

The majority of forest fires occur during the dry season of February and March and mainly in the Northern and North-eastern regions. Chiang Mai is the Province which has the greatest number of forest fires and suffers the most damage (Table 4.1.2). Forest fires in the border areas are more challenging as the issues cannot be solved only by domestic measures, but need collaborating with neighbouring countries.

**Table 4.1.1 Recent Statistics of the Fire and Forest Area Destroyed by Fire**

Year	No. of Fire extinguished (times)	Forest area destroyed by fire	
		(rai)	(ha)
2005	9,447	189,276	30,284
2006	4,711	53,885	8,622
2007	7,757	117,395	18,783
2008	5,569	70,810	11,330
2009	5,361	61,084	9,773
2010	6,570	72,912	11,666

Source: Summary of Haze Situation and Open Burning Year 2010 PCD (ha calculated by the JICA team)

**Table 4.1.2 Statistics of the Fire and Forest Area Destroyed by Fire in 2009 and 2010**

Province/Region	Financial year 2009 (Oct 1 <sup>st</sup> 08 – Jul 6 <sup>th</sup> 09)			Financial year 2010 (Oct 1 <sup>st</sup> 09 – Jul 6 <sup>th</sup> 10)			Results from Comparison				
	No. of Fire Extinguish	Area that were on fire		No. of Fire Extinguish	Area that were on fire		No. of Fire Extinguish	Area that were on fire			
		(times)	(rai)		(ha)	(times)		(rai)	(ha)	(times)	(rai)
1. Central & East	454	8,263	1,322	575	7,041	1,127	↑	121	↓	-1,222.00	-196
2. Northeast	1,267	20,852.30	3,336	1,520	19,962	3,194	↑	253	↓	-890.3	-142
3. North	3,472	26,914.60	4,306	4,198	32,374.10	5,180	↑	726	↑	5,459.50	874
4. South	168	5,053.80	809	277	13,534.50	2,166	↑	109	↑	8,480.80	1,357
<b>TOTAL</b>	<b>5,361</b>	<b>61,083.60</b>	<b>9,773</b>	<b>6,570</b>	<b>72,911.60</b>	<b>11,666</b>	<b>↑</b>	<b>1,209</b>	<b>↑</b>	<b>11,828.00</b>	<b>1,892</b>
<i>Chiang Mai</i>	1,388	8,945.30	1,431	1,633	11,128.80	1,781	↑	245	↑	2,183.50	349
<i>Mae Hong Son</i>	395	2,477	396	361	2,091	335	↓	-34	↓	-386	-62
<i>Lampang</i>	322	1,895	303	272	1,638	262	↓	-50	↓	-257	-41
<i>Lamphoon</i>	321	2,378	380	497	3,796	607	↑	176	↑	1,418	227
<i>Chiang Rai</i>	145	709.3	113	179	986.9	158	↑	34	↑	277.6	44
<i>Payao</i>	139	590	94	117	536	86	↓	-22	↑	-54	-9
<i>Prae</i>	112	591	95	100	686	110	↓	-12	↑	95	15
<i>Nan</i>	5	45	7	39	517	83	↑	34	↑	472	76
<b>TOTAL</b>	<b>2,827</b>	<b>17,630.50</b>	<b>2,821</b>	<b>3,198</b>	<b>21,379.60</b>	<b>3,421</b>	<b>↑</b>	<b>371</b>	<b>↑</b>	<b>3,749.10</b>	<b>600</b>

Source: Same as Table 4.1.1

#### 4.1.2 GHG EMISSION AND INVENTORY

As described in section 2.1.2, GHG emissions from agriculture account for 25.28% of the total GHG emissions calculated in 2005. Further breakdown of the agriculture sectors was not available from the 2005 data; hence the 2003 data was used. Rice cultivation comprised 56.13% of the total agricultural emission and comprised 13.5% of the total emissions for Thailand. Since agriculture not only contributes to the GHG emissions, but it also acts as a carbon sink, the implementation of the GHG data needs to be interpreted soundly considering following points. First, compared to the energy and transport sector, the GHG emissions from agriculture are relatively small. Secondly, rice production is an important industry and significant export item. Furthermore, rural households will be directly affected when any

measures are introduced to control emissions from agriculture. The measures should avoid jeopardizing farmers' livelihoods.

**Table 4.1.3 GHGs Emission of the Agricultural Sector in 2003**

(Unit: Million tCO<sub>2</sub>-eq \*)

Emission source	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs**	Total	Ratio of the total Emissions	Ratio of the Agricultural Emission
Total Emission and Removals	218.360	95.346	29.713	0.791	344.21	100%	-
Agriculture		56.811	25.977		82.788	24.05%	100%
Enteric Fermentation		8.163			8.163	2.37%	9.86%
Manure Management		1.742	2.18		3.922	1.14%	4.74%
Rice Cultivation		46.467			46.467	13.50%	56.13%
Agricultural Soil			23.674		23.674	6.88%	28.59%
Burning of Residue		0.439	0.123		0.562	0.16%	0.68%
Land use Change and Forestry	21.511	0.998	0.101		22.61	6.57%	-

Source: Thailand GHG Emission 2003, Proceedings the 3rd Workshop on Green House Gas Emission Inventories in Asia Region 2006

Note: \* CO<sub>2</sub> Equivalent estimate \*\*HFCs Hydro fluorocarbons

## 4.2 STRATEGIES, POLICIES, AND WORK PLANS TO CLIMATE CHANGE IN THE AGRICULTURE AND FORESTRY SECTOR

### 4.2.1 POLICIES FOR SUB-SECTORS

#### (1) Agriculture

The nine departments, namely the Land Development Department (LDD), the Department of Rice (DOR), the Department of Agriculture(DOA), the Department of Fishery (DOF) , the Department of Livestock Development (DLD), the Royal Irrigation Department (RID) , the Agricultural Land Reform Office (ALRO), the Royal Rain and Agricultural Aviation Office (RRAAO) and the Office of Agricultural Economy (OAE); have budgets allocated for Climate Change Mitigation. The MOAC Agriculture Global Warming Mitigation Plan prepared in 2007, set the following four objective; 1) To do research on emissions & storage of Green House Gases, vulnerable areas affected by Climate Change and adjustment measures for agricultural land, 2) To develop a database, increase knowledge and to develop an effective warning system for the global warming effects for agricultural areas, 3) To acknowledge the vulnerable areas or land use activities that are at high risk due to climate change in order to adjust the planting system, to prevent, to solve and to mitigate the effect as soon as possible, 4) To develop organizations, human resources, farmers and co-operative system.

The targets for four years are;

- 1) All the agencies under the MOAC are to acknowledge the danger of global warming to the agricultural sector and adjust the land use system to negate its impact.

- 2) The MOAC obtains a database on knowledge and develop an efficient warning system in order to reduce and/or store Green House Gases (GHGs) and provide data for the agricultural sector to cope with global warming.
- 3) The MOAC to set suitable crop planting systems, livestock and fishery.
- 4) Some measures are taken for the risk area affected by global warming about 18.6 million rai. (300 million ha)

In order to achieve the set targets, various research activities were conducted under the three strategies, 1) knowledge management; 2) prevention and solution of problems; and 3) information campaigns and dissemination, public relations, and human resource development.

The budget planned to allocate for the departments under the MOAC is shown in the Table 4.2.1. Approximately 1 billion THB was originally planned.

**Table 4.2.1 Budget Allocation by Departments under the MOAC Agriculture Global Warming Mitigation Plan**

(Unit :THB)

Agency	Year 2008	Year 2009	Year 2010	Year 2011	Total 4 Years Budget
1. Land Development Department (LDD)	234,394,420	171,526,202	145,276,202	126,950,000	678,146,824
2. Department of Rice (DOR)	16,800,000	0	0	0	16,800,000
3. Department of Agriculture (DOA)	35,000,000	17,000,000	17,000,000	17,000,000	86,000,000
4. Department of Fishery (DOF)	23,655,240	13,625,120	13,375,120	13,125,120	63,780,600
5. Department of Livestock(DLD)	42,225,800	36,350,800	36,100,800	35,850,800	150,528,200
6. Royal Irrigation Department(RID) *	(91,000,000)	(344,750,000)	(261,500,000)	(185,250,000)	(882,499,900)
7. Agricultural Land Reform Office (ALRO)	1,000,000	1,000,000	1,000,000	0	3,000,000
8. Royal Rain and Agricultural Aviation Office (RRAAO)	1,000,000	1,000,000	0	0	2,000,000
9. Office of Agricultural Economy (OAE)	3,825,000	3,450,000	3,200,000	2,950,000)	13,425,000
<b>Total</b>	<b>357,900,460</b>	<b>243,952,122</b>	<b>215,952,122</b>	<b>195,875,920</b>	<b>1,013,680,600*</b>

Source: MOAC, Note: The RID budget was excluded from the total amount as it is identified normal annual budget and not specifically for climate change mitigation measure.

The LDD obtained a substantial amount of the budget under the Master Plan. Since the budget of RID is not specifically mentioned for Climate Change Mitigation, the figures shown in parentheses of the Table 4.2.1 are from their normal budget. The Master Plan Budget allocated according to the three strategies mentioned previously and is shown in Table 4.2.2. Further details of the respective projects are shown in the Annex 4-1.

At the outset, the LDD was designated as the focal point of the Climate Change Policies of the MOAC. In January 2010, the OAE became the focal point.

**Table 4.2.2 Budget Allocation by Strategies under the MOAC Agriculture Global Warming Mitigation Plan**

(Unit :THB)

Strategy 1: Knowledge Management on World Climate Change							
Working Plan	Responsible Agency	Project No.	Budget (Baht)				Total
			Year 2008	Year 2009	Year 2010	Year 2011	
Sector of Plant	Dept. of Agriculture (DOA)	1	5,000,000	5,000,000	5,000,000	5,000,000	20,000,000
			5,000,000	4,000,000	4,000,000	4,000,000	17,000,000
		2	20,000,000	3,000,000	3,000,000	3,000,000	29,000,000
		3	5,000,000	5,000,000	5,000,000	5,000,000	20,000,000
Sector of Soil	Land Development Dept. (LDD)	1	15,039,420	8,276,202	8,276,202	5,200,000	36,791,824
	Department of Rice (DOR)		16,800,000	(-)	(-)	(-)	16,800,000
	Land Development Dept. (LDD)	2	8,000,000	5,000,000	3,000,000	2,000,000	18,000,000
Sector of Water	Royal Rain and Agricultural Aviation Office	1	1,000,000	1,000,000			2,000,000
Sector of Livestock and Fisheries	Department of Fishery	1	19,830,240	10,175,120	10,175,120	10,175,120	50,355,600
Climate Change and Agriculture	All agencies with Dept. of Meteorological	1	21,350,000	20,000,000	5,000,000	5,000,000	51,350,000
<b>Total</b>		<b>8</b>	<b>117,019,660</b>	<b>61,451,322</b>	<b>43,451,322</b>	<b>39,375,120</b>	<b>261,297,424</b>
Strategy 2: Prevention and Solving Global Warming Problem							
Working Plan	Responsible Agency	Project No.	Budget (Baht)				Total
			Year 2008	Year 2009	Year 2010	Year 2011	
Sector of Plant	Office of Agricultural Economy	1	15,300,000	13,800,000	12,800,000	11,800,000	53,700,000
	LDD	2	21,580,000	10,000,000	10,000,000	10,000,000	51,580,000
	ALRO	3	1,000,000	1,000,000	1,000,000		3,000,000
	LDD	4	20,800,000	16,800,000	10,800,000	10,800,000	59,200,000
Sector of Soil	LDD	5	6,000,000	2,000,000	2,000,000	1,000,000	11,000,000
Sector of Water	RID	7	Annual Budget				Annual Budget
			(91,000,000)	(344,750,000)	(261,500,000)	(185,250,000)	(882,499,900)
Sector of Livestock and Fisheries	Dept. of Livestock and Dept. of Fishery	6	38,400,800	32,900,800	32,900,800	32,900,800	137,103,200
Climate Change and Agriculture	LDD with Dept. of Meteorological	8	28,800,000	23,000,000	21,000,000	19,000,000	91,800,000
<b>Total</b>		<b>8</b>	<b>131,880,800</b>	<b>99,500,800</b>	<b>90,500,800</b>	<b>85,500,800</b>	<b>407,383,200</b>
Strategy 3: Public Campaigns, Public Relations, Knowledge Dissemination, and Human Resource Development							
Working Plan	Responsible Agency	Project No.	Budget (Baht)				Total
			Year 2008	Year 2009	Year 2010	Year 2011	
All 5 Sectors (Plant, Soil, Water Livestock and Fishery)	LDD, DOR	1	64,000,000	38,000,000	37,000,000	36,000,000	175,000,000
	All agencies	2	20,000,000	20,000,000	20,000,000	10,000,000	70,000,000
Climate Change to Agriculture	All agencies	3	25,000,000	25,000,000	25,000,000	25,000,000	100,000,000
<b>Total</b>		<b>3</b>	<b>109,000,000</b>	<b>83,000,000</b>	<b>82,000,000</b>	<b>71,000,000</b>	<b>345,000,000</b>
<b>Grand Total</b>		<b>19</b>	<b>357,900,460</b>	<b>243,952,100</b>	<b>215,952,100</b>	<b>195,875,920</b>	<b>1,013,680,600</b>

Source: Same as 4.2.1

## (2) Forestry

As part of an administration reform, the Ministry of Natural Resources and Environment (MNRE) was newly established in 2 October 2002. This ministry comprises the departments under the former Ministry of Science, Technology and Environment and MOAC. The Royal Forestry Department (RFD), originally attached to the MOAC was transferred under the supervision of the MNRE and was later divided into three Departments i.e., the Department of National Park Wildlife and Plant Conservation (DNP), and the Department of Marine and Coastal Resources (DMCR) and the Royal Forestry Department (RFD). The DNP is responsible for forestry under the National Parks and protected areas which are wildlife sanctuaries, while the RFD takes responsibility for forest areas outside protected areas. The DMCR is in charge of resource management of the coastal areas such as mangrove forests. The Thai government enacted the National Forest Policy in 1985 which proclaimed forty percent of the country area shall be kept under forest, and banned all logging in natural forests and the export of wood products in logs since the late 1980s. The Thai government also has the National Long-term Reforestation Plan from 1991 to 2020. The key performance

indicators of the RFD three-year Action Plan (2009-2011) are as follows<sup>17</sup>:

- 1) The National Forest Reserve Area has been protected and maintained at 67.7 million rai (10.83 million ha)
- 2) of the area of Forest Rehabilitation is 1.373 million rai (220,000 ha)
- 3) The numbers of Farmers have been inspected for certifying usufructuary rights at 150,000 farmers.

The 10<sup>th</sup> National Economic Social Development Plan (NESDP, 2008-2011) sets a target of maintaining at least 33% of the total area under healthy forest cover, of which 18% should be protected areas. The target for restoration of protected area is set at 464,000 ha (2,900,000 Rai.)

While the DNP admits the significance of afforestation and reforestation, the research and pilot activities have been focused in creating an incentive mechanism to attract farmers along the forest boundary to commit to forestation and forest conservation activities. The DNP published the Master Plan on Climate Change which maintains consistency with the National Strategy on Climate Change Management (2008-2012). The summary of this Master Plan is attached in the Annex 4-2.

The DNP was designated as the focal point for REDD (Reduced emissions from deforestation and forest degradation) which was formally agreed as a new measure in the COP13 held in Bali, Indonesia, December 2007. The incentive mechanism to sell Carbon Credit which reduce GHG through REDD has been of high interest among stakeholders. The DNP prepared the Readiness Plan Idea Note (R-PIN)<sup>18</sup> in order to utilize the Readiness Fund under the World Bank's Forest Carbon Partnership Facility (FCPF)<sup>19</sup>. This provides carbon emission credits against forest conservation activities, namely REDD-plus<sup>20</sup>, which includes sustainable management of forests, protection of biodiversity. According to the R-PIN, the REDD related activities are planned as follows:

- 1) A comprehensive REDD Readiness plan draft document submission to FCPF in July 2009;
- 2) A REDD national strategy has undergone a wide participatory, multi-stakeholder consultations and was adopted by government in Feb 2010;
- 3) Potential for carbon sequestration (carbon cycle assessments) from different types of natural forest in Thailand (carbon sink) during dry and wet seasons including differentiation between mature, old growth forests and plantations by Dec 2010;

---

<sup>17</sup> FAO(2009)"Thailand Forestry Outlook Study"

<sup>18</sup> [http://www.forestcarbonpartnership.org/fcp/sites/forestcarbonpartnership.org/files/Documents/PDF/Thailand\\_R\\_PIN\\_Revised\\_Feb\\_2009.pdf](http://www.forestcarbonpartnership.org/fcp/sites/forestcarbonpartnership.org/files/Documents/PDF/Thailand_R_PIN_Revised_Feb_2009.pdf)

<sup>19</sup> FCPF consists of the Readiness Fund which facilitate to assist developing countries to prepare themselves to participate in large-scale system of positive incentives for REDD in a future and the Carbon Fund which remunerate the selected countries in accordance with negotiated contracts such as capacity building for verifiably reducing emissions beyond the reference scenario.

