-lnformatics and Space Technology Development Agency (Public Organization)
Gg	Gigagrams
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Inventory
GoL	Government of Lao People's Democratic Republic
GPG	Good Practice Guidance
GWP	Global Warming Potential

HFCs	Hydro:fluorocarbons Intergovernmental
IGO	Organization Intergovernmental Panel on
IPCC	Climate Change Integrated Water Resource
IWRM	Management Japanese International
JICA	Cooperation Agency Kyoto Protocol
KP	Lao People's Democratic Republic
LaoPDR	Least Developed Country
LDC	Liquefied Petroleum Gas
LPG	Land use, land use change and forestry
LULUCF	Land use change and forestry
LUCF	Megajoule
MJ	Ministry of Natural Resources and Environment
MONRE	Ministry of Agriculture and Forestry
MAF	Mekong River Commission
MRC	Megawatt
MW	Nationally Appropriate Mitigation Action
NAMA	National Adaptation Program of Action
NAPA	National Capacity Self Assessment
NCSA	National Environment Committee
NEC	National Growth and Poverty Eradication Strategy
NGPES	National Institute for Environmental Studies
NIES	Non-Methane Volatile Organic Compounds
NMVOCs	National Steering Committee
NSC	National Steering Committee on Climate Change
NSCCC	National Social and Economic Development Plan
NSEDP	Seventh National Social and Economic Development Plan
NSEDP7	Nitrogen dioxide
N20	Nitrous oxide
NOx	Non-Timber Forest Product
NTFP	Asian Pacific Regional Space Agency Forum
PARSAF	Per:flourocarbons
PFCs	Quality Assurance/Quality Control
QNQC	Reducing Emissions from Deforestation and Forest Degradation
REDD+	

REPI	Rural Electrification APL Phase I Project
SAR	Second Assessment Report
SEI	Sensitivity and Exposure Index
SF6	Sulphur hexafluoride
Si02	Silicon dioxide
SNC	Second National Communication
S02	Sulphur dioxide
SOx	Sulphur oxide
STEA	Science, Technology and Environment Agency
TJ	Terajoule
TWG	Technical Working Group
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
V&A	Vulnerability and Adaptation Assessment
WB	World Bank
WREA	Water Resource and Environment Administration

CHAPTER 1

NATIONAL CIRCUMSTANCES

1.1 Introduction

Lao PDR ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1995 and the Kyoto Protocol in 2003. As a party to the Convention, the country has actively participated in the Convention process and submitted the First National Communication (FNC) to the UNFCCC in 2000 as part of its commitments. The FNC summarized national circumstances, inventory, mitigation measures, and financial and technical constraints and support needs.

After submitting the FNC, activities have included development of Enabling Activities II, a National Capacity Self Assessment (NCSA) and a National Adaptation Programme of Action (NAPA).

In 2008 the National Steering Committee on Climate Change Strategy, chaired by the Deputy Prime Minister, was established to formulate climate change strategies, programmes and projects for Lao PDR, beginning a critical policy process. Under the National Steering Committee, eight technical working groups staffed by representatives of concerned line Ministries and stakeholders also were created. The Water Resource and Environment Administration (WREA) was designated as the national focal point and empowered to coordinate all climate change matters; it also was named the designated national authority (DNA) for Clean Development Mechanism (CDM) projects.

As a result of Lao PDR's special attention to climate change within a broader global perspective, the Government (GoL) in 2009 revised the mandate of the National Environment Committee, also chaired by the Deputy Prime Minister, to include climate change in its duties and responsibilities.

The National Strategy on Climate Change thus was approved in early 2010, with a vision "to secure a future where Laos is capable of mitigating and adapting to changing climatic conditions in a way that promotes sustainable economic development, reduces poverty, protects public health and safety, enhances the quality of Lao PDR's natural environment, and advances the quality oflife for all Laotians."

The National Strategyt served as the framework for mainstreaming climate change in the 7th National Social Economic Development Plans (NSEDP-7). Within the NSEDP-7, the overall goal was to prioritize both economic development and poverty reduction in the national response to the impacts of climate change. The GoL also is pursuing a policy of working in partnership with international organizations and other States to develop capacities in this regard.

1.2 Geographical and Physical Characteristics

1.2.1 Geographical Characteristics

Lao PDR, a landlocked country sharing its borders with five other nations, lies in the lower Mekong basin of the Indochina Peninsula. It stretches 1,700 km from north to south and 100 to 400 km from east to west, for a total surface area of 236,800 km^2. Some 80 percent of the country's land areat largely in the north, is mountainous. The remaining 20 percent is low plain lying along the Mekong River and threatened by annual floods. The altitude ranges from 104 metres above sea level in Attapeu to 2,820 metres in Xiengkhuang, at Phoubia Mountain. More than two-thirds of Lao PDR's people live in the south and central parts of the country.

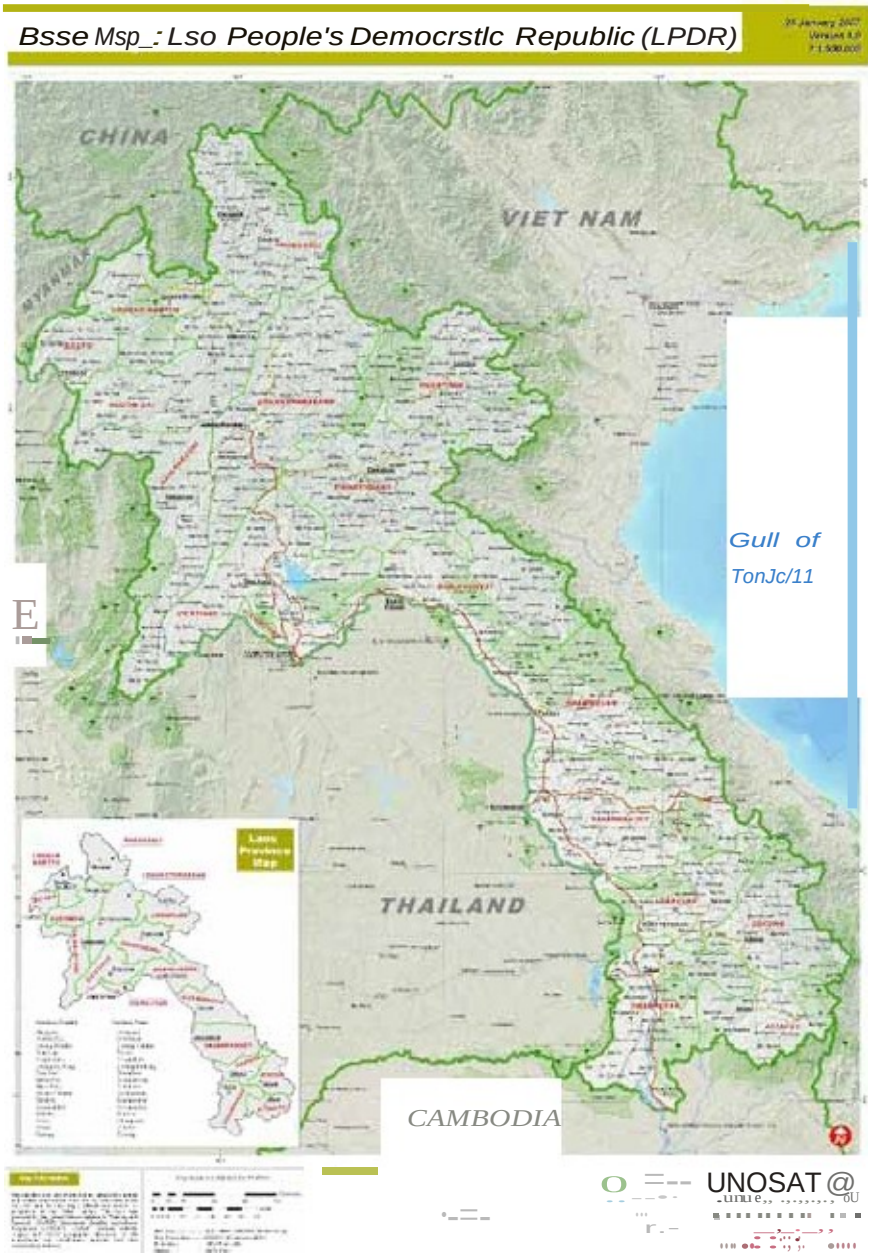
The principal waterway, the Mekong River, flows 1,898 km from north to south through Lao PDR. Water from many small rivers or tributaries represents a vital natural resource for national social and economic development, particularly for agriculture and hydroelectricity generation. Agriculture is the most important economic sector for the country, while the generation of electricity from hydropower serves as the core of the national strategy to turn Lao PDR into the prime producer of electricity for Southeast Asia.

Based on altitude, the country is generally divided into three regions:

- The mountainous regions, rising over 1,000 metres above sea level, with high humidity, average annual precipitation of 1,500 to 2,000mm, and temperatures generally cooler than other parts of the country
- Areas in the mountain regions of the central and southern parts of the country, with an altitude generally between 500-1tooo metres, high temperatures and average annual precipitation of 2,500 to 3,500mm
- The central plains region, which includes the alluvial basin of the Mekong

River as well u its principal trib'D1aries, with 11opical temperaturea aDd average llDilual precipila1ion of l,SOO to l,OOOmm

Figure 1-1:Map ofLaoPDR



Lao PDR.'s clim.BW is gRBtly iD!Iualcecl by 11opical typhooDS from 1hc soutb.wC$t aDd man.soo!IS from the DOitheast, resulliDg inheavy Iainfa1l and high humidity. Tllo cowtry's wealh« eJKXJUJfrfiSSIIII two distinct SIIIIISOIIS: the wet orrainy season fulm May to Septsnberl

October, with a mean annual precipitation of 1,300 to 3,000mm, and the dry season from late October to April, with average annual precipitation of 1,950mm. The temperature generally ranges from 20 CO in the northern and eastern mountainous regions and on the high plateau to 25-27 CO in the lowlands and the plains.

1.2.2 Natural Resource Endowment

Lao PDR is rich with natural resources, with the most important being water, forest and mineral resources. During the past three decades of social and economic development, utilization of these resources has resulted in substantial lessening in natural resource stocks. This section summarizes the development of these resources.

1.2.2.1 Water Resources

Lao PDR is particularly rich with water resources, including the Mekong's tributaries and countless smaller water bodies. These tributaries contribute greatly to national macroeconomic development as well as livelihoods oflocal communities.The Mekong's 12 major tributaries in Lao PDR supply some 247 billion cubic metres of annual surface runoff, representing 35 percent of Mekong water flowing into its alluvial basin. Total available surface water resources of332.5 km^3 are the equivalent of more than 55,000 m^3 per capita per year. Nonetheless, use of these resources has yet to reach its potential, with only 2.8 percent explored thus far. Moreover, hydropower development to date stands at less than 10 percent of the estimated potential.

Water demands in the country remain low in terms of per-capita public consumption. At the same time, development of water resources is particularly increasing with regard to hydropower and irrigation systems. Overall, national water resource development continues to be a mix of opportunities and challenges. Strengthening of an Integrated Water Resource Management (IWRM) framework will particularly be essential to support the broader goals and strategies of inclusive economic development.

The IWRM approach was largely adopted in Lao PDR in the late 1990s and has been mainstreamed at both national and sub-regional levels. In 1995 the GoL had established the Lao National Mekong Committee to coordinate policies, programmes, strategic plans and studies with regard to Mekong development projects among line Ministries and other agencies. Two years later, it also established the Water Resource Coordination Committee and its Secretariat. This committee specifically coordinates with line agencies at national level in developing strategies and action plans, programmes and regulations necessary

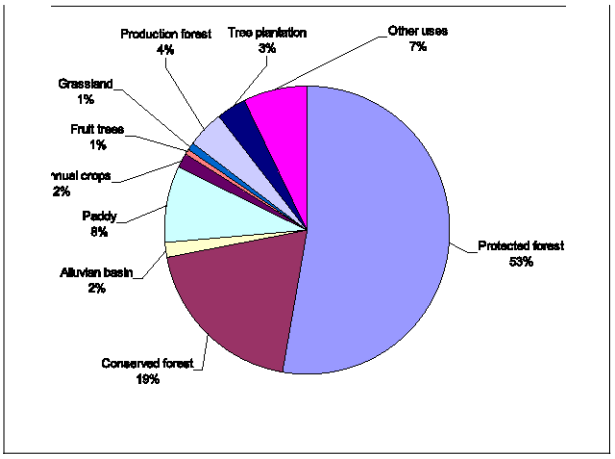
for the planning, management, use and protection of all water and water resources.

To further strengthen IWRM, during the past two years the Water Resource and Environment Administration (now Ministry of Natural Resources and Environment, or MONRE) has developed a National Water Resources Policy, Strategy and Action Plan. The draft policy aims to promote a comprehensive approach to sustainably manage water resources through stakeholder participation and assessment of the negative impacts of socioeconomic development on water resources. This policy is expected to be implemented by various Ministries and sectors under the coordination of the Lao National Mekong Committee and inter-agency bodies at basin level.

1.2.2.2 Land Resources

Of Lao PDR's total of 23.6 million hectares, about 17 million hectares are protected or conserved forests, 1.8 million hectares are production forest, and the remaining areas are agriculture and other land uses. Nearly three-quarters of the agricultural land use is paddy land, with the remainder comprising other annual crops, fruit trees and grassland. Shares of different types of land uses are shown in Figure 1-2.

Figure 1-l:Distribution of land resource by type of use, 2009 (percent)



Source: National Land Management Authority, 2009

Very recent changes in agricultural land use require special ad urgent attention. Evidence from the north of the country suggests that maize is replacing upland rice and, indirectly, reducing the rotation period of upland rice plots. The area planted with maize nearly tripled between 2005 and 2010, from 86,000 hectares to more than 212,000 hectares.

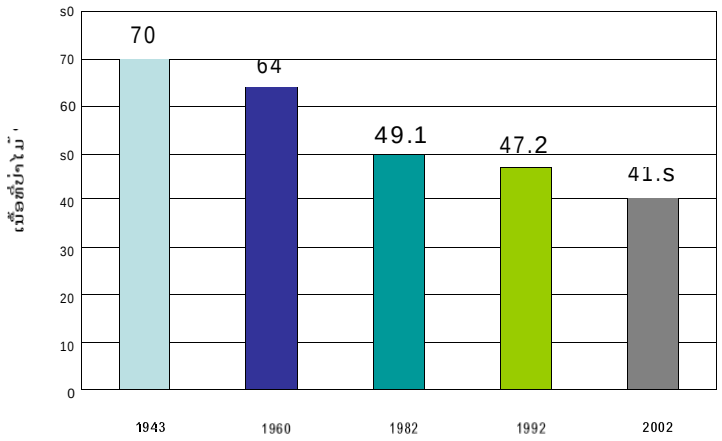
Critically, such expansion is frequently followed by planting on fallow land, substituting other crops or encroaching on forest areas. Because maize is planted in the same plot every year, this is exposing the land to high soil erosion and unsustainable use.

1.2.2.3 Forest Resources

Forest resources comprise one of the most important renewable resources in Lao PDR. These resources help regulate surface water runoff, preserve hydrological systems and protect watersheds, while contributing substantially to the national economy. Forest biodiversity also supports ecosystems and protects wildlife. In 2001, log production contributed 3.2 percent of national GDP (National Statistics Office, 2004); this share would have been higher if subsistence use and processing of wood and non-timber forest products were included. In terms of energy consumption, charcoal and fuelwood are the dominant sources of energy for cooking, even in Vientiane. These also provide heating during the winter in highland areas.

Forest resources are decreasing rapidly, however. About 41.5 percent of the country's land area was covered by forest in 2002, compared to 64 percent in 1960 and 70 percent in 1943 (Figure 1-3) (Ministry of Agriculture and Forestry, 2002). Moreover, in 2002 only 20 percent of the land area was covered by dense dominant and co-dominant canopy trees, a further warning sign of deteriorating resources. Other changes in natural forest encompass not only a reduction of quantity and the structural alteration of forest land, but also the decline and extinction of wildlife and biodiversity.

Figure 1-3: Forest cover in Lao PDR (percent of total land)



Source: Department of Forestry, 2002

In recent decadesshifting cultivation became a major issue and required rapid Government response. In 1990for example, more than 210 000 rural households still practiced traditional shifting cultivation as part of their livelihood, causing the deforestation of 245,887 hectares annually. Launch of community-based forest management programmes from 1996 to 2005 has helped to address this issue.

Recently the nation's forest cover has been classified in three groups in line with the amended Forestry Act of2007, down from the previous five.Thus, as of2010 6.9 million ha out of a total of 13.5 million ha of forest area were considered protected forestwhile 3.6 million ha were conserved forest and 3.1 million ha were production forest.

1.2.2.4 Mineral Resources

Mineral resources likewise are an important contributor to the national economy, and the mining industry has expanded substantially during the past decade. Estimates of gold reserves total 32 million tonnes, with 12 million tonnes of alluvial gold. Further, 162 million tonnes of copper, 38 million tonnes of tinand 7 million tonnes of coal are believed to be available.

All mineral extraction increased between 2005 and 2008, with the exception of gold, silvertin and lead (Table 1-1). Illustrating the mining industry's rapid growththe industry's contribution to national GDP increased from less than 1 percent in 2000 to more than 3 percent in 2005 and 8 percent in 2010. The industry has also contributed strongly to rural socioeconomic development.

Table 1-1:Minerals extracted in Lao PDR, 2005-2008

Mineral	2005	2006	2007	2008
Gold+Silver (tonnes)	10.15	12.65	9.09	5.81
Copper (tonnes)	30,480.00	60,804.00	62,452.00	64,705.00
Copper concentrate (tonnes)		746.00	3,358.81	107,430.48
Tin (tonnes)	240.00	809.00	1,109.00	260.00
Barite {tonnes)	8,600.00	6,500.00	10,000.00	1,000.00
Lignite (tonnes)	358,637.88	319,242.00	681,715.00	600,000.00
Gypsum (tonnes)	109,787.00	206,104.00	232,250.00	586,866.00

Anthracite (tonnes)		62,000.00	131,972.00	158,490.17
Lead (tonnes)	3,500.00	2,249.00	2,350.00	600.00
Zinc (tonnes)	8,000.00	4,000.00	12,116.00	6,079.00
Limestone (tonnes)	190,440.00	430,000.00	450,000.00	911,654.00
Gravy (cu.m.)	58,719.00	900,150.00	943,000.00	214,772.00
Sand (cu.m.)	160,136.00	900,000.00	920,000.00	208,608.00
Construction M (cu.m.)				70,210.00
Soil (cu.m.)				4,012.00
FE (tonnes)			20,000.00	36,218.00

Source: Ministry of Energy and Mines, 2008

1.2.3 Environmental Characteristics

Social and economic development, combined with accelerating urbanization over the past decades, increasingly threaten environmental quality in Lao PDparticularly in the capital and other large cities. Pollution from solid waste, water and air effluents is on the rise. Solid waste and wastewater in large urban areas require special attention, while air quality is deteriorating notably in Vientiane.

The GoL is continuing its longstanding commitment to efforts to sustainably manage waste. It has been enabled by both domestic and foreign assistance and investments to build dozens of sanitary landfills as well as to acquire waste transport equipment and other much-needed machinery.[1] In Vientiane metropolitan area and other major cities, 17 sanitary landfill dumping sites have been constructed, with waste collection services provided in 38 major cities and metropolitan areas, either directly by municipalities or by private subcontractors. Nevertheless, these services cover only 40 percent of municipal waste nationwide, with the major constraints encompassing a lack of transport facilities, insufficient technical staff, and a need for stronger management. Effective public campaigns to reduce waste generation, emphasizing the "3Rs.. (reduce, reuse, recycle), also are necessary to counter widespread practices of burning trash in backyards or public areas or littering streets, canals and rivers.

Currently, total per-capita municipal waste is estimated to be about 0.75 kg per day. Overall composition of such waste is 30 percent generally degradable waste, 30 percent composite waste, and 40 percent recyclable waste (15 percent paper, 25 percent glass/cans/metals) (WREA, 2001). In generally, household waste is quantitatively proportional

1. For example, a soft loan was taken fromADB in 2004 on the Small Towns Development Sector Project to develop waste management schemes in 12 districts.

to market waste. Thus, with the introduction and implementation of good practices, the amount of waste generated could be substantially reduced.

1.3 Demographic Trends

Recently, Lao PDR has experienced an accelerating rate of population increase. Between 1995 and 2005, the population grew at an average of 2.1 percent per year; the 2005 census found 5.62 million people living in the country.Of this total, about half were younger than age 20, while about 13 percent were older than 60. Life expectancy for females stood at 63 years; for males, it was 59 years (Ministry of Planning and Investment, 2005). If the current population growth rate continues, a total of 7.3 million people are expected by 2020 (National Statistics Bureau, 2004).

The population density in Vientiane is highest, at about 150 persons per km^2, even as population density in most areas of the country remained low, at fewer than 11 persons up to 40 persons per km^2 (National Statistics Centre, 2005) The higher population densities, in addition those in the capital, are usually found in and around southern provincial metropolitan areas, as well as along the major communication corridors such as Highway 13 from Vientiane to Pakse and Saravanh. Meanwhile, the highest population concentration in the north is found primarily in the southern portion of Sayabouly and Luang Prabang Provinces, in key provincial districts, and along major highways.

Overall, the population in Lao PDR comprises various ethnic groups, who speak one or more of numerous dialects and hold a wide variety of beliefs. According to historians and ethnologists, at one time more than 200 ethnic minority groups were identified as speaking more than 170 dialects. However, by official classification 49 ethnic minorities are recognized (Decision of National Assembly No 213/NA, 24 November 2008). They are further grouped by lifestyle into four principal linguistic categories (Lao-Tai, Mon-Kmou, Hmong-Eevmien and Chinese-Tibetan).

1.4 Economic Development

National economic growth of Lao PDR has been high during the past decade, ranging between 6 and 8 percent annually. Per-capita income increased from US$490 in 2005 to US$1,069 in 2010 (Ministry of Planning and Investment, 2011). Structural change in the economy also is occurring along with economic development (Table 1-2), primarily a transformation from agriculture-dominated to dominance by other sectors. During 2005-2010, for example the top performer was the service sector, which rapidly and steadily

increased its share ofGDP, from about one-fourth to more than one-third. During the first decade of the 21st Century, meanwhile, the share of agriculture in GDP decreased from halfto less than one-third, and the industrial sector performed rather poorly, with its GDP share falling well short of high expectations. Inflation remained under control.

Across regions of the country, between 2006 and 2010 the South recorded the highest growth, followed by the Central region and the North. Nonetheless, the Southern region's per-capita Gross Regional Product (GRP) remained lower than those of the other regions. Sectoral shares of GRP did not vary significantly among regions (Table 1-3).

Table 1-2: Selected indicators of development over the Fifth (2001-2005) and the Sixth Five-Year Plans (2006-2010)

	2001-2005		2006-2010	
GDP growth(% per year)	Targeted	Achieved	Targeted	Achieved
Total	*7-7.5*	*6*	*7.6*	*7.9*
Agriculture and forestry	4-5	3.4	3.2	4
Industry	10-11	11.3	13.7	12.6
Services	8-9	6.7	7.3	8.4
GDP share (%)				
Agriculture and forestry	47	45.4	36	30.4
Industry	26	28.2	36.4	26.1
Services	27	26.4	27.6	37.2
GDP per capita (US$)	500-550	490	823	1,069
Inflation (%)	< 10	9.6	7	5.1

Note: GDP per capita refers to the end of each Plan
Source:Committee for Investment and Planning (2006); Ministry of Planning and Investment (2011)

Table 1-3:Gross, per-capita and sectoral share of Regional Product, 2006-2010

Region	Growth (%)	Sectoral share{%}			Per capita (US$}
		Agri.	Industry	Services	
North	8.45	55.63	21.2	23.07	771

Central	9.94	40.67	34.03	22.81	1,142
South	10.65	46.87	24.04	29.09	718

Source: Ministry of Planning and Investment (2011)

In the agriculture sector, crop production and related areas changed substantially, Production and planted areas of field crops, particularly maize, cassava and sugar cane, increased sharply during the past decade (Ministry ofPlanning and Investment, 2011). With heavy investment from China and other neighbouring countries, areas devoted to rubber plantations also have increased significantly.

As noted above, forestry also continues to contribute to the national economy and to rural livelihoods. Collection of NTFPs for household consumption and cash income remains common. The annual value ofNTFP production reached US$200 million, most of which was for fuelwood and charcoal (Ministry of Agriculture and Forestry, 2005).

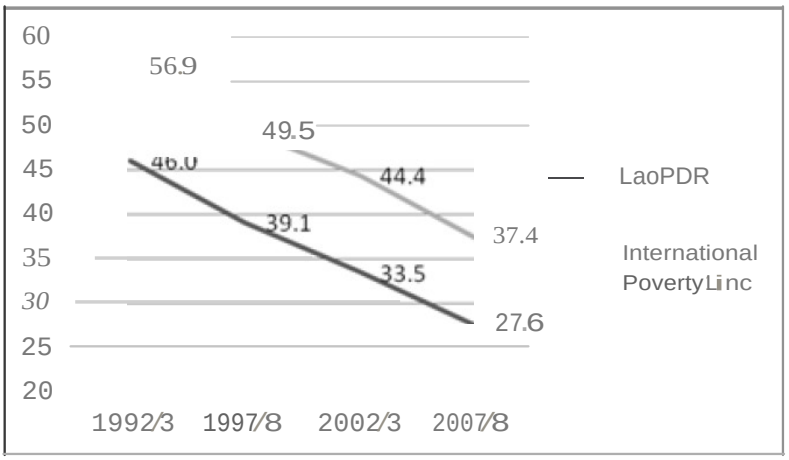
Hydropower development has become a critical focus of the National SocioEconomic Development Plan and of Government socioeconomic reform efforts. Numerous hydropower dams have been developed during the past decade to generate electricity, mainly for export. This has increased the total capacity of hydropower plants from 690 MW in 2005 to 2,583.73 MW in 2010 (Ministry of Planning and Investment, 2011). To further national efforts to become an "Asian battery" with regard to hydropower, the 7th NSEDP aims to develop an additional tO hydropower projects with a capacity of more than 5,000 MW, costing US$11.2 billion (Ministry ofPlanning and Investment, 2011).

Lastly, mining revenue rose dramatically between 2003 and 2006, from US$143 million to US$620 million. Income from mining was expected to reach 10 percent of GDP by 2010. In addition, in 2009 national mining-related revenue from taxes, duties and fees generated US$256 million from the concession areas of about 17,000 km^2.

1.5 Social Development

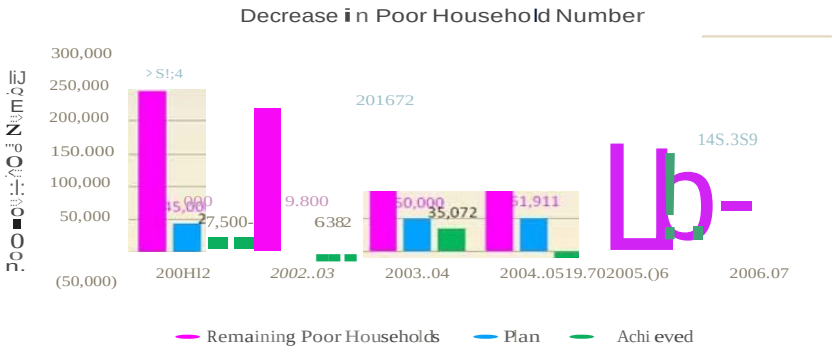
The Government prioritizes the elimination of poverty by 2020; since the early 1990s, the poverty rate has been declining steadily (Figure 1-4). However, between 2001 and 2007 the poverty reduction policy failed to meet its overall target as a result of a number of factors, including national budget constraints, accessibility of remote regions, and people's deeply rooted dependence on natural resources. Natural disasters and extreme climate events such as flooding in 2004-2005 exacerbated the situation (Figure 1-5).

Figure 1-4: Headcount of poverty incidence using national and intemational poverty lines, 1992-1993 to 2007-2008



Source; Lao Statistics Bureau. *Poverty in Lao PDR,* 2008

Figure 1-5: Planned and achieved targets of poverty reduction, 2000-2007



Source; Ministry of Planning and Investment

National human development indicators are increasing notably. In education, the proportion of students attending primary schools increased from less than 80 percent in 2000 to about *85* percent in 2005 and more than 90 percent in 2009. Adult literacy increased to 74 percent in 2005 (Ministry of Planning and Investment, 2011). Overall, the education network has improved, with an emphasis on regions and communities, and the numbers of primary, secondary and higher secondary schools have increased

gradually during the past decade. Vocational, university and higher education also have been developed, with two branches of the national university opened in the south and the north and a number of vocational and technical schools established.

As a result of health system development since 2000, the people's health has improved significantly. By 2005, the Infant Mortality Rate had fallen to 70 per 1,000 live births, while the Under-5 Mortality Rate also reduced to 98 per 1,000. The Maternal Mortality Ratio, although still unacceptably high, likewise reduced to 405 per 100,000 live births. The country has been able to meet 48 percent of the population's demand for medicines from local production.