<sup>20</sup> REDD and REDD-plus: Distinctions are made between REDD and REDD-plus depending on the range of activities. While the scope of REDD is the control of deforestation and forest degradation, REDD-plus also includes conservation, sustainable management of forests and the enhancement of forest carbon stocks within its scope. (REDD-plus- Forest Conservation in Developing Countries August 2010, JICA)

- 4) Updated emissions data (2005/6) from forest sector as compared with baseline of 1994, and projections to 2020 by Dec 2010;
- 5) By March 2011, updated information and data at national level on deforestation and land use change by types of forest ecosystem affected, and by administrative regions; immediate causes of deforestation and underlying drivers; updated forest cover and land use maps with comparisons between 1989, 1995, 2000, 2005, and 2010;
- 6) A national referencing scenario with measurement, monitoring and verification mechanisms in place at national and local institutional levels (RFD/DNP and regional offices) by June 2011.

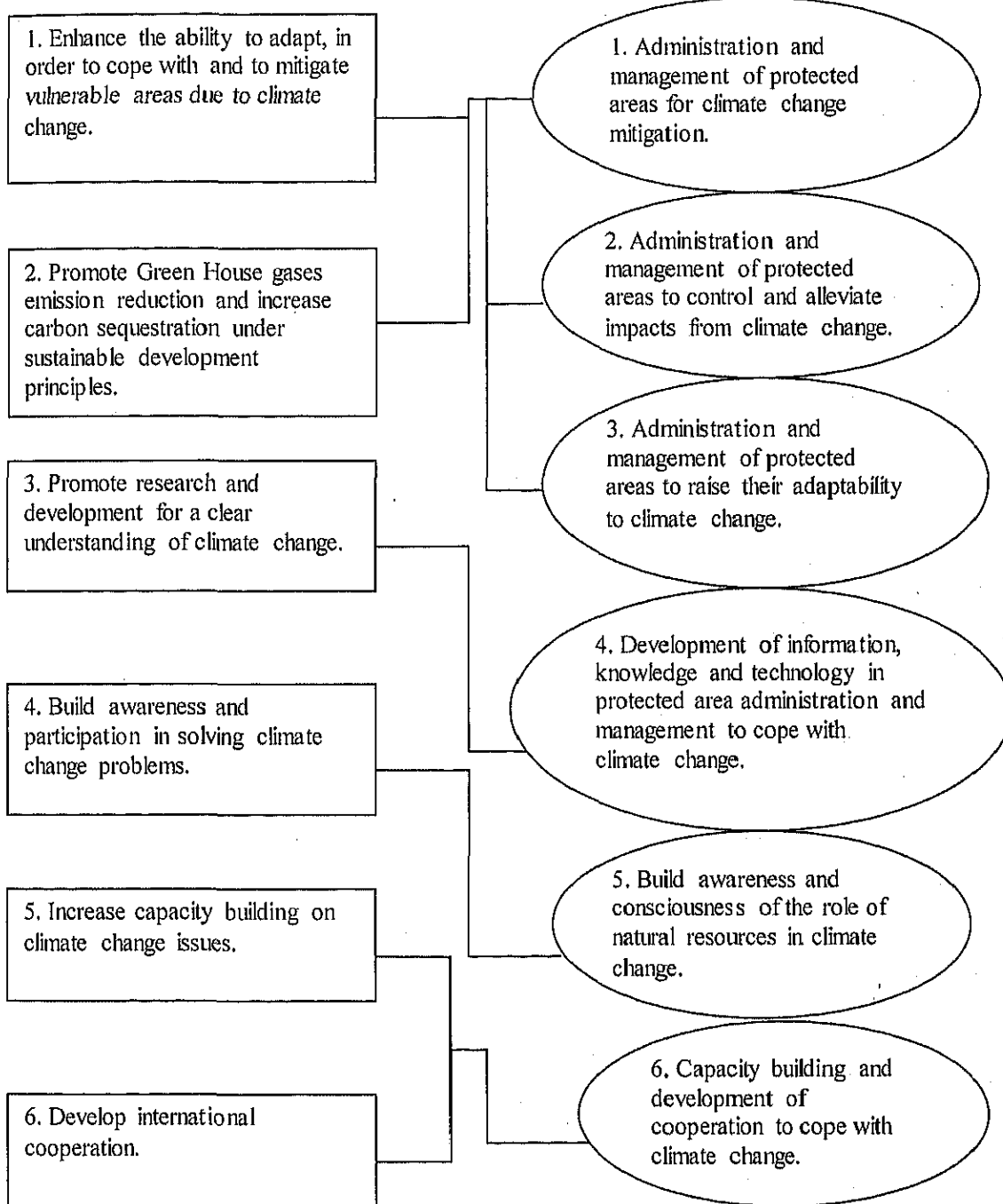
Due to the fact that there is no budget approval from the FCPF and the budget has not allocated by the DNP, these activities have not been implemented as of August 2010.

The focal point for controlling open burning is the Pollution Control Department (PCD), which has prepared a Master Plan and Action Plan as shown in Table 4.2.3 and Annex 4-3. The control target for open burning is defined as 1) agriculture land, 2) forest, and 3) community waste according to the National Master Plan for Open Burning Control in 1997. Having discussion with the PCD and examined related documents, forest fire is identified as the most urgent issue and is heavily budgeted shown in the Table 4.2.3. The most challenging issues is to prevent farmers from burning down trees for turning the forest into farm land where forest lands are close to the existing farming zones. This has to be combined with improving the farmers' economic situation. While this approach inevitably requires the cooperation of local governments, the PCD does not have the authorities to request activities for concerned local governments. Local budgets need to be assured in order to provide training to local farmers. Banning the cultivation inside the protected forest area by law has not been successful. Penalties have not been effective in reality. The controlling of forest fires is regarded as one of the most difficult challenges.

The targets of the Action Plan for Solving Problem of Haze and Forest Fires are; the ambient particulate matter should not reached the levels that are detrimental to health; area of forest burned will not exceed more than 300,000 (48,000 ha) rai/year. Taking into account the seriousness and actual damage, 1.54 billion THB more than 60 % of total budget of 2.374 billion THB, is allocated to the northern eight provinces, i.e., Chiang Mai, Mae Hong Son, Lampang, Lamphun, Chiang Rai, Phayao, Phrae and Nan.

**National Strategy on Climate Change  
(2008-2012.)**

**Master Plan on Climate Change  
Dept. of National Parks, Wildlife and  
Plant Conservation**



**Figure 4.2.1 Relation between DNP Master Plan and National Strategy on Climate Change**

Source: Master Plan on Climate Change Department of National Parks, Wildlife and Plant Conservation

**Table 4.2.3 Action Plan for Solving Problem of Haze and Forest Fires Year 2008-2011**

Strategy/Measure/Project	Budget (Million THB)				Total (Million THB)
	2008	2009	2010	2011	
Strategy 1 : control burning in both public and agricultural areas (7 projects)	56 (138)	174	174	55	459 (138)
1) Measures to control open burning in residential areas (3 projects)	16	16	16	16	64
2) Measures to control open burning in agricultural areas (4 projects)	40 (138)	158	158	39	395 (138)
Strategy 2 : control forest fire (4 projects)	114.01 (283)	386.09	386.09	386.09	1,272.28 (283)
3) Measures to control open burning in conservation forests (2 projects)	40.1 (278)	307.09	307.09	307.09	961.28
4) Measures to control open burning in protected forests (1 projects)	74	74	74	74	296
5) Royal Artificial Rain (1 project)	(5.0)	5	5	5	15 (5.0)
Strategy3: campaign, advertise, publicise the knowledge, participation, monitoring, protecting and impact on public health (33 projects)	140.86 (21.0)	167.85	167.85	166.35	642.91 (21.0)
6) Campaign, advertise, publicise the knowledge (3 projects)	11.5 (10.5)	32	32	32	107.5 (10.5)
7) Measures of public participation (15 projects)	119.34	117.84	117.84	117.84	472.86
8) The monitoring and warning of haze and forest fire situation Centre (3 projects)	0.51 (10.5)	11.01	16.01	16.01	43.54 (10.5)
9) Educate inside and outside schools regarding pollution from haze and forest fire (1 project)	-	-	-	-	-
10) Research (7 projects)	0.51	4.0	-	-	4.51
11) Monitoring and Prevention the impact to Public Health (4 projects)	9	3	2	0.5	14.5
<b>Total 44 projects</b>	<b>310.87 (442)</b>	<b>727.94</b>	<b>727.94</b>	<b>607.44</b>	<b>2,374.19 (442)</b>

Note : Figures in parenthesis are the budget which has been allocated in year 2008

Source : PCD

#### 4.2.2 MEASURES IMPLEMENTED FOR CLIMATE CHANGE (ACHIEVEMENT AND ONGOING PROJECTS)

##### (1) Agriculture related departments

Current Climate Change Policies under the MOAC put an emphasis on research, data building, identification of the vulnerable areas and crops, and institutional buildings. The activities requiring substantial budgets such as extension activities of introducing new techniques to large numbers of farmers are not well articulated. At this stage, the major adaptation measure for Agriculture is to implement the existing water resource management policies, as well as to assess the Climate Change impacts on major products such as rice, cassava, maize and sugarcanes for different types of land. The OAE studies the potential impact of Climate Change on farm economies. With regard to mitigation measures, the LDD and the DOR and related agencies started to study the emission mitigation and carbon sequestration which still require continuous technical support. The introduction of the mitigation measures which bring



economic impact are not clearly planned. The technical measures already implemented are as follows:

The LDD promotes the demonstration and public campaign which contribute to mitigation, adaptation and to both in order to develop effective policies. The pilot activities conducted are outlined in the following tables. The Action Plan in the year 2010 was specifically targeted as land resource improvement for 2.08 million hectares which benefits to 1.2 million farmers.

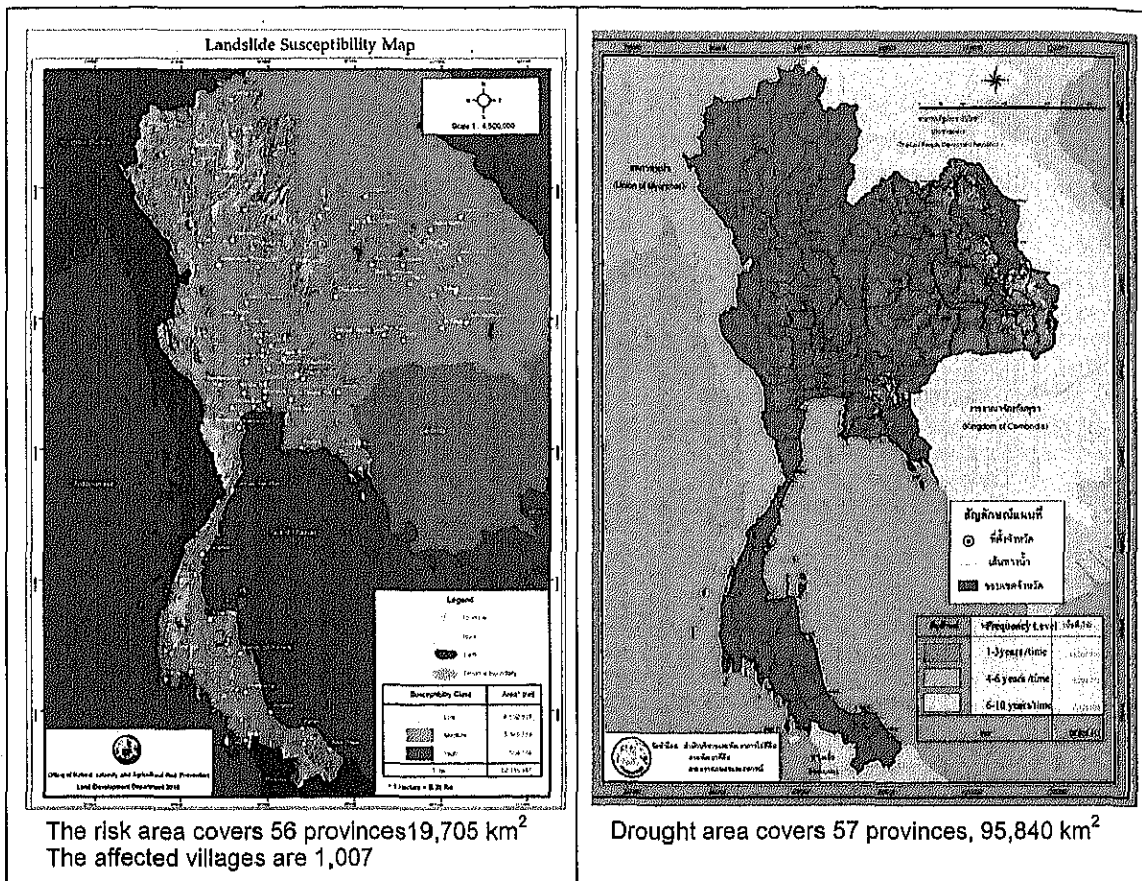
**Table 4.2.4 Research Activities for Climate Change Conducted by the LDD**

1) Soil Carbon Sequestration: - Soil and water conservation measures, - Land use patterns, - Land management, - Chemical and organic fertilizers application	2) GHG emission from agricultural area - rice in lowland - crops in upland - fruit trees and trees in highland
--	---

**Table 4.2.5 Development Activities for Climate Change Conducted by the LDD**

Campaign on crop residue management by incorporating the residue into the soil for carbon sequestration Year 2008: 1,645 ha, Year 2009: 1,654 ha	
Implementation on soil and water conservation measures and trees plantation in target areas Year 2008: 11,193 ha, Year 2009: 6,463 ha	
Data collection of Landslide susceptibility ( Low, Moderate, High) *	Data collection of Drought Frequency* Data collection of Flood Frequency
<ul style="list-style-type: none"> <li>● Flood and drought mitigation project master plan (Short-term and long –term)</li> <li>● Tree plantation on hillside ditches in Chiang Rai, Phrae Provinces</li> <li>● Vetiver plantation on hillside ditches where soil is eroded.</li> <li>● Check dam sediment trap</li> </ul>	<ul style="list-style-type: none"> <li>● Soil and water conservation measures in critical loss of top soil (Chiang Mai, Chiang Rai, Nan Provinces)</li> </ul>

Note \*the following figures are the maps based on the data obtained through the survey.



**Figure 4.2.2 Landslide Susceptibility Map and Drought Frequency Map**

Source : LDD

The DOR together with related agencies conducted studies on rice, which is a staple food and one of the most important export products in Thailand, and on other major crops for increasing adaptation capacity for farmers, developing new farming techniques, such as breeding, change and impact of change in crop patterns<sup>21</sup>. The DOR addressed the needs to purchase the equipments in order to scale up the experiment for carbon footprint and analysis of impacts on major crops in different regions. Specifically, pilot studies were conducted in Chiang Rai (Northern upland, intercropping cultivation), Ubon Ratchathani (North-eastern, rainfed lowland, monocrop cultivation), and Pathum Thani (Central plain, continuous cropping) in order to continue the studies on breeding farmer adaptations, organic production systems, and so on.

Departments and agencies under the MOAC accumulated various research data on the impact on temperature by cultivation patterns, water use, relation to GHG, verification of major GHG emitters under the current master plan. In addition, there are various researches conducted by Universities and Research Institutes<sup>22</sup>. The adaptation measures, substantially regarded as

<sup>21</sup> "Research Report (Progress Report No.2) on Impacts of Global Warming on Rice, Sugarcane, Cassava and Maize Production in Thailand" (2009) "Rice Planting System Management Project"(2010) Both documents are in Thai.

<sup>22</sup> There were some papers presented such as "Estimation of Carbon Footprint of Rice Cultivation with Different Field Management" at the 1st NATIONAL CARBON NEUTRAL CONFERENCE, Climate Thailand Conference (CTC) August 2010 organised by TGO.

equal to the conventional development agenda such as water resource management which existed before Climate Change became the key agenda.

In 2010, the MOAC proclaimed the new policy to restrict sequential cropping and limit to double cropping as one of the measures in response to the record-breaking drought. Due to the fact that there are negative impacts for sequential cropping in terms of valuable water consumption, damage from insects and soil erosion, the government set the policy to extend double cropping step by step. Since this measure decrease methane emission, it is also categorized as mitigation policy. Unless new technology or other cash crops are introduced to maintain the farmers' livelihood, they have little incentive to follow this policy, as income from rice would decrease in the short-run.

The public campaign to prevent the burning of rice stubble by the use of tractors has already started. in order to. The mechanism for the rental of tractors at reasonable prices by organising cooperatives and the introduction of other cash crops besides rice will be encouraged. It will require time before these two measures are fully taken up, as this requires incentives for farmers.

On the other hand, the planting of energy crops has been expanding as one of the renewable energy sources (See Transportation section 3.2.2), although this activity is not categorized as a mitigation measure in the Agriculture sector.

The adaptation and mitigation measures even underpinned by scientific researches will not be sustainably implemented unless they have sound economic incentives. Like many other countries, Thailand continuously requires the studies on economic impacts when these measures are applied. The MOAC, at this stage acknowledges the significance for public campaigns in providing sound knowledge on climate change for local government, individuals, and private sectors.

## (2) Departments related to forestry sector

The budget for afforestation and reforestation (A/R) has been allocated every year constantly. The recent budget and outcomes are shown in Table 4.2.6. According to the RFD, the recent reforestation rate has been stagnant, which indicates the need for more budget allocation in order to reach the national target of 40% forest cover. Currently, the budget of A/R has been allocated in term of preventing flood, watershed management, eco-system protection, economically viable tree plantations for energy trees and the wood industry in order to prevent natural forest logging. Secondly, the program of providing seedlings for farmers and public continues in order to expand green areas. Thirdly, the subsidizing the plantation of economically viable trees, such as eucalyptus, Hevea brasiliensis being compatible with specific topography are being implemented. The RFD regards subsidized plantations for economically viable tree should be further expanded as it expects positive economic, social and environmental impacts. The budget allocated for the year 2009 and 2010 is shown in the following table.

**Table 4.2.6 Budget and Plan of RFD Activities in 2009 and 2010**

Activity	2009		2010	
	THB	Output	THB	Output
Afforestation and Reforestation (A/R) of national reserved forest	437,194,800	106,920 rai 171.0 km <sup>2</sup>	694,185,810	104,700 rai 167.5 km <sup>2</sup>
Provided forest tree seedlings to public and farmers	57,137,570	29,500,000 seedling	121,626,370	48,220,000 seedling
Subsidize farmers to plant economic trees	23,960,879	-	109,957,100	-
<b>Total</b>	<b>518,293,249</b>		<b>925,769,280</b>	

Source : RFD

The DNP Master Plan described that the REDD would be an effective approach to mitigate climate change and would be accepted internationally. Since the REDD mechanism is directly related to the DNP's function, the DNP articulated the commitment to the REDD through conducting the plans identified in the Master Plan. One of the pilot undertakings of the REDD is the Project of Tenasserim Biodiversity Conservation Corridors, Western Forest Complex - Kaeng Krachan Complex<sup>23</sup> located on the Western boarder of Thailand. This is part of the Biodiversity Cotridors Initiative (BCI) under the Core Environment Program of Greater Mekong Sub-region countries, funded by the ADB. This project aims to restore biodiversity, capacity development of local governments and communities, better use of land management, and sustainable fund mechanism. Approximately 7,000 households are involved in the restoration of 5,000 ha of degraded forest. This forest management system closely collaborates with forest dwellers and needs to be extended to other parts of the country.

Furthermore, since government officials even in the central offices do not have sufficient knowledge of the framework of the international negotiation on climate change, the REDD-plus, and applicable monitoring system, "Measurable", "Reportable", and Verifiable"(MRV) , the DNP acknowledged the needs for trainings of trainers to extend the knowledge, and has gradually started such trainings.

Developing the network for the fire inspection system in protected areas is required in order to control illegal encroachment and forest fire management. Capacity development of local government and farmers is prerequisite for controlling forest fire, thus the training and public campaign will be the one of the major activities under this activity.

There have been pilot activities<sup>24</sup> implemented in the North, such as Chiang Mai province.

<sup>23</sup> The Tenasserim Biodiversity Conservation Corridors, Western Forest Complex - Kaeng Krachan Complex, Thailand Pilot Project Biodiversity Corridors Initiative (BCI) Pilot Site Implementation under the Core Environment Program of Greater Mekong Sub-region countries, funded by ADB : Status Report (2005-2008, 2006-2009)

<sup>24</sup> In Chiang Mai province, following seven activities are conducted for approximately 5.8 million THB (the Report of the PONRE Chiang Mai)

1. Enhance integrated management of provincial and district Board, arrange Board meeting regularly and outside meeting 3 times/year
2. Increase efficiency of notification and warning
3. Drive, motivate and evaluate local administration office
4. Enhance efficiency of forest fire prevention in Doi Suthep area with people's participation
5. Promote activities at sub-districts, near forest zone 126 sub-districts to enhance forest fire prevention capacities

Incentives of 500 to 800 THB per rai (0.16ha) were provided when the fire prevention measures were introduced. However, there are not sufficient budget to extend the activity. Therefore, it is required to monitor the activities conducted for five years properly. Later the plan for extending the pilot activities needs to be drafted.

#### 4.2.3 PLAN TO MITIGATE CLIMATE CHANGE, EXPECTED PROJECTS AND INVESTMENT TARGETS

Reviewing the outcomes of the first and second year (2008, 2009) of the Agriculture Global Warming Mitigation Plan (Master Plan), the LDD plans to continue the analysis pilot activities and expand six specific activities<sup>25</sup> identified as climate change mitigation measures. The budget allocated for 2008, 2009 was verified and monitored by internal government reports, but these are not released according to the OAE. The total budget for the Master Plan for four years (2008~2011) was 1,013 million THB. If the budget allocated for the RID which is not specifically categorized as climate mitigation measures is included the total budget will be 1,896 million THB as shown in Table 4.2.1.

The total budget under the Action Plan for Haze and Forest Fire Control was 2,374 million THB (Table 4.2.3). Basically, it is not clear how to define the measures for Climate Change under the RFD portfolio. Since the RFD would like to enhance its current activities utilizing external funding, the RFD specifically, proposed three projects<sup>26</sup> against the CCPL and estimated the necessary budget as 4,737 million THB. The details of the proposals were attached in the Annex 4-4. The total budget required under the DNP Master Plan is described as 4,108 million THB, but this plan does not specify the duration it covers. Consequently, the investment volume categorized for climate change control under the government budget is not clearly estimated. For reference, 2009 year budget allocated for Programme on creating balance between utilization and conservation of natural resources and bio-diversity, amounted to 25.291 billion THB<sup>27</sup>. However, it is not clear whether the programme specifically addresses Climate Change.

---

6. Prevent and control fire in farmland area by promoting bean growing after harvest without stubble burning

7. Follow and alert to the change of natural resources situation with investigating forest conditions and natural resources after sub-districts work

<sup>25</sup> 1. The project of rapid perennial plant including land and water conservation system,

2. The project of encouraging plough rice-stubble,

3. The project of reducing destroyed land by fire,

4. The project of perennial plant including land conservative system and water in the abandoned farmland area,

5. The project of land in the farmland area of conservative and water in the farmland area of critical vanishes soil surface,

6. The project of land conservative and water in the high risk area of landslide.

<sup>26</sup> The three proposals submitted were; 1. Afforestation and Reforestation to Increase Forest Cover and Carbon Stocks 2. Forest-tree seedlings production to encourage the participatory of the public, 3. Promotion of the economic-tree plantation for socio-economic and environment improvement

<sup>27</sup> Thailand's Budget in brief fiscal year 2009, Bureau of the Budget

#### 4.2.4 FUTURE PLANS AND DIRECTION OF THE THAI GOVERNMENT

Currently, the OAE began the process of drafting the Second Master Plan for Climate Change while reviewing the outcomes of the First Plan. This is the stage to identify the measures for Climate Change based on the research outcome drawn from the pilot activities. The LDD and the DOR addressed the research mitigation measures necessary, in order to continue to develop well-founded policies.

With regard to forestry, conducting DNP master plan and launch the REDD activities will be focused in addition to continuing the A/R activities, economically viable trees extension, seedling production, and community forestry. Forest fire control will continue to be the number one priority as it is the most acute problem for the open burning issues.

#### 4.3 BACKGROUND OF THE POLICY MATRIX CONTENTS ON AGRICULTURE AND FORESTRY

##### 4.3.1 REVIEW OF THE POLICY MATRIX (ADAPTATION IN AGRICULTURE AND WATER RESOURCE MANAGEMENT SECTOR) AS OF JUNE 2010

Regarding the Adaptation Measures under the Key strategy of Enhance Agriculture Sector, two Outcomes were selected based on the discussion among concerned agencies by June 2010.

**Table 4.3.1 Draft Policy Matrix (Adaptation in Agriculture and Water Resource Management Sector) as of June 2010**

Outcome	Action	Year1 2009/2010	Year2 2010/2011	Year3 2011/2012	Agency	Ministry
K1. Enhance agriculture Sector						
O1. Sustain & increase rice production	Breed for tolerance to climate change: flood & lodging	Not specified as of June 2010			DOR	MOAC
O2. Improve water resource management	Enhancement of water level monitoring system: to upgrade 555 stations (8)	Implementation of upgrade program			RID	MOAC
	Drainage system improvement (9)	Revise M/P, updated implementation program	Implementation of updated program		RID	MOAC

\* The number indicates reference No. of the original long list initially assessed by JICA.

##### (1) Breed for tolerance to climate change: flood & lodging

There are researches assessing the impacts of climate change for the agricultural sector as previously noted. Breeding rice to tolerate climate change is one of the most important measures in the agricultural sector in Thailand. However, as it does not directly contribute to

adaptation, this was concluded to be excluded from the Policy Matrix<sup>28</sup>.

- (2) Enhancement of water level monitoring system: to upgrade 555 stations (8)
- (3) Drainage system improvement (9)

The above two actions were referred to in Section 5.3.

Regarding the Mitigation Measure in Agriculture, under the Key strategy 4 of Create low carbon society, two Outcomes were selected as below.

#### 4.3.2 REVIEW OF THE POLICY MATRIX OF AGRICULTURE (MITIGATION) AS OF JUNE 2010

**Table 4.3.2 Draft Policy Matrix (Mitigation: Agriculture Sector) as of June 2010**

Outcome	Action	Year1 2009/2010	Year2 2010/2011	Year3 2011/2012	Agency	Ministry
K4. Reduce GHG in key sectors						
Reduce GHG in agriculture sector	Encourage two crops/year in the irrigated area	Convert cultivation pattern from 3 to 2 crops/year			LDD	MOAC
	Encourage non-open burning cultivation (41/42)	Convert open burning cultivation to non-open burning			LDD PCD	MOAC MNRE

\* The number indicates reference No. of the original long list initially assessed by JICA.

- (1) Encourage two crops/year in the irrigated area
- (2) Encourage non-open burning cultivation

These two actions are mutually related. These measures might decrease rice production in the short-run unless applying intensifying techniques of rice production and ploughing stubble to assure the same level of rice yield. Shifting triple cropping to double cropping will certainly reduce methane emission. Flooding rice fields emit methane through the anaerobic decomposition of organic matter in an oxygen-deficit environment. Further, if the drying period of rice field is extended, it will include more oxygen into the soil which reduces methane emission. This measure also contributes to soil and water conservation and crop diversification.

*Farmers burn the farm fields not only in the mountainous regions, but also in the rice fields on the plain, due to the fact it clears rice stubbles faster for preparing the next plantation. Burning agricultural wastes increases large amount of aerosols and airborne-irritants which affect the human respiratory system, and thus, regarded as old technique needs to be banned. The burning the rice stubble is carbon neutral and will not be counted as part of the CO<sub>2</sub> emissions. However, the burning of forest trees to increase agricultural land has a detrimental effect, since the burning produces CO<sub>2</sub> plus losing of a carbon sink.*

The accuracy of GHG emissions from the agriculture sector in Thailand remains highly

<sup>28</sup> Based on the Meeting with Director General of Department of Rice on August 2nd, 2010

controversial, although there are many studies attempting to estimate the emission of GHGs<sup>29</sup>. These two actions in the Policy Matrix are based on the study outcome that rice cultivation is the main source emitter and recommended for further regulation. Since there is also contradicted policy for paying inflated prices for rice crops which encourage rice farmers to maintain the triple cropping and burning rice stubbles in order to maximize rice yield, farmers may show resistant to adopt these policies.

These two measures are certainly important policies in terms of water conservation and health concern. There are however, no firm consensuses on the impact of GHG emissions yet. Additionally, the incentive measures to regulate rice cropping and burning rice stubbles are not well established. In the short-run, these two actions might not be effectively implemented. Furthermore, little progress has been made in implementing mitigation measures in the agriculture sector on a global scale due to the fact that there are difficulties in formulating a policy framework and providing economic incentives to the farmers<sup>30</sup>.

Livestock management is other significant measures for controlling GHG emissions in the agriculture sector. Methane emission from enteric fermentation and methane and N<sub>2</sub>O emissions from manure management are expected to increase based on the demand for dairy products. There are some CDM approved projects shown in the TGO website<sup>31</sup>. Middle to Large scale of livestock management projects will foresee an increase.

Based on the discussion, the outcome of “Reduce GHG in agriculture sector” was agreed not to be included in the Policy Matrix.

The significance of open burning control on forest is acknowledged widely. The National Management Committee on Forest Fire and Haze was established in 2009. Subsequently, the Prime Minister appointed concerned agencies to tackle this urgent issue. Control of Open Burning for forest conservation is therefore, included in the Outcome under the Reduce GHG through forest conservation and restoration.

#### **4.3.3 REVISED POLICY MATRIX FOR AGRICULTURE AS OF AUGUST 2010**

Based on the discussion with concerned agencies, the Policy Matrix in the Agriculture sector excluding the water management was revised as follows.

---

<sup>29</sup> Supruet Thavornyutikarn and Puree Sirasoontorn ‘Climate Change and Responding Mechanisms in the Context of Agriculture and Food Security in Thailand,’ presented at International Conference on Collaborative Research Project, Thailand Research Fund, Bangkok, Thailand, 25-27 May 2009.

<sup>30</sup> International Food Policy Research Institute, ADB (2009) Building Climate Resilience in the Agriculture Sector in Asia and the Pacific Chapter V

<sup>31</sup> <http://www.tgo.or.th/>



**Table 4.3.3 Revised Policy Matrix (Adaptation in Agriculture and Water Resource Management Sector) as of June 2010)**

Outcome	Action	Year1 2009/2010	Year2 2010/2011	Year3 2011/2012	Agency	Ministry
O1. Sustainable Agricultural Production	Increase resilience to climate change through adoption of HM the King Sufficiency Economy Principle (SEP) practices i.e. shifting to more sustainable agriculture system, farming diversification and improved livelihood.	Policy Advocacy ; Identify sites vulnerable to climate change	Enhance awareness of HM Sufficiency Economy Philosophy (SEP) towards sustainable agriculture through workshops, seminar, and study visits.	Implement sustainable use of resources through shifting to a more sustainable agriculture system (bio energy from farming wastes; farming diversification)	DOA	MOAC
K6. Knowledge management on Climate Change						
Master plan preparation for Climate Change	MOAC Climate Change Master Plan	Implement current master plan, Draft 2nd Master Plan	Complete final draft in June 2011	Implement 2nd Master Plan	OAE	MOAC

- (1) Increase resilience for climate change practices, i.e., shifting to more sustainable agriculture systems and farming diversification

The adaptation involves practices that reduce the impact of climate change such as temperature increase, drought, flood, etc. There are number of ways to increase resilience in agriculture. The major strategies are 1) sustainable use of resources through shifting to a more sustainable agriculture system, 2) reducing use of fossil fuels by utilizing more bio-energy from farming waste, and 3) farming diversification<sup>32</sup>. The farmers in rural areas are generally marginalized and prioritize to solve their short-term economic problems – i.e. how to get the maximum yield from their lands and repay their debts, there is a lack of knowledge on how to utilize manure effectively, - resulting in unchanged extensive use of pesticides and fertilizer to economize labour, which, in fact, reduces the sustainability by exacerbating the soil quality in the long-run and when focusing on rice farming there needs to be greater sale price stability than there is for other cash crops.

In order to introduce new technology or management systems into the farmland, identifying the vulnerability based on the sound research as well as policy advocacy for longer-term benefit of adaptation measures are a prerequisite, followed by training and implementation.

- (2) MOAC climate change master plan

While mitigation strategies in agriculture were excluded in this PMx, there are substantial studies for mitigation measure conducted under the first Master Plan on Climate Change in the Agriculture Sector, MOAC in 2007. These include 1) Carbon sequestration in soils, 2) On-farm emission reductions, and 3) Production of liquid fuels from energy crops which reduce

<sup>32</sup> Referred to the paper prepared by DOA on 20 August ,2010 “ Enhanced Resilience to Climate Change and Improved Livelihood thru HM the King’s Sufficiency Economy Proposing Agency :”

fossil fuel dependence and reduce carbon emissions. Reviewing the outputs of the on-going master plan, the OAE is currently drafting the second master plan on Climate Change in the Agriculture Sector. Therefore, this action was included in the Key strategy of the Knowledge management on Climate Change<sup>33</sup>.

#### 4.3.4 REVIEW OF THE POLICY MATRIX FOR FORESTRY AS OF JUNE 2010

Regarding the Mitigation Measure in Forestry under the Key strategy 5: Increase carbon absorb capacity of two actions were initially selected under the Outcome of "Reduce GHG through forest conservation and restoration" as below.

**Table 4.3.4 Policy Matrix (Mitigation: Forestry Sector) as of June 2010**

Outcome	Action	Year1 2009/2010	Year2 2010/2011	Year3 2011/2012	Agency	Ministry
K5. Increase carbon absorb capacity						
O10. Reduce GHG through forest conservation and restoration						
Reduce GHG through forest conservation and restoration	Increase the forest area to 40% of total land area by afforestation /reforestation (48)	Restored the forest area by 30% in 2006	Efforts to increase the forest area		RFD	MNRE
	Prepare Forest Master Plan and Action Plan (47)	Master Plan on Climate Change, DNP, drafted June 2009	Finalize M/P, prepare Action Plan and implement		DNP	

\* The number indicates reference No. of the original long list initially assessed by JICA.