The number of health service centres also increased, with four central hospitals, 12 provincial hospitals, four regional hospitals, 127 district hospitals, 793 health centres, and 6,707 hospital beds in the country in 2010. In aggregate, however, the number of beds has not increased notably. In addition, attention should be paid to the fact that, by location, it is clear that improvement was made mainly in terms of central hospitals (Table 1-4).

Table 1-4: Number of beds by types of hospitals, 2005-2010

Item	2005	2006	2007	2008	2009	2010
Total	6,736	6,636	6,955	7,115	6,425	6,707
Central hospitals	660	835	940	810	825	856
Curative centres	160	160	140	120	120	120
Regional hospitals	907	632	675	675	675	675
Provincial hospitals	985	985	1,559	1,559	884	930
District hospitals	2,366	2,366	1,304	1,845	1,845	1,845
Dispensaries	1,658	1,658	2,337	2,106	2,076	2,281

Source: Lao Statistics Bureau, accessed at http://www.lsb.gov.la/index.php?option=com_content&view=article&id=55&Itemid=80&1ang=lo

Despite concerted efforts by the GoL, many social services remain inadequate and lag behind those of neighbouring countries. In 2009, for example, only 57 percent of the population had access to clean water and 53 percent to improved sanitation. Proportions were lower in rural areas (Ministry of Public Health, 2009). Dengue fever showed a distinct upward trend that year, with 7,810 cases and 19 casualties, compared to 4,328 cases and

22 deaths in 2008. Measles also was reported to be on the rise, from 76 cases in 2008 to 189 in 2009. Undernutrition among young children remains very high,with 40 percent of children younger than age 5 years found to be underweight. In addition, 41 percent of children and 36 percent of women are reported to have iron deficiency anaemia, which gives rise to significant nutritional and child development issues.

1.6 National Development Policies and Plans

In 2004, the Government adopted the National Growth and Poverty Eradication Strategy (NGPES) with the goal of graduating from the group of Least Developed Countries (LDCs) by 2020. The NGPES presents a holistic, ecologically sound strategic approach to national development, involving all sectors and all policy areas as well as cross-sectoral priorities. Further, the NGPES was the framework for the Sixth Five-Year National Socioeconomic Development Plan (NSEDP 2006--2010), which paved the way for a series of strategies, legal and regulatory frameworks, and institutional arrangements directly linked to the protection and rationally sustainable use of the national resource base.

The Seventh Five-Year NSEDP (NSEDP-7, 2011-2015) continues the dynamic objectives of the Sixth Plan and has an important role in realizing the aims ofNinth Party Congress Resolution to achieve socioeconomic development by 2020. It is expected to take firm steps to move the country toward LDC graduation.

The Seventh Plan consists of four dynamic objectives, namely: (1) dynamic in imagination, (2) dynamic in human resource development, (3) dynamic in mechanisms, regimes and administrative rules; and (4) dynamic in poverty reduction.The basic aims of this Five-Year Plan are to achieve the human development objectives of the Millennium Development Goals (MDGs); to build primary foundations for industrialization and modernization of the country; and to integrate with regional and international development by 2015.The Plan has drawn up the following key targets:

Item	Target by 2015
Total population (million persons)	6.9
GDP at current prices (US$ million)	11,929
GDP growth (percent per year)	>8

Agriculture	3.5
Industry	15
Services	6.5
Share of total GDP (percent)	
Agriculture	23
Industry	39
Services	38
GDP per capita (US$)	1,700
Poverty ratio (percent)	19
Proportion of poor households with access to electrification to total households (percent)	80

Source: Ministry of Planning and Investment, 2011

With total GDP growth expected to be slightly higher than that recorded during the last Plan, more emphasis is to be given to the industrial sector than to the services sector. Agriculture's share of national GDP will be further reduced. All this is expected to result in a 70 percent increase of per-capita income in 2015 compared to 2010.

1.7 Climate Change Policy

Since its ratification of the UNFCCC, the GoL has actively and consistently participated in processes related to the Convention. National climate change policy originally was under the Science, Technology and Environment Agency (STEA) of the Prime Minister's Office, with a National Greenhouse Gas Inventory Committee and a related Technical Working Group established. At that time, climate change was not well understood, not only by the public but also by some public agencies and technical experts. Yet a deep understanding of climate change impacts is particularly critical for Lao PDR, given the high importance of water and forest resources to the economy in general and to the agriculture sector and rural households in particular. Development of Enabling Activities II and other projects, such as theNational Capacity Self Assessment (NCSA) and the National Adaptation Plan of Action (NAPA), have now substantially enhanced domestic understanding and awareness on climate change and its potential threat Such a threat has been further confirmed by the recent devastating damage from climate-induced floods and droughts in the country.

The GoL has paid special attention to climate change impacts and mainstreamed climate change factors into overall sustainable development as well as into sectoral plans. To integrate climate change concerns into national development planning, the Government

instructed the WREA[2] to develop a climate change strategy combining this objective with the need to maintain the natural resource base during implementation of the NGPES.

Under the guidance of the National Steering Committee on Climate Change (NSCCC), eight cross-sectoral working groups were established to assess climate change issues, particularly related to mitigation and impact, and to identify priority actions. The first National Climate Change Strategy was officially endorsed in March 2010.

This strategy took into account a number of other development strategies, including the National Environment Strategy, Forest Strategy, Agriculture Strategy, Strategy for Water Resource Development, Energy Strategy, and National Disaster Strategy. It was then integrated into NSEDP-7.

The goals of the National Climate Change Strategy are aligned with vision of sustainable development, povertyreduction, enhancedqualityofthenatuml environment, and strengthened public health for all Lao people. Specifically, they aim to:

a) Reinforce the Sustainable Development Goals of Lao PDR, including measures to achieve low-carbon economic growth

b) Increase the resilience of key economic sectors and natural resources to climate change and its impacts

c) Enhance cooperation and partnerships with national stakeholders and international partners to implement national development goals

d) hnprove stakeholders• public awareness and understanding about climate change vulnerabilities and impacts, GHG emission sources and their relative contributions to climate change, and how climate change will affect the national economy, thereby increasing stakeholder willingness to take action

Based on these strategic goals, major strategic priorities for adaptation and mitigation are identified in the following key sectors:

a) Agriculture and food security

b) Forestry and land use change

c) Water resources

d) Energy and transport

2 The WREA resulted from the reorganization of the Science, Technology and Environment Administration in 2006.

e) Industry

f) Urban development

g) Public health

All sectors have adaptation strategies, and all except water resources and public health have mitigation strategies. The former Department of Environment of WREA (now MONRE) also has been expanded into three departments: Department of Environmental Promotion, Department of Pollution Control, and Department of National Disaster Management and Climate Change, with the latter designated as the national focal point for the UNFCCC.

CHAPTER 2

NATIONAL GREENHOUSE GAS INVENTORY FOR 2000

2.1 Introduction

As required by Decision 17/CP.8 of the UNFCCC, each Non-Annex I Party shall, in accordance with Article 4(a) and Article 12, paragraph 1(a), of the Convention and to the extent that its capacity permits, communicate to the Conference of Parties (COP) a national inventory of anthropogenic emissions by sources and removals by sinks of the greenhouse gases (GHGs) not controlled by the Montreal Protocol.

The National Greenhouse Gas Inventory (GHGI) forms a key element of the National Communication on Climate Change. The GHGI for the first national communication (FNC) of Lao PDR was conducted in 1997, using 1990 as the base year as mandated. Subsequently, Lao PDR's FNC was submitted to the UNFCCC in November 2000.

For this Second National Communication (SNC), the GHGI was prepared using 2000 as the base year. With support from the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP), the WREA, produced the GHGI for 2000 in collaboration with relevant agencies. Its successor the Ministry of Natural Resources and Environment, established in 2011, continued this work. Five Technical Working Groups (TWGs) were established to coordinate among agencies and provide activity data for inventory preparation. To strengthen the TWGs'capacities, various trainings and technical consultation workshops were carried out.

2.2 Scope, Time Frame and Methodology

The inventory examines the emission by sources and removal by sinks of GHGs in the following five sectors:

a) Energy

b) Industrialprocesses

c) Agriculture

d) Land-use change and forestry

e) Waste

The inventory is estimated in units of mass; by sources and removals by sinks; and by anthropogenic emissions of carbon dioxide (CO_2); methane (CH_4) and nitrous oxide (N_2O), including carbon monoxide (CO) and nitrous oxides *(NO)*, Non-Methane Volatile Organic Compounds (NMVOCs) and sulphur dioxide (SO_2) Hydrofluorocarbons (HFCs), Perflourocarbons (PFCs) and sulphur hexafluoride (SF_6) are not included because the data are inadequate and the consumption and emissions are likely to be negligible.

The estimation and reporting of this national GHGI followed the revised 1996 guidelines of the Intergovernmental Panel on Climate Change (IPCC) and used UNFCCC software, IPCC Good Practice Guidance (GPG) and UNFCCC Improved Reporting Guidelines. All emissions factors are IPCC default values. Uncertainty management also was conducted.

The Global Warming Potential (GWP) used for conversion of other gases to CO_2 equivalence follows the values provided in the Second Assessment Report (SAR) of IPCC (IPCC, 1996) (Table 2-1).

Table 2-1: GWP for 100 years and the atmospheric lifetime (CO_2 equivalent)

GHG	Chemical and formula	Lifetime	GWP
Carbon dioxide	CO_2	50-200	1
Methane	CH_4	12	21
Nitrous oxide	N_2O	120	310

Source: IPCC (1996)

Because not all data were available for the inventory year, particularly those related to fuelwood, charcoal, solid waste, fertilizer, burning of savannah, agriculture residues and land-use change and forestry (LUCF), an average value for several years is used for certain activities (Table 2-2). This approach is recommended in the IPCC guidelines.

Table 2-2:Sub-sector or activity time periods other than 2000 used in calculating national inventory

Sub-Secr	Activity	Averag time peno s
boob of v		1999-2001
Field burning of agricultural residues		1999-2001
Changes in forest and other woody biomass stock	Plantation	1967-2000
	Harvest of fuelwood	1999-2000
Forest and grassland conversion		1992-2002
J\bandODEnentofntWnagooland	J\bandODEnent of forest for 20 years	1992-2002
CO_2 from biomass		1999-2000

2.3 Institutional Arrangements and Report Preparation Process

2.3.1 Institutional Arrangements

Preparation of the national GHGI was conducted by Department of National Disaster Management and Climate Change (DNDMCC)t with the close collaboration and coordination of the Technical Working Groups and other stakeholders. The organizational structure for inventory preparation is shown in Figure 2-1.

Technical Working Groups (TWGs) are groups of specialized technical personnel which act as focal points to provide data as well as verify the accuracy and relevance of the data within their own sectors. The TWGs are also respons1ble for providing feedback and comments to the inventory particularly with regard to the structure and contents of the report, including dataused The TWGs consist of representatives from the (former) Department of Environment; Department of Forestry; Department of Livestock; Department of Forest Inventory and Planning; Department of Meteorology and Hydrology; Department of Water Resources; National Agriculture and Forestry Research Institute; Faculty of Environmental Science and Faculty ofForestry (National University of Laos); Department of Import and Export; Department of Industry; Department of Electricity; Department of Geology and Mining; Department of Urban Planning and Housing; Department of Transport; and Urban Development Administrative Authority.

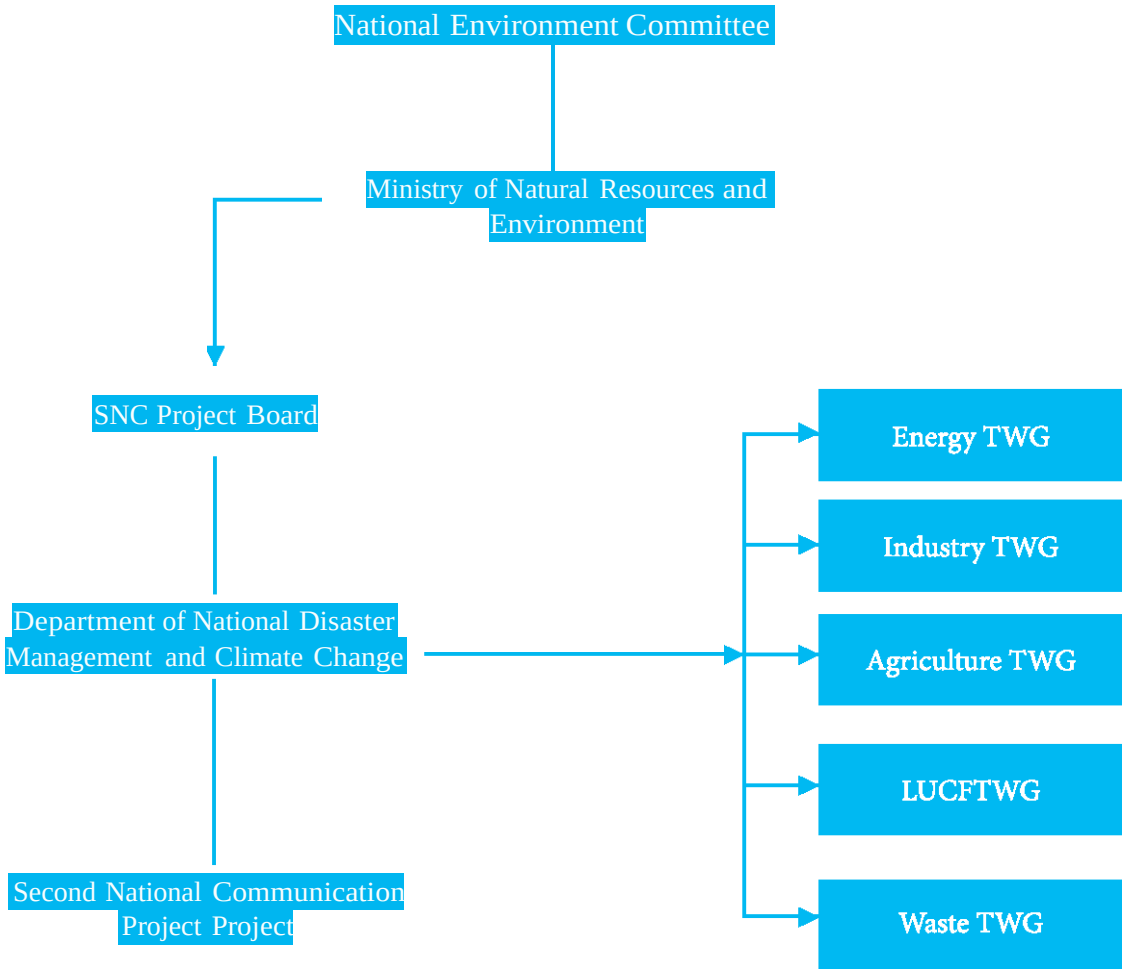
Department of National Disaster Management and Climate Change (DNDMCC). As the UNFCCC focal point under MONRE, DNDMCC has the overall responsibility of monitoring, supervising and guiding the TWOs, seeking feedback on the national GHGI and reporting to MONRE and the National Environment Committee on progress and results of the inventory.

Ministry of Natural Resources and Environment (MONRE). As a standing body of the NEC, the Ministry has the overall responsibility to provide guidance and direction to DNDMCC and to report to the NEC on progress and results of the inventory.

SNC Project Board oversees the actual preparation of the Second National Communication, including the GHGI. Board members comprise representatives of relevant Ministries.

National Environment Committee is the interagency body that provides overall policies and approval for the National GHG Inventory Report.

Figure 2-1:Organizational structure for the National GHG Inventory Report



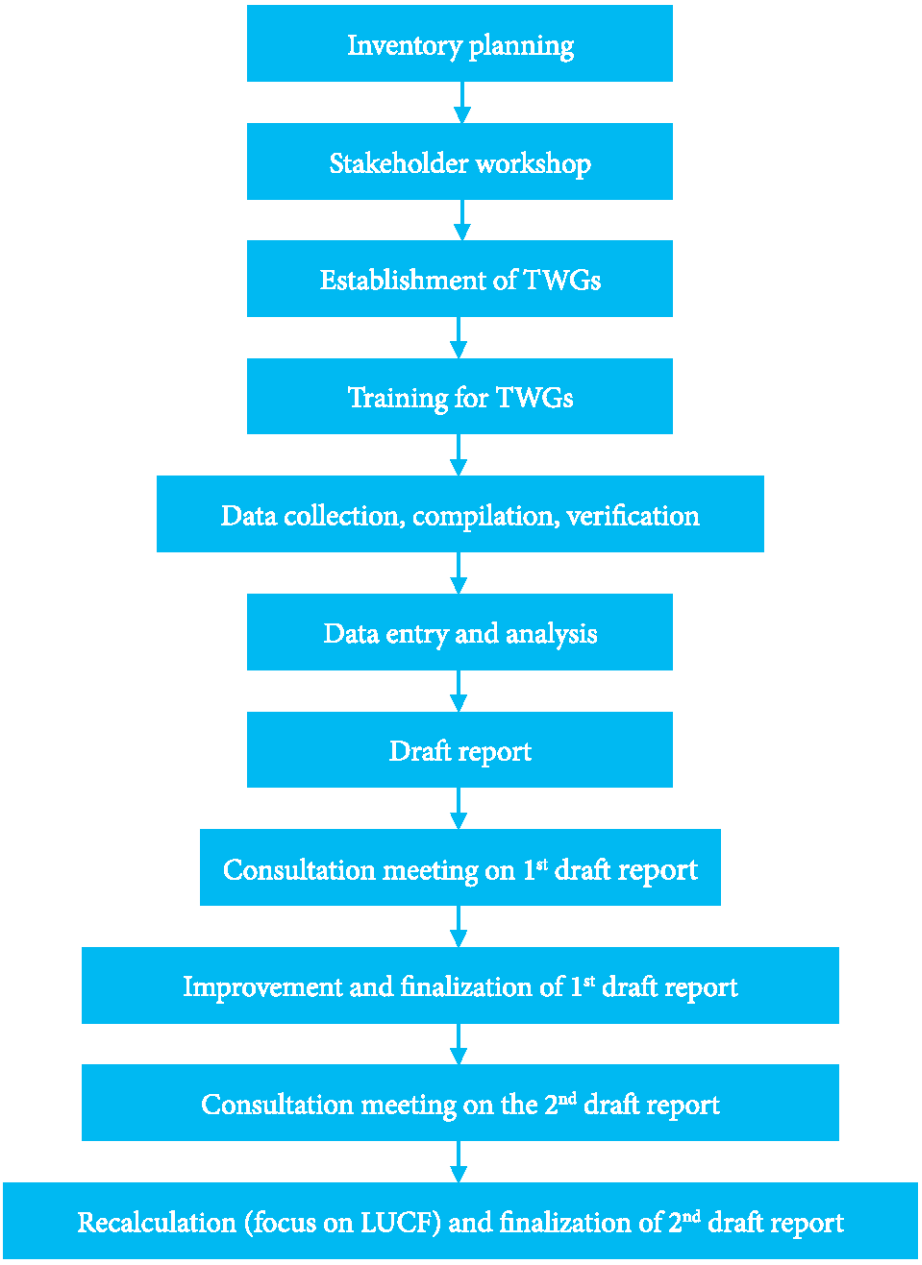
2.3.2 Process for Inventory Preparation

National GHGI preparation followed the technical guidance of the IPCC. Activities carried out included preparation and planning, introductory workshops for stakeholders, TWG establishment, training, collecting, compiling, verifying and analyzing data and drafting the report. The draft report was circulated to all TWG members and stakeholders for accuracy and consistency checks, comments and endorsement.

After consultation with relevant parties from the sectors, the first draft inventory report was revised and a second consultation was conducted. International experts facilitated

through UNDP also reviewed and provided the comments to the draft report, which was then finalized.

Figure 2-2: National Greenhouse Gas Inventory Report preparation process



2.4 National Greenhouse Gas Inventory for 2000

All sectors in Lao PDR's GHGI are approached by the Tier 1 method; for the energy sector, a reference approach also was used. The lack of comprehensive national statistics hinders the use of higher tiers for inventory calculation. Similarly, limited technical and financial resources to conduct research and development of local emissions factors have constrained the application of more complex methods of inventory calculation.

2.4.1 National GHG Emissions, by Gas

Table 2-3 shows Lao PDR's national GHGI for the year 2000. In that year, the country recorded emissions of a total of 43,811 Gg of CO_2 and the removal of about 2,047 Gg, for a net CO_2 emission of about 41,764 Gg. This represents a substantial increase compared to a net sink of 104,570 Gg in the year 1990, only 10 years earlier. This is believed to be due in part to rapid socioeconomic development, and in part to improved technical capacities and data availability.

Of the total CO_2 emissions, nearly all were from the land-use change and forestry sector (42,758 Gg), with only 1,004 Gg of CO_2 contributed by the energy sector. Industrial processes, especially mineral products, contributed only 48.4 Gg of CO_2, while emissions from biomass stood at 10,895 Gg.

For methane, Lao PDR emitted a total of 306.7 Gg in 2000. The agriculture sector was by far the most important emitter, producing about 251.4 Gg (82 percent of the total). Land-use change and forestry contributed about 52 Gg, or another17 percent. Waste and energy contributed only a small fraction of CH_4, at 2.4 and 0.7 Gg respectively.

Another key GHG, N_2O, primarily emitted from land use management. In 2000 Lao PDR emitted about 8.4 Gg of N_2O; of this total, 7.7 Gg were from agriculture. Small amounts of 0.36, 0.27 and 0.08 Gg of N_2O were from land-use change and forestry, wastewater management and energy respectively.

In addition to the three key GHGs, Lao PDR also reported on CO, NOx, NMVOC and SOx, as also shown in Table 2-3. In general, the country reported relatively insignificant amounts of these gases were emitted in 2000. Most of the 506.7 Gg of CO emitted was from the land-use change and forestry sector, with only about 42 Gg from the energy sector. Similarly, of the total emission of 20.8 Gg of NOx, about 13 Gg were from the land-use change and forestry sector and 7.5 Gg from the energy sector. For NMVOC,

17.9 of the total of 24.3 Gg were from industrial processes, followed by 6.4 Gg from the energy sector. Lastly, nearly all of the total of 1.6 Gg of SOx emitted was from the energy sector, as well as a small fraction from industrial processes.

In aggregate, for the year 2000 the land-use change and forestry sector in Lao PDR was the single most important source of CO_2 emission and other GHGs except for CH_4 and N_20, followed by energy combustion. Mineral production processes in the industrial sector also emitted a small amount of CO_2. For CH_4 and N_20, agriculture was the most important emitter, followed by land-use change and forestry.

2.4.2 National GHG Emissions, by Sector

2.4.2.1 Energy Sector

Following the IPCC guidelines, this inventory covers emissions from energy combustion of the three key energy types – fuel oil, coal and LPG gas – in energy, manufacturing, transport and other sectors (residential, agriculture and forestry). In the energy sector CO_2 emissions from biomass fuels are included only as an informational item, although the emissions of non-CO_2 gases derived from biomass fuels are included and reported in the emissions of the energy sector and in the inventory. This inventory applied reference and sector approaches, with Tier 1 and default values used for calculations.

By sources of emission, CO_2 emissions in the energy sector were related primarily to the use of biomass fuels derived from forest conversion. Fuel combustion from transport and other sources constituted less than 1 percent of the total. It is notable that all electricity in Lao PDR is generated by hydropower; hence, emissions from this sector are negligible. Partly as a result of this and other socioeconomic factors, emissions from conversion of forest and grassland thus dominated the sector.

The main energy sources consumed in the country are fuelwood, oil, electricity and coal. Fuelwood, electricity and coal are domestically produced, while fuel oil and LPG are imported. About 1,663.2 ktoe of energy was consumed in 2000, with fuelwood accounting for some 56 percent of total energy consumption. Oil, electricity and charcoal comprised 18.11, 11.85 and 10.80 percent respectively. Coal and LPG contributed only marginally to energy consumption.

In 2000 a total of 326,093 tonnes of fuel oil were imported to Lao PDR. Of this, 145,641 tonnes were diesel; 102,439 tonnes were gasoline; 68,109 tonnes were kerosene; and

522 tonnes were LPG. The rest was composed of 6,473 tonnes of lubricant and 3,431 tonnes of residential oil. Coal production in Lao PDR is mainly for export; of the more than 175,000 tonnes produced in 2000, only 72 tonnes were consumed within the country (Viengphoukha Coal Mining Company, 2010). Also produced were 300,000 tonnes of stink coal and 253 tonnes of lignite (NSC, 2005).

Table 2-3 GHG emission inventory for 2000, Lao PDR (Gg)

Green House gas souree and sink categories	CO_2 emission (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	NO_x (Gg)	CO (Gg)	MNVOC (Gg)	SO_x (Gg)
removals	43.810,7	-2.046,7	306,7	8,43	20,84	S06,7	24,28	1,60
1.Energy	1.003,79		0,67	0,08	*7,55*	41,48	6,43	1,55
1.1.Approach	1.003,79		0,63	0,08	7,55	41,48	6,43	1,55
1.Energy Industries			0,05	0,05	0,05	0,05	0,05	
2:Mmufacturing indus1iies and conslructi.on	446,44		0,39	0,01	0,51	7,08	0,26	0,74
3. Transport	441,62		0,09	O,Ql	5,46	30,39	5,84	0,81
4.0ther Sectors(Residential Sector)	115,72		0,10	0,00	1,53	3,96	0,28	0,00
5.Other (please Specify)								
1.2.Fugitive emissions from fuels			0,04		-	-	-	-
l.Solid Fules			0,04					
2.0i1 and Natme gas								
2.1.Miniral Products	47,61							
2. Industrial processes	48,41			-	0,00	0,00	17,86 - -	0,05 0,02
					0,00	0,00	0,00 -	0,00
2.2. Chemical Industry							-	
2.3.Metal Production	0,80						- -	-
2.5.and								
2.4. Other Production							17,85	0,02
2.6.and								
2.7.Other (Please specify)			-	-	-	-	-	-
3.Solvent and Product use								
							-	-
4.1. Enteric Fermentation			100,42					
4.2. Manure Management								

4.Agric::ult!R			251,41	7,73	0,32	8,39
			13,00			
4.3.Rice Cultivation			137,60			
4.4.Agricultural soils				7,72		
			0,35	0,01	0,30	7,45
4.5.Savannahs			0,04	0,00	0,02	0,94
4.6.residues						
4.7.Other (please Specify)						
5.Land-use chaDge and forestey	42.758,48	-2.046,7	52,21	0,36	12,97	456,84
5.l.woody	7.673,78					
5.2.conversion	35.084,70		52,21	0,36	12,97	456,84

Green House gas source and sink categories	CO_2 emission (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	N- (Gg)	- (Gg)	- (Gg)	-O_x (Gg)
S.3.lands								
5.4. from siol								
S.S. Other (please specify)		-2.046,7						
6.2.waste - water handling	-	-	1,31	0,27				
6. Waste			2,41	0,27				
6.1.Siol waste disposal on land			1,10					
6.3.wa1rte incineration					-	-	-	
6.4.Other (please Specify)			-	-	-	-		
7. Other (please specify)								
7.1 Interna1ional Bunkers			-	-	-	-	-	
Aviation								
Marine			-	-	-	-	-	
7.2. CO_2 emissions from biomass	10.894,63							

Based on expert judgment, about 70 percent of diesel and gasoline were consumed by the road transport sector. The remainder was equally consumed between industry and construction, agriculture, and the residential sector. Nearly all kerosene was used by domestic aviation, with only 10 percent used in the residential sector. Most coal was used in industrial processes, and the majority of LPG gas and residential oil went to the residential sector. There were no fuel and energy stocks or storage sites, and it is assumed that energy was entirely consumed within the year of import.

The Biodiversity Country Report 2004 estimates that 5.6 million tonnes, or 7.5 million cubic metres, of firewood were consumed annually. Of this, about 5.4 million tonnes (7 million cubic metres) were consumed by households and 111,000 tonnes (144,000 cubic metres) were used in industrial sector, especially for drying agricultural products. In addition, households and economic activities consumed about 9,489 tonnes (63,620 m^3) and 42,146 tonnes (280,973 m^3) of charcoal. About 680,000 m^3 of wood were harvested for household construction and other uses.

Based on the production and consumption of energy by sectors and methods mentioned above, the energy sector generated all key GHGs. The largest emission was CO_2, at about 1,004 Gg. The sector also generated minimal amounts of CH_4 and N_2O. Other gases generated were CO (41.48 Gg), NOx (7.5 Gg), NMVOC (6.4 Gg) and SOx (1.5 Gg). Thus, it can be concluded that the energy sector generated mainly CO_2.

1 One cubic metre of firewood converts to 775 kg, and one cubic metre of wood converts to 150 kg of charcoal (FAO, 1999).

2.4.2.2 Industrial Processes

Processing activities of certain types of industrial production also produce GHGs. For example, cement production processes result in the emission of CO_2 and SO_2. CO_2 is emitted during heating of $CaCO_3$ or high carbonate materials to produce clinker and intermediate cement products. Because SiO_2 and/or silica-containing materials are used as a compound of cement, this production process also releases SO_2. The process of heating limestone at high temperature to produce lime likewise causes CO_2 to release. In the iron production process, where carbon and its compounds also are used, iron melting and production generate GHGs coupled with other ozone and aerosol precursors. Lastly, food and beverage production can release NMVOC.