(1) Increase the forest area to 40% of total land area by afforestation /reforestation

Thailand was covered by the forest approximately 53.3% in 1961. Within the last four decades however, the forest area has decreased to 25.3% in 1998. The forest area was estimated as 33.2% in 2000 after applying the GIS/Satellite imagery, and latest figure in 2009 was 33.6%. Continuous efforts for afforestation and reforestation have been made, but the latest annual reforestation area has been stagnant (Refer to the Section 4.1.1(2)).

The first comprehensive National Forest Policy in 1985 was to maintain forest area at 40% of the total land area, which initially 25% was set aside for conservation (protected area) and 15% for production purposes. Therefore, the agencies concerned with this action should include the DNP in addition to the RFD.

(2) Prepare forest master plan and action plan

The DNP published the Master Plan on Climate Change in August 2009. This action had to be amended in order to comply with the current focus on the measures taken by the DNP.

<sup>33</sup> Based on the Meeting with OAE, 20 August, 2010

#### 4.3.5 REVISED POLICY MATRIX OF FORESTRY AS OF AUGUST 2010

Based on the discussion with concerned agencies, the actions under the same outcome of “Reduce GHG through forest conservation and restoration” were revised as follows.

**Table 4.3.5 Revised Policy Matrix (Mitigation: Forestry Sector) as of August 2010**

Action	Year1 2009/2010	Year2 2010/2011	Year3 2011/2012	Agency	Ministry
K4. Reduce GHG in key sectors					
O7 Reduce GHG through forest conservation and restoration					
Control of Open Burning	Implement Action Plan for Solving Problem of Forest Fire and Haze Year 2008-2011	Promote community participation in open burning control by capacity building, leader of change, awareness raising and support alternative livelihood.		PCD	MNRE
Increase the forest area to 40% of total land area by afforestation /reforestation, and green area by public participation	Conduct A/R of national reserved forest by Ordinary Thai Budget : 76,900 rai	Conduct A/R of reserved forest and Protected Forest Areas by 1) Ordinary Thai Budget: 19,500 rai 2) CCPL: 200,000 Rai	Conduct A/R for reserved forest and Protected Forest Areas by 1) Ordinary Thai Budget: 50,000 rai 2) CCPL: 200,000 Rai	RFD DNP	
	Provide forest-tree seedlings to public and farmers by Ordinary Thai Budget: 13.9 million. seedlings	Provide forest-tree seedlings to public and farmers by 1) Ordinary Thai Budget: 25.5 million seedlings 2) by CCPL: 151 million seedlings	Provide forest-tree seedlings to public and farmers by 1) Ordinary Thai Budget: 25.5 million seedlings 2) by CCPL: 151 million seedlings		
	Subsidize farmers to plant economic trees	Subsidize farmers to plant economic trees by 1) Ordinary Thai Budget: 0 rai 2) CCPL: 150,000 rai	Subsidize farmers to plant economic trees by 1) Ordinary Thai Budget: 50,000 rai 2) CCPL: 0 rai		
Enhance conservation activities on forest protected areas and launch REDD	Implement DNP Climate Change Master Plan	Enhance conservation activities		DNP	MNRE
	Draft REDD Preparation Plan	Complete REDD Preparation Plan	Conduct REDD Activities		
Capacity building to cope with Climate Change					
Capacity Building for DNP to Enhance Forest Conservation Action	Train the trainers for REDD-plus Monitor, Reportable and Verifiable Activities	Train the regional staff for REDD-plus Monitor, Reportable and Verifiable Activities	Train the regional staff for REDD-plus Monitor, Reportable and Verifiable Activities	DNP	MNRE
	Develop a network of warning system for the Monitoring and Surveillance Centre for Forest Encroachment and Forest Fire in Protected Areas	Train utilization and interpretation of GIS and satellite imagery for other 4 regional centres established in 2011	Train on utilization and interpretation of GIS and satellite imagery for another 4 regional centres established in 2012		
	Improve Forest Fire Management by Local community participation; train community personnel	Support & Establish Community Fire Suppression Units (CFSUs)	Supervise & Monitor the Implementation of the CFSUs		

(1) Control of open burning

The focus of the Open Burning was the forestry under this Key Strategy. The Action Plan for Solving the Problem of Forest Fire and Haze Year 2008-2011 was prepared by the PCD.

The current action focuses on the continued forest fires in the upper Northern part of Thailand. Forest fires are one of the main causes of deforestation. This is mainly observed as a slash and burn practices as well as land preparation by ethnic minorities and the poor living in the North. Since the cause of the forest fire is primary human activities, raising awareness of residents near the forest is prerequisite, followed by supporting alternative livelihoods.

The PCD is in the position to formulate the policies while local government authorities play a significant role to implement the policy. Reviewing the pilot projects executed in the Northern provinces, incentive mechanisms for residents are required for other regions.

(2) Increase the forest area to 40% of total land area by afforestation /reforestation, and green area by public participation

The growth of the afforestation /reforestation (A/R) area is stagnant in recent years as discussed in section 4.2.2(2), thus the RFD together with the DNP proposed three actions; Reforestation, Seedling, and Economically viable tree plantation, in order to expand the A/R activities beyond the area financed by the normal government budget. The annual actions are further described in the Annex 4-4. The first activity is A/R, and second one is providing seedlings in significant measures to expand the green area in the farmland and public area. The third one is provide farmers with economically viable trees which can be sold for alternative energy and wood products, in order to support other income source of farmers, and increase forest coverage. This was developed considering the fact that famers have little incentives to cooperate with the forestation policy. These three activities have been conducted under the normal budget. The RFD has been eager to expand these activities utilizing external funding source.

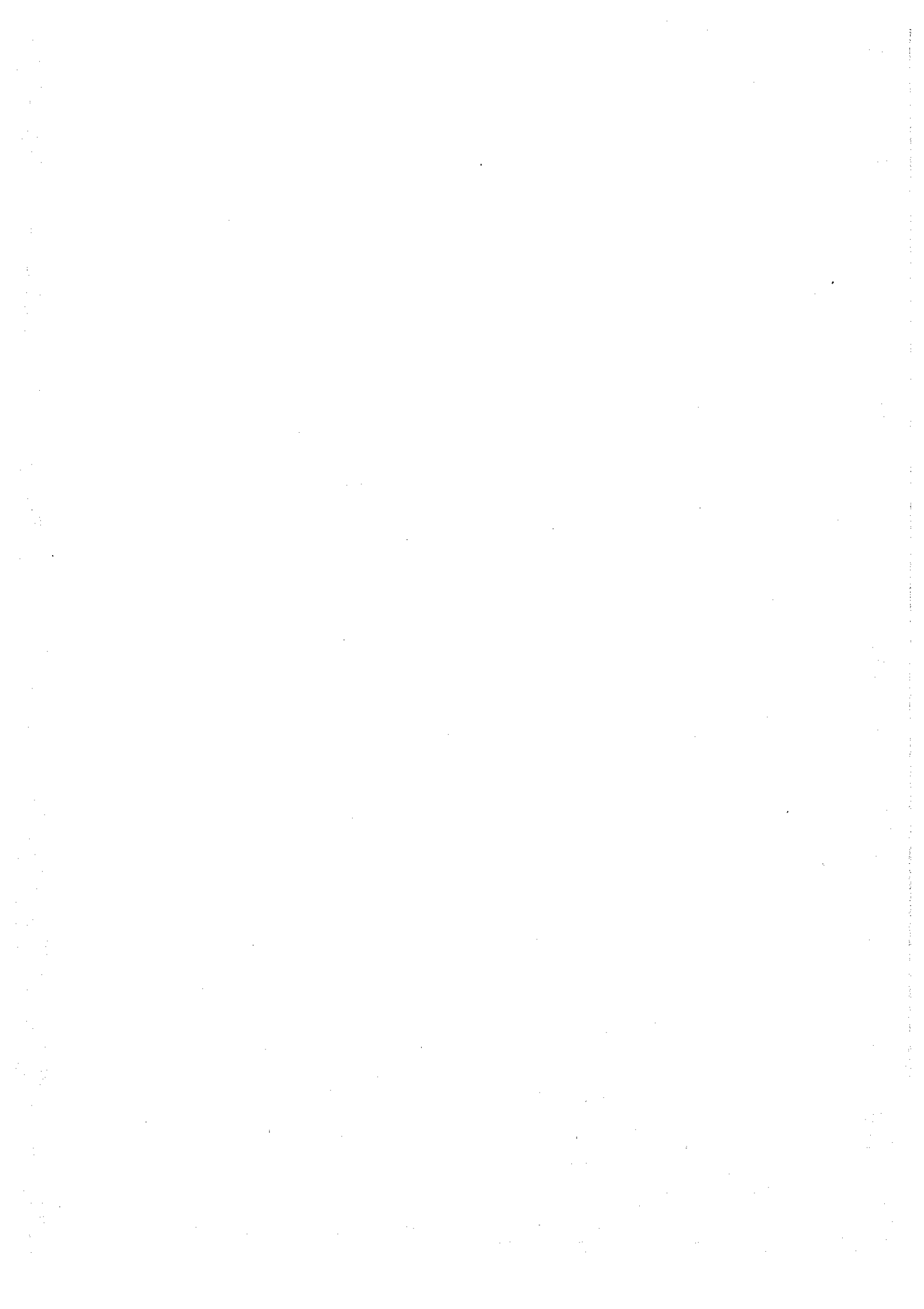
(3) Enhance conservation activities on forest protected areas and launch the REDD

The DNP requested to include the implementation of 1) the Master Plan 2) activities to launch the REDD (Reducing Emissions from Deforestation and forest Degradation). First, regarding the Master Plan, the contents shown in the Figure 4.2.1, corresponds to the National Climate Change Management Strategy and current functions of the DNP. Special focus is paid to enhance conservation activities from the second year.

Secondly, the DNP already developed the Readiness Plan Idea Note (R-PIN) in order to receive readiness funding from the World Bank, Forest Carbon Partnership Facility. However, the funding will support studies, but not their implementation. The DNP, thus, requires the further finance for activities identified during the study period. While preparing for the REDD activities, the DNP continue to enhance conservation activities described in the Climate Change Master Plan.

(4) Capacity building for the DNP to enhance forest conservation action

The DNP administers, conservation, promotion, strategy application and public awareness building are the focal point of the REDD. The REDD approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks are not well acknowledged among the local authorities. The activities under climate change are cross cutting issues which relate to interdisciplinary and many offices in both intra- and international. Therefore, personnel who are working on climate change issues should be knowledgeable on the current situation of climate change scenario in order to integrate their knowledge and cooperation to cope up with the changes to maximize the efficiency of conservation and forest ecosystem protection. Therefore, one of the priorities of the DNP is to provide sound knowledge of the REDD-plus among the relevant officials both in centre and local levels. Further, the DNP would like to enhance the network among stakeholders for monitoring and surveillance capacity to prevent forest encroachment and forest fires. Thirdly, the DNP added the improve forest fire management by local community participation. The DNP strongly believes it important to develop knowledge and capacities of local community personnel. Based on these three aspects, the DNP plans to implement the activities.



## 5. DISASTER PREVENTION AND WATER RESOURCE MANAGEMENT

### 5.1 THE SITUATION AND EXPECTED IMPACTS OF CLIMATE CHANGE IN THE DISASTER PREVENTION AND WATER RESOURCE MANAGEMENT

#### 5.1.1 THE SITUATION ON WATER RESOURCE MANAGEMENT AND NATURAL DISASTERS

The climate conditions in Thailand are influenced by the South Western and North Eastern monsoons. The South Western monsoon brings hot moist air, which usually means rain, from the Gulf of Thailand and Indian Ocean while the North Eastern monsoon brings cool dry air from China. For the past 30 years, the average rainfall in Thailand has been about 1,426 mm/year with a water volume reaching 732.975 million m<sup>3</sup>/year. Figure 5.1.1 shows the water cycle in Thailand.<sup>34</sup>

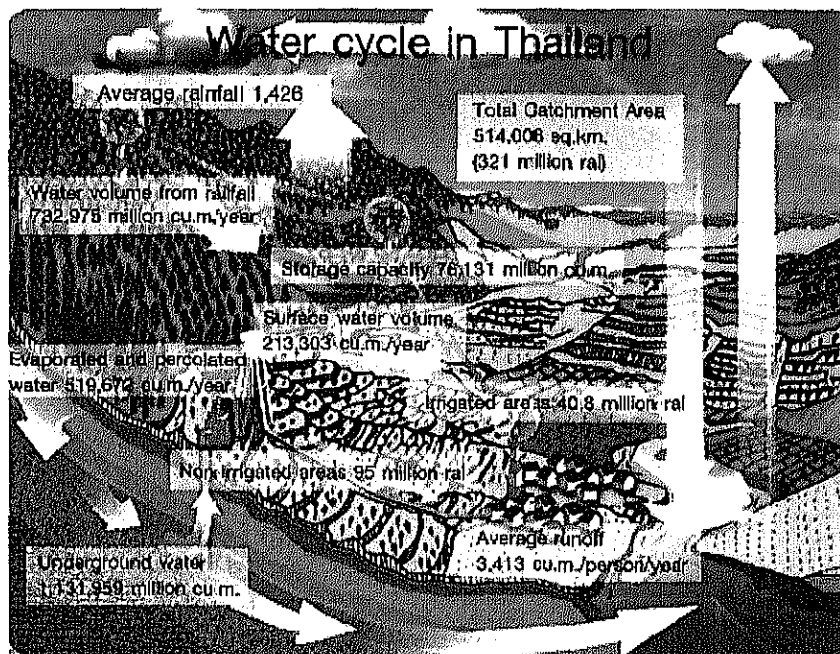


Figure 5.1.1 Water Cycle in Thailand

Source: "Role in Thailand's Water Management" DWR, 2010

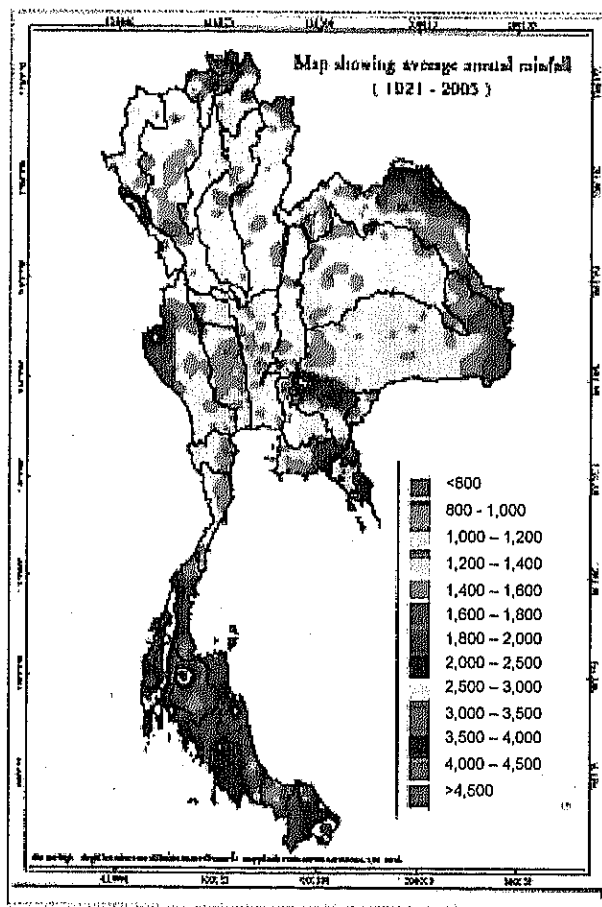
Figure 5.1.2. shows the annual rainfall measured at rainfall stations in major river basins, which indicate an average rainfall of 1,426 mm/year, with variations between stations range from 800 to 4,400 mm/year. The heaviest rains fall mainly in the Southern river basins, especially in the South Western river basins, where the average annual rainfall is more than 2,400 mm.

The total runoff from all the river basins in the country is 213,303 million cubic meters. Out of the total, 4.4% of the runoff flows into Salawin River, 30.5% into the Mekong River, 10.5%

<sup>34</sup> "Role in Thailand's Water Management" DWR, 2010

into the Andaman Sea and 54.6% into the Gulf of Thailand.

Water shortage is apparent mostly in Northeastern, Central and Eastern regions of the country. Water from Bhumipol and Sirikit reservoirs has been utilized to offset the shortage of water in the Central region, which resulted in a water shortage in the Northeastern region. Generally, in the Southern region, there is no serious water shortage; yet some river basins do experience water shortages because of the lack of a suitable water distribution system.<sup>35</sup>



**Figure 5.1.2 Average Annual Rainfall (1921 – 2005)**

Source: ditto

Table 5.1.1 and Table 5.1.2 show the current and future water balance by river basins compiled by the DWR. According to the DWR study<sup>36</sup>, “with a total runoff of 213,303 million cubic meters/year, the storage capacity of the present water storage structures is 76,131 million cubic meters (increased in year 2006) that could be utilized at an average of 45,434 million cubic meters/year.”

<sup>35</sup> ditto

<sup>36</sup> ditto



**Table 5.1.1 Water Balance for the River Basins in 2009**

Sub River Basin	Sq. km *1	Runoff Volume (mil cu.m/year)	Irrigated Area (rai)	Water Demand (million cu.m./year)			Water Shortage (million cu.m./year)		
				Agriculture	Others	Total	Agriculture	Others	Total
<b>Northem and Central River Basins</b>									
Salawin	19,103.52	9,401.18	243,517	228.97	17.28	244.25	25.09	0.00	25.09
Mekong (north)	10,027.93	3,718.85	525,472	813.78	40.20	853.98	39.58	0.00	39.58
Kok	7,300.42	3,630.11	525,858	459.64	33.61	493.25	18.21	0.00	18.21
Ping	34,536.87	9,043.77	2,612,912	4,603.56	158.83	4,762.19	648.16	0.00	648.16
Wang	10,793.23	1,582.24	644,729	608.48	41.36	649.84	49.36	0.00	49.36
Yom	24,046.87	3,965.16	1,464,884	1,675.97	132.91	1,808.88	516.60	55.00	571.60
Nan	34,682.07	12,199.63	2,510,295	3,032.65	70.65	3,103.30	68.18	0.00	68.18
Chao Phraya	20,523.39	1,774.31	5,593,020	7,787.60	1,704.23	9,491.83	479.17	0.00	479.17
Sakaekrang	4,906.52	1,203.29	639,098	585.85	18.99	604.84	226.78	0.00	226.78
Pasak	15,625.86	2,913.75	1,301,233	1,872.96	155.70	2,028.66	5.58	0.00	5.58
Tachin	13,477.13	1,395.44	2,668,620	4,952.97	174.22	5,137.19	444.44	0.00	444.44
<b>North Eastern River Basins</b>									
Mekong (north eastern)	47,146.18	24,583.35	2,232,116	1,999.92	188.33	2,188.25	183.75	0.00	183.75
Chi	49,131.93	11,948.34	2,834,477	3,715.91	485.67	4,211.58	367.66	0.00	367.66
Mun	71,059.91	18,972.48	3,320,215	4,177.14	416.90	4,594.04	708.64	0.00	708.64
<b>Eastern River Basins</b>									
Prachin Buri	9,651.36	4,986.04	626,478	471.33	149.17	620.50	12.20	0.00	12.20
Bangpakong	10,707.45	4,058.19	1,483,306	2,154.02	427.89	2,581.91	200.13	0.00	200.13
Taonle Sap	4,083.46	2,203.53	122,134	122.66	12.37	135.03	22.68	0.00	22.68
Eastern Coast	13,095.76	12,781.94	388,417	386.29	378.80	765.09	58.96	0.12	59.08
<b>Western River Basins</b>									
Maeklong	30,171.18	13,659.04	3,124,489	6,406.14	204.90	6,611.04	100.32	0.00	100.32
Petch Buri	6,254.43	1,548.20	631,722	850.90	58.47	909.37	8.94	0.00	8.94
Western Coast	7,097.29	1,952.64	683,369	534.84	71.32	606.16	30.02	0.85	30.87
<b>Eastern South River Basins</b>									
Eastern South	26,023.68	22,260.80	2,039,505	3,208.67	196.51	3,405.18	413.35	14.71	428.06
Tapae	13,454.40	13,026.66	289,535	180.04	111.87	291.91	0.94	0.00	0.94
Songkha Lake	8,484.26	5,426.99	1,045,209	198.50	153.41	351.91	58.15	0.00	58.15
Pattanee	3,684.17	2,670.00	138,460	177.57	19.35	196.92	1.50	0.00	1.50
<b>Western South River Basins</b>									
Western South	18,929.00	22,396.60	214,823	571.78	83.89	655.67	2.73	0.34	3.07
<b>TOTAL</b>	<b>514,008.27</b>	<b>213,302.53</b>	<b>37,903,891</b>	<b>51,786.14</b>	<b>5,516.63</b>	<b>57,302.77</b>	<b>4,691.12</b>	<b>71.02</b>	<b>4,762.14</b>

Source: ditto

**Table 5.1.2 Water Balance for the River Basins in 2025**

Sub River Basin	Sq. km *1	Runoff Volume (mil cu.m/year)	Irrigated Area (rai)	Water Demand (million cu.m./year)			Water Shortage (million cu.m./year)		
				Agriculture	Others	Total	Agriculture	Others	Total
<b>Northem and Central River Basins</b>									
Salawin	19,103.52	9,401.18	416,998	397.22	28.14	423.36	73.07	0.00	73.07
Mekong (north)	10,027.93	3,718.85	526,272	817.08	47.26	864.34	38.88	0.00	38.88
Kok	7,300.42	3,630.11	710,983	631.36	40.07	671.43	45.62	0.00	45.62
Ping	34,536.87	9,043.77	3,310,570	5,048.65	221.06	5,269.71	1,038.81	0.00	1,038.81
Wang	10,793.23	1,582.24	831,553	788.88	48.28	836.88	43.67	0.00	43.67
Yom	24,046.87	3,965.16	2,243,697	2,820.23	179.32	2,999.55	821.82	55.00	876.82
Nan	34,682.07	12,199.63	3,583,309	4,754.21	80.21	4,834.42	75.75	0.00	75.75
Chao Phraya	20,523.39	1,774.31	5,668,920	7,888.03	2,436.46	10,324.49	1,408.00	0.00	1,408.00
Sakaekrang	4,906.52	1,203.29	940,500	1,040.98	27.08	1,068.06	593.15	0.12	693.27
Pasak	15,625.86	2,913.75	1,588,245	2,379.80	227.57	2,607.37	58.28	0.00	58.28
Tachin	13,477.13	1,395.44	3,008,620	5,319.41	298.30	5,617.71	1,160.04	0.54	1,160.58
<b>North Eastern River Basins</b>									
Mekong (north eastern)	47,146.18	24,583.35	4,339,215	3,675.58	221.80	3,897.38	395.67	0.00	395.67
Chi	49,131.93	11,948.34	4,661,956	6,275.49	1,386.93	7,662.42	989.94	0.00	989.94
Mun	71,059.91	18,972.48	5,678,059	6,475.36	855.70	7,331.06	1,157.63	0.00	1,157.63
<b>Eastern River Basins</b>									
Prachin Buri	9,651.36	4,986.04	970,387	713.79	176.29	890.08	3.86	0.00	3.86
Bangpakong	10,707.45	4,058.19	1,707,123	2,432.72	503.24	2,935.96	222.73	0.00	222.73
Taonle Sap	4,083.46	2,203.53	240,227	220.35	25.17	245.52	22.47	0.00	22.47
Eastern Coast	13,095.76	12,781.94	1,179,460	1,288.17	789.60	2,077.77	68.87	141.53	210.40
<b>Western River Basins</b>									
Maeklong	30,171.18	13,659.04	4,694,222	7,646.89	220.91	7,867.80	610.34	0.00	610.34
Petch Buri	6,254.43	1,548.20	700,415	876.19	117.02	993.21	8.95	0.02	8.97
Western Coast	7,097.29	1,952.64	756,113	599.93	224.02	823.95	40.58	35.63	76.21
<b>Eastern South River Basins</b>									
Eastern South	26,023.68	22,260.80	2,792,773	4,308.98	352.35	4,661.33	0.40	0.01	0.41
Tapae	13,454.40	13,026.66	429,594	453.35	187.50	640.85	0.23	0.00	0.23
Songkha Lake	8,484.26	5,426.99	1,141,989	263.77	199.94	463.71	58.15	0.00	58.15
Pattanee	3,684.17	2,670.00	149,805	192.23	30.27	222.50	1.50	0.00	1.50
<b>Western South River Basins</b>									
Western South	18,929.00	22,396.60	506,138	1,008.92	121.50	1,130.42	11.29	0.01	11.30
<b>TOTAL</b>	<b>514,008.27</b>	<b>213,302.53</b>	<b>52,779,141</b>	<b>68,317.27</b>	<b>9,043.99</b>	<b>77,361.26</b>	<b>8,950.70</b>	<b>232.86</b>	<b>9,183.56</b>

Source: ditto \*1:Beneficiary Area

The current water demand is approximately 70,248 million cubic meters/year, including groundwater, which is categorized in four major groups:

- 1) Domestic 3.5% of the total demand
- 2) Industry and Tourism 3.4%
- 3) Agriculture and Electricity generation 75.5% and
- 4) Maintain ecosystem 17.6%.

For 2005, the total water shortage for the whole country was 12,456 million cubic meters, not including rainwater and side flow and is forecasted to be 12,566 to 33,982 million cubic meters in 2025, depending on the agricultural area to be developed and the increase in water demand for tourism and industry in the next 15 years.

Figure 5.1.3 shows the analysis of water balance in 2025, considering water shortage in 25 main river basins based on rainfall and side flow. The chart illustrates the available storage capacity and shortage for 2009 and forecasted three cases for year 2025. The current case exemplifies that water shortage in Thailand is about 4,762 million cubic meters per annum, which is mainly due to the water demand from the Agricultural Sector which requires at 4,691 million cubic meters per annum. The severe water shortage can be seen in the Northern and Central river basins and stands at 2,567 million cubic meters per annum. The water shortage for next 20 years will increase to 9,182 million cubic meters per annum, and for the worst case scenario, the Northern and Central river basins are predicted to have a shortage of 5,414 million cubic meters per annum.

- Case 1 shows if agricultural areas extend to 53 million rai (8.48 million ha).
- Case 2 shows if agricultural areas remain unchanged but water demand for consumption, tourism and industry increase.
- Case 3 shows if agricultural areas remain unchanged but other water demand increase, while water uses efficiency increases by 10%.

The highest water shortage for an individual river basin is predicted to be in the Chao Phraya River basin at 1,408 million cubic meters per annum, while there are no water shortages expected in the Pattani River Basin.<sup>37</sup>

Thailand has experienced flood damage more frequently and resulted in serious damages, i.e. more than 10 times in almost all provinces in the past 30 years. The most severe floods that Thailand experienced were in 1975, 1983, 1995, 2002, 2005 and 2006.<sup>38</sup>

According to the DWR, the damaged areas caused by flooding include 27.2 million rai (4.35 million ha) of agricultural areas and 6.8 million rai (1.09 million ha) of urban areas, this data was compiled from statistical data and satellite images from 1982 to the present. The DWR identified 65 cities as flood prone areas, which equates to about 845,625 rai (135,300 ha) in urban areas and 2.17 million rai (0.35 million ha) in rural areas. Figure 5.1.4 shows flash

---

<sup>37</sup> ditto

<sup>38</sup> ditto

flood and landslide prone areas identified by the DWR, and Figure 5.1.5 shows 2,370 flash flood and landslide prone high risk village areas.

Figure 5.1.6 shows the important commercial zones in flood prone areas in 32 cities. The damage to communities, agricultural land and public utilities caused by such floods and landslides from 1989 to 2001 were estimated to be 69,266 million THB annually.<sup>39</sup>

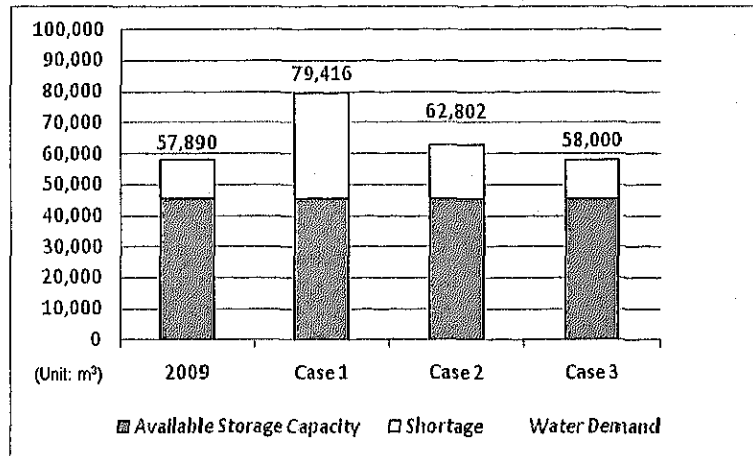


Figure 5.1.3 Water Storage at Present and Estimated Cases for 2025

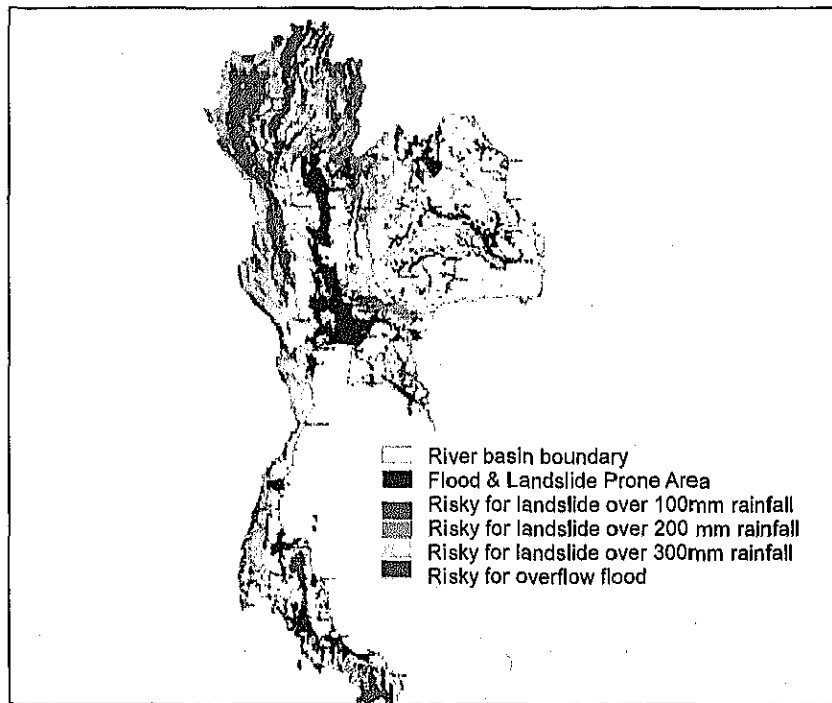


Figure 5.1.4 Flood and Landslide Prone Areas

Source : Figure 5.1.3 and 5.1.4 ditto

<sup>39</sup> ditto



### 5.1.2 PROBLEMS OF WATER RESOURCES MANAGEMENT IN THAILAND

The DWR points out three major problems in the “Role of Thailand’s Water Management” report for water resources management in Thailand<sup>40</sup>.

There is no unified policy or plan for water resources management.

Although a national vision and policies have been set up for the water resources management, there are no strategies and implementation plans at either national or local level that are acceptable and efficiently enforced.

Institutional structure and cooperation does not functioned effectively or efficiently.

Laws and regulations are not coherently structured, and there are a variety of water related laws and regulations. The different governmental authorities are intertwined with respect to their protocol approval and supervision structure. The DWR highlights the fact that there currently is no governing law or national water act and that some water related laws and regulations are obsolete, plus there is redundancy for the enforcement of the law.

Problems of database and knowledge base on water resources management.

Accumulated data and information are scattered in various agencies and conflicts on information reference is inevitable, and access to databases at other agencies is limited and quite difficult to obtain.

The Study Team also encountered the problems identified above, in particular, when the Team tried to collect the data about the long-term plan, i.e. master plan, mid to short-term plan and implementation or action plans. Besides that, respective agencies, dealing with flood and landslide, have their own countermeasure policies, based on their own data collection and analysis, i.e. those agencies appear not to have close cooperation to be able to discuss and produce an integrated database and analysis.

### 5.1.3 GUIDELINES IN NESDP<sup>41</sup> ON WATER RESOURCES MANAGEMENT

The government will continue its base policy on water resources management for the next five years, concentrating more on disaster prevention and on mitigation measures.<sup>42</sup>

- Watershed forests rehabilitating to become more fertile by constructing check dams and planting vetiver grass.
- Increase water storage capacity, proper water distribution in basins, transboundary water resources management, wetland rehabilitation, flood prevention in urban areas and so on.
- Develop forecasting and warning systems to prevent disaster caused by drought, flood and landslide.
- The mechanism and tools necessary to increase capacity of river basin organizations and

---

<sup>40</sup> ditto

<sup>41</sup> NESDP (2007-2011). The full text of NESDP was not available at the time of reporting, yet it is understood from the interview that core policies of water resources management will be kept in the succeeding NESDP.

<sup>42</sup> ditto

integrated water resources management are developed and provided.

### 1) Flood

Recently, Thailand has annually experienced flood and landslide which caused significant damage to the public and their properties. Table 5.1.3 shows the damages caused by flood from 2002 - 2008.

**Table 5.1.3 Damages Caused by Flood (2002 – 2008)**

Year	Number of Occurrence	Number of Province	Damage		
			Injured	Deaths	Damages (million THB)
2002	5	72	0	216	13,385.31
2003	17	66	10	44	2,050.26
2004	12	59	3	28	850.65
2005	12	63	0	75	5,982.28
2006	6	58	1,462	446	9,627.41
2007	13	54	17	36	1,687.86
2008	6	65	0	113	7,601.79

Source: "The National Disaster Prevention and Mitigation Plan (2010-2014)" (Draft), DDPM, 2010.