This inventory estimation uses default values from IPCC. Activity data are from national statistics reports between 1975 and2005, as well as the industrial statistics report for 2000.

As shown in Table 2-4, the industrial processes of Lao PDR generated about 48 Gg of CO_2 in 2000. Of this, about 95 percent was originated from cement production processes. Cement production also generated 0.02 Gg of SO_2. The paper production process, meanwhile, also produced 0.02 Gg of SO_2, and the food and beverage industry produced 17.9 Gg ofNMVOC.

By gases, industrial processes in Lao PDR generated mainly CO_2 (52.8 Gg) and NMVOC (17.9 tonnes). Insignificant amounts of SO_2 also were produced.

Table 2-4:Total greenhouse gas emissions from industrial processes (Gg)

Source	CO_2	N_2O	NO_x	CO	NMVOC	SO_2
Cement production	47.23					0.02
{Quick) Lime production	0.25					
Limestone used	0.13					
Iron steel processing	0.80		0.00	0.00	0.00	0.00
Paper factory						0.02
Food and beverage					17.86	
Total	48.41		0.00	0.00	17.86	0.05

2.4.2.3 Agricultural Sector

Emissions from agriculture were mainly derived from 6 sub-sectors: (1) livestock enteric fermentation; (2) manure management; (3) rice cultivation; (4) savannah burning; (5) agricultural residue burning, and (6) agricultural soil.

Total cultivated rice land in 2000 stood at slightly more than 510,000 ha, with about 20 percent irrigated. To estimate emissions, the IPCC emission default value and Seasonally Integrated Emission Factor for Continuously Flooded Rice Without Organic Amendment of Thailand, 16 (g/m^2) (Towpryaoon et al., 1993), were used. Savannah burning was rampant and visibly observable; it occurs every year, especially in dry season. However, there exists no record of savannah burned area, nor of biomass before and after the burning. For the year 2000, therefore, it was assumed that 5 percent of total savannah in the country was burned. The IPCC default values were used.

In addition to savannah burning, scrub forest and rangeland are also burned as a result of uncontrolled slash-and-bum agriculture, which includes burning dry grasses for animal grazing. However, there is again no record of burned area, as well as a lack of data associated with biomass before and after burning. Hence, this inventory estimated that about 5 percent of a total savannah area of 94,400 ha (MAF, 2005), or 4,720 ha, were burned during the year. Note that CO_2 is assumed neutral for the savannah sub-section. The IPCC default emissions factor was used.[2]

Burning of agricultural residue varies among crops, with both on- and off-site burning. The main crops grown in Lao PDR are rice, maize, sugar cane and tobacco. Data related to crop residue were not available, however. Only rice and maize are considered in the inventory, where it was assumed that 5 percent of rice residue and 10 percent of maize residue were burnt on-site. The ratios were used with IPCC default factors to obtain emission values.

The primary emission from agricultural soil is N_2O; altogether, emissions from agricultural fields depend on the amount of nitrogen input to soil from synthetic fertilizer, animal manure, nitrogen-fixing crops and agricultural residues. Because aggregated data on the amount of N input were not available, the inventory did not include direct soil emissions from nitrogen-fixing crops. Therefore, only emissions from synthetic fertilizer, animal manure and agricultural residues were estimated as the emissions from agricultural soil. Using livestock statistics and IPCC default values, emissions from animal manure

2 The values of default emission factors from IPCC appear to be high for Lao PDR, especially with regard to the fraction of living biomass. The majority of burning in the country occurs in the dry season, when most grasses are already dry or dead.

management were estimated. Similarly, planted areas of nitrogen-fixing crops and others were used to derive emissions from crop residue. Indirect nitrous oxide emission from fertilizer was estimated based on consumption values for 2000.

Of the six sub-sectors, rice cultivation and livestock enteric fermentation represented the two key sources. Rice cultivation in Lao PDR emitted 137.6 Gg of CH_4 in 2000, followed by 100.4 Gg from enteric fermentation. Manure management contributed 13 Gg of CH_4. Agricultural soil emitted only 7.7 Gg of N_2O, while burning of savannah or agricultural residue generated several GHGs of different magnitudes, including 8.4 Gg of CO and an insignificant amount of NOx and N_2O. Thus, agriculture contributed largely CH_4 to GHG emissions in 2000.

2.4.2.4 Land-Use Change and Forestry

In the land-use change and forestry sector, there are three main sources of GHG emissions. These include changes in forest and other woody stock, forest and grassland conversion, and abandonment of managed land. Because of a lack of data, emissions from forest soil carbon are not included.

Changes in forest and other woody biomass stock can be a net source or sink, depending on the carbon uptake from forest plantation and biomass loss caused by harvesting of timber, fuelwood and other wood such as that used for household construction. Meanwhile, for the year 2000 forest plantation was classified by types and ages to the extent possible. Other woody biomass stock covers timber harvest, fuelwood consumption and wood harvest for house construction and other uses, but not the wood removed from forest clearance. Changes in forest and other woody biomass stock resulted in a net release of GHG.

Emissions from the conversion of forest were based on IPCC guidelines, with the assumption that there is not much change in carbon uptake or release among degraded forest, shifting cultivation areas or agricultural croplands. Major causes of the forest loss include timber harvesting, shifting cultivation, forest fire, forest encroachment, and development projects. Estimates of biomass loss are based on statistics, research reports and informed judgments by Thematic Working Group member. Such biomass losses occur through three main sources, namely, on-site burning, [3] off-site burning,[4] and being left to decay. Slightly more than 200,000 ha of forest land per year was converted to other uses. These converted areas were used to calculate GHG released from on- and off-site burning and

3 The slash-and-burning practice of burning branches and twigs of harvested timber and other wood in forest areas.

4 Wood, branches and twigs extracted from slash-and-burn harvested areas and used elsewhere for fuel and energy purposes.

decay ofbiomass.

The main carbon storage facility is found in the increase of forest cover and wood stock from the abandonment of managed and rehabilitated forests. This study followed Good Practice Guidance and LUCF guidance to separate re-growth trees into two groups, namely, less than 20 years and more than 20 years. Based on IPCC guidelines, carbon storage of the abandoned wood stock in both managed and rehabilitated forests was estimated.

As noted above, LUCF represents the key source and sink of CO_2 in the country, During 2000 the sector emitted about 42,800 Gg and removed about 2,100 Gg of CO_2. Most emissions arose from conversion of forest to other land uses, with only about 7 percent from harvesting of timber and fuelwood Removal of CO_2 primarily occurred from abandonment of managed land or forest rehabilitation; however, the amount removed was small, at less than 1 percent of emissions. As a result, the CO_2 net emission of the land-use change and forestry sector differed little from the aggregate.

In addition to CO_2, the land-use change and forestry sector also emitted other gases from forest land and grassland conversion. These included about 52.2 Gg of CH_4 0.360 Gg of N_2O, 13 Gg ofNOx. and 457 Gg of CO released into the atmosphere.

2.4.2.5 Waste Sector

Solid waste, biological waste and wastewater, along with their treatments and discharges, stand as the main sources of GHG emissions in the waste sector.Methane and nitrous oxide are the key gases released from landfill and wastewater as well as their treatment systems. This inventory covers only landfills of municipal waste, wastewater from residential areas and main manufacturing, and sewage. Although waste incineration, particularly of clinical waste, occurs, it was not estimated because of insufficient data and/or the assumed insignificance of emissions. A lack of emissions factors and methodologies further constrained the exercise.

With limited information, it was estimated that total municipal waste generated in the year 2000 was 233,100 tonnes.It was further assumed that 30 percent of these wastes, or about 70,000 tonnes, was disposed of at dumping sites. For wastewater, the estimation covered urban households and key manufacturers with access to piped water supply. In this case, it was estimated that the total organic wastewater and sludge from urban households was 31,460 tonnes of BOD/year and 317,780 tonnes of BOD/year respectively. Only 10 percent of the wastewater produced was covered by wastewater management facilities; management facilities for sewage and excrement were even more limited. Because data

on wastewater from manufacturing were limited, only key industries were included. Based on these limited data, certain assumptions were made and emissions factors for different categories were then derived.

GHG emissions from the waste sector in Lao PDR were comprised mainly of CH_4 and N_2O. Methane emissions from solid waste disposal and from handling of solid waste and wastewater were about the same, at between 1.1 and 1.3 Gg. Handling of waste and wastewater also emitted 0.27 Gg of N_2O.

2.4.3 National GHG Emissions, in CO_2 Equivalent

Using IPCC global warming potential factors, CH_4 and N_2O emissions were converted into CO_2 equivalent. Table 2-5 shows the emissions in CO_2 equivalent, by sectors and types of gases.

In 2000 the net GHG emission of Lao PDR in terms of CO_2 stood at about 50,000 Gg. The rank of sources of emission remains the same: Land-use change and forestry was the single major source, accounting for about 83 percent of total emissions, followed by the agriculture sector, at 15 percent. The energy sector contributed only 2 percent, while waste and industrial processes contributed negligible proportions.

Similarly, the rank of sources in each sector also remains the same. Conversion of forest and grassland was the most important source of emissions in land-use change and forestry. Meanwhile, enteric fermentation of livestock and rice cultivation were the agriculture sector's two key sources, and transport and manufacturing/construction were the two key sources of the energy sector.

Table 2-5: National GHG emissions in CO_2 equivalent, 2000 (Gg)

Sector	CO_2 Source	CO_2 sink	CH_4	N_2O	Total
Total	43,810.68	-2,046.73	6,441.54	2,537.43	50,742.91
Energy	1,003.78		14.91	21.07	1,039.76
Fuel combustion	1,003.78		13.23	21.07	1,038.08
Energy industry			1.05	15.05	16.10
Manuf. & consl	446.44		8.19	3.01	457.64

		Transport	441.62		1.89	3.01	446.52
		Other (resi.)	115.72		2.10		117.82
		Other					
	Fugitive emission				1.68		1.68
		Solid fuel			0.84		0.84
		Oil &nat. gas			0.84		0.84
Industrial processes			48.41				48.41
	Mineral prod.		47.61				47.61
	Chemical						
	Metal		0.80				0.80
	Other						
	Pro. Halo & hexa						
	Cons. Halo& hexa						
	Other						
Agriculture					5,279.61	2,326.73	7,606.34
	Enteric ferment.				2,108.82		2,108.82
	Manure mgmt.				273.00		273.00
	Rice cultivation				2,889.60		2,889.60
	Agri.soil					2,323.72	2,323.72
	Burninfhof savann				0.84		0.84
	Burning of agr. res.				7.35	3.01	10.36
	Other						
LUCF			42,758.48	-2,046.73	1,096.41	108.36	41,916.52
	Change in F & WBS		7,673.78				7,673.78
	F&GL conversion		35,084.70		1,096.41	108.36	36,289.47
	Abandoned land			-2,046.73			-2,046.73
	Emis & remov. from soil						
	Other						
Waste					50.61	81.27	131.88
	Solid waste disposal land				23.10		23.10
	Wastewater handling				27.51	81.27	108.78
	Waste incineration						
	Other						

Other			
Memoitems			
	International bunker		
		Aviation	
		Marine	
	Emission from biomass		10,894.63

2.4.4 Comparison of GHG Inventories for 1990 and 2000 (CO_2 equivalent)

Of the 24,200 Gg of emissions in CO_2 equivalent in 1990, 71 percent were from forestry and about 24 percent were from agriculture. At that time, the energy sector emitted 4 percent. The remaining negligible amounts were from industrial processes and waste (Figure 2-2). In contrast, about 51,000 Gg of CO_2 equivalent was emitted in Lao PDR in 2000, thereby doubling in the course of a decade. Shares of emissions by sectors, other than agriculture and land-use change and forestry, remained similar between the two periods (Figures 2-3 and2-4).

At the same time, the share of the land-use change and forestry sector increased to 83 percent, while that of agriculture dropped to 15 percent. The increase in emissions from the land-use change and forestry sector is partly a result of different assumptions for sequestration between the two periods.[5] Nevertheless, this increasing share of emissions also suggests the increasing pressure on Lao PDR's forest areas. Meanwhile, the lower share of the energy sector in total emissions suggests a steady contribution of renewable energy to total energy consumption, resulting from the development of national hydropower and biomass energy sources.

5 The 1990 inventory assumed a net positive sequestration from natural forest areas, while that for 2000 assumed this was neutral.

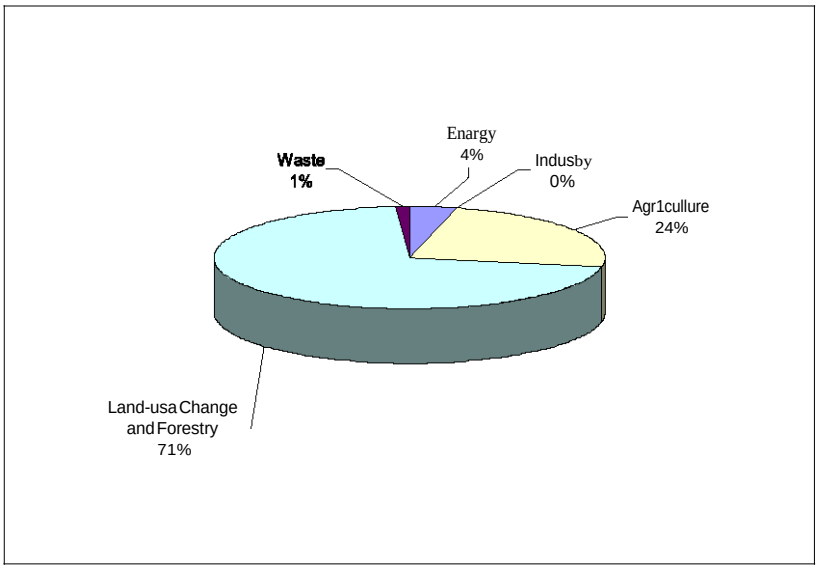


Figure 2-3 Shares of total emission by sector in CO_2 equivalent, 1990, Lao PDR

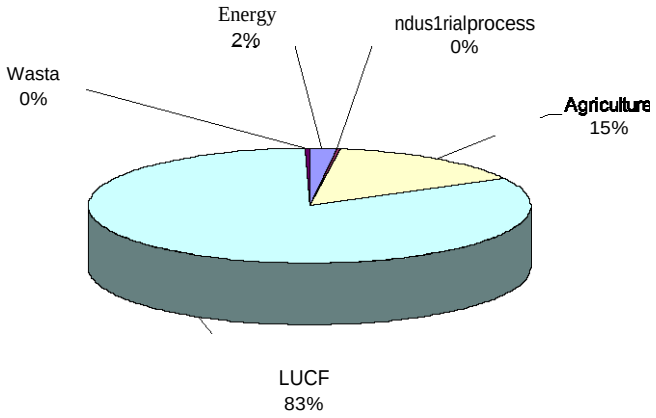


Figure 2-4: Shares of total emissions by sector, in CO_1 equivalent, 2000

2.5 Key Source Category Analysis

The key source category analysis emphasizes the number of emissions by sources and removal by sinks, as well as GHG emissions by gas, sector and sub-sector, including prioritization of major sources of emission. It also includes an emissions assessment based on conditions with and without the forestry sector.

Total GHG emissions of 50,700 Gg of CO_2e came from 36 source categories and 1 sink category. Emissions from the forestry sector alone included 4 source categories and 1 sink category, with the net emission of the sector standing at 41,900 Gg of CO_2e. The other 32 source categories belonged to other sectors, which emitted a total of 8,870 Gg of CO_2e (Figure 2-5).

With regard to GHG gas, CO_2, CH_4 and N_2O accounted for 41,750, 6,440 and 2,540 Gg respectively (Table 2-6).

Table 2-6:Total GHG emissions by gas, in CO_2 equivalent, 2000, (Gg)

Gas	Total emissions
CH_4	6,441.54
CO_2	41,754.48
N_2O	2,537.43
Total	50,733.45

Divided by sector, it is clear that the LUCF sector emits by far the highest amount, again contributing about 83 percent of the total. This is followed by agriculture at 15 percent and energy at 2 percent. The contributions of the waste sector and industrial processes were minimal (Figure 2-5).

Figure 2-5:Total emissions by sector, in COl equivalent (Gg)

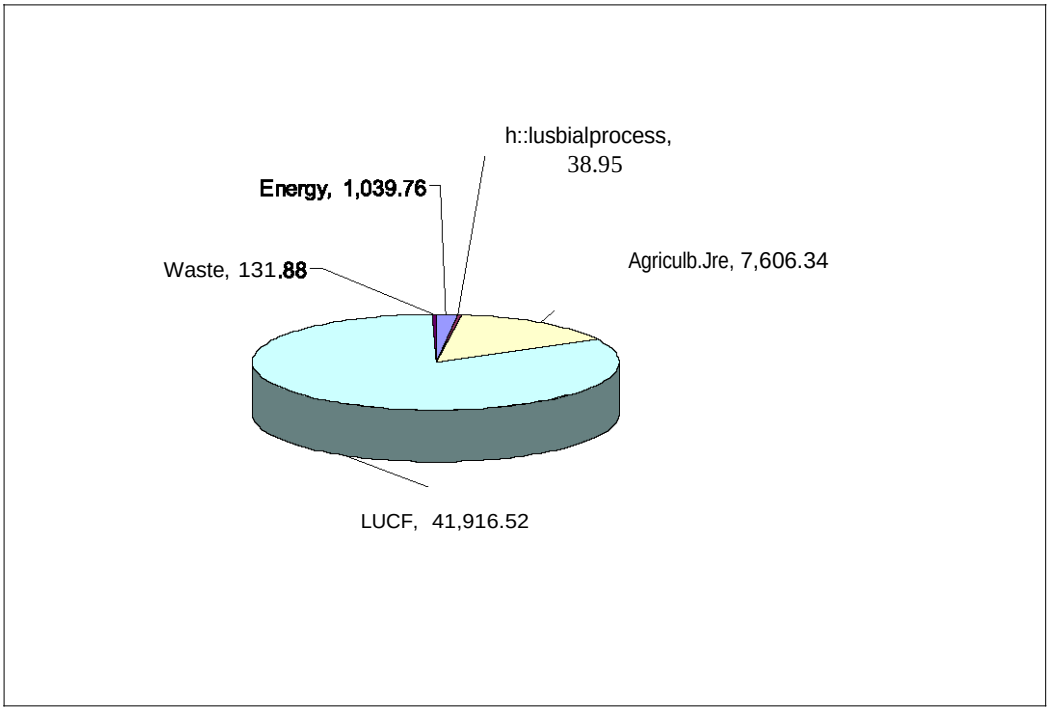
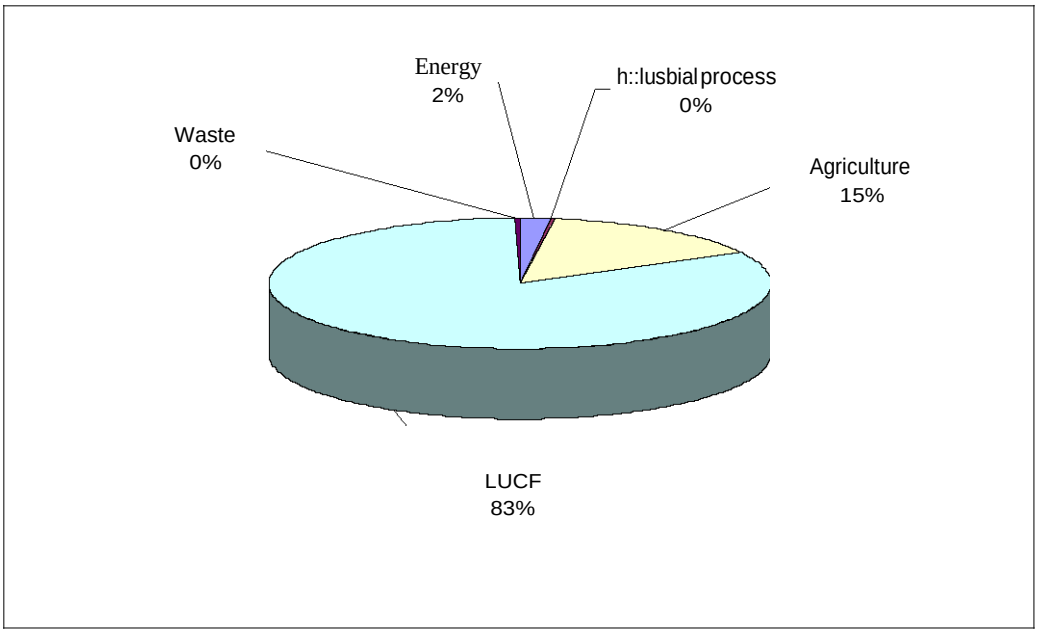


Figure 2-6:Total emissions by sector, in $C0_1$ equivalent(%)



Among sub-sectors, land-use change-especially conversion of forest and savannah fields

into other land uses – contributes to forest degradation and represents a major source of GHG emissions, accounting for 72 percent of total net emissions. Logging and the use of wood was the second-biggest source, contributing about 15 percent. Emissions from rice farming and livestock fermentation accounted for 6 and 4 percent respectively. If land-use change and forestry were not included, rice farming, livestock raising and agricultural soil disturbance would be the key sources of GHG emissions in Lao PDR, with a total share of 83 percent. Energy, industrial processes and the waste sector remained minor contributors of GHG emissions in the country.

The key source category analysis suggests that, based on the inventory for 2000, mitigation of GHG emissions in Lao PDR should concentrate on the land-use change and forestry sector. Strengthening forest conservation and proper utilization of forest resources would reduce emissions substantially and enhance the sink potential of the sector. Adoption of appropriate technologies that simultaneously reduce emissions and increase net return to rice fanning and livestock raising also would support national mitigation efforts.

2.6 Inventory Uncertainty

A Tier 1 uncertainty analysis was conducted following the Good Practice Guidance (GPG) (IPCC, 2000), with the level of uncertainty for activity data and emissions factors assessed based on expert judgment and consultation with the TWGs of the relevant sectors. The report on uncertainty, which covers 37 sources as recommended in the Revised 1996 IPCC Guidelines, was calculated both in terms of percentage of gases ($C0_2$, CH_4, and N_20) and of sectors.

Aggregate uncertainty of the GHG inventory of Lao PDR for 2000 was found to be around 29.3 percent (Ministry ofNatural Resources and Environment, 2012).The uncertainty per gas was ±34.62 percent for N_20, ±27.14 percent for CH_4 and ±26.75 percent for $C0_2$ (Table 2-7).

Table 2-7:Uncertainty levels, by gas and by sector

Source	Uncertainty(%)
ByGas	
CH_4	±27.14
col	±26.75
N_20	±34.62

By Sector	
Energy	±27.14
Industry processes	±13.98
Agriculture	±29.60
Land-use change and forestry	±44.03
Waste	±31.57

Within sectors, LUCF had the highest uncertainty, at ±44.03 percent. The waste, agriculture and energy sectors had moderate levels of uncertainty, ranging between3!27.14 and±31.57 percent, while industrial processes had the lowest uncertainty of ±13.98 percent (Table 2-7).

2.7 Quality Assurance, Quality Control and Completeness

Lao PDR currently has no system for quality assurance and quality control (QNQC) for GHG emissions. In the future, it is expected that sectors responsible for activity data for inventory will develop *QNQC* systems that are centralized and sustainable. The inventory for 2000, following the GPG (IPCC, 2000),has been developed in a transparent, consistent, comparable and complete manner as far as the current capacity of Lao PDR allows. The following approaches also were used to ensure a good-quality inventory:

- *Re-calculation:* In the final stage of drafting the report, the inventory team revisited and re-calculated the LUCF and agriculture sectoral emissions and removal, the key sources. The results were shared among all stakeholders, including TWGs and participants in various national and international workshops or meetings, where comments were considered and consistency and cross-checks were further performed.
- Peer review:Lao PDR conducted a mutual learning programme with emphasis on the peer review of the LUCF sector, in collaboration with the Greenhouse Gas Inventory Office (GIO)/National Institute for Environmental Studies (NIES) of Japan. This enhanced accuracy and completeness of the LUCF inventory.
- *External expert review:* The inventory *QNQC* also was enhanced by a review by experts from UNDP and international experts on GHGI, through UNDP's National Communications Support Programme in New York. The final draft report was further shared with GHGI experts from Thailand for additional technical review.
- *National Steering Committee review:* The GHGI report was reviewed by

the NEC, which has a formalized system of review procedures. Before submission to the UNFCCC, the report likewise was reviewed by independent experts who were not directly involved in inventory compilation and preparation.

CHAPTER 3

VULNERABILITIES AND ADAPTATIONS

3.1 Introduction

As an LDC with few relevant adaptive capacities, Lao PDR is highly vulnerable to the impacts of climate change. Moreover, without the development of capacity to manage the current risk, the country will be exposed to even higher climate risks in the future. Assessments related to vulnerabilities and adaptations are thus crucial to assist vulnerable sectors to develop strategies to manage such risks.

Information was not provided in the FNC on measures or actions to address climate change impacts, vulnerabilities and adaptations, mainly because of a lack of national capacities. During the last decade, however, an understanding of climate change impacts and adaptations has been gradually developed. The NAPA process, under the UNFCCC, has particularly enhanced national capacities on climate vulnerability and extreme events.

In this chapter key vulnerabilities to climate change of the Lao PDR are identified, while national progress made on work related to vulnerabilities and adaptations to climate change/climate variability and extreme events is summarized. Constraints and gaps in development in this area also are identified.

3.2 Vulnerabilities and Adaptations and the National Climate Change Strategy

The National Climate Change Strategy, realizing the high vulnerability to climate change of the country's physical, biological and socioeconomic development, has given special attention to climate change vulnerabilities and adaptations.

Increasing resilience in this regard in key sectors is thus an important goal of the strategy (WREA, 2010). Strategies include:

- Mainstreaming climate change into the agriculture sector's policies, strategies

and action plans to enhance adaptive capacity of this important sector

- Monitoring and improving water resources and water supply systems
- Intensifying research and development on vulnerabilities and adaptations in the agriculture sector at all levels
- Increasing forest cover and strengthening the protection of ecosystem-sensitive forest areas
- Enhancing biodiversity conservation and appropriate utilization ofNTFP
- Intensifying research and development on vulnerabilities and adaptations of water resources, with appropriate climate scenarios
- Developing early warning systems to reduce disaster risks with regard to water resources and public health
- Mainstreaming climate change adaptations into infrastructure and transportation development

3.3 Climate Trends and Climate Hazards

Overall, vulnerability to climate change encompasses the degree to which geophysical, biological and socioeconomic systems are susceptible and unable to cope with adverse impacts of this change (see Chapter 17, IPCC, 2007b; Fiissel and Klein, 2006). Key wlnerabilities [1] are associated with many climate-sensitive systems, including, for example, food supply, infrastructure, health, water resources or ecosystems.

To identify the key vulnerabilities for Lao PDR, two climate variables – rainfall and temperature, and historical records of impacts – were used. However, available historical climate data (1970-2009) in the country are very limited and incomplete. To develop long-term historical rainfall data, the climate data from grids of the World Climate Research Programme Global Precipitation Climatology Centre were used to fill in missing values for each gauge station. To investigate historical climate variability and change, especially during the 20th Century, rainfall and temperature were modelled as a function of time.

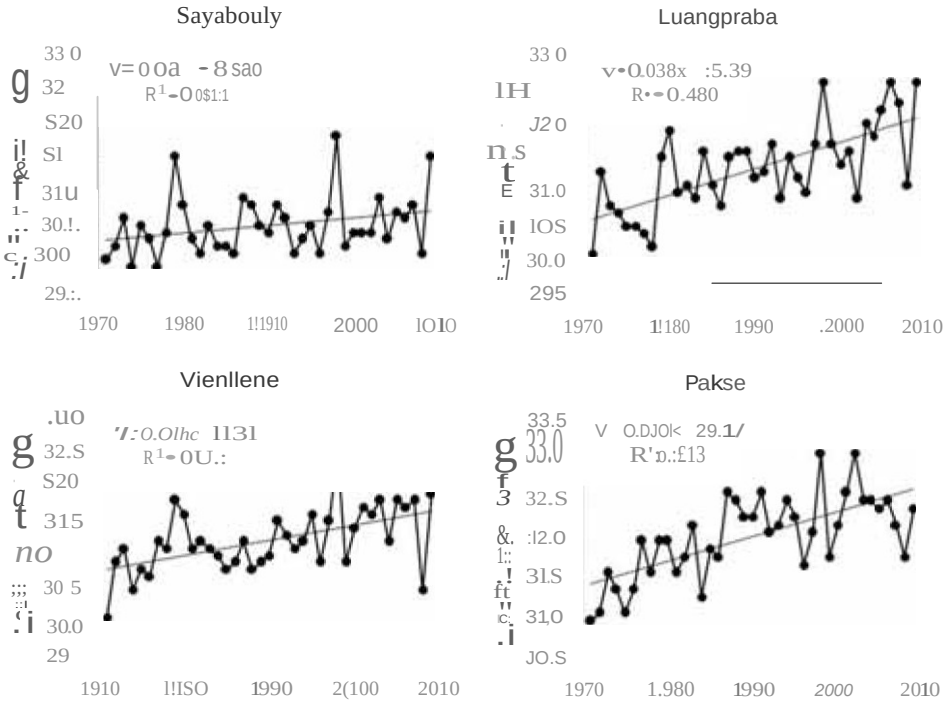
1 Determining key vu1nerabilities or risks is a dynamic process that needs to combine scientific knowledge with factual and normative elements (Patwardhan et al.; Dessai et al., 2004; Pittini and Rahman, 2004, in Chapter 19 IPCC, 2007b). Some aspects of confidence in the climate change-impact relationship are factual, while others are subjective. In addition, the choice of which factual criteria to employ in assessing impacts has a nonnative component (IPCC, 2007b).

3.3.1 Climate Trends in the Lao PDR

As a result of Lao PDR's geographical location, its climate is dominated by monsoon variability, with the southwest monsoon particularly contributing to high rainfall and high temperatures from May to September. The monsoon contributes to a seasonal cycle of rainfall where more than 70 percent occurs during the wet season. In addition, the climate is driven by interannual rainfall variability that can be linked with extreme climate events such as frequent floods, mostly in the south, and droughts in the north. This interannual variability of rainfall in the region may be associated with large-scale climate drivers such the El Nino-Southern Oscillation {ENSO). Using data from national grids and water stations, supported by those from international grids, the link between rainfall anomalies and ENSO were investigated by using correlation and regression coefficients.

Regression analysis shows that the annual mean temperature in Southeast Asia has consistently increased over the past 40 years.[2] Likewise, such analysis shows that the annual mean temperature in Lao PDR has risen by as much as 0.05 °C/year, especially in the south {Figure 3-1).

Figure 3-1:Temperature trends in selected provinces, 1970-2010



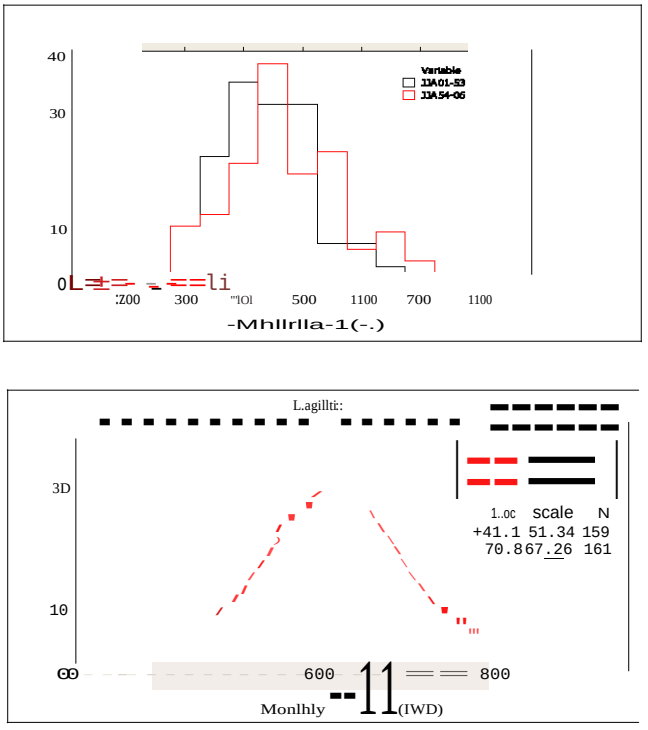
2 Data from CRU TS2.1 dataset

Rainfall pattems,[3] as differentiated by the total amount of rainfall during wet and dry seasons, indicate that some parts of the country tend to have relatively high rainfalls, including Phongsaly, Oudomxay, Bokeo, Xayabury, Vientiane and Borikhamxay. In contrast, relative drier areas, with a maximum of 288mm of monthly rainfall during the wet season, encompass some parts of Xayabury and Vientiane. In general, it can be said that many parts of the country are relatively rich in rainfall, while others are drier; such variance could happen even within the same regions.

Historical rainfall data indicates the increasing trends of seasonal and annual rainfall in the country, with rates of 2,046 and 2,741mm/year respectively. These upward trends are associated with the increased frequency of extreme events related to heavy rainfall in the region.

Using probability analysis, it was found that the monthly rainfall with an intensity of more than 600mm has increased, while intensities between 300-500mm declined (Figure 3-2).

Figure 3-2: Change in monthly rainfall distribution in Lao PDR between 1901-1953 and 1954-2006

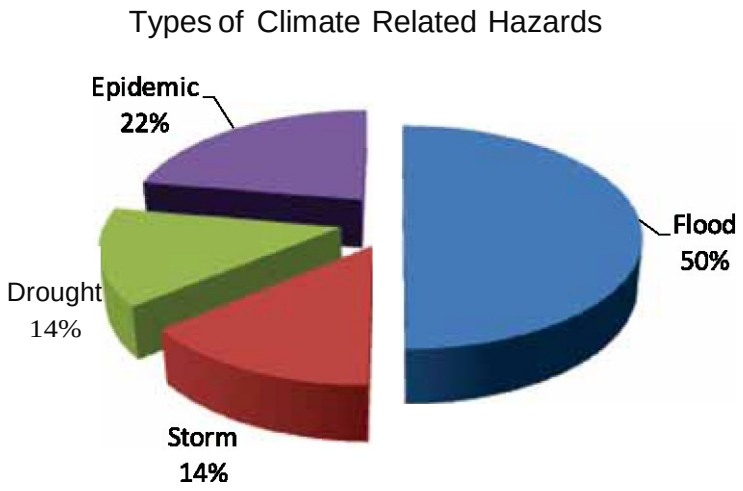


3 Rainfall patterns in Lao PDR are divided into eight groupings, with higher numbers representing more average monthly rainfall.

3.3.2 Climate hazards

Types of Climate-Related Hazards. During 1966 to 2009, 36 climate-related hazards in Lao PDR were classified as global hazards.[4] Flooding was the most frequent hazard, followed by health epidemics (such as dengue, cholera, diarrhoea, and avian influenza), storms and droughts. Most storms were followed by severe floods. On the other hand, shortages or delays in rainfall can cause droughts. As shown in Figure 3-3, about three-fourths of the disasters in Lao PDR during this period were climate-related. Floods normally occur from May to September when monsoon rains accumulate in the upper Mekong River basin, while droughts happen between November and March. Flash floods in the northern mountainous areas also are common (GoL PDR, 2010).

Figure 3-3:Types of climate-related hazards in Lao PDR, 1966-2009



Source:Analyzed from the OFDA/CRED International Disaster Database

Regionally, floods and droughts occur almost every year, or sometimes twice a year, in the south and central parts of the country, where the majority of people live. (Lao PDR, 2009). Areas most at risk from floods are those located along the Mekong and its main tributaries. Meanwhile, areas in the upland north, and in a few southern provinces like Savannakhet and Khammouan, were more prone to droughts.

Frequency and Intensity of Climate Hazards. Climate hazards, particularly floods, tend to be more frequent and intensified in recent years. It was found that about half of these hazards

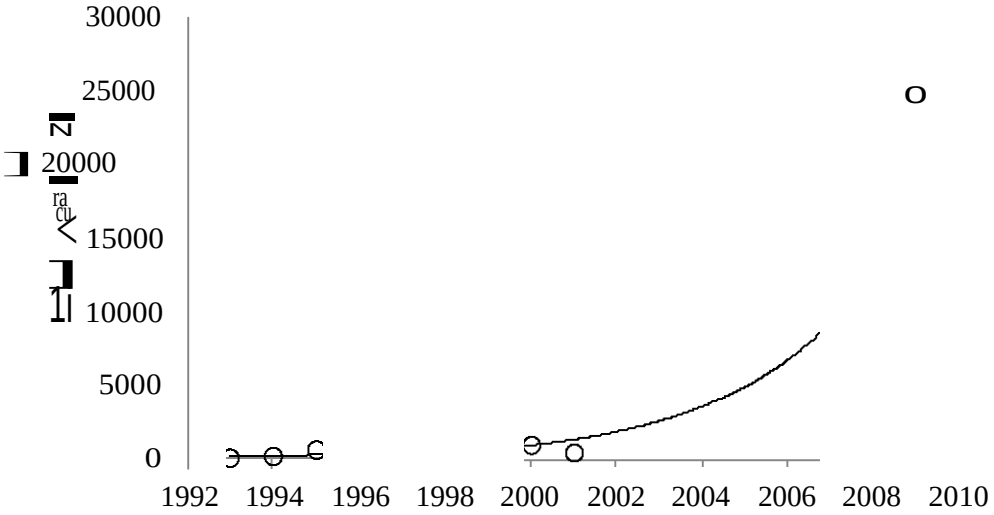
4 Based on OFDA/CRED International Disaster Database.

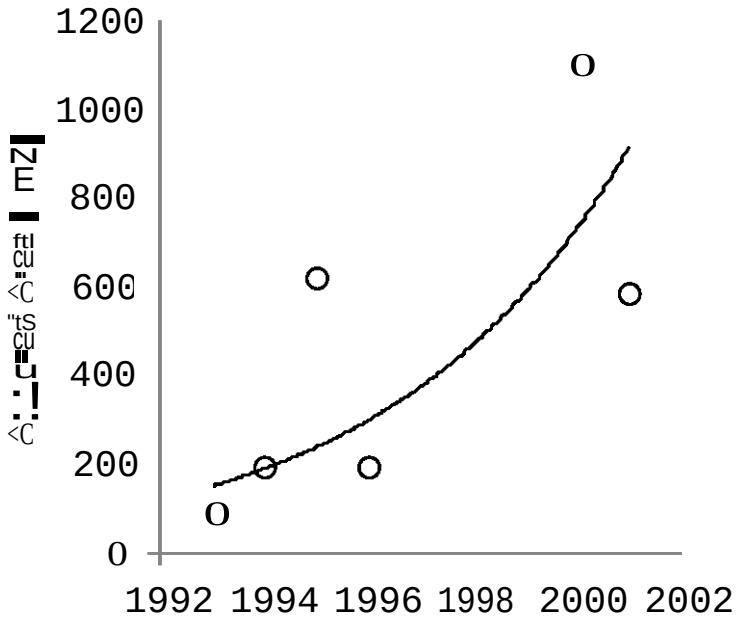
occurred between 1966 and 1992, a period of 26 years, while the other half occurred between 1992 and 2009, a period of only 17 years. Thus, the frequency of the climate related hazards in Lao PDR increased from about once every two years before 1992 to every year or even twice a year after 1992.

Areas affected by floods also grew at an accelerated pace during the last two decades (1992-2009). Areas flooded before 2002 generally were less than 1,200 sq.km. On the other hand, in 2009 alone more than 2,500 sq.km of land was flooded (Figure 3-4). According to the Ministry of Agriculture and Forestry, the area affected by floods arising from Tropical Storm Washi Tahiti in 2005 also was much larger than that affected in 2002 (National Disaster Management Office, 2005). This is very much in line with the conclusion of the Mekong River Commission (MRC), that extreme flood years have tended to be more common since 1986 and to affect wider areas across the country.

Although not as frequent and devastating as floods, drought hazards also have been more frequent and more intense in the last three decades. Between 1995 and2005, drought conditions were characterized by higher and irregular increases in temperature. In particular, abnormally high temperatures experienced in 1996 and 1998 triggered the occurrence of drought in specific areas, including ponds, streams and lakes.

Figure 3-4: Total area in Lao PDR affected by O.ooding, 1992-2009





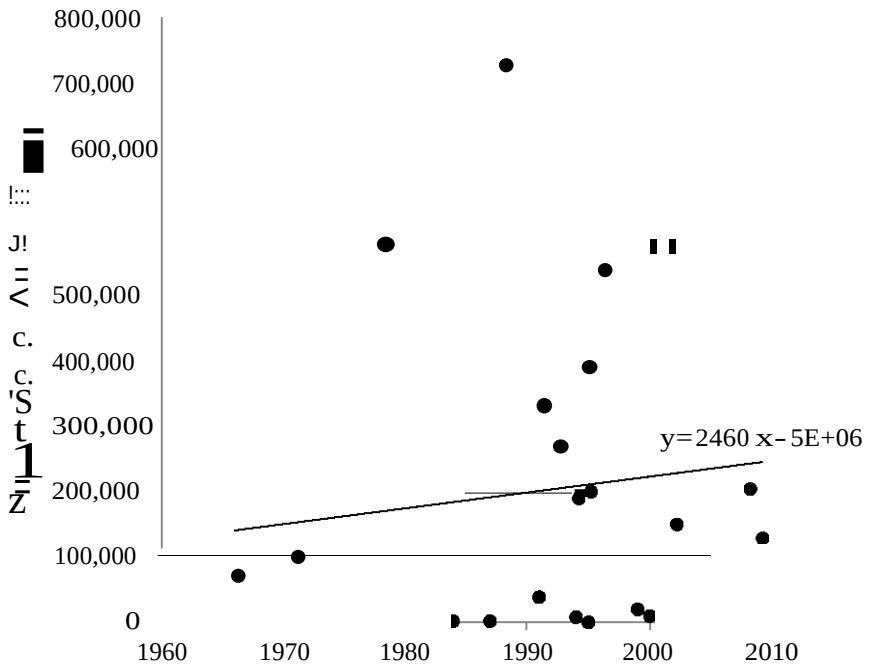
Source: Analyzed from EM-DAT data

3.3.3 Key vulnerabilities

Historical records of rainfall and temperatures over the past four decades show increasing trends for both. Damages and losses experienced also suggest different magnitudes of impact in various sectors and, hence, key vulnerabilities.

Based on EM-DAT data, flooding in the country causes damages of about US$50 million every year. Similarly, damages as a result of severe drought also can reach up to US$20 million annually (National Disaster Management Office, 1996). Although the number of affected people from climate-related hazard events varied greatly, the trend was increasing (Figure 3-5). On average, floods and storms affected about 200,000 people and killed about 40 people in Lao PDR annually. Large disasters can cause damages of as much as 1 percent of GDP (World Bank and United Nations, 2010); for example, in 2009 losses from Typhoon Ketsana reached US$ 57.5 million, the equivalent of 1.1 percent of GDP (Lao PDR, 2009).

Figure 3-5: Numbers of people affected by climate hazards (floods, storms) in Lao PDR



Source: Analyzed from EM-DAT data

Flood disasters in Lao PDR have seriously affected almost all sectors. Table 3-1 estimates damages from flooding during 2005-2008.[5] In the productive sectors, agriculture, especially rice, was the main sector affected. Extensive impacts were particularly seen in flooding after Typhoon Ketsana in 2009, with very high damages and repair costs across sectors (Table 3-2). Besides agriculture, the most severely affected sectors have been transportation, communications, housing and utilities. These sectors account for more than 80 percent of total flooding damages, with even wider impacts linked to loss of livelihoods and food insecurity, among others.

Assessments indicate that the people of Lao PDR are not adequately prepared for climate hazards, particularly floods. Timely monitoring and prediction of upstream flows from rainfall, along with development of and capacities to manage effective early warning systems, are imperative.

5 Information from Provincial Agriculture and Forestry Office, Ministry of Agriculture and Forestry and National Disaster Management Office.

Table 3-1: Impacts offtooding, by sector, 2005-2008

	2005	2006	2007	2008
Number of provinces affected	16	4	4	4
Number of districts affected	84	20	27	26
Number of villages affected	2,510	404	614	664
House and people				
Number of houses affected		13,549	25,292	
Number of people affected	480,913	89,849	118,074	95,157
Number of people killed			2	3
Agriculture				
Flooded rice fields (hectares)	87,724			
Rice fields damaged (hectares)	*55,955*	6,913	256,778	28,517
Flooded vegetable fields (hectares)			491	
Cattle lost (heads)	14,941	298	343	702
Poultry lost (number)		5,912	74,980	*995*
Fish ponds and aquaculture affected (number)	4,289	168	136	44
Fish ponds and aquaculture damaged (hectares)	609	98	1,000,000	356
Infras1ructure				
Schools affected/damaged (number)	102	13	11	63
Health centres affected (number)		3	2	3
Markets affected (number)		1		
Bridges damage (number)		2		3
Temples affected (number)			2	
Locations of irrigation affected (number)	1,421	259	29	
Locations of irrigation damaged (number)	117		23	48
Irrigation channels damaged (metres)	15,124	8,000		
Drainage systems affected (metres)				53
Water wells damaged (number)				929
Underground water sites damaged (number)				812
Natural spring sites damaged (number)				1
Roads affected (km)	225,726		*65*	
Roads damaged (km)		4		314
Boats lost (number)			27	
Total value of damage and losses ($US)	28,565,000	NA	NA	NA

Sources: Ministry of Agriculture and Forestry and National Disaster Management Office

Table 3-2: Impact of '!YPhoon Ketsana on sectors and recovery costs required in five southern provinces (Savannakhet, Salavan, Xekong, Attapeu and Champasak), 2009 (US$)

Descnp on	N um er	Damages and losses	Costs for recovery
Houses (number)	3,178	8,644,353	17,599,647
Hospitals and health centres (number)	39	1,251,373	1,103,088
Schools (number)	266	1,049,288	3,831,865
Agriculture (crops, 56%; livestock, 32%; other, 12%)		17,660,000	15,000,000
Commerce and industry		3,773,435	N.A
Tourism		777,941	N.A
Roads (km)	1,843	17,470,000	14,180,000
Telecommunications Power		3.080,000	2,900,000
transmission lines Water		3,230,000	6,900,000
supply and sanitation		566,000	533,750
Total		54,422,390	62,048,350

Source: Lao PDR (2009)

Thus, the review suggests that the key vulnerabilities in the Lao PDR are caused by flooding and droughts, with agriculture (and those who depend on it) as the sector most vulnerable to climate change. Note also that several other sectors closely linked to agriculture would further contribute to its vulnerabilities, including water resources, the transportation network and public health services.

3.4 Climate Change' in Lao PDR

To analyze climate change impacts, two periods of climate situations —future climate (with three GHG emission scenarios), and current climate or baseline —are needed. This requires good historical climate data and appropriate climate scenarios from General Circulation Models (GCMs). Consequences on different sectors can be analyzed and compared, and hence, potential climate change impacts can be assessed. To reduce uncertainties, scenarios from several GCMs are used in the Lao PDR study.

This study used observed rainfall data from 17 stations and outputs from GCMs with a resolution of 1OOxl00km (Masutomi *et al*, 2009).A total of 14 GCMs, with one baseline

6 The UNFCCC defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."

and three emission scenarios (AlB, *A2* and B1), thus were used in the analysis (Ministry ofNatural Resources and Environment, 2012).

Using observed data for 1991-2000, the baseline climate scenario from the GCMs and scaling factors, calibration and interpolation was employed to obtain future baseline scenarios for all GCMs. Average monthly rainfall for two periods were used, 2021-30 and 2051-60.[7]

Comparing the rainfall scenarios under three emission scenarios and the baseline, results suggest no significant change in rainfall patterns for the next one or two decades in all regions of the country (Figure 3-6, above). However, by the middle of the century rainfall patterns could change considerably, particularly in some areas of the Northern and Central regions. Rainfall in the Northern region is likely to decrease, while that of the Central region also suggests a similar trend with a smaller magnitude (Figure 3-6, below).

Analysis of seasonal rainfall changes indicates that this likewise is expected to change. Rainfall is projected to decrease during transition periods, with delays of the onset of the monsoon in the south suggesting a possible shift in rainy season. In turn, this could substantially affect the country's traditional agriculture.

These results generally align with a study of future climate in Lao PDR derived as a mean projection from seven GCMs (Lefroy R. et al., 2010). In that study, it was suggested that "... the rainfall in the early wet season, in May, will decrease, and rainfall at the very start of the wet season in April and the end of the wet season in October will increase. This is a continuation of the trend seen in the 20th Century for a *delay in the main wet season, in June to October*, and perhaps an increase in the risk of a false start to the wet season, with more rain in April but less rain in May. Thus, rainfall variability remains the critical issue."

7 For details of data and methodology, see Ministry ofNatural Resources and Environment, 2012.

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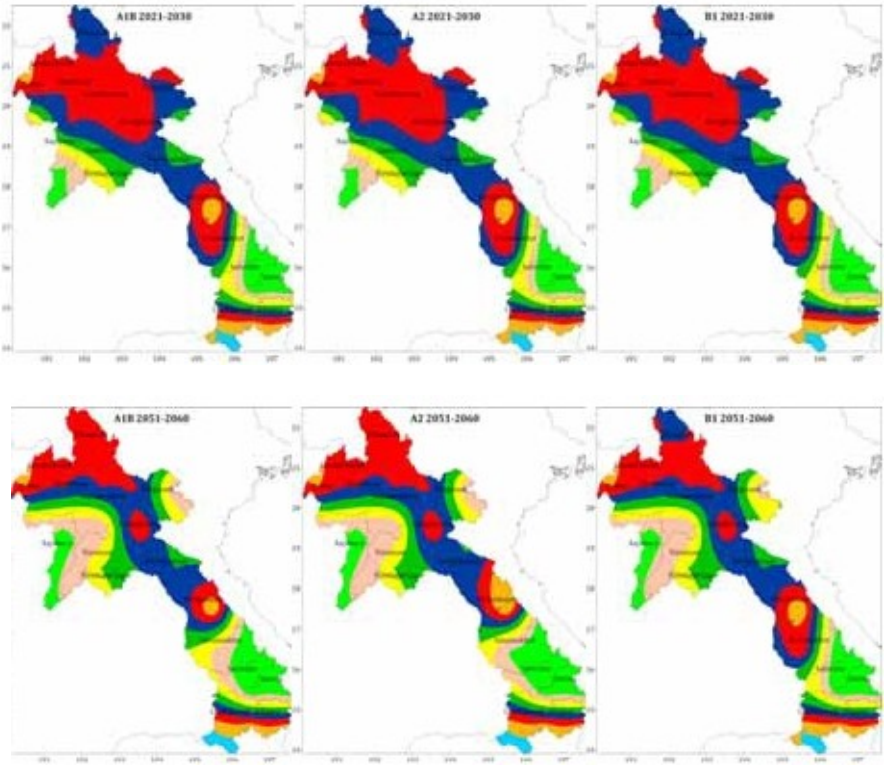


To 8ddresa uooertainlies, direaions of ebsnging paltm!s among GCMII are used to test lhe conftdeooe of the u:ndency II:IDO!Ig1hem.'l'bill Sludy evaluated lhe direc!ioo af rainfiiD change (eilber iDcn:as:iDg or decn:uiD,g) suggested by the 14 GeMs. The level of ooniidenoe for a panicular dinlction o fis eolllliclemi to iDl:mise if most or all of lhe models are in agreema: t. Howeva-,1his aual.ysis was eonducted.at an cady slage, and more studies are r:equiied to addlesunCC!rtainties.

3.5 Vulnerability and Risk to CUmate Change

To further identify adaptation options, vulnerability to climate change and climate variability c:an be measured usiDg 1be tbree dimensions of level of exp()81.lN, level of sensitivity, and adap1ive eapacjty of 1he system.• A system with a high level of exposure and sensitivity and low adaptive c:apac:ity is c:onsidered most vulzle.Rblc, while one wi1h a low level of exposun'l and sensitivity and high adaptive eapacity is c:onsidered least vulnerable.

6 For details, see Ministry of Natural Resources and Environment, 2012.

3.5.1 Vulnerability

The aggregate Sensitivity and Exposure Index (SEI) and Adaptive Capacity Index (ACI) reflect vulnerability and adaptive capacity levels of villages in Lao PDR; the higher the SEI or ACI), the more vulnerable the village or the higher its adaptive capacities.

Results show that only Champasak Province and Vientiane capital have a small proportion of villages with an SEI of more than 0.5, meaning that fewer than one-fourth of the villages in these locations are considered vulnerable. Other provinces have at least one-fourth or more of their villages rated as sensitive and exposed to extreme climate. With some exceptions, provinces with higher SEI also have higher poverty levels (Table 3-3).

Table 3-3: Categories of provinces based on SEI

No.	Category	Province Name
	Provinces with *0-25%* of villages with SEI > 0.5	Champasak. Vientiane Capital
2	Provinces with 25-50% of villages with SEI > *0.5*	Borikhamxay, Khammuane, Saravan, Savannakhet, Vientiane Province
3	Provinces with *50-5%* of villages with SEI > 0.5	Attaeu, Borkco, Huaphanh, Xayabury, Xiengkhuang
4	Provinces with 75-100% of villages with SEI > 0.5	Luangnamtha, Luangprabang, Oudomxay, Phongsaly, Sekong

At the same time, the ACI shows that most villages and provinces have low adaptive capacity to climate change. Many provinces in the country have more than 75 percent of their villages with an ACI less than 0.25 (full ACI equals 1). These include Attapeu, Borkeo, Huaphanh, Luangnamtha, Luang Prabang, Oudomxay, Phongsaly, Sekong and Xiengkhuang. Only Vientiane capital has fewer than one-fourth of its villages with an ACI ofless than 0.25 (Table 3-4).

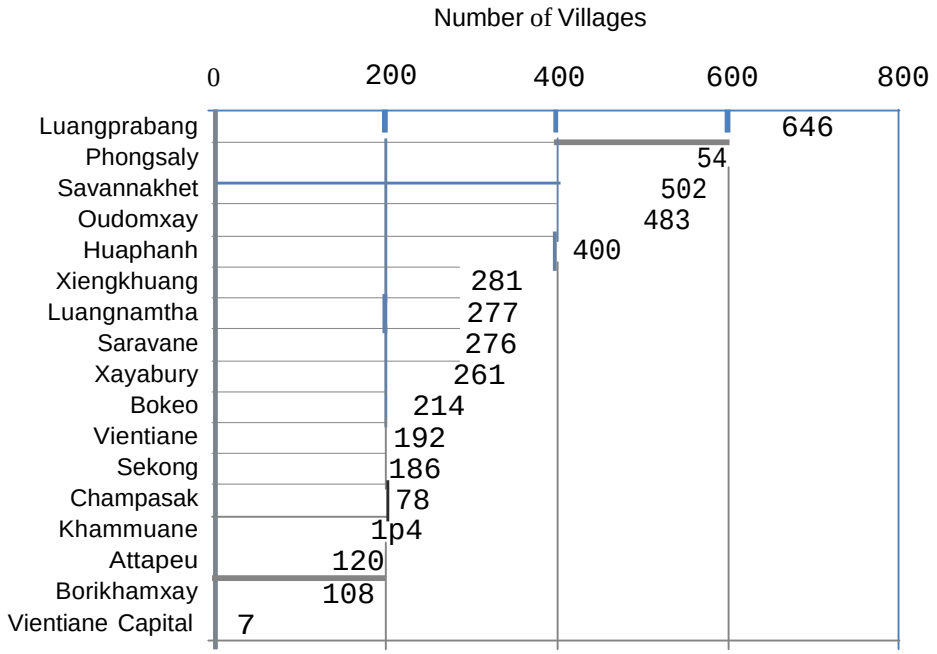
Table 3-4: Categories of provinces, based on ACI

Category	Province
Provinces with 0-25% of their withACI < 0.25	Vientiane Capital
Provinces with *25-50%* of their villages with ACI <0.25	Khammuane, Vientiane Province
Provinces with 50-75% of their villages withACI < 0.25	Borikhamxay, Champasak, Saravane, Savannakhet, Xayabury
Provinces with 75-1000/o of their villages withACI < 0.25	Attapeu, Borkeo, Huaphanh, Luangnamtha, Luang Prabang, Oudomxay, Phongsaly, Sekong, Xiengkhuang

Villages with high ESI and low ACI will be very vulnerable to climate variability – in this case, flooding -- while villages with low ESI and high ACI will be less vulnerable. Significantly, this assessment shows that more than 4,800 villages- or nearly half of the total villages[9] across all provinces – were regarded as very vulnerable. Provinces with more than half of total villages classified as very vulnerable include Luang Prabang, Phongsaly, Savannakhet, Oudomxay and Huaphanh (Figure 3-8).

The study of vulnerability and adaptive capacity undertaken in Lao PDR thus has concluded that the country is already highly vulnerable to even the existing impacts of climate change, particularly floods and droughts. Agricultural activities, especially related to rice production, are the most vulnerable. In general, poverty levels are higher with higher vulnerability to climate change and with lower adaptive capacities.

Figure 3-7: Number of villages categorized as very high vulnerability, by province



9 In 2005 there were 10,552 villages in Lao PDR (Department of Statistics, Lao PDR), accessed at http://www.nsc.gov.la/Statistics/Selectedo/o20Statistics/AdministrativeData.htm

3.5.2 Climate Risks

Climate risks depend on the probability of climate hazards and vulnerability. In the case of Lao PDvillages with high vulnerability would be at high risk if climate hazards occur. A matrix of risk. as a function of probability of unexpected events and their consequences can be formulated (Beer and Ziolkowski, 1995). This approach has been used to assess levels of current and future climate risks of villages in the country.

Current Climate Risks. All provinces have experienced floods and droughts to different extents (Figure 3-9); the assessment also indicates that most are at high risk of these hazards (Figure 3-10). Provinces with the largest proportion of villages at high risk of flooding include Xiengkhuang, Sekong and Attapeu, while those with a larger proportion of villages at high risk. of droughts are Savannakhet and Huaphanh (Figure 3-11).