### 2) Landslide

In the past, landslide was not that much significant issue in Thailand; yet nowadays landslide has happened increasingly more frequently and resulted in severe problems. Table 5.1.4 shows the damages caused by major landslide since 1988.

**Table 5.1.4 Damages Caused by Landslide**

Year	Name of Province	Damage		
		Injured	Deaths	Damages (million THB)
Nov. 22, 1988	Nakhon Si Thammarat	n.a.	242	1,000
Sep. 11, 2000	Phetchabun	n.a.	10	n.a.
May 4, 2000	Phrae	n.a.	43	100
Aug. 11, 2001	Phetchabun	109	136	645
May 20, 2004	Tak	391	5	n.a.
May 23, 2006	Phrae and Uttaradit	n.a.	83	308

Source: ditto

### 3) Drought

It is a dry season from November to June in Thailand and during that period, there is less rainfall across the country. Water supplies from large dam water catchment and reservoirs are insufficient for the domestic and industrial usage, and also for agricultural activities, in particular the area without any irrigation systems. Drought is getting more serious damages recently as shown in Table 5.1.5.

**Table 5.1.5 Damages Caused by Drought (2002 - 2008)**

Year	Number of Affected Province	Damage		
		No. of Affected People	Damaged Agricultural Areas (rai)	Damages (million THB)
2002	66	12,841,110	2,071,560	508.78
2003	63	5,939,282	484,189	174.32
2004	64	8,388,728	1,480,209	190.66
2005	71	11,147,627	13,736,660	7,565.86
2006	61	11,862,358	578,753	495.27
2007	66	16,754,980	1,350,118	198.30
2008	61	3,531,570	524,999	103.90

Source: ditto

## **5.2 STRATEGIES, POLICIES AND WORK PLANS FOR CLIMATE CHANGE IN THE DISASTER PREVENTION AND WATER RESOURCE MANAGEMENT**

### **5.2.1 NATIONAL DISASTER PREVENTION AND MITIGATION FRAMEWORK**

It is crucial that disaster prevention and mitigation framework, organizational structure, and demarcation of responsibility are clearly established at the national, provincial and local government levels. According to the "National Master Plan for Disaster Prevention and Mitigation," disaster-related data and information collection, warning and communication systems, responsibility structure and agencies, evacuation guideline, emergency response, rehabilitation and reconstruction are structured by the central government, as the DDPM being the main actor to coordinate with other central government agencies.

Disaster prevention and mitigation in Thailand was mainly based on Civil Defense Act of 1979 and the Civil Defense Plan 2002, followed by National Master Plan for Disaster Prevention and Mitigation in 2009. After October 2002, the Government of Thailand has enacted the Bureaucrat Reform Act 2002, and at that time Department of Disaster Prevention and Mitigation (DDPM) was established under the umbrella of Ministry of Interior and has been designated to shoulder the responsibility of disaster management of the country and thus, replaced the former Civil Defense Division as the National Civil Defense Committee Secretariat.<sup>43</sup> The master plan was enacted in November 2009, and is expected to be reviewed and updated every five years. The master plan contains goals, methodologies, indicators and so on by phase by phase for all disasters, which defined by the DDPM.

The DDPM has 18 regional offices and 75 provincial centers, and broadcasts disaster prevention information and warnings to those centers. After 2004 Indian Ocean earthquake and Tsunami, the government enacted the Disaster Prevention and Mitigation Act in November 2007. The prime ministry or an appointed deputy prime minister will be assigned as commander of national disaster prevention and mitigation activity, and the DDPM will run the operation of preparedness, prevention and rehabilitation activities, and will provide

<sup>43</sup> "Country Profile" DDPM, 2010.

necessary supports to provincial and local governments.

According to the master plan, there are 14 disasters defined, including human-made disasters, as target for national prevention and mitigation activities. Among them, eight disasters are derived from natural causes. The DDPM has already set up the master plan and a framework for each disaster; yet, it has not formulated any kind of detailed action plan. Although there are some physical construction, like dikes and related disaster prevention infrastructure construction at disaster preparedness phase, there is no detailed construction action plan and performance measurement indicator.

[Definition of Disaster]

In accordance with the National Master Plan for Disaster Prevention and Mitigation (DDPM) of 2009, a disaster is an occurrence that causes distress or destruction and these causes are; fire, storm, strong winds, floods, droughts, epidemics in humans, animals, aquaculture and plants, and other natural or man-made disasters, accidents or incidents that effect to human life, body or the property of the people, so in this regards, air threats and sabotages are also disasters.

[Type of Disaster]

- 1) Flood and landslide
- 2) Cyclone (typhoon)
- 3) Fire
- 4) Chemical and hazardous material
- 5) Transportation
- 6) Drought
- 7) Cold Weather
- 8) Forest fire and smoke
- 9) Earthquake and building collapse
- 10) Tsunami
- 11) Epidemic in human
- 12) Disease, bugs, animals and pests dispersion
- 13) Epidemic in animals and aquaculture
- 14) Information Technology

(Source: National Master Plan for Disaster Prevention and Mitigation, DDPM)

As for preparedness and preventive measures, the master plan describes following issues;

1. formulate disaster prevention and mitigation plan for all levels from national to community levels,
2. develop a hazard map,
3. install forecast and alert system,
4. set up and install forecast and warning facilities,
5. practice/preliminary drill disaster prevention and mitigation plan at all levels,
6. form and enhance the capacity of disaster management volunteers,



7. develop information system,
8. develop volunteer units,
9. strengthen local preparedness for disaster prevention and management,
10. prepare necessary facilities and equipment, and
11. prepare evacuation shelters.

It should be pointed out, however, that there is no explicit description about the development of physical infrastructure, such as dike, check dam, dredging and reservoir in the master plan.

Each provincial office of the DDPM formulates a provincial prevention and mitigation master plan under authority of the Governor. One of issues of the master plan at the provincial, as well as local government levels, is that a hazard map of flood and landslide is not attached, at most cases, to the master plan, so that it is obviously shows that the master plan and countermeasures are not prioritized by the hazard level or by prioritized areas. As for the local government level, the provincial disaster prevention and mitigation master plan serves to substitute for the local government one, or local governments are given self-initiative to prepare of it. The provincial governments are responsible for providing advice and/or technical support to local governments under its jurisdiction.

Regarding to the disaster prevention and mitigation master plan of sub-district, it is known that only some sub-district in Chiang Mai and Lamphun, where flood has occurred frequently, have formulated such master plan already, and overall picture of the preparedness of such master plan at sub-district level could not be captured during this study period.

Other than above master plans, "Strategic National Action Plan for Disaster Risk Reduction (SNAP)," enacted at the national assembly in March 2009, was formulated with the technical assistance from Asian Disaster Reduction Center (ADRC) and financial support from United Nations International Strategy for Disaster Reduction (UNISDR), and its target year period is from 2010 to 2019.

## **5.2.2 IMPLEMENTATION LEVEL OF MEASURES TOWARD CLIMATE CHANGE**

### **(1) Existing meteorological observation system for disaster management**

#### **1) Thai Meteorological Department (TMD)**

The Study Team visited the TMD to confirm about basic meteorological information collection system, regarding wind and water related natural disaster occurrence, in particular focusing on wind and flood damage, rainfall data and cyclone. The Study Team also reviewed whether scientific data collection, process and analysis systems were sufficiently functioning for the forecast of natural disasters.

The TMD has its headquarter in Bangkok, four regional centers and 120 metrological observation stations in total which includes 71 meteorological observation centers, 33 meteorological observation points exclusive for agriculture and 16 hydraulic observation stations. It applies the World Meteorological Organization (WMO) standard and conducts

meteorological observation and data collection every 3 hours. As for upper-air observation, the TMD collects data using balloon and radio observation at its 11 observation stations. In addition to 11 ground observation posts, there are 22 posts, which have radar observation facilities, to collect and analyze more accurate weather forecast. The radar observation is also utilized to forecast for heavy rain along with ground observation posts.

Regarding to a flood forecast and alarm system, the TMD carries out rainfall observation and water level monitoring at 12 major river basins throughout the country, and collects data from the network of 161 telemetering systems.

Traditionally, the TMD uses distributed image data from meteorological satellite and then analyze it for weather forecast, but now it is building a communication station for meteorological satellite to obtain the image data directly.

The TMD has enough capabilities to collect, compile and put the data in database system. According to the discussion, the TMD would like to send its staff to JICA training programs for enhancing the data analysis, interpretation of satellite image, and evaluation. In addition, great interest is shown on radar observation system, automation of ground observation system and other state of art technology on equipment and facilities.

## 2) GISTDA (Geo-Informatics and Space Technology Development Agency)

After consolidating remote sensing center and other governmental agencies, the GISTDA was established under Ministry of Science and Technology in November 2000. It collects satellite data images and processes them, develops applied systems, and provides image data service to other governmental agencies and the private sectors. The GISTDA has around 300 staff and its annual budget is about 3 billion THB. It has corresponding system at ground station and purchases satellite image from SPOT, Landsat, Radarsat, NOAA, ALOS, MOS, JERS and IKONS<sup>44</sup>, which resolutions are from 13 m to 3.6 m. The GISTDA has cooperated and contracted with the countries which launched those satellites, so that Thailand can obtain satellite image of Thailand and surrounding Indochina areas.

Thailand has two own satellites with the French technology, launched two years ago. The satellites are called THEOS and have four channel data communication equipments with 2 m black and white image, and 15 m multi image resolution. They are used to collect image data for environmental change, soil shading, forest fire hot spot, open burning, coastal erosion and flood occurrence monitoring. In the future, it is expected to use them to monitor damage from drought. THEOS image data costs about 7,000 THB per sheet, which is quite reasonable amount compared to other satellite image data.

## (2) Disaster source and disaster information

It is important to identify accurate location of disaster source, in order to, not only plan effective and noticeable disaster mitigation measures, but also decide the priority of investment for disaster mitigation. The Study Team has reviewed and comprehended the

---

<sup>44</sup> SPOT, Landsat, Radarsat, NOAA, ALOS, MOS, JERS and IKONS are the names of satellite or of product.

situations of natural disasters by regions, after conducting a series of hearing from the DDPM, the RID and MONRE, and collected information about disasters and statistical data.

#### 1) National Disaster Warning Center (NDWC)

National Disaster Warning Center was established in 2006. Its main task is to set off alarms for Tsunami, collect information, set buoys and maintain them. NDWC has set alarm towers to coastal region, mainly in Indian Ocean side of the Peninsula, and is planning to set more towers inland of coastal areas, so they can be used to warn for flood. It also conducts evacuation trainings to the communities residing along the coastal areas.

#### 2) Warning system (RID & DWR)

The RID has more than 1,000 water level monitoring stations throughout the country, and its telemetering devices send the data every 15 minutes to its provincial offices and the headquarter in Bangkok. Along the Chao Phraya River, there are 50 automated telemetering stations and the collected data is transferred to the head office every 15 minutes. All provincial offices collect and process the data and then send these data to the head office at 7 a.m. every morning. The head office has a regular meeting at 8:30 am to evaluate the collected data and sets off a warning, if it is necessary. It is planned to expand and to upgrade the observation system and to continue the process of upgrading telemetering system.

The DWR conducts water level and rainfall monitoring in non-agricultural areas, mainly mountainous areas. The data is collected every 15 minutes, and sent to the head office of the DWR. The head office processes the data and informs the result to local governments, if the situations are crucial. In 2008, the DWR warned to local governments and communities 64 times. It has 20 local centers and its target villages for water level and rainfall monitoring are 2,370 villages, where the risk of flood is considerably high. A warning system was installed at 204 locations so far, and will be installed 306 more warning systems to the selected villages. Although the DWR is planning to build the telemetering system in 5 km radius, since the water basins that the DWR monitors is relatively small and the slope is steep, it is suggested to install more telemetering observation stations to enhance the accuracy and degree of density of the monitoring areas.

The RID was established about 100 years ago, while the DWR was established 6 years ago, so it does not have enough experience like the RID yet. Although one of their objectives is to carry out countermeasures against flood disaster, the coverage areas are slightly different, so that they conduct the countermeasures respectively. It is suggested, thus, to integrated their facilities and operation, in order to get maximum efficiency and effectiveness in the forecast and warning system, and also review the coverage areas to minimize the overlap.

#### 3) Community Based Disaster Risk Management (CBDRM)

According to the DDPM, the number of communities which have high risk for flood and are susceptible to landslide is about 20,000 communities throughout the country. The DDPM analyzes the risk for flood disaster, and carries out the CBDRM activities in communities. After 2004 Indian Ocean earthquake and tsunami, the CBDRM has been given more attention

and emphasis as a tool for the preparedness, prevention and mitigation for natural disasters. The CBDRM is not only deployed to coastal areas, but also to flood and landslide-prone areas.

JICA has been supporting the governmental agencies in Thailand to enhance their disaster prevention capacity. One of the projects being carried out at the DDPM, "The Project for Capacity Development in Disaster Management in Thailand," is already in the second phase, which main components are to 1) review disaster prevention and mitigation master plans prepared by national, provincial and local governments, 2) support CBDRM activities, 3) support disaster drills and 4) support disaster prevention and mitigation education. The main focus of JICA is to enhance the capacity of disaster prevention and mitigation, so that it conducts capacity development for the staff at the DDPM. As for the CBDRM, the emphasis is to educate facilitators and personnel who can conduct disaster drills at communities. DDPM is planning to deploy CBDRM to 360 communities every year.

Regarding to disaster prevention measures, it is necessary to consider about the construction of physical infrastructure like check dam and dike; yet, considering cost effectiveness, such a huge investment could not be the first choice. In that case, one of the solutions is to educate the people at the community level, where flood and landslide disasters are prevailing, and enhance the awareness of disaster management, evacuation procedure, emergency response and preparedness of disaster management equipment. (See Figure 5.1.5).

#### 4) Development of hazard map

The TMD collects and analyzes rainfall, meteorological data, and water level of major rivers throughout the country. Four governmental agencies, the TMD, DDPM, RID and DWR, are responsible for giving forecast and alarm to the public. Their covering areas and objectives are slightly different from each other; yet, it does not necessary mean that they do not have overlap on their functions. At present, each governmental agency has its own forecast and warning system. According to the discussion, the RID is the only agency which does not make flood hazard map; however, it already started technical review for making a flood disaster hazard map, which is similar to the one that Ministry of Land, Infrastructure, Transport and Tourism in Japan made.

The DWR covers the disasters of flood and landslide in non-agricultural areas, in particular, mountainous areas. The DWR has installed river observation systems in 598 villages and has made hazard maps with the communities. By 2009, the map of 232 villages are made, and is planning to cover 1,540 villages from year 2010 to 2012, and its final target is to cover all 2,370 villages, where the DWR named them as high risk villages for flood and landslide.

The DWR already has macro-level hazard maps covering the entire country. The maps, made with GIS application, have attributes of slope grade, soil texture, land-use, and so on. The DWR combines those data and produced various maps like landslide disaster, flood-prone lowland and water shortage area maps.

It also has mudslide and landslide hazard maps, using 1/50,000 topographical maps as base map and overlapping the 1/250,000 scale-size hazard maps made by the provincial

governments. Out of 51 mudslide and landslide-prone provinces in Northern Thailand, 31 provinces have already completed making such hazard maps and the remaining 20 provinces are going to complete the maps within 2 years.

[Responsible agencies for making hazard maps by disaster type]

- Flood and mudslide: DDPM and DWR
- Landslide: DMR and LDD
- Earthquake: DMR, LDD, DDPM and technical assistance from universities
- Tsunami: DDPM
- Others: earthquake/Tsunami – National Disaster Warning Center (monitoring and data accumulation), risk map development – DDPM

#### 5) Disaster Prevention and Mitigation Academy (DPMA)

DPMA was established in 2004 to educate the personnel for disaster prevention and mitigation and it has 6 training centers. At the training centers, the personnel from fire department, provincial and local governments join the trainings. About 3,500 to 7,500 people annually have undergone the training since 2005.

#### (3) Disaster prevention and mitigation measures in Bangkok metropolitan administration

The biggest challenge is how to implement disaster prevention and mitigation measures in the Bangkok Metropolitan Area. Bangkok, which encompasses the mouth of the Chao Phraya River, is located in the low flat delta terrain. Flood protection and sea level rise and saltwater intrusion due to flooding of the Chao Phraya River caused by climate change agenda are the major issues to be studied. The RID has been implementing the flood control of Chao Phraya River for a long time, and has also built dikes. However, the occurrence of heavy rain in the recent years, the rapid change of socioeconomic conditions and land use have resulted in the more complicated disaster causes. It is necessary, thus, to review the planning criteria and the overall operation of the disaster management and flood warnings systems in the Bangkok Metropolitan Area.

In addition, considering the topographical conditions of Bangkok, the city is the most susceptible to the effects of sea level rise due to abnormal rainfall during the monsoon season and sea level rise due to low pressure. If the impact of sea level rise is taken into account to above mentioned situations, it is expected to have big flood along the Chao Phraya River. In addition, the area below sea level has been identified in the 1980s and it appears to be due to subsidence. It is assumed that subsidence has gone along, so that how to prepare flood disaster countermeasures will be the significant challenge for the Bangkok Metropolitan Administration (BMA).