Figure 3-8: Frequency of floods (1996-2005) and droughts (1995-2005) In Lao PDR

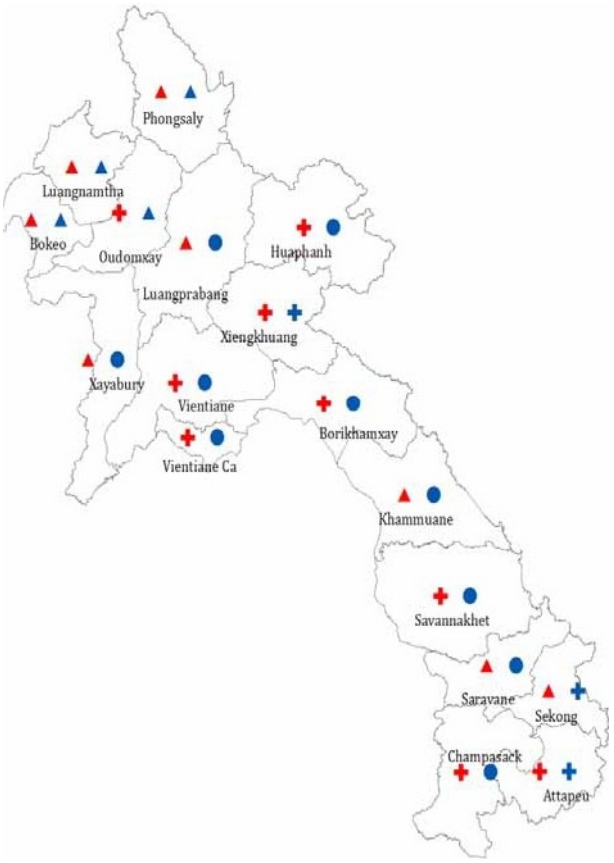
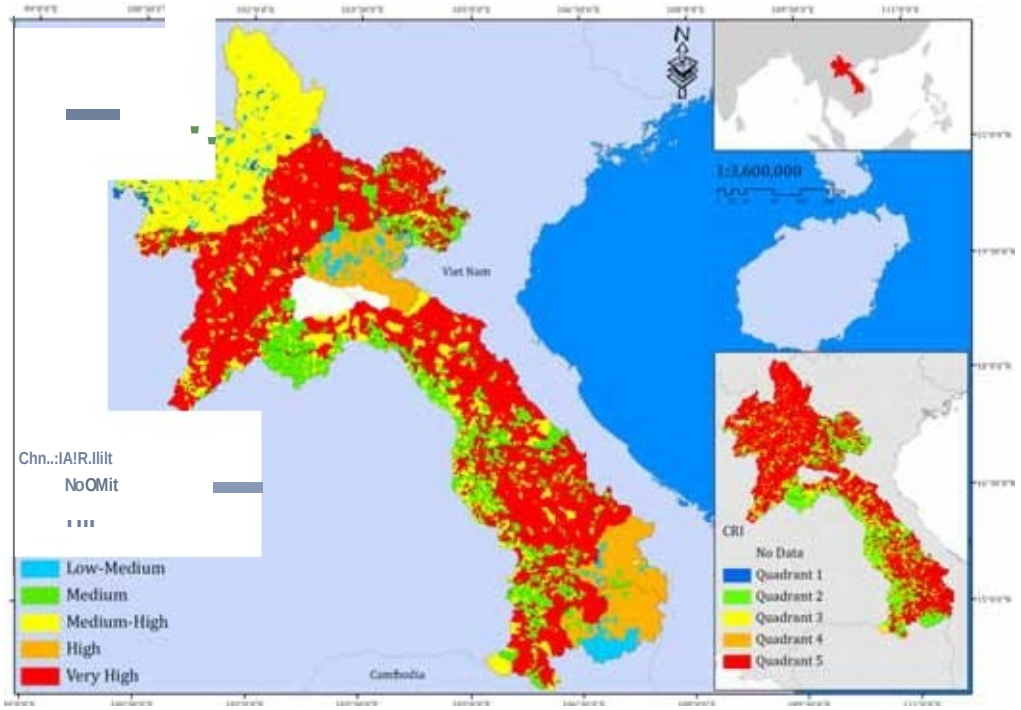


Figure 3-9: Distribution of villages according to their climate risks (floods, droughts)

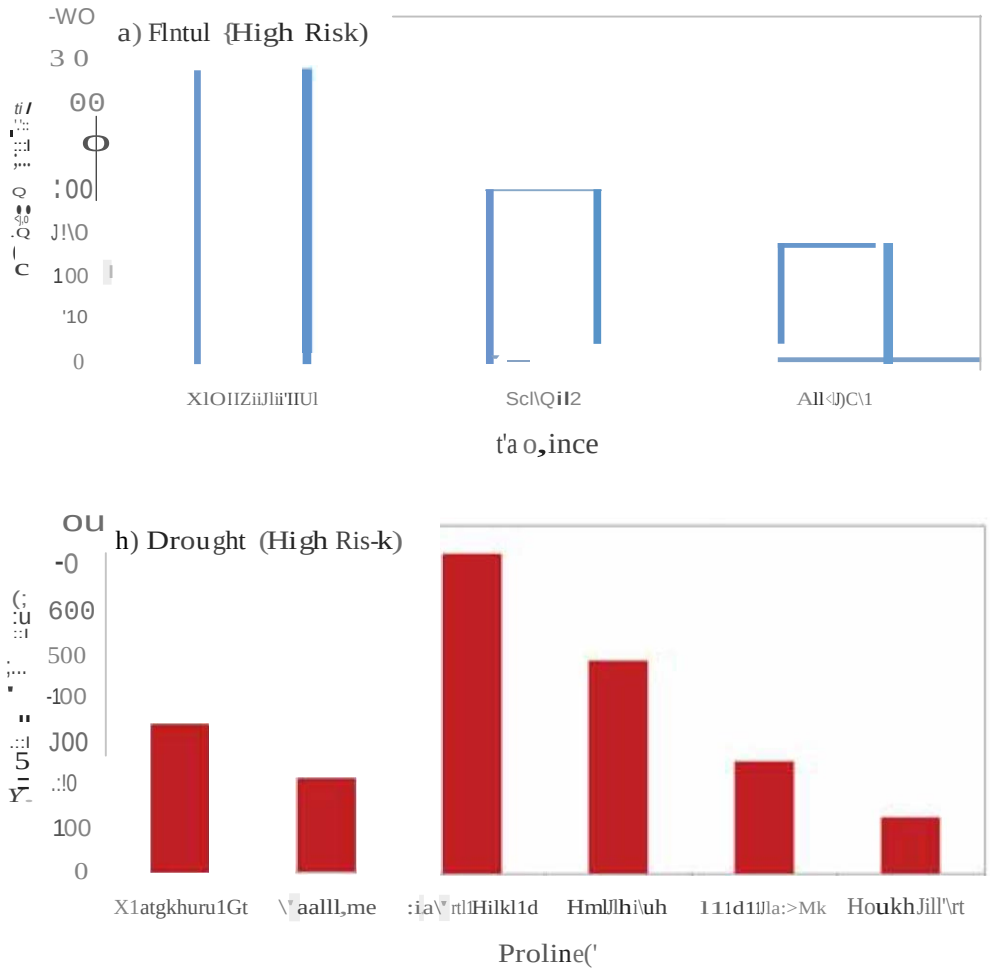


Future Climate Risks. Based on 0!.e level of risks under di1l'erart scc:1181'i0(!,clima1e risks in allregi.OilllofLaoPDRareexpectedtoincreasebetween202Sa:nd208S.Areaaideruiftedaa having a very high level of risk are expected to e:xta1d iom the no:rth of 1he cotm1l:y at 1he beginning of Ibis 60-ye«r period to the 80Uib. by 1he end.

These results are consistent wid!!he studyon vulnerability and risk due to drougbt,"which suggested Chat a large proportion of households were at risk, especially provin.oe6 in Che Calttal and Somhem owsuch aa Xayabury, VJ.entiaoe, Savannakbet, Khammoune and Champasak (F3-12) (WREA, 2009).

10 Oeftnbsa dJk = lurraftl.Vllllwnblll:ly,!be8llld)' IUIleo!reel baa.Nboldlomla *that*-'YIIhlerahleiOrid:tac-!O:!Jllbly coalae:ftom/bea!'t'"""•d hy cllma!oChaose- Hauaeholda *that*–at rlak offwomtns food-Ill-becaaae ofa hazardallo uee.nimaled. C«1aa!!dm!!holcli-IIJIJe<:dvo,8llJ!1bo MIU!!a -IM!<*lve (WEP, 2007, Mrefell'ed10 In WREA, 2009)

Figure 3-10: Provinces with villages at high risk of (a) floods and (b) droughts



Thus, the assessment of village vulnerability and risk indicates that households in most part of the country are already highly vulnerable to climate variability, with the situation likely to be more severe in the future. Three provinces have particularly high risk of floods, while six have high risk of droughts. Moreover, as time passes the risks tend to expand from north to south.

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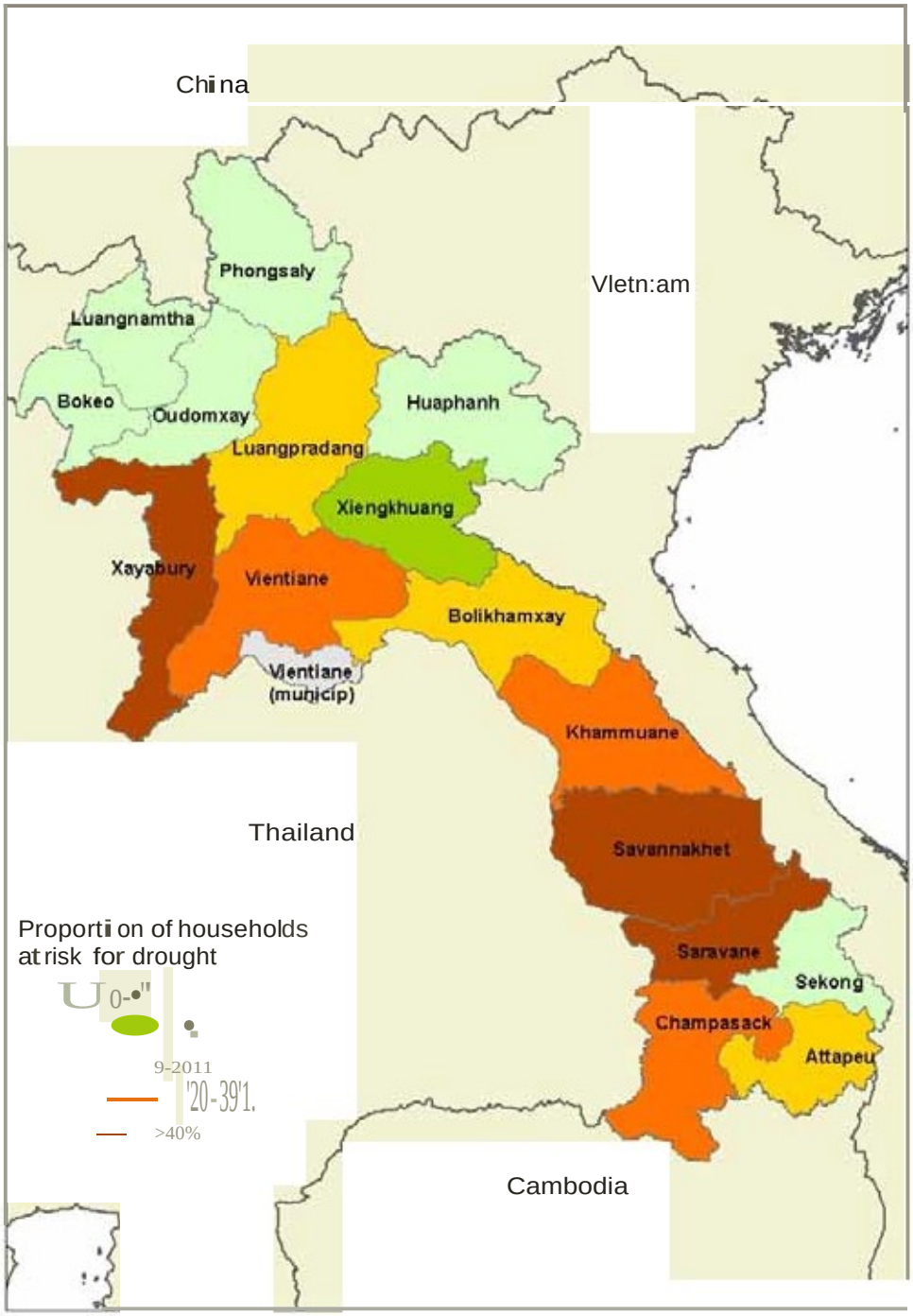


So=o:WREt\(2009)

3.6 Adaptation Needs

The study on climate change impacts and vulnerability in Lao PDR has not yet reached the stage of adaptation analysis, including for specific sectors or regions. [11] However, adaptation to climate change, which is long-term and generally through a modelling approach, is arguably less perceived by stakeholders, especially the rural poor who are likely to be most affected. On the other hand, the impacts of climate change, through climate variability and extreme events, are already happening and easily seen. Overall, as noted above, LDCs such as Lao PDR are the most vulnerable to the impacts of climate variability and extreme events, while also being the most lacking in adaptive capacities.

3.6.1 National Adaptation Programme of Action

To address urgent adaptation needs of LDCs, the UNFCCC established the mechanism of the National Adaptation Programme of Action (NAPA) in its 7th Conference of the Parties. The NAPA takes into account current coping strategies at grassroots level and builds upon these to identify priority activities, rather than focusing on scenario-based modelling to assess future vulnerability and long-term policies at State level.

The NAPA thus focuses on urgent and immediate needs, those for which further delay could increase vulnerability or lead to increased costs at a later stage. Because NAPA is designed to use existing information, no new research is needed It must be action-oriented, country-driven, flexible and based on national circumstances.

Steps for NAPA preparation include synthesis of available information; participatory assessment of vulnerability to current climate variability and extreme events, and of areas where risks would increase due to climate change; identification of key adaptation measures as well as of criteria for prioritizing activities; and selection of a prioritized shortlist of activities. Project profiles and/or activities are submitted to the UNFCCC and are eligible to apply for LDC funds.

Under the NAPA process in 2009, four sectors were emphasized in Lao PDR, namely, agriculture, forests, water and water resources, and health Adaptation needs were then identified and prioritized, and 45 priority project proposals were developed and submitted to the UNFCCC. Among these, 12 projects were listed as top priority for adaptation actions in the country. They are:

11 One pilot study on paddy production was conducted, with very preliminary results (see Southeast Asian START Regional Centre, "Pilot Study on Future Climate Change Impact on Water Resources and Rain-Fed Agricultural Production," Technical Report No. 13. Bangkok, 2005).

Area	Projects
Agriculture	1. Strengthen the capacities ofNational Disaster Management Committees 2. Promote secondary professions to improve the livelihoods of farmers affected by natural disasters induced by climate change
Forestry	1. Continue a slash-and-bum eradication programme and a permanent job creation programme 2. Strengthen the capacity of village forestry volunteers in forest planting, caring and management techniques, as well as in the use of village forests
Water	1. Raise awareness on water and water resource management 2. Map flood-prone areas 3. Establish an early warning system for flood-prone areas, and improve and expand meteorology and hydrology netwrub and weather monitoring systems 4.Strengthen institutional and human resource capacities related to water and water resource management 5. Survey underground water sources indrought-prone areas 6. Study, design and build multi-use reservoirs in drought-prone areas
Public health	1. Improve systems for the sustainable use of drinking water and sanitation. with community participation, in flood- and drought- prone areas 2. Improve knowledge and skills of engineers who design and build water and sanitation systems

3.6.2 NAPA follow-up projects for the agriculture sector

Learning by doing, the GoL, in collaboration with UNDP, has developed a project proposal on improving the resilience of the agriculture sector to climate change impacts. The four-year project, from 2011 to 2014, aims at minimizing food insecurity resulting from climate change and at reducing the vu1nerability of farmers to extreme flooding and droughts. This project, implemented by the Ministry of Agriculture and Forestry, is designed to produce four outcomes in the areas of knowledge management, capacity building, community-based agricultural adaptation practices, and adaptation learning.

A second project following the NAPA proposed activities relates to effective governance for small-scale rural infrastructure and disaster preparedness in a changing climate. This aims at addressing the vulnerable livelihoods of rural communities arising from climate variability, particularly in the south. Among the most severe impacts of floods, flash floods, storms and droughts caused by increasing intensive but irregular rainfall patterns in this region are the regular destruction of rural roads and small-scale irrigation schemes, as well as water scarcity for household and agricultural consumption. The project objective is to improve local administrative systemsaffectingthe provision andmaintenance of small-scale rural infrastructure (including water and disaster preparedness), through participatory decision

making that reflects the genuine needs of communities and natural systems vulnerable to climate risk. Three outcomes are expected:

Outcome 1: Incentives provided for local administrative institutions to integrate climate risks into participatory planning and financing of small- scale rural water infrastructure provision

Outcome 2: Small-scale rural infrastructure protected and diversified against climate change induced risks (droughts, floods, erosion and landslides) in 12 districts of Sekong and Saravane Provinces

Outcome 3:Natmal assets (such as wetlands, forests and other ecosystems in sub-catchments) of more than 60,000 ha are managed to ensure maintenance of critical ecosystem services, especially water provisioning, flood control and protection under increasing climate change-induced stresses in Sekong and Saravane Provinces

At sub-regionallevethe Climate Change Adaptation Initiative Programme mder the Mekong River Commission has also implemented local demonstration activities in southern Lao PDR

3.7 Managing Climate Risks: The Way Forward

From the analysis above, it is clear that Lao PDR is very vulnerable to the impacts of climate change. Without improving current capacities to manage climate risks, the increasing variability of climate will expose the Lao people to even more serious impacts. Several general descriptions of adaptation approaches – for example, diversifying crop portfolios and farmlands in different agro-ecological zones – have been suggested. In practice, however, adaptation at community level usually involves informal mechanisms, village-based networks, or extended family networks. Such mechanisms can respond to limited shocks, but not shocks that are covariate or spatially extensive. At State level, better access to greater resources is expected, and many measures are normally supported by the central Government (IRI & ADPC, 2005).

Overall, State-supported precautionary programmes to manage climate risks should produce benefits at household and community levels in addition to reducing transitory poverty. These benefits are expected to include reduced vulnerability to climate variability and enhanced sustainable consumption patterns. Therefore, well-designed climate risk management programmes should (IRI & ADPC, 2005):

- Respond to demands of communities and agencies
- Strengthen community and household precautionary strategies
- Be sustainable with respect to fiscal resources and institutional structures
- Integrate a range of information and resources, such as climate and price information, agricultural production inputs, and credit
- Communicate probabilities involving a diverse set of outcomes
- Promote timely, "no regrets" interventions that avoid expensive or irreversible decisions
- Integrate decisions across local, regional and national levels

Given the existing climate threats and the risks of climate hazards that Lao PDR is encountering, it is extremely urgent for the country to prepare for potential impacts. Some of the key components that should be emphasized include:

Existing support mechanism. To a limited extent, the NAPA has contributed to climate change adaptation in Lao PDR, although activities implemented thus far have been small compared to the priority needs identified. It is hoped that the LDC Fund of the UNFCCC will serve as the key financial mechanism for the country's adaptation needs. Intensification of financial and technical support from the UNFCCC is therefore critically important and urgently needed to strengthen national adaptation measures.

Research and development. Technical capacities of relevant national personnel with regard to vulnerability and adaptation must be developed and sustained; at present, international experts are almost exclusively relied upon to provide this sort of technical analysis.[12] Additional support to strengthen a coordination network among national and regional researchers is particularly needed.

Policy mainstreaming. The GoL has already integrated the National Climate Change Strategy into sectoral and national development policies and planning. However, even more effective mainstreaming is necessary with the sustainable social and economic development process of the country.

12 This includes the technical capacity to address existing risks of climate variability and extreme events, particularly in agriculture and water resources; development of scientific knowledge and capacity on climate modelling and scenario building; and development of sectoral impact models, particularly on water resources, agriculture, rural communities and health, socio-economic scenarios, and potential climate change effects on existing climatic patterns.

Adaptation measures.Adaptation programmes with strong local ownership continue to be needed, with strengthened local capacities to address climate change and mechanisms to sustain the process. This includes the use of participatory inducements and public relations at all stages of adaptation, ranging from planning to execution and evaluation.

Climate resilience and poverty eradication. A holistic approach and workable programmes should be developed to simultaneously reduce poverty and enhance climate resilience, particularly in rural communities. Win-win or "no regret" policy options must be practical and appropriate for local conditions.

Regional cooperation. Tropical countries of the ASEAN region and Mekong sub-region have many similar social and economic structures. Strengthening of regional cooperation will make technological transfers and knowledge exchange more practical, applicable and cost-effective.

CHAPTER 4

MITIGATION ACTIONS AND MEASURES

4.1 Introduction

This section describes national development over the past decade that has contributed to mitigation efforts. It also captures potential mitigation actions/measures in key sectors that could be implemented amid the dynamics of the climate change negotiation process

It is important to bear in mind that hydropower contributes about 40 percent of economic growth in Lao PDR, while services adds about 20 percent, agriculture more than 10 percent, manufacturing more than 10 percent, and mining and construction small proportions each. While manufacturing is increasingly important, hydropower and agriculture thus remain the most important sectors, especially in addressing rural poverty and GHG mitigation.

4.2 Mitigation Measures and Actions Implemented

Based on the national development goals and the levels of technology available, the FNC identified potential mitigation measures in all emission sectors, with energy and forests being key sectors. It is important to recognize that Lao PDR has long emphasized renewable energy development through hydropower development projects that harness the country's abundant water resources. Despite Lao PDR's small share of total GHG emissions, primarily from fossil fuels, mitigations of such emissions also was found to be worth pursuing. At the same time the net sink performance in the forestry sector was found to reflect a need to continue to balance utilization and conservation of forest resources.

Development related to mitigation actions over the past decade, focused on measures related to renewable energy and forests, are summarized below.

4.2.1 Energy Sector

There are three major sources of energy for domestic and economic activities in Lao PDR: biofuel, hydropower and fossil fuel. More than half the energy in the country comes from biomass, particularly fuelwood and charcoal. In 2002 fuelwood constituted about

56 percent of total energy consumption, followed by petroleum, at 17 percent. Electricity and charcoal each constituted 12 percent. The remainder was from coal and other sources (ADB, 2006). By user, the residential sector consumed more than half of the total supply, followed by the transport sector (26 percent) and industry (20 percent). Small proportions were consumed by agriculture and commerce.

4.2.1.1 Hydropower

Hydropower remains the most abundant and cost-effective energy source in Lao PDR. Excluding the mainstream Mekong River, the country has more than 26,000 MW of hydroelectric power potential; of this, about 70 percent is technically exploitable. Less than 2 percent of the country's hydropower potential has been developed during the past 30 years. It is expected that development of hydropower will not only fulfil domestic electricity demands, which are increasing by 8 to I0 percent annually, but also will support the regional demand for power supply and indirectly enhance GHG mitigation efforts of other Southeast Asian countries. Agreements for future hydropower exports are in place with Thailand, VietNam and Cambodia.

The Government has put in place policies that promote renewable energy and guide the actions to be taken at operational levels. The main energy policies over the past decade that have contributed to national GHG mitigation efforts include:

- Increase of households with electricity to 70 percent by 2010, with a goal of 90 percent by 2020
- Development of relatively low-cost indigenous fuel to reduce the import of expensive petroleum products and the consumption of fuelwood
- Development of hydropower to meet the country's power demand as well as to provide export earnings from electricity sales to neighbouring countries
- Implementation of appropriate pricing policies to induce efficient consumption patterns and accelerate implementation of public policies on fuel substitution, energy efficiency and conservation
- Strengthening of institutional capacity in the energy sector, particularly on training, policy formulation, project implementation and financial management

Under the policies above, various measures have been undertaken by relevant Ministries and departments. In particular, the GoL has continuously developed different sizes of hydropower projects across the country throughout the past two decades.

As shown in Table 4-1, before 2000 12 hydropower plants with a total installed capacity of 2,120 MW were developed. During the 2000s, several new plants were developed, while some old ones were terminated. By 2011 14 hydropower plants with a total installed capacity of2,548 MW were in operation. It is expected that another 10 power plants with more than 4,300 MW of installed capacity will be in operation within a few years, while more than 50 prospective plants, with about 13,000 MW, are in the planning or feasibility study stage. Assuming that the installed capacity operates at 50 percent per year and CO_2 reduction at 0.673662 Gg/TJ,t Lao PDR may have contributed directly and indirectly to about 2,163 Gg of CO_2 reduction in the 2000s. Moreover, this amount could more than double in the 2010s.

Table 4-1:Power projects in Lao PDR as of January 2012

Stage	Number plants	Total installed capacity (MW)	In TJ/year	Imputed C0 reduced per year
Developed before 2000	12	2,120.5	26,718.30	1,799.91
Operational	14	2,548.5	32,111.10	2,163.20
Under construction	10	4,331.2	54,573.12	3,676.38
Under planning	23	5,930.9	74,729.34	5,034.23
Feasibility study	33	7,266.5	91,557.90	6,167.91

Source: Adapted from Department of Energy Business, Ministry of Energy and Mines, Power Projects in Lao PDR (www.poweringprogress.org,Electric_Power_Plants_in_Laos_January_2012.pdf)

Note: Assuming installed power plant operated 50 percent per year. 1 MW = 3.5 GWh/year, 1 GWh = 36 TJ

4.2.1.2 Rural Electrification

Rural electrification has been one of the key strategies to fight poverty in Lao PDR. Under this policy, the Rural Electrification Programme was introduced in 1995 to extend the electricity grid to rural households and promote off-grid renewable energy throughout the country. With a total ofUS$138 million in grants and loans through the World Bank, electricity access across Lao PDR between 1995 and September 2010 steadily increased, to 71 percent from 16 percent, and reached 730,000 households.[2] The electrification programme has enhanced agricultural productivity and off-farm activities alike, as well as extended social and education opportunities in rural communities.

1 Derived from figures in energy sector of National GHG Inventory for 2000, Thailand, CO/fJ = 0.673662.

2 http://web.worldbank.orgfWBSITEIEXTERNAUCOUNTRIES/ EASTASIAPACIFICEXT ILAOPRDEX-TN/O,contentMDK:22858227-pagePK:141137-piPK:141127-theSitePK:293684,00.html

Under the programme, cost-effective incentives are provided to the rural poor to connect to the grids, while policy assistance and capacity building are also carried out. The Rural Electrification Programme covers social and development aspects such as:

Cross-subsidies in the tariff system, covering 20 percent of the cost of supply to rural households to ensure that electricity costs for these households are not higher than alternatives for lighting (kerosene and rechargeable batteries)

Village screening programme that ensures that villages with clinics, schools, irrigation systems and higher potential for economic growth are prioritized

Power to the Poor, a component that provides interest-free credit for poor families to connect to the grid. It particularly benefits female-headed households, since these are usually the poorest and most vulnerable in rural communities

Productive Use of Electricity, a programme that provides support to local communities and rural households to use electricity for income generation

Assessment of the project shows outstanding achievements. These include:

An almost fivefold increase in access to electricity between 1995 and 2010

35,000 of the households connected using off-grid systems such as solar home systems or mini-hydro power plants

A growing number of new businesses, especially retail stores, weaving and knitting shops, and rice mills, in newly electrified villages. Since electricity arrived, about 30 new businesses per village have been established. The use of electric tools and appliances has improved living standards and allowed for other productive activities. In addition, electric lighting extends the evening hours for the family to work at home or to study

An increase in agency capacities in planning, design, procurement, installation, and assessment of environmental and social impacts

An increase in connection rates in previously electrified villages, from 70 percent to 95 percent on average

Design of an innovative system to manage off-grid connections in remote areas. Solar home systems and small village-based hydro schemes have helped electrify more than 23,000 households in villages without grid coverage

Achievements of the rural electrification programme demonstrate the integration of climate change policies into the national development process, especially with regard to poverty reduction. Overall, electrification reduces the use of kerosene for lighting, and hence, emissions of C02. Assuming average household consumption of kerosene is 30 litres per year, the electrification programme could reduce kerosene burning by more than 2.1 million litres annually. Assuming net calorific value and emission factors of 37.5 MJ/litre and 71.5 tC02ffJ, electrification in Lao PDR has thus reduced C02 emissions by about 5,630 tonnes (78.75 TJ*71.5 trrJ) per year.

At the same time, the programme has encountered various challenges and constraints. Payment for off-grid electricity, although heavily subsidized, had to be partly shouldered by the rural poor. Monthly fees were due even when farmers did not use electricity (for example, if they were away to other farm plots for a period of time). The high value of solar panels and power storage utility facilities make them susceptible to robbery (Hanna, 2008). In addition, a lack of diversified models for other off-grid technologies hindered the options to develop off-grid systems indifferent conditions (World Bank, 2011).Sustajning the off-grid system to eradicate poverty in Lao PDR remains a considerable challenge.

The experience of the programme confirms that switching energy from fossil fuels to renewable requires a high cross-subsidy and would not be possible for LDCs such as Lao PDR without sufficient international support.

4.2.1.3 Energy efficiency and conservation

Energy efficiency and conservation efforts have concentrated on the residential and manufacturing sectors. The Demand-Side Management/Energy Efficiency (DSM/EE) Project, a component under the Rural Electrification APL Phase I Project (REP I), was established to increase access to electricity of rural households in the central and southern provinces of the country. REP I is funded by the World Bank/GEF. The DSM/EE project is divided into two phases, Phase I (2007-2010) and Phase II (2010-2012). The overall objectives of Phase I were to determine reasonable energy consumption levels for the major energy-consuming Ministries/agencies and to address the issue of inefficient practices in public-sector electricity consumption. The improvement of such inefficiency not only is expected to generate positive fiscal and financial impacts, but also to enable the country to generate more revenues from

electricity exports as a result of savings from this higher efficiency.

DSMIEE project tasks include:

1. Capacity building of DSM cells and energy conservation
2. Development of a public-sector energy efficiency programme
3. Expansion of the energy consumption database
4. Development of a residential sector DSM programme
5. Undertaking of a household appliance saturation survey

A shortcoming of the DSM programme has been the persistent lack of public awareness and adoption of energy-efficiency technologies and practices by public agencies and customers of the Electricity Authority ofLao PDR (EdL) (World Bank, 2011).

4.2.2 Forestry sector

In 2001 the forestry sector contributed about one-fourth of export earnings and about 3.2 percent of GDP (Ministry of Agriculture and Forestry, 2005). This does not include the contribution of NTFP to the subsistence livelihoods of rural communities. Because wood energy, including fuelwood and charcoal, remains the dominant source of energy for cooking in both urban and rural areas, this makes the forest sector highly important to national social, economic and environmental development. As confirmed by the 2000 GHG Inventory, the land-use change and forestry sector is the most important source and sink in the country, and hence the most vital sector for a national response to address climate change issues. Mainstreaming climate change mitigation and adaptation into sustainable forestry development, such that this contributes to national socioeconomic development objectives, is therefore a key issue for Lao PDR.

Of the total area of 23,680 million ha, forest areas with more than 20 percent canopy density comprise about 41.5 percent. To ensure that the forestry sector maintains its ecological services and continues to support sustainable livelihoods for the rural poor, the GoL established a policy to stabilize shifting cultivation by 2005 and to completely eradicate the practice by 2010. The policy also aimed to expand economic forests and accelerate classification and delineation of forests for protection, conservation and production purposes. Several forest-related laws, decrees and orders have been promulgated since the 1990s (Ministry of Agriculture and Forestry, 2005).

Table 4-2 shows the change in size of forest areas over the last decade, as well as planned and targeted areas for the next two decades. During the past decade, officially declared forest areas (defined as areas with canopy density of at least 20 percent) increased from less than 10 million ha in 2000 to about 13.6 million ha in 2010.The Government further plans to increase the forested area to 65 percent of total land by 2015, or 15.4 million ha, and to particularly promote protected and conserved forests. This could be achieved by rehabilitation and replantation of degraded or abandoned land. By 2020, the Government plans to increase the forested area to 70 percent of total land.

Maintenance/expansion of forest areas also means maintaining/enhancing the GHG sink capacity of the country. Assuming biomass of 90 tonnes of CO_2 per ha of forest land, the emissions avoided or potentially avoided in 2010 were as much as 338,000 Gg; this could increase by 160,000 Gg in 2015 and another 106,000 Gg in 2020. If these targets are achieved, Lao PDR could avoid emissions of up to 600,000 Gg of CO_2 per year.

However, huge economic costs are involved. Keeping 70 percent of the country's land as forest for global benefits despite pressures to use land resources to reduce poverty will require cautious policy measures.This also brings to a test the potential of new UNFCCC mechanisms to enhance sinks, particularly NAMA and REDD+.

Table 4-2:Areas of production, protection and conservation forest in 2000, 2010 and 2015 (000 ha) and potential emissions avoided (mil.tonnes)

	2000	2010	2015 (planned)	2020 (target)
Production	NA	3,100.0	3,100.0	NA
Protection	NA	6,881.0	8,200.0	NA
Conservation	NA	3,600.0	4,100.0	NA
Total	9,824.7	13,581.0	15,400.0	
Rehabilitation			1,670.0	
Replantation			111.5	
Planned total			15,362.5	
Targeted total			15,392.0	16,576.0
Incremental		3,756.3	1,781.49	1,184.0
Potential CO_2 emissions avoided (mil.tonnes)		338.07	160.33	106.56

Note: NA = Not Available.

Sources: Data for 2000 are obtained from National Forest Inventory, 2002; data for 2010 and 2015 are from Five-Year Sustainable Forest Protection Action Plan (2006-10) and Future Directions for 2011-2015, Department of Forestry; and data for 2020 are from Forestry Strategy to the Year 2020. The planned total for 2015, by calculation, is slightly lower than the targeted total; on the other hand, the two were slightly lower than the sum of the three categories.

4.3 Mitigation Under CDM Projects

The GoL has already approved 10 Clean Development Mechanism (CDM) projects with a total mitigation potential of 1,450 Gg of CO_2 per year. Of these, six projects are hydropower, with the remainder comprising one each from agro-forestry, biogas, energy efficiency and alternative fuel. Out of the 10 projects, only two – Beer Brewery energy efficiency and Xekaman 3 hydropower project, have been approved by the CDM Executive Board (Table 4-3). The time consumed from project development to final approval was high, with the process generally taking at least 1 or 2 years, but some could take even 3 or 4 years. This issue will need to be urgently addressed.In terms of CO_2 mitigation, hydropower projects have much higher potential than other types of projects. Overall, the six hydropower projects contributed to more than 90 percent of the total estimated CO_2 reduction.

Another four projects (three hydropower and one afforestation) are under development and are expected to be submitted for approval soon.

Table 4-3: List ofCDM projects approved by the DNA ofLao PDR

No.	Name of project	Estimated GHG reduction (Gg of CO_2e/y)	Letter of Approval issued
	Beer Brewery energy efficiency•	2.17	18/1/07
2	Xesetll hydropower project	181.53	1n/09
3	Rubber base agro-forest system	35.72	18/5/10
4	Biogas project	32,51	1214/2011
5	Cement alternative fuels project	66.25	10/3/2011
6	NamLik 1-2 hydropower project	204.57	9/8/2011
7	Xekaman 3 hydropower project•	499.48	9/8/2011
8	Nam Lik 1 hydropower project	120.23	711112011

9	Nam Sim hydropower roject	18.73	7/1112011
10	Num Gneum 5 hydropower project	290.82	7/1112011
	Total	1,452.01	

Note: * =Projects already approved by the CDM Executive Board

4.4 Mitigation Options and Potential

The above sections describe the emissions options identified in the FNC and key mitigation measures taken by Lao PDR since the FNC. These measures were the result of national sustainable development policies and planning. The policies took into account the priorities of socioeconomic development objectives, considering natural resource conservation and environmental protection, including from climate change. This section discusses the assessment of mitigation potential for the future, under different technical options and by sectors.

4.4.1 The Approaches

The main objective of this assessment is to enhance national technical capacities to develop, formulate and prioritize mitigation options that would form a basis for policymakers to develop national sustainable policies on climate change. To assess mitigation options, several Working Groups were established to analyze mitigation potential in the energy, industrial processes, agriculture, land-use change and forestry, and waste sectors.

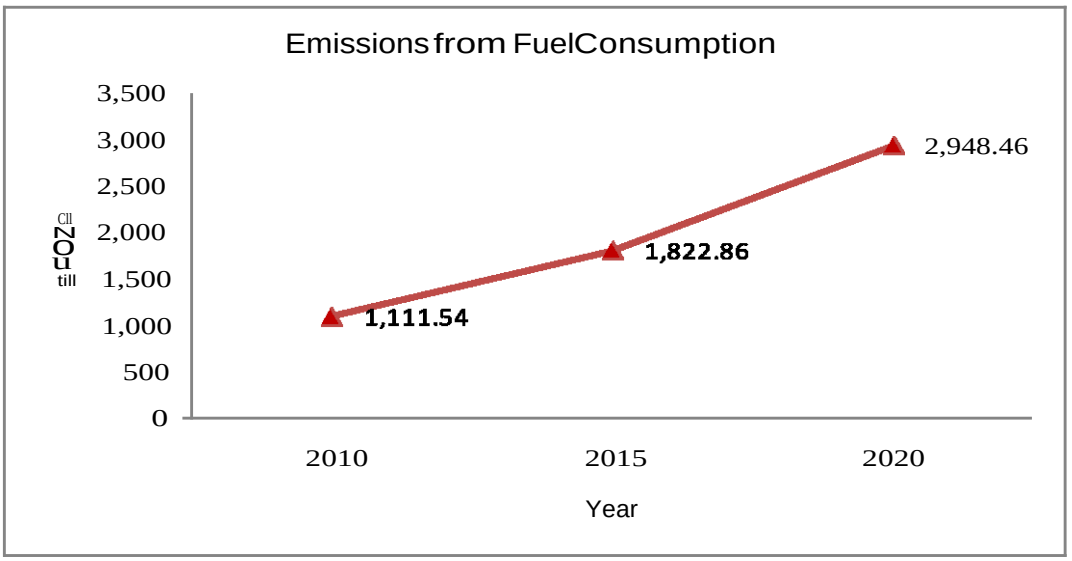
The mitigation assessments involve the projection of GHG emission baselines or BAU scenarios and identification of mitigation options for future GHG reduction. The baseline scenarios were developed from historical data and projected into the future by 20 to 50 years, depending on the sector. Mitigation options were identified based on commercially available soft and hard technologies, or those believed to be potentially available over the relevant periods (Ministry ofNatural Resources and Environment, 2012).The assessment was not able to apply the prioritization criteria described; instead, national development policies and plans, national circumstances and expert judgment were used to identify potential technologies likely to be favourable to Lao PDR. This was due partly to data availability, as well as to the complexity of assigning and aggregating indices for the criteria (Ministry ofNatural Resources and Environment, 2012).

Results of the assessment for each sector are summarized below.

4.4.2 Energy sector

Energy combustion covers the power or energy industry, manufacturing and construction, transportation and residential establishment. Energy consumption in Lao PDR is projected to increase from 2,654 Ktoe in 2010 to 3,036 Ktoe in 2015 and 3,667 Ktoe in 2020. Assuming 90 percent of fuel demand is consumed, CO_2 emissions from fuel demand could be estimated as shown in Figure 4-1. CO_2 emissions increase steadily from about 1,000 Gg in 2010 to more than 1,800 Gg in 2015 and nearly 3,000 Gg in 2020.

Figure 4-1Projected CO_2 emissions from fuel consumption, 2010,2015 and 2020 (Gg)



Several mitigation measures identified in the FNC have already been implemented, as previously discussed. Many, such as the Rural Electrification Programme, will be carried out until 2020. Other potentials have been identified in other studies and consultation processes. Taken together, it is believed that GHG reduction can be achieved through the following measures:

1. Power generation

a) Electrification: targeted to increase access to electricity to 90 percent by2020

b) Renewable ene!ID': accelerating the development of renewable energy from solar, wind, biogas and hydropower for urban and rural areas

c) Cleaner energy: making use of coal-bed methane and coalmine

methane, while also seeking cleaner technologies for development of the country's abundant lignite resources

d) EnemY efficiency and sayings: introducing or improving energy-efficient technologies such as lighting and appliances, as well as energy-efficient buildings

e) Public awareness on energy saving: through implementing initiatives such as car-free day, Earth Day and World Environment Day

2. Industrial processes

a) Energy efficiency: improving energy inputs in production processes

b) Waste minimization: reducing wood waste through the enhancement of furniture manufacturing efficiency

c) Energy from wastes: promoting the use of agricultural wastes or residues to produce energy or heat for post-harvest activities

3. Transport sector

a) Fuel efficiency: stimulating improvements by controlling the import and use of secondhand vehicles, proper vehicle maintenance and promotion of the use of fuel-efficient vehicles (e.g., hybrids, battery and solar cars)

b) Fuel switching: by promoting alternative low-carbon fuel sources such as biofuels and compressed natural gas (CNG)

c) Improved road and land-use planning: promoting dense settlements instead of urban sprawl

d) Expansion of public transport: by improving infrastructure and facilities that support the mass transit system, such as buses and trains

e) Promotion of fuel-free commuting: including the use of bicycles and walking paths, especially in tourist-attractive towns

4. Building sector

a) Introduction of energy-efficient heating and cooling systems, lighting and appliances

b) Improvements in building thermal integrity through insulation and air sealing

c) Use of solar energy in active and passive heating and cooling, and effective use of natural light ("day lighting,.) by innovative design

d) Effective wastewater management/treatment and reuse

In practice, economic and/or regulatory instruments have been used to improve energy efficiency. These include:

- Voluntary and mandatory measures on energy efficiency performance standards, building codes, appliance efficiency standards, and efficiency labelling
- Regulatory control of outdated and secondhand engines, fuel standards and low- carbon fuels, as well as performance and emissions standards
- Market-based solutions including GHG or energy taxes, cap-and-trade systems, and subsidies and incentives for renewable energy and application of waste for energy

Some of these instruments are already in place in Lao PDR, while others have not yet been introduced (Ministry of Natural Resources and Environment, 2012). These options could be pursued unitarily, bilaterally or multilaterally through many opportunities, including CDM, NAMA or REDD+ and other flexible, pragmatic financing mechanisms.At the same time, more comprehensive studies are needed to analyze priorities within and between sectors, resultant social and economic welfare, and environmental aspects of these options.

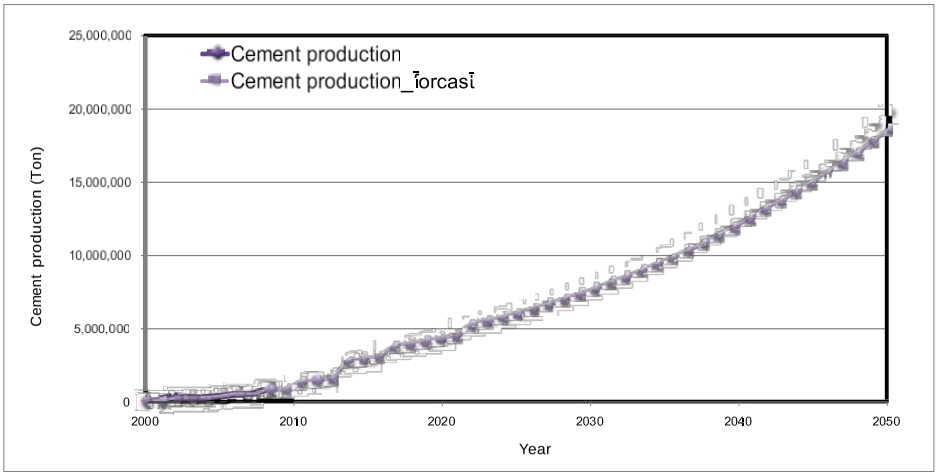
4.4.3 Industrial processes

Mitigation options for industrial processes in general include: 1) standardizing the production process and technology; 2) improving wastewater treatment and other pollution controls; 3) using efficient lighting, processing and heating; and 4) applying or recycling raw materials or wastes. Note that the energy-related options are already included in the energy sector.

Two types of factories in Lao PDR, cement and lime, as well as iron rod processing, are key contributors to GHG emissions from industrial processes. Relevant mitigation options thus focus on these two industries.

During 2000-2009, cement production in Lao PDR grew dramatically, at a rate of 12 percent annually. Using GDP as the driver, the projected demand for cement to 2020 is estimated as being at about 4.5 million tonnes, and at 20 million tonnes by 2050 (Ministry of Natural Resources and Environment, 2012) (Figure 4-2). Based on the production plan, a new plant will be operating in 2013. Assuming operation at full capacity over the next 5 years, total cement production in Lao PDR could reach a 3 million tonnes by 2020. Using this figure as a conservative estimate, and assuming the continuation of present technology, emissions in CO_2 equivalent therefore could be as high as 1,530 Gg in 2020.

Figure 4-2: Actual cement consumption to 2008 and projected demand to 2050 (tonnes)



Based on the best available technology,[3] four main potential mitigation options for the cement industry have been identified. These include thermal and electric efficiency, alternative fuels, clinker substitution, and carbon capture and storage (CCS). These are capable of reducing CO_2 emissions by one-third from the "business as usual" scenario in the next four decades.

Under national circumstances, energy efficiency and alternative fuels are potential technologies during the next two decades. Clinker substitution and CCS options are possible only at the later stages. Detailed technical assessments and financial implications, as well as the potential for flexibility mechanisms, are yet to be studied.

4.4.4 Agriculture sector

In agriculture only paddy and livestock, the two key sources, were covered. To project their emissions, paddy areas and number of livestock were used as dependent variables,

3 See, for example, IEA (2008, 2009), CSI (2009), ECRA (2009), CCAP (2008), McKinsey (2008)

and GDP and population variables were used as the drivers. The potential emission trends to 2030 were then derived (Ministry of Natural Resources and Environment, 2012). Figures 4-3 and 4-4 show the forecasts. Methane emissions from paddy are projected to increase from less than 150,000 Gg in 2001 to more than 300,000 Gg in 2030. Similarly, emissions from livestock are projected to more than double, from more than 120,000 Gg in 2001 to more than 250,000 Gg in 2030.

Several technically feasible mitigation options in agriculture have been identified. These include:

- Applying advanced water and fertilizer management, such as Multiple Aeration Technique and Multiple Nutrient Urea Block; improving soil amendments, organic matter management, tillage, rotation, and cultivar selection
- Improving livestock production efficiency
- Applying balanced feeding, lowering the nitrogen content of animal feeds, employing waste-to-energy technology and introducing household-, community- and farm-based biogas facilities
- Promoting new technology transfers for wastewater treatment, such as biogas digesters and bio-ethanol production for agro-processing industries
- Promoting public awareness on green consumption patterns in agricultural products

Figure 4-3:Forecast methane emissions from paddy land, to 2030

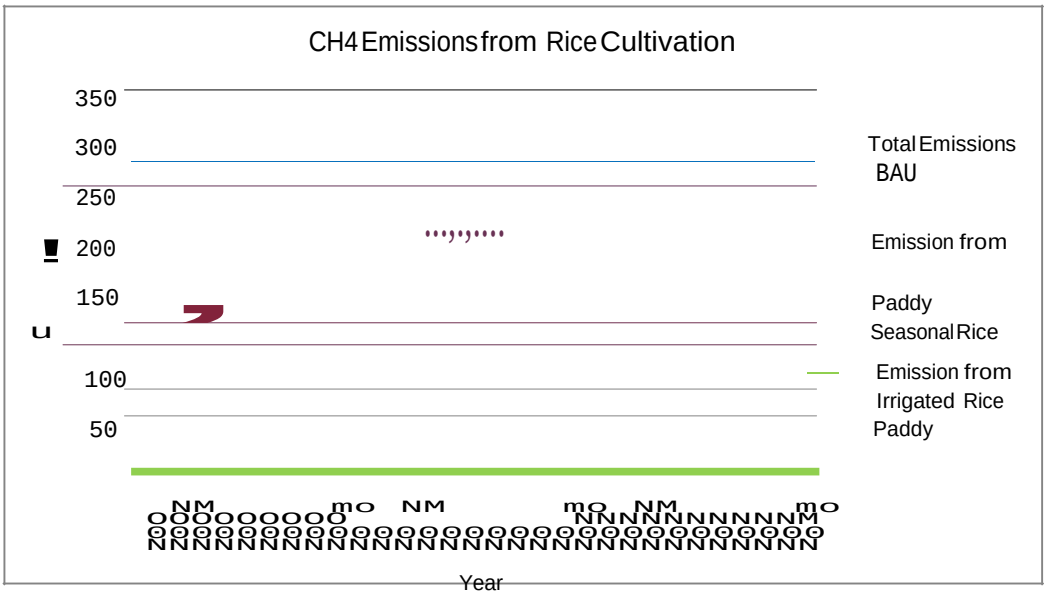
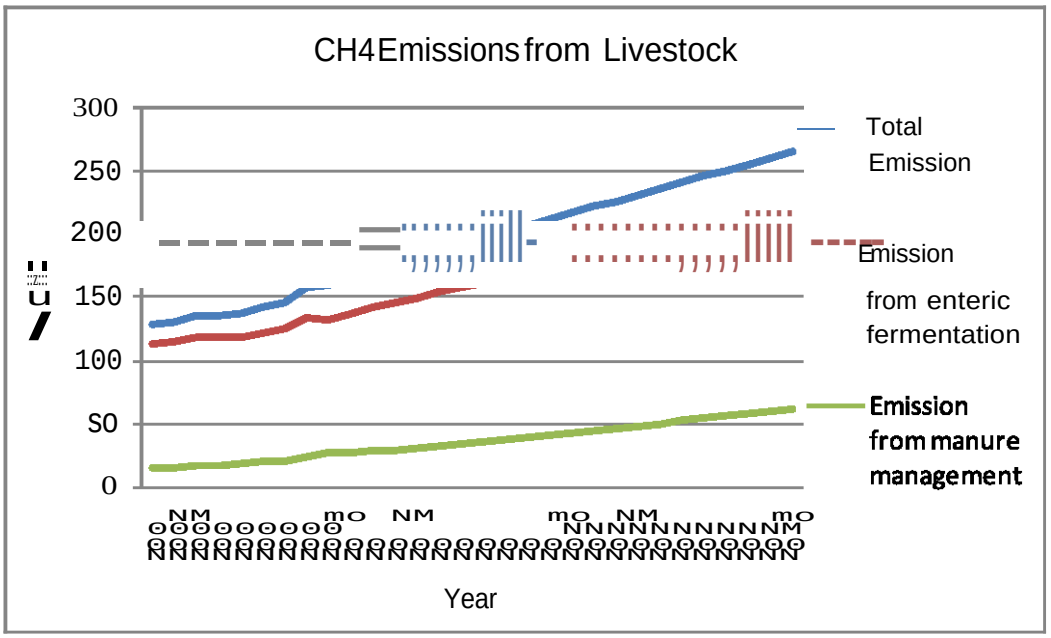


Figure 4-4:Forecast methane emissions from livestock and manure management, to 2030



4.4.5 Forestry

The GoL has been implementing the National Forest Strategy to the Year 2020 since July 2005. Within the broader objectives ofLDC graduation and eradication of poverty in the country, sustainable forest management has been identified as a key element.

Specifically, capacities of the public sector are being enhanced to ensure effective management of forest resources. Laws and regulations will be revised to integrate sustainable NfFP utilization into rural livelihood systems, while environmentally sensitive areas will be properly guarded (Ministry of Agriculture and Forestry, 2005). Under the strategy, forest areas also are being expanded to 65 percent of total land in 2015 and to 70 percent in 2020, as discussed above. Also as noted, opportunities exist to mobilize new mechanisms under the UNFCCC, such as NAMA and REDD+, to support forest expansion measures.

With regard to technical aspects, mitigation options the in forestry sector are:

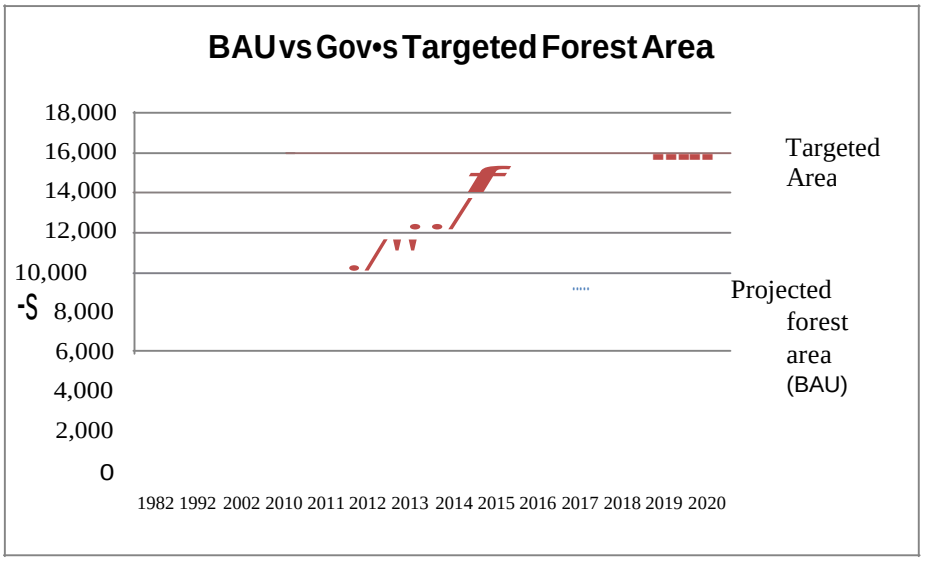
1. Stop "slash and burn" agriculture and stabilize shifting agriculture; protect existing forests, plus enhance forest management, afforestation of degraded forest and reforestation
2. Reduce off-site burning by substituting wood fuel with alternatives such as biogas, small hydro, energy-saving stoves, agricultural residues and community-based fuelwood plantations in forest-dependent communities
3. Reduce forest fires by setting regulations and other necessary measures
4. Integrate forest management, reducing logging while enhancing forest certificate systems and encouraging sustainable NfFP and community-based forest management, including promoting ecotourism
5. Effectively map and plan for sustainable landuse, based on land use suitability
6. Develop/improve regulations and enforcement to minimize forest impact caused by development projects, land encroachment into National Protected Areas, or conversion of forests for agriculture expansion and other types of land uses that appear unsustainable
7. Pursue carbon market opportunities and early introduction of pragmatic

flexibility mechanisms, particularly the REDD+, CDM and NAMA

8. Promote forest plantation with appropriate species, especially in the context of improving degraded forest as well as expanding carbon storage and means for improved livelihoods

If implementation of the national strategic plan is successful, Lao PDR would have a total forest cover of about 16.58 million ha in 2020 (Figure 4-5). The country's forests, at that size, would mitigate about 75,000 Gg of CO_2 especially from the increase of biomass stock as well as from rehabilitation and mainterumce of existing forest from the BAU.[4]

Figure 4-5: Projected and "business as usual" forest area scenarios to 2020



Realizing these targets will be very challenging, since demands and pressures on forest resources remain extremely high. Financially, as estimated by the Ministry of Agriculture and Forestry, US$180 million will be needed to fulfil implementation of the Forestry Strategy and achievement of the targeted goals. In addition, mitigation measures and options will need to be considered and implemented effectively.

In the end, one of the most important activities will be the development of sustainable forest resource management plans for each type of forest in the climate change context, along with effective implementation, including laws enforcement. In addition, sufficient financial and human resources need to be ensured for implementation. Moreover, other

4 For details, see Ministry ofNatural Resources and Environment, 2012.

actions such as poverty reduction, integrated spatial planning, sustainable land use and suitability planning, and application of corporate social responsibility (CSR) among developers will be necessary to enhance sustainable forest management practices.

4.4.6 Waste

Waste generation to 2030 was projected using the assumptions of an increasing rate of per-capita waste generation in urban and rural areas over time and based on demographic projections. The Waste production was projected to be 5.4 million tonnes by 2010, 11 million tonnes by 2020 and 18.3 million tonnes by 2030 (Ministry ofNatural Resources and Environment, 2012). Assuming that (a) 20 percent of waste disposal was landfill in 2010 and that it increases by 20 percent every *5* years, and (b) 10 percent of this is sanitary landfill in 2010 and that it increases *5* percent every five years, estimates were made with regard to CH_4 emissions from managed and unmanaged landfill until2030 (Figure 4-6).