It is suggested to study about the measures for preventing inundation damages from flooding and sea level rise by combining various measures effectively, such as strengthening river dike along the Chao Phraya River, imparting embankment function to arterial roads, improving main drainage canal and drainage facilities capacities, and constructing tide embankment.

### 5.2.3 PLANNING AND BUDGETING FOR DISASTER PREVENTION AND MITIGATION

Budget sources to finance the plan and measures illustrated in the “National Disaster Prevention and Mitigation Plan B.E. 2553 – 2557 (2010-2014)” are summarized as followings<sup>45</sup>:

1. General Account Budget: Government agencies responsible for disaster prevention and mitigation shall request annual budget for operations as assigned to them in the national master plan. The policy and strategy in the national master plan are broken down into programs and projects, which will ultimately be part of four year implementation plans.
2. Geographically Deliberated Budget: The budget from provincial and local governments allocated for disaster prevention and mitigation activities. The budget source could be from development budget and local administrative budget items.
3. Emergency Appropriation for Disaster Victims: The budget to provide relief assistance to disaster victims, in order to alleviate immediate difficulties right after the disasters.
4. Central Budget Items: These budget items are allocated for the rehabilitation and reconstruction of losses and damages caused by disasters, like reconstruction of infrastructure.

Table 5.2.1 shows the budget of the RID in the next three years. The RID does not have budget exclusive for climate change, so the budget below simply shows their general development budget.

---

<sup>45</sup> “The National Disaster Prevention and Mitigation Plan B.E. 2553-2557 (2010-2014)” (Draft). DDPM, 2009

**Table 5.2.1 The Budget of the RID**

Production/ Project	No.	Budget on Fiscal Year (million THB)			
		2011	2012	2013	2014-end
1. Production: Irrigated Water Management	39	700.6080	476.4857	96.0000	-
2. Production: Survey of new water resources and increase the Irrigated Area	71	3,205.2550	3,239.0922	1,166.5796	-
3. Production: Support Royal Development Projects	1	97.6461	-	-	-
4. Production: Prevention & Mitigation of Water Disaster	41	1,742.9210	314.0098	237.8220	-
5. Project: Sri-yat Canal Project	3	314.0098	40.1119	-	-
6. Project: The Royal Project, Kaey Noi Dam, Nakornnayok Province	2	293.0535	83.1113	-	-
7. Project: Kew Koh Ma Project, Lumpang Prov.	3	174.0299	69.0983	-	-
8. Project: Water Diversion Project from Chao Praya east river basin to Bang Pra Reservoir	3	1,295.8533	1,880.5212	1,248.3819	-
9. Project: Water Diversion Project from Chantaburi Province to Reservoir in rayong	3	1,054.6461	1,534.4860	1,016.0102	-
10. Project: Tapee - Pumduang River Basin Development, Suratthani Province	2	358.0161	478.6848	477.3351	-
11. Project: Project of mitigation of flood disaster in Chantaburi Province (plan phase 2)	3	666.9083	891.6888	889.1779	-
12. Project: Project of Pha Juk irrigated dam, Utaradit Province	2	181.2957	338.6304	338.6304	336.6097
13. Project: Project of Klong Luang Reservoir, Chonburi Province	2	245.6138	328.3980	327.4732	-
14. Project: The Royal Project, Huay Samomg , Prajinburi Province	2	419.1900	587.2332	587.3223	1,169.7936
<b>TOTAL</b>	<b>177</b>	<b>10,749.047</b>	<b>10,261.552</b>	<b>6,384.6435</b>	<b>1,506.403</b>

Source: RID

#### 5.2.4 PLAN AND DIRECTION FOR DISASTER PREVENTION AND MITIGATION

“The National Disaster Prevention and Mitigation Plan” demonstrates policy and management direction for the disaster prevention and mitigation administration, which function as a framework for future operations. The prominent policies are summarized as followings<sup>46</sup>:

- 1) Focus on proactive approach to prevent the disasters, in order to minimize potential losses
- 2) Focus on a participatory approach and encourage the participation from all parties concerned to the disaster administration
- 3) Focus on administrative unity
- 4) Focus on community preparedness building through community based disaster risk administration

<sup>46</sup> ditto

- 5) Focus on efficient warning system at both the community and the national levels
- 6) Focus on efficient communication systems
- 7) Focus on the development of human resources
- 8) Focus on the establishment of volunteer systems to provide certain assistance to the operation of the disaster management
- 9) Focus on creating networks by coordinating with foreign agencies in terms of technology transfer and joint training
- 10) Focus on learning from lessons by studying disaster occurrences in the past

It is pointed out, however, in the master plan that there are general shortages in the fields of research on disasters, guidelines for disaster administration and capable personnel, and demarcation of roles and responsibilities among governmental agencies should be clearly defined and the cooperation among those agencies should be further fostered.

The master plan also illustrates the disaster measures, not climate change exclusive though, in four strategies, which comprise of 31 measures and 132 main activities.

Strategy 1 – Prevention and Mitigation; is to adjust disaster management system in order that public officers will have necessary capacities to deal with the disasters, defined in the master plan. This strategy comprises of 8 measures and 56 major activities.

Strategy 2 – Preparedness; is to develop plans of action to manage and counter their risks and take action to build the necessary capabilities needed to implement such plans and to create a certain system to deal with possible disasters and to lessen public officers' burdens during and after the disasters. This strategy comprises of 9 measures and 37 major activities.

Strategy 3 – Emergency Response; is to mobilize the necessary emergency services and first responders in the disaster area. This strategy comprises of 6 measures and 19 major activities.

Strategy 4 – Rehabilitation and Reconstruction; is to provide assistance promptly and effectively to disaster affected persons. This strategy comprises of 8 measures and 20 major activities.

## **5.3 BACKGROUND FOR THE POLICY MATRIX CONTENTS ON DISASTER PREVENTION AND WATER RESOURCE MANAGEMENT**

### **5.3.1 REVIEW OF THE POLICY MATRIX AS OF JUNE 2010**

Table 5.3.1 shows the policy matrix as of June 2010 for the disaster prevention and water resource management sector. The appropriateness of each action is assessed in this section.



**Table 5.3.1 Draft Policy Matrix (Disaster Prevention and Water Resource Management Sector) as of June 2010**

Outcome	Action	Year1 2009/2010	Year2 2010/2011	Year3 2011/2012	Agency	Ministry
<b>K1 Enhance Agriculture Sector</b>						
O2. Improve water resource management	Enhancement of water level monitoring system: to upgrade 555 stations (8)	Implementation of upgrade program	Implementation of upgrade program	Implementation of upgrade program	RID	MOAC
	Drainage system improvement (9)	Revise M/P, updated implementation program	Implementation of updated program	Implementation of updated program	RID	MOAC
<b>K2 Prevent Natural Disaster</b>						
O3. Enhance disaster prevention capacity	Prepare Disaster prevention Master Plan & Action Plan (29)	Master Plan approved by Cabinet in Nov. 2009	Prepare Action Plan to each risk; implement action plans	Prepare Action Plan to each risk; implement action plans	DDPM	MOInt
O3. Enhance disaster prevention capacity	Implement disaster prevention program supported by JICA (2010-2014)(New)	Implementation of the program	Implementation of the program	Implementation of the program	DDPM	MOInt
	Development of Community Based Disaster Risk Management: CBDRM (28)	Disseminate to 4699 villages	Disseminate to 4699 villages	Disseminate to 4699 villages	DDPM	MOInt
	Enhancement of water level monitoring system (30)	Water level monitoring system: 27 points installed	Water level monitoring system: 100 points to be installed	Water level monitoring system: 100 points to be installed	DWR	MNRE
	Enhancement of water level telemetering system (32)	41 stations improved	to improve approximately 160 stations	to improve approximately 160 stations	DWR	MNRE
	Enhancement of flood warning system (38)	2,370 villages under risk, 592 vil. Installed. 4th ph. on-going	5th ph. to be implemented	to increase no. villages with flood warning system	DWR	MNRE

\* The number indicates reference No. of the original long list initially assessed by JICA.

### 5.3.2 REVISED POLICY MATRIX AS OF AUGUST 2010

After a series of discussion with related agencies, the draft policy matrix was slightly revised and some similar actions were combined into one action. However, the actions, which were similar in their activities, but are to be implemented by different agencies were not combined, since the respective agencies have different policy objectives to conduct such actions, and it was agreed by JICA not to merge actions proposed by separate agencies.

A new action, "soil and water conservation measures in abandon agriculture areas, critical soil loss area and landslide risk areas" was added to the outcome O2 "improve water resource management," under the key strategy K.1, "enhance agriculture sector."

The actions proposed by the RID, which are both about the enhancement of telemetering system, were combined into one action, "enhancement of telemetering rain-gauge stations, and telemetering system for monitoring and forecasting water situation for flood warning," due mainly to limit the number of the actions under outcome O3, suggested by the ONEP.

**Table 5.3.2 Revised Policy Matrix (Disaster Prevention and Water Resource Management Sector) as of September 2010**

Outcome	Action	Year1 2009/2010	Year2 2010/2011	Year3 2011/2012	Agency	Ministry
<b>K1 Enhance Agriculture Sector</b>						
O2. Improve water resource and watershed management	Irrigation and Drainage system improvement (9)	Irrigation improvement project (6 projects) Land consolidation in one province	Irrigation improvement project (6 projects) Land consolidation projects in 8 provinces	Irrigation improvement project (6 projects) Land consolidation projects in 4 provinces	RID	MOAC
	Enhancement of telemetering system for Monitoring Water Situation for Water Management	Integrated telemetering system for monitoring water situation in Chao Phraya River Basin	Integrated telemetering system for monitoring water situation in Chee-Mun River Basin	Integrated telemetering system for monitoring water situation in Bang-prakong River Basin	RID	MOAC
	Soil and water conservation measures in abandon agricultural areas, critical soil loss areas and Landslide areas	Review the pilot projects	Implement measure in the target areas (160,000 rai or 25,600 ha)	Implement measure in the target areas (160,000 rai or 25,600 ha)	LDD	MOAC
<b>K2 Prevent Natural Disaster</b>						
O3. Enhance disaster prevention capacity	Prepare Disaster prevention Master Plan & Action Plan (29)	Master Plan approved by Cabinet in Nov. 2009	Prepare Action Plan for each risk; implement action plans	Prepare Action Plan for each risk; implement action plans	DDPM	MOInt
	Implement disaster prevention program supported by JICA (2010-2014)(New)	Implementation of the program: 1) Disaster management Planning, 2) CBDRM model project, 3) Disaster management training, 4) Disaster education	Implementation of the program: 1) Disaster management Planning, 2) CBDRM model project, 3) Disaster management training, 4) Disaster education	Implementation of the program: 1) Disaster management Planning, 2) CBDRM model project, 3) Disaster management training, 4) Disaster education	DDPM	MOInt
	Development of Community Based Disaster Risk Management: CBDRM (28)	Implementation of CBDRM program for 360 communities.	Implementation of CBDRM program for 360 communities.	Implementation of CBDRM program for 360 communities.	DDPM	MOInt

Outcome	Action	Year1 2009/2010	Year2 2010/2011	Year3 2011/2012	Agency	Ministry
	Enhancement of water level monitoring and Telemetering System (30)	Water level monitoring system: 27 points installed, CCTV: 41 points installed	Water level monitoring system: 80 points to be installed, CCTV: 50 points installed	Water level monitoring system: 80 points to be installed, CCTV: 50 points installed	DWR	MNRE
	Enhancement of water level monitoring system: to upgrade 555 stations (8)	Implementation of upgrade 370 stations.	Implementation of upgrade 185 stations.		RID	MOAC
	Enhancement of telemetering rain-gauge stations / telemetering system for monitoring and forecasting water situation for flood warning	[Telemetering rain-gauge] Preparation for the implementation  [Telemetering system] Upgrade 80 systems	[Telemetering rain-gauge] Upgrade 400 stations  [Telemetering system] Upgrade 200 systems	[Telemetering rain-gauge] Upgrade 400 stations  [Telemetering system] Upgrade 200 systems	RID	MOAC
	Enhancement of flood warning system (38)	Flood Warning System: 204 points Installed	Flood Warning System: 306 points Installed		DWR	MNRE

(1) Irrigation and drainage system improvement

This action includes activities to 1) develop new irrigation areas, 2) increase the water capacity by increasing the capacity of existing reservoirs, i.e. physical expansion and dredging, increasing the potential of natural reservoirs and develop new water resources, 3) promote environmentally sound drainage system. It also includes improvement of existing check dams and water reservoirs, i.e. increasing the height of dike and dam ridge and adjusting water-overflow structure.

The RID conducted irrigation improvement projects in Maharakam province in year 2010 and plan to carry out in Lopburi, Nakonsawan, Chainat, Khonkean, Buriaram, Supanburi, Petchburi and Nhonkhai provinces in year 2011, and Singburi, Angton, Chainat and Saraburi provinces in year 2012.

(2) Enhancement of telemetering system for monitoring water situation for water management

The RID initially proposed this action as “Enhancement of telemetering system for monitoring water situation in reservoir for water management,” but when it submitted the revised PMx to the Study Team, the target of the action proposed was not exclusively for reservoirs, but for river basin which cover mainly the resources for agricultural activities, so that the term “reservoir” was deleted from the title of the action for corrections.

The action includes the activities to integrate and upgrade to automatically data collection system from manual system for monitoring water situation in river basins. The target river

basins are Chao Phraya River basin in year 2010, Chee-Mun River basin in year 2011, and Bangprakong River basin in year 2012.

- (3) Soil and water conservation measures in abandon agriculture area, critical soil loss area and landslide risk area

Based on the master plan on climate change mitigation, formulated by the MOAC and the LDD which identified two major activities against climate change, i.e. research and development activities. The proposed action is identified in “soil and water conservation measures” under soil carbon sequestration of the research activity.

The LDD started the action in 2008 with its own budget, as a pilot project, yet this year, 2010, the agency could not secure the budget for the action, so there is no activity for this year; therefore, the LDD expects the Ministry of Finance will allocate the necessary budget after the Government of Thailand receives the TH-CCPL from Japan. The action proposed by the LDD is based on the expectation of receiving the necessary budget from the Ministry of Finance, i.e. it does not have budgetary foundation or a plan to conduct the action next year, unless an additional budget is allocated from the TH-CCPL.

The main reason that this action is categorized under the key strategy K1 Enhance Agriculture Sector is that the main target lands for soil and water conservation is in agricultural areas, which include critical soil loss and landslide risk areas. According to the hearing from the LDD, the target areas are different from those of the DWR and the RID.

Since the LDD does not have enough budget to implement the pilot project this year, it has been reviewing the pilot project conducted in the last two years and expects to implement the pilot project in five provinces next year, totaling 160,000 rai (25,600 ha), in which 50,000 rai (8,000 ha) is abandoned agriculture areas, 60,000 rai (9,600 ha) is critical soil loss areas and another 50,000 rai (8,000 ha) is allocated for landslide risk areas.

- (4) Prepare disaster prevention master plan and action plan

The National Master Plan for Disaster Prevention and Mitigation was approved by the parliament of Thailand in November 2009, and local governments are now preparing their own territorial master plan for disaster prevention and mitigation. As for the 75 provinces, they are supposed to complete their master plans by the end of 2010, these master plans will be reviewed by the DDPM to complete the master plans. At this moment, several provinces have already completed their master plans and submitted them to the DDPM, and as a part of the technical cooperation project, the following action in the policy matrix “implement disaster prevention program supported by JICA (2010-2014), the project team dispatched from JICA will assist in its review process and provide technical assistance.

The national master plan consists of 28 chapters and 3 annexes, which covers almost all conceivable disasters, not only natural, but also nature-derived and man-made disasters. There are 14 disasters defined in the master plan, of these the ones which are due to climate change related natural disasters are:

- 1) flood and landslide
- 2) cyclone (typhoon)
- 3) drought
- 4) cold weather
- 5) fire and haze
- 6) tsunami and somehow to a certain degree
- 7) disease, bugs animals and pest dispersion

Local governments under the provincial governments are also expected to prepare their own master and action plans for disaster prevention and mitigation, so it is expected that disaster prevention plans and activities will be gradually spread to the public.

Along with the disaster master plans prepared by local governments, it is also crucial for them to prepare detailed specified and effective measures for the prevention of natural disaster risks, i.e. flooding, landslide, earthquake, tsunami, forest fire and so on. for the next step, it is necessary to prepare detailed action plans dealing with each natural disaster, i.e. breakdown of the above mentioned master and action plans.

As mentioned above, the government, at all levels, endorses and solidly fosters the formulation of the master plan for disaster prevention and mitigation, so that the action in the policy matrix is one of the crucial issues and it is imperative that the associated activities be conducted in the next few years.