Mitigations proposed under the National Climate Change Strategy, the FNC, and the Environment Strategy 2020, and Action Plan 2010 include:

a) Reduce waste generation through applying the "3Rs" (reduce, reuse and recycle)

b) Upgrade solid waste collection services in major urban centres and neighbourhoods

c) Compost organic contents to manufacture organic fertilizers

d) Effectively manage sewage sludge from domestic septic tanks and slurry from waste treatment plants

e) Construct new landfill facilities that can capture methane; if financially viable, retrofit existing landfills

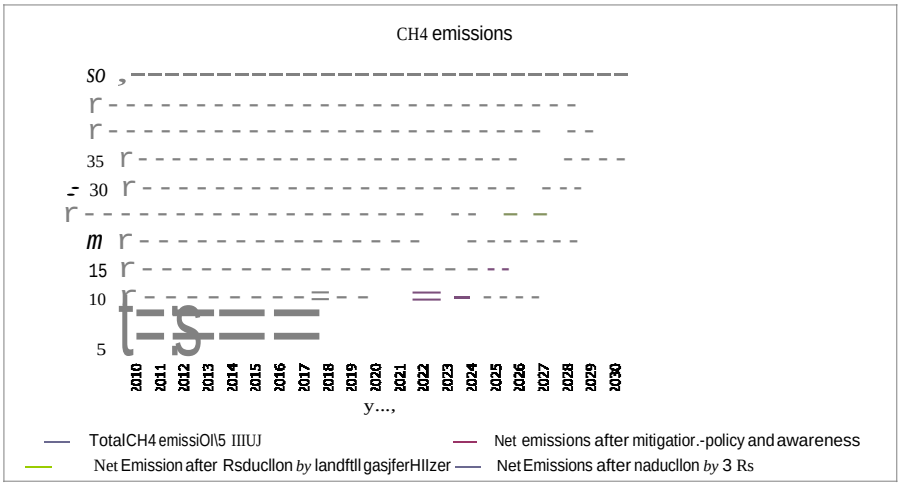
f) Integrate waste management into environmentally sustainable urban development

g) Promote the CDM or other financial mechanisms in the waste management sector

Three mitigation options in waste management also have been identified in the National Climate Change Strategy: (I) education and awareness to reduce waste generation; (2) practice of the "3Rs"; and (3) conversion of waste to energy and fertilizer. Under certain

assumptions, it was estimated that these three options could reduce CH_4 by about 31,000 Gg by 2030; nearly all of the reduction would come from conversion of waste to energy and fertilizer (Figure 4-6).[5]

Figure 4-6: Projected CH_4 emissions from wastes and net of different mitigation measures (Gg)



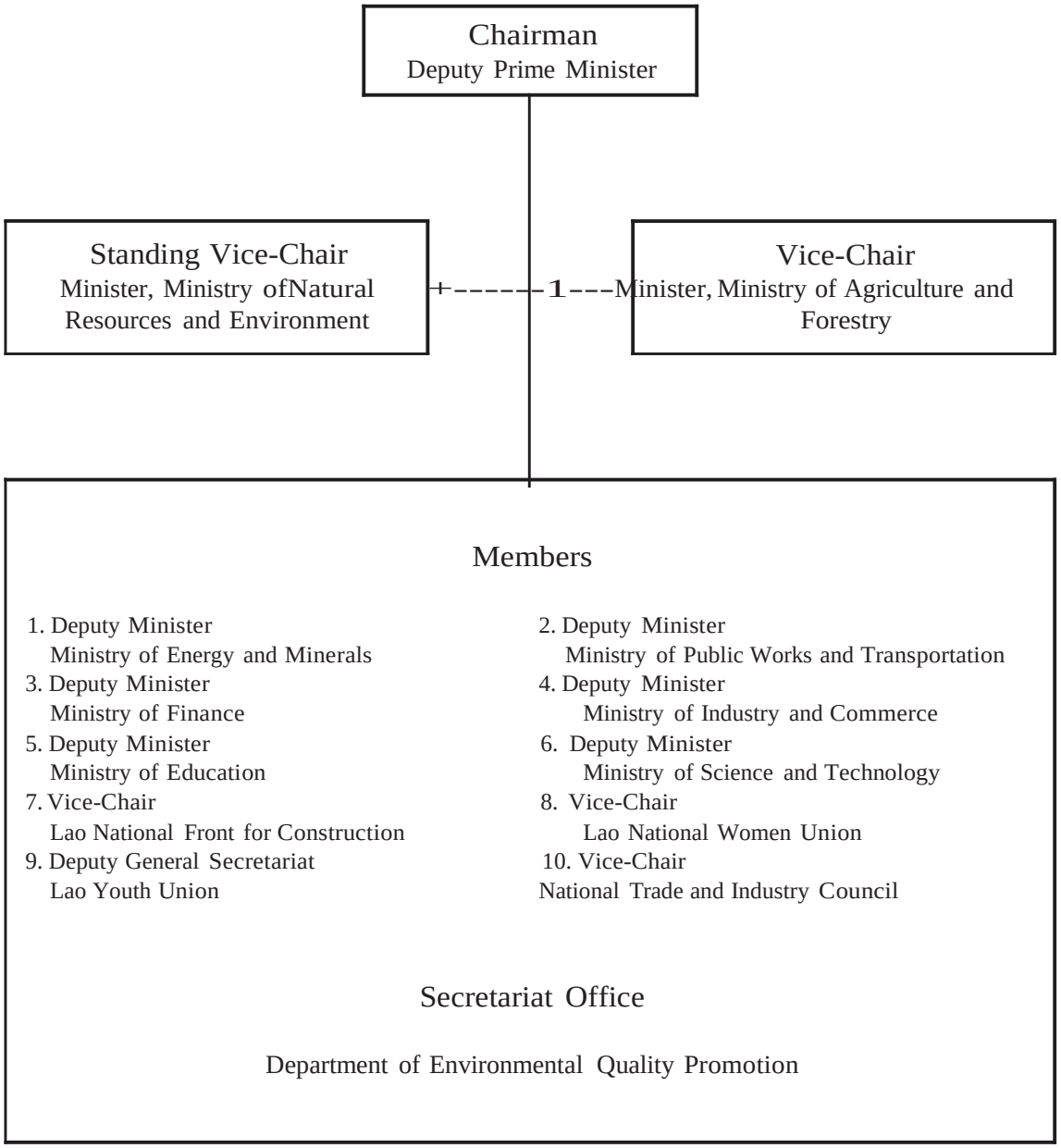
4.5 National Policies and GHG Mitigation

As indicated in the FNC, Lao PDR initiated economic reform in 1986 and has emphasized environmental protection to ensure sustainable development. The Government's objective is to integrate environmental concerns into long-term development planning, particularly into the national socioeconomic development planning process. Public bodies responsible for natural resource conservation and environmental protection have also been institutionalized and gradually strengthened through reorganization.

At present the National Environmental Committee (NEC), chaired by the Deputy Prime Minister, remains the top body providing policy guidance on natural resources and the environment. Under the guidance of the Committee, MONRE is responsible for natural resources and environmental policies and plans. As noted above, the Department ofNational Disaster Management and Climate Change (DNDMCC) has been established under the Ministry to carry out tasks related to climate change. Similar to other environmental issues, national climate change policies are guided by the NEC, whose structure is shown in Figure 4-7.

5 For details, see Ministry ofNatural Resources and Environment, 2012.

Figure 4-7:Institutional arrangements for climate change under the NEC



During the first half of the 2000s, line Ministries gave particular attention to forest conservation and development, with more plantation and a decline in exploitation. Allocation ofland use between forest conservation and agriculture, particularly in upland areas, was clearly defined with community participation. Thus, the GoL expended considerable effort to balance rural poverty reduction with forest protection.

During 2006-2010, the GoL became increasingly aware ofthe global challenge of climate change and introduced the issue into the Sixth National Socio Economic Development Plan, while also expanding relevant cooperation in the Mekong sub-region. As development of hydropower and expansion of forest cover intensified, this resulted in substantial emissions avoided over this period, as illustrated in the preceding sections.

The National Steering Committee on Climate Change, chaired by the Deputy Prime Minister, has provided insight and guidance for preparation of the National Climate Change Strategy and integration of the climate change issues into NSEDP-7. Mitigation aspects under the two plans, which have been implemented since 2010, are summarized below.

4.5.1 Mitigation and the Climate Change Strategy of Lao PDR

As noted above, the purpose of the National Climate Change Strategy is to outline the GoL's approach to mainstreaming climate change in NSEDP-7, building climate resilience in critical sectors in relation to economic development and poverty reduction, and involving its people in partnership with the international community.

Under this vision, goals and guiding principles, and taking into account the national circumstances, the Government has identified a series of priority actions on mitigation to ensure low-carbon growth that can be considered as "nationally appropriate mitigation actions" according to the Bali Action Plan. Among the key sectors of the economy, sustainable transport systems, sustainable energy efficiency, sustainable forestry management and conservation systems, and development of national technical capacity are considered the most important mitigation strategies. These actions, which have been previously noted, will be integrated into key areas of development as again summarized:

Agriculture and food security. Potential actions include improved water and organic matter management, soil amendment and planting techniques to reduce methane emissions from paddy fields. Enhancing production efficiency and balanced feeding to reduce methane emissions from enteric fermentation and livestock manure, along with development of

community- and fann-based biogas facilities, also are specified, as noted above.

Land-use change and forestry. Key strategies to increase forest cover to 70 percent of total land by 2020 include stopping slash-and-bum agricultural practices, enhancing alternative sustainable livelihood strategies, increasing the use of alternative energy sources to fuelwood, integrating forest management and forest fire protection, and effectively mapping and planning land uses.

Energy and transport. Several strategies have already been implemented and will continue; among them are expanding electrification, accelerating development of renewable or cleaner energy, enhancing energy efficiency, promoting low-carbon transport and improving public awareness.

Industrial processes. Major components of the strategy encompass improving energy efficiency and promoting renewable energy sources, as well as reducing wood waste in wood processing.

Waste. Several potentials particularly exist to mitigate GHGs in urban development patterns, including the reduction of solid and water wastes, enhancing practice of the "3Rs" and of waste disposal facilities, and integrating GHG mitigation measures into urban development planning.

4.5.2 Mitigation and the Seventh National Socio Economic Development Plan

Under NSEDP-7, the GoL aims to maximize the hydropower capacity of the country and turn Lao PDR into the "battery" of the upcoming ASEAN Economic Community. Increasing forest cover areas also will be vital to developing a sustainable hydropower system. In addition to the social and economic targets set by the Plan, the Government has set natural resource and environmental targets as follows:

- Expanding forest cover areas to 65 percent of total land
- Completing land allocation, particularly between different types of forest land and other types of land use
- Joining the global community to fight the negative impacts of climate change by appropriately utilizing and conserving natural resources and the

environment, taking into account mineral exploitation as well as soil, water and air quality preservation

- Protecting the country from natural disasters such as forest fires, droughts and floods

Priority programmes and projects have been specified to ensure social and economic objectives are met without compromising these natural resource and environmental objectives. Focal areas for development priorities also are identified, as are projects for settlement and allocation of permanent crop and residential land. In rural districts, projects for establishing green rural areas will be developed.

Overall, the mainstreaming of climate change issues into national development planning has imposed more constraints on national economic development path. Given the continuing high dependency on NTFP as a somce of income in rural households, achievement of a 65 percent target for forest cover and simultaneous enhancement of rural income will require sustained and concerted efforts.

CHAPTER 5

Other Information

5.1 Introduction

The FNC emphasized inventory and mitigation as steps taken to address climate change, while other information is introduced in this SNC report. Following the Improved Reporting Guidelines, other information covers information relevant to the achievement of the objectives of the Convention. The main components described in this section are crosscutting issues that include activities related to development and transfer of technology; climate change research and systematic observations; education and public awareness; capacity development at national, regional and sub-regional levels; and information sharing and networking.

5.2 Development and Transfer of Technology

Technology development occurs to different extents in all activities, depending on both existing technologies and capacities to develop new technologies. As an LDC, Lao PDR is short of up-to-date and appropriate technologies to mitigate greenhouse gases or adapt to climate change risks.

Under Article 4.5 of the UNFCCC, developed countries have an obligation to help developing countries to address climate change by promoting, supporting and facilitating the development and transfer of technology and capacity. The technology transfer issue has been negotiated for over two decades and covers both hard and soft technologies, including technology needs assessments, creation of an enabling environment, and transfer mechanisms.

Lao PDR has received no explicit or direct technology transfer projects/activities under the Convention. Nevertheless, some of the projects/activities under the UNFCCC, such as those related to mitigation and vulnerability and adaptation, could contribute to technological or knowledge development. However, the extent of this contribution has never been assessed.

Lao PDR also has received Official Development Assistance (ODA) or loans from international partners, as well as from public or private investment, that related to natural resource and environmental management in general, and in many cases, to climate change in particular. These activities mostly comprised research or demonstration projects. In many cases, technical or capacity enhancement components existed as well. Similarly, however, there has been no assessment of the contribution to national technology development or transfer from these projects/activities.

5.2.1 Projects/activities under the UNFCCC process

A pilot project on technology needs assessment (TNA), carried out in 2011, is particularly related to development and transfer of technology under Article 4.5 of the Convention.

A TNA is a country-driven set of activities directed mainly at the identification and prioritization of climate change mitigation and adaptation technologies. It also is a means by which to track evolving needs in developing countries for new equipment, techniques, practical knowledge and skills. The expected output of the TNA is the Technology Action Plan that will identify priority technologies, including relevant actions to accelerate the transfer and deployment of clean technologies.This project was expected to be completed in Lao PDR in 2012.

The TNA is just the first step of development and transfer of technology, however. The establishment of an enabling environment that promotes incentives for such transfer from developed countries to Lao PDR, along with mechanisms for such transfer, are even more crucial to the process. Overall, the transfer of technology to enable Lao PDR to effectively counter the impacts of climate change depends on the prospect of international climate change funding and the performance of the national Technology Executive Committee.

5.2.2 International Cooperation in Climate Change-Related Projects

During the Sixth NSEDP, nearly US$90 million worth of projects/activities related to water resources, environment, meteorology and hydrology were carried out in the country. Of this, nearly 90 percent related to water resources, and the rest to the environment as a whole (Table 5-1). Most projects were supported by the Asian Development Bank (ADB), World Bank and Government of China (Table 5-1, Figure 5-1 and 5-2).

Table 5-1: Support for water resource and environment projects, by sources, 2006-2010

Source of support	Water resources		Environment	
	Number	US$000	Number	US$000
World Bank	3	11,834	3	1,486
ADB	5	40,325	2	3,100
UNDP	-	-	9	2,589
Germany	2	6,086	-	-
Sweden	-	-	1	1,804
Finland	-	-	1	850
Japan	1	7,000	2	20
China	1	13,425	-	-
Switzerland	-	-	1	400
Total	12	78,670	19	10,249

Figure 5-1: Support for water resource projects, by source, 2006-2010

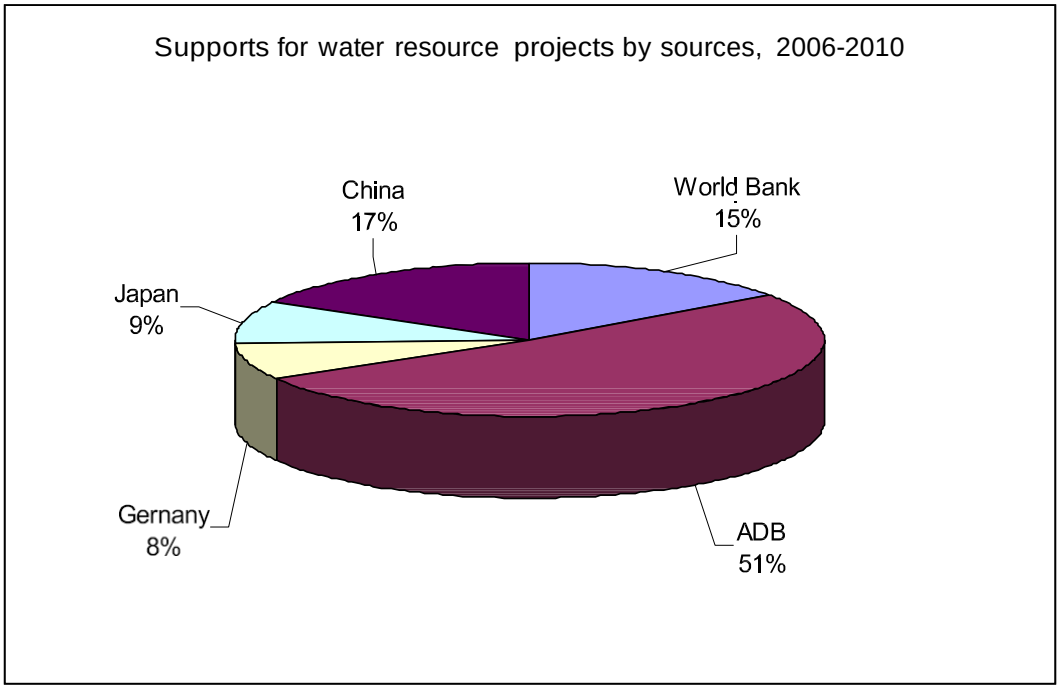
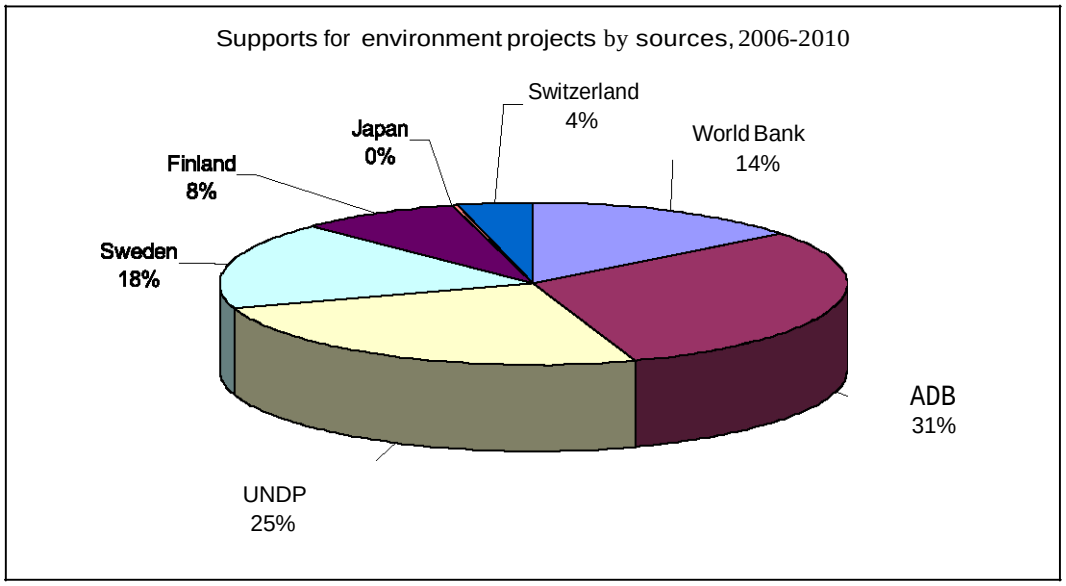


Figure 5-2: Support for environmental projects, by source, 2006-2010



Other Sources of Technology Transfer

The common path for development and transfer of technology is through trade and investment This type of technology transfer could be seen as "business as usual." In Lao PDR Direct Foreign Investment increased gradually between 1994 and 2010, with extremely sharp growth in some years.

Public investment and ODA concentrated in public priority areas, especially those related to poverty eradication, science and technology, and infrastructure development. On the other hand, FDI concentrated in commercial or attractive business areas: hydropower, mining, agriculture and forestry. Several huge investments in hydropower made FDI in certain years (2006 and 2009) extraordinary high (Ministry of Planning and Investment, 2011).

To a certain extent, this FDI has contributed to technology transfer. However, it is important to keep in mind that Lao PDR has invested substantially in renewable energy through the market economy. In its efforts to mitigate GHGs, the country is paying near market prices for technologies, instead of receiving privileges from Article 4.5 of the Convention. Thus, it is critical to operationalize the obligations under Article 4.5 to enhance development of technologies in LDCs such as Lao PDR.

5.3 Climate Change Research and Systematic Observations

With limited resources, progress on climate change research and systematic observations in Lao PDR has been slow. Nevertheless, the Meteorological Department increasingly participates at regional and global levels on long-range climate research.

The Meteorological Department, under MONRE is primarily responsible for weather and climate monitoring, assessment, and reporting/dissemination of the information. The Department provides weather data and information to support domestic and international aviation, relevant Ministries and responsible local agencies. It also cooperates with international organizations and regularly exchanges weather data with the World Meteorological Organization as well as provides weather information to the Mekong River Commission Secretariat.

At this stage the Department is emphasizing the establishment of regional and local centres on meteorology and hydrology, particularly weather stations and rainfall gauges. International support for development of monitoring weather events and earthquakes was received from Japan and China in 2007 and 2009 respectively. Early warning systems were introduced, focused on weather and water level forecasts and climate and hydrological information networking. Information is disseminated by radio transceiver, public telephone, facsimile, email and website to the mass media, relevant Ministries and provincial meteorological services.

With regard to human resource development, meteorologists have participated in domestic, regional and international seminars, workshops and trainings, including on issues related to seasonal climate cycles, El Nino and La Nina, long-range weather forecasting and advisories, and utilization of climate predictability tools. Lao PDR also has developed a two-year curriculum in intermediate meteorology for students and technicians. So far, more than 100 persons have completed this course.

At policy level, the Meteorological Department is preparing the meteorological and hydrological strategy of the country, focused on floods and droughts. Early warning systems have been strongly enhanced over the last decade, and meteorological information is used to support flood forecasting procedures. The radar station in Vientiane has improved its rainfall forecasting and flash flood warning systems. Experiences after the Typhoon Ketsana disaster in 2009 showed that early warnings systems in the country were not able to cope with increasing and intensified climate variation, with information unable to be disseminated effectively to communities at risk. Development of weather stations and networks, along with significant upgrading ofhydro-meteorological stations,

will contribute to regional climate information in support of a systematic observation network under the UNFCCC.

Meanwhile, research on climate scenarios in Lao PDR remains at an early stage and benefits primarily from the regional climate model, PRECIS, or from statistically downscaling from global models. As noted above, development of appropriate climate scenarios for Lao PDR to support vulnerability and adaptation studies also will enhance the national integration of climate change and disaster management.

During the period ofNSEDP-7, emphasis will be given to research and development on early warning systems and to the development of models to monitor climatic situations and integrate with related indicators.

5.4 Education and Public Awareness

5.4.1 Education

General education in Lao PDR consists of five years of primary, four years of lower secondary and three years of higher secondary level. The GoL has paid special attention to expanding education to remote rural areas, building numerous schools. These include primary schools, special schools for ethnic groups in all provinces, and ethnic group boarding schools. In addition, illiteracy eradication programmes have resulted in a 70 percent literacy rate for the population aged 15 years and older.These achievements have progressively reduced the gaps in education between the sexes and improved ethnic group participation in the broader society.

Education on natural resources and the environment has been incorporated into formal and non-formal education in Lao PDR, and in 2004 a B.Sc. programme in Environmental Science and Management was launched. This provided the first opportunity for formal environmental education in the country. Courses on forest and environment or environmental economics also have been developed. In 2009,the Centre for Environmental and Sustainable Development Study, established in 2000, was upgraded to a Faculty of Environmental Science.

In 2008 the National Strategy on Environment Education and Awareness (EEA) to the year 2020, and an accompanying Action Plan for 2006-2010, were endorsed. The EEA strategy has been derived from the national policy on environmental protection. It aims

at providing people with environmental knowledge and skills, influencing their positive attitudes and engagement in the preservation of the natural resources and the environment, and promoting sustainable development.

The EEA focuses on five target areas: formal education, non-formal education, public awareness, capacity development, and networking, collaboration and communication. Climate change issues also have been specifically introduced into the education system, especially at the higher education level, although as part of the main topic of environment or as a course in certain fields.

Thus, the GoL continues to implement policies and plans that emphasize better access to all levels of education for the people, with environmental education developed more extensively during the 2000s. Development of infrastructure and human resources has been of top priority. In 2011, Lao PDR and the German development agency GiZ launched their technical cooperation on Communicating Environment and Climate Change in Lao PDR (ComC1im); one of the main objectives of this initiative is to improve communication and education related to environmental and climate change awareness.

At the same time, implemented activities have focused almost exclusively on the exchange of experiences on education and public awareness on climate change, with no concrete technical or financial support. To further enhance capacity on climate change, especially among young people, additional support for climate change education at all levels is needed.

5.4.2 Public awareness

Public awareness on conservation of natural resources and environment has been regularly promoted by relevant Government agencies and non-Government organizations (NGOs). The GoL has actively encouraged special environmental days such as Tree Planting Day, Fish Release Day, World Population Day, World Water Day and World Environment Day.

As one of the five target areas of EEA and its related Action Plan, public awareness on the environment, including climate change, emphasized a wide range of target groups. These include policymakers, officials, journalists and practitioners at all levels. During 2006-2010, a campaign for "green communities and schools" was launched in Vientiane. As part of the campaign against global warming, 1 million trees will be planted by 2020 in the main cities across the country. Long-term impacts of these programmes remain uncertain, however. Regular campaigns to promote environmental and climate change

education and awareness in the form of leaflets, brochures, books and other materials also have been implemented, and training materials and manuals for environmental and disaster management have been developed and disseminated.

The NSEDP-7 has recognized and strongly promoted public awareness on climate change. In addition, results of climate change studies, the NCSA, the FNC and relevant national strategies, including CDM, NAPA and its priority projects/activities, have been disseminated to regional and local stakeholders. Exchanges of information with development partners and donors likewise were organized to campaign for technical cooperation and financial support.

The National Strategy on Climate Change has improvement of public awareness a on climate change vulnerabilities and impacts, as well as on GHG emission sources and mitigation, as one of its objectives This awareness continues to need to be raised at all levels, including policy, technical, operational and implementation. Participation at the grassroots level is even more important to ensure the integration of climate change factors into sustainable livelihood strategies.

Lastly, application of modem technologies to enhance public awareness on climate change is yet to be developed in the country. With limited communication infrastructure and facilities, including space technology (ICT, satellite, long-distance learning, etc.), dissemination and exchange of information to enhance environmental awareness remains a formidable challenge.

5.5 Capacity Building

Human resource development is a priority area of the five-year Action Plans and activities of the Ministry ofNatural Resources and Environment. However, following the upgrade of STEA to WREA, and currently to MONRE, capacity enhancement for relevant staff and representatives from line Ministries is increasingly needed. Through national and international support, national trainings on climate change have been organized.

As a crosscutting issue, capacity development is normally directly or indirectly included in technical cooperation or assistance programmes and projects. However, it is difficult to critically assess the outputs/outcomes or effectiveness of this component in development programmes. Over the past two decades, technical staff of MONRE and other line Ministries have attended domestic and international training workshops on climate change, including inventory estimation, mitigation option analysis, CDM issues,

vulnerability assessment, and adaptation option analysis. These activities were carried out by responsible national agencies in cooperation with international organizations and donor countries.

Cooperation with countries in the region and sub-region also has been developed and strengthened to enhance national capacity on climate change topics such as climate modelling, GHG inventory, National Communication preparation, and other emerging Issues.

During the Sixth NSEDP, technical capacity enhancement activities on environmental protection, including climate change, were organized at central, regional and community levels. As a result, the environmental protection capacities of more than 700 persons were upgraded and, in tum, applied in their respective regions. These activities will be continued over the NSEDP-7 period.

Meanwhile, technical assistance from ADB on capacity development to cope with climate change was launched in 2010. This involves capacity development and technical support, as well as pilot activities on climate change in priority sectors. It addresses capacity barriers among the national TWGs on climate change, while also raising awareness of the public and policymakers alike. Pilot adaptation actions in the water, agriculture and forestry sectors in support of a "learning by doing" approach also are to be established.

Despite efforts to strengthen national capacities on climate change, limited human resources, high workload and high turnover rates within some Government entities continue to be the main constraints faced by the country. At the same time, the complicated issues and dynamics of climate change require long-term development and consistent engagement. Because climate change remains a relatively new issue, external support for national academic or research institutes also remains limited. Capacity strengthening for these institutes, especially in advanced methodologies related to climate change vulnerability and adaptation and mitigation analysis, is strongly needed.

5.6 Information Sharing and Networking

At global and regional levels, information and experiences on climate change and the UNFCCC are shared through National Communications and participation in forums including Conferences of the Parties and technical workshops. The NAPA, TNA and National Communications are key examples of information and experience sharing with

other parties to the Convention. Regional cooperation also has been developed, with the Geo-Informatics and Space Technology Development Agency (GISTDA) of Thailand and the Asia-Pacific Regional Space Agency Forum (APRSAF) on remote sensing and space technology to monitor environmental and disaster risks.

In turn, knowledge, experiences and commitments at global level have been conveyed back to Lao PDR for appropriate responses. Within the country, the vertical flow of information is smooth and effective mainly as a result of the existing institutional systems and mechanisms. However, horizontal flows of information and networking remain more critical and challenging, since good communication infrastructure and facilities are still lacking in the country.

As noted above, although climate change awareness among the public has been emphasized in the NSEDP-7, this area remains to be sufficiently developed in Lao PDR. Access to Internet at provincial level is limited to urban areas and specific sectors, for example, the public administration and the business sector.

Although Internet has been used to exchange information and network among researchers and other stakeholders, local websites/webpages are few. At present, more conventional approaches such as leaflets, brochures, radio or TV continue to be the main mechanisms to disseminate information to the public. Information on project activities is primarily developed by project implementers or support organizations, such as UNDP, World Bank, ADB and other international or national non-Government organizations.

Likewise, the role of the national focal point for climate change with regard to information sharing and networking remains limited. This is partly a result of the institutional change and reorganization of agencies responsible for environmental issues during the past two decades. Most information dissemination thus is in the form of news and events, but not technical information or development.

Hence, there exists substantial room for improvement on information sharing and networking at national level, with the national focal point as the centre for such initiatives. An Internet base needs to be developed and sufficient resources provided to maintain and update information and a website. This Internet base could reach only selected sectors at provincial level, requiring additional appropriate approaches to be developed at regional and community levels.

Development of a relevant information system has been identified as one of the priority programmes in the five-year plan (2011-2015) of MONRE. It is intended that information

and statistics on water resources, environment and meteorology-hydrology will be systematically developed and disseminated at central, regional and provincial levels. At the same time, this development will require strong technical and financial support.

CHAPTER 6

CONSTRAINTS, GAPS, AND NEEDS FOR SUPPORT

6.1 Introduction

Submitting a National Communication provides an opportunity for a party like Lao PDR to enrich and enhance its experience in addressing climate change and to fulfil its obligations under the UNFCCC, especially in identifying constraints, gaps and related technical and financial support needs.

In preparing the FNC report, Lao PDR was heavily dependent on external experts. Over the past decade, however, the country has gradually enhanced its capacity to address the issues itself. During preparation of this SNC, the national TWGs were trained to estimate GHG inventory, with technical support from neighbouring countries and the NCSP. Similarly, national experts, along with external resource persons, were in charge of mitigation studies. The most problematic area for Lao PDR was in terms of conducting long-term vulnerability and adaptation studies, where the requisite extensive historical meteorological data and high degree of technical expertise are still lacking.

Although Lao PDR's experiences in the enabling activities have improved considerably, the evolving issues and technical progress of climate change are even more rapid. Lao PDR will continue to need to strengthen and update national capacity with regard to climate change in order to keep pace with this issue.

This chapter summarizes the constraints, gaps and needs for implementation of the UNFCCC discussed in the earlier chapters, including those experienced in implementing the National Climate Change Strategy and its related Action Plans. These are further separated into general (or policy) and sectoral (or specific) levels.

6.2 General Constraints, Gaps and Needs

- *Transforming the national strategic plan into concrete development and action plans.* The National Climate Change Strategy has identified goals, missions, guiding principles and priority areas, and strategies have been integrated into sectoral development and action plans. However, the chal-

lenge remains to effectively carry out such plans. Given that the impacts of climate change are less perceivable compared to other pressing economic issues, approaches are needed to ensure sufficient consideration is given to climate change issues in prioritization processes.

- *Effectively monitoring and evaluating actions/measures to (ulfil climate change strategic plans and policies.* Implementation of a national strategy and action plan on climate change will eventually require the establishment of an overall and comprehensive monitoring mechanism, especially on integrating implementation by different agencies.1bis is especially important for an issue such as climate change, where crosscutting areas are common.

- *Ensuring fOreign investment and international development cooperation and assistance are in line with sustainable development and a "green economy" in general. and with climate change strategies and plans in particular.* This is critical to a country such as Lao PDR, in which the people are highly dependent on sustainable natural resources.

- *Reviewing and revising climate change policies and plans.* A need exists to regularly review and adjust climate change policies and plans to harmonize with national development priorities. Formulating a win-win approach will be key for Lao PDR to pursue a national climate change strategy without sacrificing primary socioeconomic objectives. Capacity to develop an appropriate longer-term climate change path for the country is needed to properly address this highly complex area of development.

- *Developing research and capacity on climate change in all areas.* Experience so far confirms that climate change requires integrated and interdisciplinary approaches, especially at policy level. Lao PDR continues to urgently need national capacities in this area.

- *Developing policies f0r climate financing options.* The options to secure climate change finance from various emerging funding sources under the Convention remain to be developed. These will need to be in line with national priorities for action. They can, however, be bilateral or multilateral for various forms of support and through appropriate mechanisms available under the Convention.

6.3 Constraints, gaps and support needs in specific areas

Implementation of the FNC and SNC has highlighted various areas of constraints and gaps. These are categorized by sections of the Communication as follows:

6.3.1 National GHG Inventory

To carry out a strong inventory requires good information, good techniques and good human resources. These are, however, all still limited in Lao PDR. Key issues include:

- *Inadequate and inaccurate infOrmation and activity data (Or GHGI.* Moreover, available data are not disaggregated as categorized by the IPCC Guidelines.
- *Lack of local emissions factors.* Paddy cultivation and domestic animal raising in Lao PDR are primarily subsistence-based, with conventional technologies employed. Similarly, the highly diversified tropical forest resources require specific emissions factors. Emissions factors reflecting these characteristics are not available, so that default factors, which may not be appropriate, are used. Research and development in this area will strengthen national inventory capacity.
- *Inadequate capacities oflocal researchers among relevant agencies.* Gaps exist in both knowledge and skill in understanding the processes of estimating GHGI for different sectors. More intensive training to increase national capacities and efforts to maintain these are needed.
- *Poor database to support inventory activities.* A GHGI database remains to be developed, although the recent decision of the COP requires a more regular flow of inventory updates to the UNFCCC. Ibis database, along with archiving of data, will need to be developed along with the improvement of national activity data.
- Insufficient coherence and coordination. An interdisciplinary is needed to achieve a strong GHGI, but different agencies are occupied by their primary responsibilities. Despite efforts undertaken, coordination thus remains problematic in the inventory process. However, since the inventory is evolving into a regular process, a strong coordination institution is needed.
- Development of regular inventory preparation programme. To comply with the requirement that non-Annex I communicate with the UNFCCC on the national GHGI more regularly, Lao PDR will need to significantly improve its inventory process as well as receive strong technical and financial support.

6.3.2 Vulnerability and adaptation

Vulnerability and adaptation assessments were carried out only after the FNC. As experienced in preparation of the SNC, maintaining the momentum of the NAPA process is key. At the same time, long-term climate change research is only at an early stage, as noted above. The vulnerability and adaptation tasks for the SNC were thus carried out primarily by external consultants, with development of national capacities in climate change again featuring as a prominent need. Primary constraints, gaps and needs in vulnerability and adaptation include:

- *Shortfall of appropriate climate scenarios for impact analysis.* Lao PDR needs more appropriate national climate scenarios as a foundation for impact analysis.The climate models from which scenarios are derived will need to have sufficient resolution to support this impact analysis.The models also should be compatible to address issues of uncertainty.

- *Poor database.* A lack of long-term historical data on meteorology, hydrology and water flow, and forest resources continues to constrain vulnerability and adaptation studies. Data or information on crop parameters, soil properties and parameters for climate factors are particularly lacking.

- *Lack of comprehensive and in-depth studies on sectoral impacts. especially on socioeconomic aspects in relation to agriculture. water resources. forests and public health.* Linkages between the natural resource and economic sectors merit integrated system studies, which are currently lacking.

- *Lack oflong-term socioeconomic scenarios to assess the vulnerability and autonomous adaptation process in diiferent sectors.* To assess vulner- ability, a strong impact analysis should feature compatible periods between socioeconomic and climate scenarios. This gap will need to be addressed urgently.

- *Shortage of technical experts to develop climate scenarios and im- pact models in relevant sectors.* National capacity development requires strengthening to address gaps in climate modelling, statistical modelling, and vulnerability assessment and adaptation for relevant sectors.

- *Updated information on various sectors for vulnerability and adaptation analysis.*This includes such key information as updated vector distribution maps for health impact analysis and regional hydrological data.

- *Need to mainstream climate risks into national disaster prevention and risk management programme.* This will need to include contingency programmes during extreme events.
- Weak local ownership of NAPA projects. By design, local communities should actively participate in NAPA projects, but progress has so far been limited. To ensure sustainability of the adaptation process, local ownership of the project must be well-established.
- Need for accelerated implementation of NAPA projects, Out of the four identified areas encompassing the proposed 12 Priority I and 33 Priority II NAPA projects, only two areas have received support. These cover some of the projects under agriculture and water resources. However, more support from climate change financing is required and should be accelerated.

6.3.3 Mitigation

Although development in the mitigation component is more advanced than in vulnerability and adaptation, progress nonetheless remains rather limited. In particular, national capacity to comprehensively develop effective mitigation options for Lao PDR is extremely limited. Key constraints, gaps and needs include:

- Limited capacities to develQP long-term projections relevant to the mitigation analysis, to use modelling tools, and to develQP mitigation scenarios.
- Insufficient information and data to develop alternative options analysis.
- Insufficient technical capacities to develop an integrated analysis model to prioritize options, particularly across sectors.
- Insufficient economic incentives and prices to induce development of alternative energy for fossil fuels, such as in the transportation sector.
- Insufficient technical and financial support for priority options, particularly in alternative energy and energy efficiency in the transportation sector.
- Need to integration forest conservation with broader rural poverty reduction efforts.

6.3.4 Development and transfer of technology

Technologies are embedded in all areas of climate change, ranging from basic and advanced or applied research and development to the implementation of actions or measures to address issues. Adoption of appropriate technologies remains highly important to Lao PDR. Constraints and gaps in technological aspects include:

- High capital costs in technological development
- Insufficient research and development to advance technical knowledge
- Limited integration of climate change technological needs into the national science and technology development and innovation process
- Significant upfront investment for most available or appropriate technologies. which are protected by patents or licenses. This represents a huge burden for low-income countries like Lao PDR.
- Continuing need for national capacity enhancement along with technology transfer. This requires financial assistance as well as relaxation of protection of property rights, but is vital in enabling Lao PDR to achieve its "green economy.. objective.

6.3.5 Climate change research and systematic observation

The Lao PDR has participated in the network of the World Meteorological Organization. Development of the national grid system is extremely limited and urgently need to be strengthened. Constraints and gaps are:

- Poor, inadequate and lack of uniformity of meteorological observation system
- Limited technical capacity to handle observation network
- Lack of human resources to support the development in the areas

6.3.6 Capacity building, including education and public awareness

Public awareness on climate change has only been implemented in recent years. Climate change impacts are difficult to perceive, yet influence all sectors; thus, innovative ideas or approaches to enhance public awareness are urgently needed, but financial support in this area is inadequate.

Constraints and gaps include:

- Very limited training and public awareness programmes, campaigns or activities at national level.
- Limited inclusion of climate change subjects into the curriculum at secondruy and higher education levels.
- Need to reach the grassroots level with dissemination of knowledge and experiences in climate change.
- Extremely limited development of national capacity. especially on the global climate change negotiation process. To promote active participation at international level, negotiation and diplomatic skills, including language proficiency, are vital.
- Limited research netwotk/forum among national academics, scientists and researchers to exchange resources/eLg>eriences and COQPeration in climate change research. A regular technical forum should be developed to promote cooperation.

6.3.7 Information sharing and networking

Information sharing and networking on climate change can contribute to many aspects of national progress on the issue, with an efficient information system updating technical and operational aspects as well as providing public understanding and supporting policies and key decisions. Development of an information system and networking in Lao PDR has not been effective thus far, especially with regard to coping with the rapid evolution of the UNFCCC process. Without an adequate national infrastructure and transport network, effective design of information sharing and strong technical and financial support are even more crucial. Primary constraints and gaps on information and networking include:

Limited information flows among researchers and Government agencies. as well as limited dissemination to the public.especially local communities. Horizontal and vertical systems of information flows need to be developed. Specifically, information exchange within the scientific community and between the scientific community and policymakers, as well as information dissemination to the public, particularly at regional level, must be systematically developed.

- Lack of updated information. Technical and policy developments on climate change are highly dynamic, particularly in recent years.The lack of trained technical and human resources in Lao PDR constrains the national ability to manage the information flow.
- Lack of an appropriate information mechanism for local conditions. Many countries use the Internet as a tool to communicate on climate change. However, this may not be practical in Lao PDR, and a mechanism more appropriate to local circumstances should be designed.
- Limited role of the national focal point. The role of the national focal point requires strengthening to make it the climate change "gateway," nationally and internationally, so that is can perform an important role in information sharing and networking.
- Insufficient networking with key stakeholders, particularly the private sector and civil society. As the ASEAN Economic Community is operationalized in the coming years, the private sector and civil society will play increasing roles in national development processes. Thus far, however, networking with these groups has been limited in Lao PDR. Because climate change affects many sectors, more efforts will urgently be needed to enhance the information network with numerous stakeholders.

BffiLIOGRAPHY

National Circumstances:

- Bank of Lao PDR. Economic and Monetary Statistics. Vientiane, 2002. Committee for Investment and Planning. National Socio Economic Development Plan 2006-2010. Vientiane, 2006.
- Environmental Health Division., Climate Change and Health Adaptation Strategy (CCHAS) in Lao PDR. Department of Hygiene and Prevention, Ministry of Health, Vientiane, 2009.
- Eravanh Boungnaphalom. Mineral Development in Lao PDR. Slides presented at International Conference on Mining, Phnom Penh, 26-27 May 2010.
- Ministry of Agriculture and Forestry. Report on the Assessment of Forest Cover and Land Use During 1992-2002., Department of Forestry, Ministry of Agriculture and Forestry, Vientiane, 2002.
- Ministry of Agriculture and Forestry. Forestry Strategy of Lao PDR to the Year 2020. Vientiane, July 2005.
- Ministry of Agriculture and Forestry. Strategy for Agricultural Development 2011-2015. Vientiane, 2010a.
- Ministry of Agriculture and Forestry. Agricultural Master Plan 2011-2015. Vientiane, 2010b.
- Ministry of Agriculture and Forestry. Agricultural Investment Plan 2011-2015.Vientiane, 2010c.
- Ministry of Energy and Mines. Energy and Mineral Strategy from 2006 to 2010 and 2020. Vientiane, 2010.
- Ministry of Planning and Investment. Survey of Population and Accommodation. Vientiane, 2005.
- Ministry of Planning and Investment. The Seventh Five-Year National SocioEconomic Development Plan 2011-2015. Vientiane, 2011.
- National Statistics Office. Statistical Year Book 2003. Vientiane, 2003.

- World Bank Lao PDR: Policy, Market and Agricultural Transition in the Northern Uplands, Washington D.C., 2008.
- WREA. State of the Environment. Vientiane, 2001.WREA. Strategy on Climate Change of the Lao PDR. Vientiane, 2010.

Greenhouse Gas Inventory:

- ALIZ.Report on Fertilizer Use:Status and Study on Minerals for Fertilizer Manufacturing Industry in Laos. Agricultural Land Inventory and Zoning, Crops and Agriculture Extension Department, Ministry of Agriculture and Forestry, Vientiane, 1999.
- Department afForests.Timberand Non-Timber Forest Products Harvesting Plan 1999-2000. Department of Forestry, Vientiane, 2000.
- Department of Forests. Implementation of Forestry Programme of 1999-2000 and Plan 2000-2001. Department ofForestry, Vientiane, 2001.
- FAO. Community-Based Fire Management: Case Studies from China, the Gambia, Honduras, India, the Lao People's Democratic Republic and Turkey. Rome, 2003.
- FAO. Nutrition Laos: Nutrition Country Profiles. Rome, July 2003.
- IPCC. Second Assessment Report. 1996.
- IPCC. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Modules I, II, IV, V & VI. 1996.
- IPCC. IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventory. 2000.
- llCA and Ministry of Agriculture and Forestry. Study on Teak Plantation Management and Processing. Japan International Cooperation Agency, Ministry of Agriculture and Forestry, Department of Forestry, Vientiane, 2001.
- Lao PDR. Country Paper: Utilization of Biomass for Renewable Energy in Lao People's Democratic Republic. Workshop on Utilization of Biomass for Renewable Energy, Kathmandu, Nepal, 11-15 December 2006.
- Lao PDR.The First National Communication on Climate Change:Submitted to The United Nations Framework Convention on Climate Change. Science,

Technology and Environment Agency, Lao PDVientiane, 2000.

- Ministry of Agriculture and Forestry. Report on the Assessment of Forest Cover and Land Use During 1992-2002. Department of Forestry, Ministry of Agriculture and Forestry, Vientiane, 2002.
- Ministry of Agriculture and Forestry. The Statistics of State Tree Planting 1975-2008. Ministry of Agriculture and Forestry, Department of Forestry. Vientiane,2009.
- The Training Course on Research Methods and Management for Growth and Yield Study in Tree Plantation in Lao PDR. Proceedings of Report, Vientiane, 2002.
- Ministry ofNatural Resources and Environment. National Greenhouse Gas Inventory for the Year 2000 for the Second National Communication for Climate Change. Vientiane, 2012.
- NORAD and UNEP. Lao PDR: State of Environment Report. Vientiane, 2001.
- NSB, WHO and UNICEF. National Statistics Bureau and WHO-UNICEF Joint Monitoring Programme. Vientiane, 2004.
- NSC. Primary Report for Multi-Indicator Cluster Survey 2000. Vientiane, 2000.
- NSC. Statistics 1975-2005. Committee for Planning and Investment, State Statistics Centre, Vientiane, 2005.
- SNV. National Biodigester Programme, Cambodia. Information folder. Phnom Penh, 2006.
- STEA. National Environment Action Plan 2000. Science, Technology and Environment Agency, Vientiane, 2000a.
- STEA. National Environmental Performance Assessment (EPA) Report. Vientiane, 2004.
- TRI. Annual Report 1999-2001. Technology Research Institute, Science, Technology and Environment Agency, Vientiane, 2007.
- VPKNTE. The Report on Coal Selling Overseas and Domestic, 1995-2009. Vienphoukha Coal Mine Co. Ltd., Lao PD2010.

Vulnerability and Adaptation:

- ADB. Participatory Poverty Assessment Lao PDR. Asian Development Bank, Manila, 2001.
- Adger,W.N.and Brooks,N."Does environmental change causevulnerability to natural disasters?"in Pelling ed., Natural Disasters and Development in a Globalising World. London: Routledge, 2003, pp. 19-42.
- Beer, T. and Ziolkowski, F. Environmental Risk Assessment: An Australian Perspective. Commonwealth of Australia, Supervising Scientist Report 102, 1995, accessed at http://www.environment.gov.aulssg/pubs/risk/risk_foreword.html
- Boer, R., Campbell, L.C. and Fletcher, D.J. "Characteristics of Frost in a Major Wheat Growing Region of Australia," in Australian Journal of Agricultural Research (44):1751-1743, 1993a.
- Boer, R., Fletcher, D.J., and Campbell. L.C. "Rainfall Pattern in a Major Wheat Growing Region of Australia,"in Australian Journal of Agricultural Research (44):609-624, 1993b.
- Boulidam. "Vulnerability and adaptation of Rain-Fed Rice Farmers to Impact of Climate Variability inLahakhok, Sebangnuane Tai, Dongkhamphou and Koudhi Villages ofSongkhone District, Savannakhet Province,Lao PDR." Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science (Natural Resource Management), Faculty of Environment and Resource Studies, Mahidol University. Bangkok, 2005.
- Cassman, K.G (ed). Breaking the Yield Barrier. Proceedings of Workshop on Rice Yield Potential in Favorable Environments, IRRI, 29 November-4 December 1993.
- EM-DAT., The *OFDNCRED* International Disaster Database. Created on 11 January 2011; data version: v12.07. Universire Catholique de Louvain, Brussels. Accessed at www.emdat.be.
- EM-DAT. The OFDA/CRED International Disaster Database. Data version: v11.08. Universite Catholique de Louvain, Brussels.Accessed at www.emdat.be.
- Emanuel K."Increasing Destructiveness ofTropical Cyclones Over the Past 30 Years," in Nature, Vol. 436:4, August 2005. doi:10.1038/nature03906.

- FAO. "Lao PDR: Asia's Woman in Agriculture, Environment, and Rural Production." Available at www.fao.org/WAICENT/FAOINFO/SUSTDEV/Wpdirect/WpreO109.htm.
- FAO. Harmonized World Soil Database. 2009.
- **Fukai, S. Rajatasereekul, S., Boonjung, H., and Skulkhu, E. "Simulation** Modelling to Quantify the Effect of Drought for Rain-Fed Lowland Rice in Northeast Thailand," in Fragile Lives in Fragile Ecosystems, proceedings of the International Rice Research Conference, Manila. IRRI, 1995, p:657-674.
- Fukai, S., Sittisuang P., and Chanphengsay, M. "Increasing Production of Rain-Fed Lowland Rice in Drought-Prone Environment: A Case Study in Thailand and Laos," in Plant Prod. Sci. 1:75-82, 1998.
- Fiissel H.-M., and R. J. T. Klein."Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking," in Climatic Change, 75:301-329, 2006.
- GoL PDR. The Ketsana Typhoon in the Lao People's Democratic Republic (29 September 2009): Damage, Loss and Needs Assessment. Government of Lao People's Democratic Republic, Vientiane, November 2009, accessed at http://www.gfdrr.org/gfdrr/node/674
- GoL PDR. , Results from the Population and Housing Census 2005. Steering Committee forCensus of Population andHousing, Vientiane, 2006.
- Goodyear E.J. Draft National Disaster Management Plan 2012-2015. Report prepared for the Institutional Strengthening and Capacity Development on Disaster Risk Management in Lao PDR Project, National Disaster Management Office, Ministry of Labour and Social Welfare, Vientiane, 2011.
- Hansen, J. et al. "Global Temperature Change," in Proceedings ofNational Academy of Science, 103: 14288-14293. 2006.
- IPCC. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, USA, 2007a.
- IPCC., Climate Change 2007: Impact, Adaptation and Vulnerability. Contribution ofWorking Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press,

Cambridge, United Kingdom, and New York, USA, 2007b.

- IPCC. Climate Change 2007: Synthesis Report. Contribution ofWorking Groups I, II and IIIto the FourthAssessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland, 2007c.
- IRI and ADPC. Report on the Workshop On Climate Risk Management in Southeast Asia. International Research Institute for Climate and Society and Asian Disaster Preparedness Centre. Bangkok, 2005.
- Isvilanonda, S. "Trends in Rice Consumption in Thailand." Paper presented at at the symposium on World Rice at Stake, 13-14 March 2005. Tokyo.
- Jones,R. et al."Assessing Current Climate Risk," in Bo Lim, I. Burton, E.L. Malone and S. Huq, Adaptation Policy Framework for Climate Change: Developing Strategies, Polices and Measures. UNDP, Cambridge University Press. London, 2004.
- K.asperson, J.X. et al. "Vulnerability to Global Environmental Change," in Andreas Diekmann, Thomas Dietz, Carlo C. Jaeger, and Eugene A. Rosa (eds.), The Human Dimensions of Global Environmental Change, MIT Press. Cambridge, Mass.,USA: 2002.
- Lefroy R. et al. "Study on Potential Impacts of Climate Change on Land Use in Lao PDR," a report prepared for the Lao-German Land Management and Registration Project, Lao PDR.
- Linquist, B, and Sengxua, P. Nutrient Management in Rain-Fed Lowland Rice in Lao PDR. International Rice Research Institute, Los Banos, Philipines, 2001.
- Linquist, B.A, Keoboualapha, Sipaseuth, and Inthapanya, P. "Rice Production System of Laos," in J.M. Schiller, M.B. Chanphengxay, B. Linquist and S. Appa Rao (eds.), Rice in Laos, International Rice Research Institute, Los Banos, Philippines, 200l.MAF. Irrigated Agriculture National Action Plan. Ministry of Agriculture and Forestry, Vientiane, 201Ob.
- MAF. Strategy for Agriculture Development 2011 to 2020. Ministry of Agriculture and Forestry, Vientiane, 20lOa.
- MAF. Crop and Food Security Assessment Mission to Lao People's Democratic Republic. Special Report. Ministry of Agriculture and Forestry, Vientiane, 2011a.MAF. Lao PDR National Policies on Climate Change. Ministry of Agriculture and Forestry, Vientiane, 20IIb.

- Masutomi, Y. et al. "Impact Assessment of Climate Change on Rice Production in Asia in Comprehensive Consideration of Process/Parameter Uncertainty in General Circulation Models," in Agriculture, Ecosystems and Environment, Vol. 131:281-291, 2009.
- Ministry of Natural Resources and Environment. Climate Change impact and Vulnerability Assessment for the Second National Communication on Climate Change in Lao PDR. Vientiane, 2012.
- Mitchell T.D. and Jones P.D. "An Improved Method of Constructing a Database of Monthly Climate Observations and Associated High-Resolution Grids." International Journal of Climatology, Vol. 25 (6):693-712. 2005.
- MRC-LNMC (MRC-Lao National Mekong Committee). "Report on the outcomes of studies and analysis carried out in sub-area 4L," accessed at http://www.mrcmekong.org/download/programmeslbdp/LNMC-0404b-SA-4L.pdf
- Phonevilay S. "2011 Floods Affected by Tropical Cyclone Best Tracks Over Lao PDR," presented at South-East Asia Flood Risk Reduction Forum. Bangkok, 20 February 2012.
- Rasabud, S. "Country Report: Lao PDR." Paper presented at Workshop on Climate Change and Its Impact on Agriculture, Seoul, Republic of Korea, 13-16 December 2011.
- Rasabud, S. "Agriculture Sector and Climate Change in Lao PDR." Paper presented on behalf of the Ministry of Agriculture and Forestry at the Training Workshop on Capacity Enhancement on Climate Change Adaptation. Thalad, 7-10 June 2011.
- Rayner N.A. et al. "Global Analyses of Sea Surface Temperature, Sea Ice and Night Marine Air Temperature Since the Late Nineteenth Century." Journal ofGeophysic Research, Vol. 108 (D14), 2003. doi:4407 I0.1029/2002JD002670.
- Rudolf B. et al. "GPCC Status Report, December 2010." December 2010.
- Schiller, J.M, Hatsadong and Doungsila. "A History of Rice in Laos," in J.M. Schiller, M.B. Chanphengxay, B. Linquist and S. Appa Rao (eds), Rice in Laos, International Rice Research Institute, Los Banos, Philippines, 2006.
- Timmerman, A. et al."ENSO Response to Greenhouse Warming," Nature, Vol. 398: 694, 1999.

- World Bank and United Nations. "Natural Hazards, Un-Natural Disasters: The Economics of Effective Prevention," accessed at http://www.gfdrr.org/gf-drr/node/281
- WREA. National Adaptation Programme of Action to Climate Change. Vientiane, 2009.

Mitigation:

- FAO. Nutrition Laos: Nutrition Country Profiles. FAO, Rome. July 2003.
- GoL PDR. Seventh National Socioeconomic Development Plan 2011-2015. Ministry of Planning and Investment. Vientiane, 2011.
- Hanna Kaisti. "Intended and Unintended Outcomes of RE Projects in Lao and Cambodia: Stories from the Field," presented at the Seminar on Energy Policy, Climate Change and Ecology Democracy in the Mekong Region, 3 November 2008.
- IPCC. Climate Change 2007: Mitigation, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, USA, 2007.
- llCA. Study of the Master Plan on Comprehensive Urban Transport in Vientiane in Lao PDR. Vientiane, 2008.
- Khamphone Nanthavong. Socioeconomic Survey in Lao PDR. Promotion of the Efficient Use of Renewable Energies in Developing Countries (FE/NUOL), Energy Intelligent, n.d., EIE 06-256 REPRO.
- Lao PDR. The First National Communication on Climate Change: Submitted to the United Nations Framework Convention on Climate Change. Science, Technology and Environment Agency, Vientiane, 2000..
- Ministry of Agriculture and Forestry. Forest Strategy of Lao PDR to the Year 2020. Ministry of Agriculture and Forestry, Vientiane, 2005.
- Ministry of Natural Resources and Environment. Mitigation Measures for Climate Change for the Second National Communication on Climate Change of Lao PDR. Vientiane, 2012.
- NSC. Statistics 1975-2005. Committee for Planning and Investment, State

Statistical Centre. Vientiane, 2005.

- NSC. Statistics 2006. Committee for Planning and Investment, State Statistical Centre. Vientiane, 2006.
- NSC. Statistics 2007. Committee for Planning and Investment, State Statistical Centre. Vientiane, 2007.
- NSC. Statistics 2008. Committee for Planning and Investment, State Statistical Centre. Vientiane, 2008.NSC. Statistics 2009. Committee for Planning and Investment, State Statistical Centre. Vientiane, 2009.
- NSB, WHO and UNICEF. National Statistics Bureau & WHO-UNICEF Joint Monitoring Programme. Vientiane, 2004.
- Smith, P. et.al. "Greenhouse Gas Mitigation in Agriculture," Philosophical Transactions of the Royal Society, B., 363. doi:10.1098/rstb.2007.2184.
- STEA. National Environmental Performance Assessment (EPA) Report. Vientiane, 2004.
- Wassmann, R., Yasukazu Hosen, and Kay Sumreth. "Agriculture and Climate Change: An Agenda for Negotiation in Copenhagen," "Reducing Methane Emissions from Irrigated Rice," "2020 Vision," for Food Agriculture and the Environment, Focus, 16, Brief3, May 2009.
- World Bank. "Lao PDR Republic – Rural Electrification Phase I Project of the Rural Electrification (APL) Programme: P075531 – Implementation Status Results Report: Sequence 06, 2709-2011," accessed at http://www-wds.worldbank.org/extemal/default/WDSContentServer/ WDSP/EAP/2011109/27/ DA6BB5950943694A8525791800576F7B/1 0/ Rendered/PDF/P0755310ISRODi0272011013171389013 75.pdf

- Other Information:

- Ministry of Education. National Education System Reform Strategy (2006-2015).Vientiane, 2008.
- Ministry of Education. Summary of Implementation of Education Development Plan 2008-2009 and Education Development Plan 2009-2010. Vientiane, 2009 (in Lao).
- MONRE. Strategy and Plan, Natural Resources and Environment, 2011-

2015. Vientiane, n.d.

- Non-Formal Education Development Centre. Case Study: Development of Local Curriculum in MuangSing District, Luang Namtha Province, Lao PDR. Non-Formal Education Development Project for Ethnic Minority Villages, Ministry of Education, Vientiane, 1999.
- STEA. National Strategy on Environmental Education and Awareness to the Year 2020. Vientiane, 2004.
- World Bank. "Lao Environment Monitor 2007," accessed at www.world-bank.org/lao.
- WREA. Assessment of the Five-Year Plan 2006-2010 and the Direction of the Five-Year Plan 2011-2015 on Water Resources, Environment and Meteorology and Hydrology. Vientiane, 2010.