(5) Implementation disaster prevention program supported by JICA (2010-2014)

After 2004 Indian Ocean earthquake and tsunami, JICA has supported the government of Thailand to reinforce its capacity for disaster prevention measures through various manners. At present, the project for capacity development in disaster management in Thailand (phase-2) started in May 2010 and under the implementation with the DDPM, as the main counterpart agency. The main components are:

- 1) to support disaster management planning
- 2) to support Community Based Disaster Risk Management (CBDRM)
- 3) to conduct disaster management training and
- 4) to support the implementation of disaster education activities, targeting the public.

The program will be conducted for four years, until 2014, and it has a mutually complementary relationship with the CBDRM conducted solely by the DDPM. Through the JICA program, it is expected that facilitators, who will be working in communities will be trained and the necessary technical knowledge/information transfers will be made during the implementation of a model project for the CBDRM.

(6) Development of Community Based Disaster Risk Management (CBDRM)

The DDPM started the CBDRM project in 2002 and has implemented its program to 5,189 communities up to 2010. The DDPM plans to conduct the CBDRM to 360 communities every year until it covers all communities, there are about 20,000 communities, under the risk

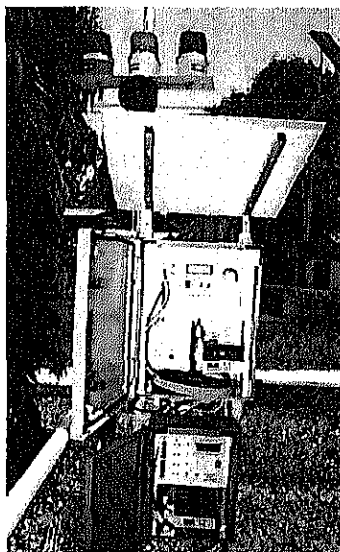
of disaster, which the DDPM has identified based on its own criteria. The annual budget for the program is about 7 million THB and at this moment the DDPM does not have a plan to increase the number of communities to be covered annually, because of a limited number of suitable personnel to be able to conduct the activities.

(7) Enhancement of water level monitoring and telemetering system

The DWR is mainly responsible for mountainous and hillside areas, where an irrigation system cannot be developed and for rather small river systems, which need water resource management and natural disaster prevention measures for local residents. In particular, the DWR is responsible for the preventive measures for landslide in mountainous areas and issuing forecasts and warnings against disasters to the public.

Although the DWR has invested heavily on water level monitoring and telemetering systems so far and announced flooding and landslide warnings, not only are there too many mountainous areas to be covered by the agency, but also the scales of watersheds are relatively small and the geographical conditions are harsh, so that its effective data collection and networking are not sufficient for building a comprehensive warning system structure.

The proposed action is to installed telemetering and water level monitoring systems to 160 monitoring points in total. In addition to that, it has planned to install 100 CCTV to the monitoring points. Telemetering system is for metrology, hydrology and water quality as well as acts as a real time data collection system. As a consequence, the data collection will be upgraded to the centralized control system, so that the time for identifying disaster risk areas and issuing the warning to those areas will be shorten. It is also expected that mathematical models for water resources will be developed by utilizing the automatically collected data, and could be adopted to use as the tool for water resources management, surveillance, forecasting and provide warnings against floods and landslides. Accordingly, due to early evacuation instructions, the public can prepare against disasters earlier than before, so that this action will directly affect the public's life, and it is important for it to be included in the policy matrix.



**Figure 5.3.1 Telemetering and Warning System Installed in Village**

Source: "Role in Thailand's Water Management" DWR, 2010

(8) Enhancement of water level monitoring systems to upgrade 555 stations

The main objective of this action is to upgrade the monitoring system of the water level for the 25 major river basins and 254 sub-basins, which the RID is responsible for, by digitalizing the system, i.e. provide automatic data collection and transfer to the data center.

Although it was under the key strategy of “K1 Enhance Agriculture Sector” in the policy matrix formulated in June 2010, the target areas of the monitoring system is for the river basins of the plain land and its main objective is to monitor the water level for forecasting flooding, so it was agreed with the RID, that it is more appropriate to categorize it under “K2 Prevent Natural Disaster.”

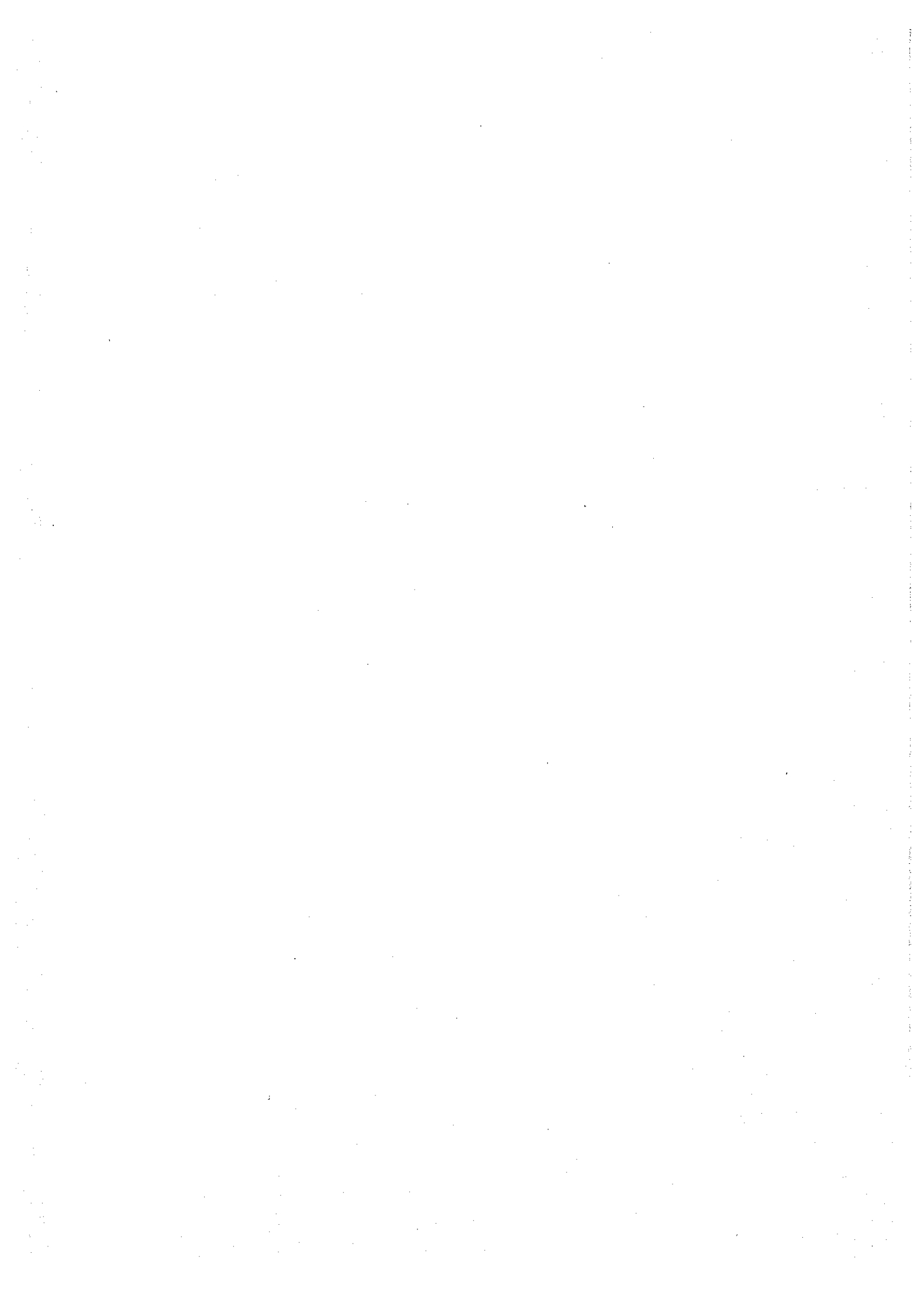
According to the hearing from the RID, 370 stations have already been upgraded, i.e. automated data collection and data transfer to a central repository, it also plans to upgrade 185 stations in 2011. After upgrading 185 stations, all the stations under the RID will be completely upgraded, so the action will be completed by next year.

(9) Enhancement of telemetering rain-gauge stations, and telemetering system for monitoring and forecasting water situation for flood warning

Since two actions proposed previously have almost the same components, it was proposed by the ONEP after discussion with the RID and the Study Team to combine two actions into one. The action proposed by the RID is to upgrade current manual data collection system into automatically gauge rain precipitation system at its observation stations in main 25 river basins and their subsidiary streams, while the upgrade of the telemetering system for monitoring and forecasting water situations, which target stations are not necessary overlapping with the observation stations for the rain-gauge stations, so that although two activities are put under one action, there are two separate implementations under different budget sources .

(10) Enhancement of flood warning system

The DWR has 20 local centers and its target villages for water level and rainfall monitoring are 2,370 villages, where the risk of flood is considerably high. A warning system was installed at 204 locations so far, and will be installed 306 more warning system to the selected villages. Telemetering and water level data are collected every 15 minutes and automatically sent to the central repository, located in the DWR building in Bangkok, and then the data is analyzed to determine the degree of risk for flooding. Once it reaches an alerting level, the DWR is responsible for issuing a warning to the related local governments and the communities. The current flood warning system does not cover all areas that the DWR is responsible for, so that it is planned to establish 306 monitoring points in the next two years. It is vital to install automatic flood warning systems to uncovered areas and reinforce its warning capability to the public.





## 6. COASTAL EROSION

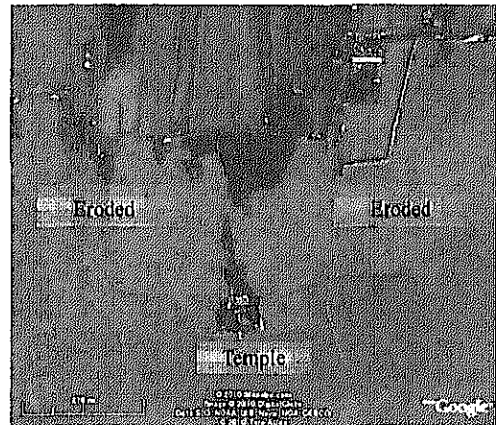
### 6.1 VULNERABILITY OF COASTAL AREA

#### 6.1.1 EROSION AND CAUSES

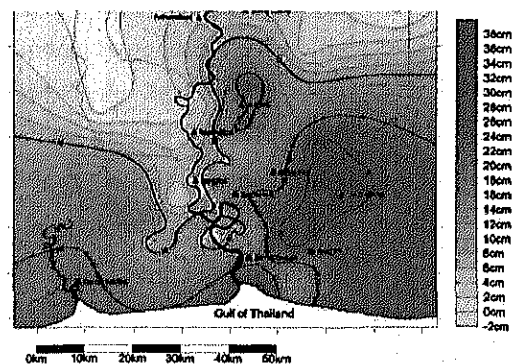
Thailand has a coastline approximately 2,730 km long, (excluding its islands). The majority of its coastline is located either adjacent to the Andaman Sea or the Gulf of Thailand. However, its coast has varied characteristics, with many sections of Thai coast rapidly being eroded. 570 km of coastline are being eroded at a rate of greater than 1 m/year, with 200 km of coastline at the rate of greater than 5 m/year. For an instance, the Southern Thai Gulf coast is in a typhoon zone which in recent years, has eroded nearly 100 m of land in just a few days. The coast of Chao Phraya delta is also being severely eroded. Topography of the hinterland is extremely low and flat which makes it vulnerable to future sea level rises. However, the cause of erosion is not rising sea level, but it is thought to be caused by other reasons. The followings are the major causes of erosion of Thai coast.

#### (1) Decrease of run off sand/silt supply from rivers

The Northern Thai coast used to receive sand/silt supply from the Chao Phraya River. But after Dams such as the Bhumibol Dam and the Sirikit Dam were built, sediment of the river is trapped in the reservoirs. In addition to that, excavation from river is a major cause for the decrease in the sediment supply. There is major dredging at downstream of Ayutthaya, and, presumably the most influential activity of coastal erosion is dredging for the navigation channel from river mouth to the Bangkok port, almost 40 km in length. Sand/silt, 5,000,000 m<sup>3</sup>/year, which is supposed to arrive at the coast, are dredged from the river and dumped at offshore area. The photo shows a temple on the West bank of the Chao Phraya River mouth, the surrounding area is being eroded and now sea water surrounds it during high tide.



Source: Google earth



Source: UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific)

#### (2) Land subsidence

Another cause of the coastal erosion at the Northern Gulf of Thailand is land subsidence of the area caused by excessive groundwater extraction. The figure shows land subsidence occurred during a period of eight years (1992-2000). There are coastal areas subsiding more than 20 cm during that period.

(3) Changes in land use

Once abundant mangrove forests along the Northern Gulf of Thailand were transformed to aquiculture ponds, the wave dissipating function of the shore was lost together with mangrove. As a result, the same grade of waves can now penetrate deeper inland, especially at high tide together with a low pressure climate. Development of unused coastal areas for industries and residential

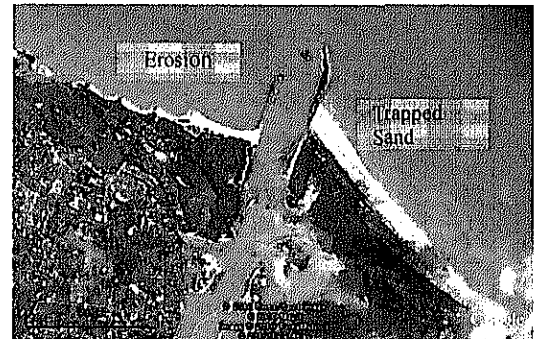


Source: Google earth

purposes increase the flood prone areas on its own without the need of other influences. The increasing in the number of vulnerable places along coastal areas is not due to change in natural conditions, but could be a man-made phenomenon for many areas.

(4) Cutting off of littoral drift by man-made structures

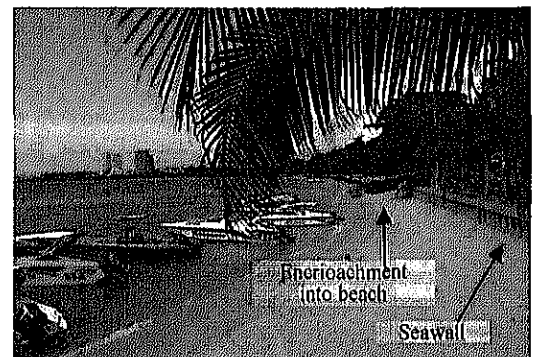
Jetty, breakwater, port, and land reclamation cut off littoral drift. Sand is accreted on the upstream side of the structure; and at the same time, the downstream side is eroded. Coastal erosion occurred after a large reclamation land project was undertaken in Rayong province on the Eastern Gulf of Thailand. The residents are now preparing court case, because they believe the erosion was totally manmade. The aerial photo shows the eroded beach of Narathiwat Province. The training wall of river mouth stopped the sand flow, and erosion occurred on the downstream side (left) due to a reduction of sand supply from upstream side.



Source: Google earth

(5) Development of tourism such as vertical seawall

Highly valuable beaches for tourism are often dwindled by the encroachment of commercial facilities or land use. A seawall is constructed in front of a road, park or commercial facilities for protection frequently; however, the seawall reflects the wave energy directly back towards the sea with sand, and can eventually excavate beach. Right photo shows encroachment of facilities into the beach, and a vertical seawall in Pattaya.



Source: Google earth Panoramio

Coastal erosion of Thailand is shown in Table 6.1.1 and Figure 6.1.1 Rapid erosion is obvious at the Northern and Southern Coast.

Table 6.1.1 Progress of Erosion

Province	Over 5m/yr			1-5m/yr			Total			Existing Coastal Protection Structure			Coast Length (km)
	Eroded Distance (km)	No. of eroded coast	Eroded Distance (km)	No. of Location	Distance (km)	Eroded Coast Range	No. of Location	Covered (km)	No. of Location	Structure Type			
										No. of Location	Structure Type		
1. Ranong	4.0	1	23.5	7	27.5	31%	8	0.0	0	-	-	89	
2. Phangnga	0.0	0	28.5	9	28.5	13%	9	2.0	1	Seawall	Seawall	222	
3. Phuket	3.0	1	1.5	1	4.5	3%	2	1.0	1	Seawall, sand nourishment	Seawall, sand nourishment	162	
4. Krabi	6.0	4	11.0	5	17.0	7%	9	2.0	1	Seawall (rock, concrete)	Seawall (rock, concrete)	234	
5. Trang	4.0	1	18.5	6	22.5	20%	7	-	-	Seawall (rock, concrete)	Seawall (rock, concrete)	114	
6. Satun	6.0	4	9.0	5	15.0	10%	9	-	-	Seawall (rock, concrete)	Seawall (rock, concrete)	148	
7. Narathiwat	25.2	3	16.0	3	41.2	74%	6	22.5	2	Groin, detached breakwater	Groin, detached breakwater	56	
8. Pattani	11.0	5	12.5	3	23.5	24%	8	3.5	3	Groin, seawall	Groin, seawall	99	
9. Songkhla	4.0	1	38.5	10	42.5	27%	11	2.5	1	Rock embankment, groin, detached breakwater	Rock embankment, groin, detached breakwater	155	
10. Nakhom Si Thammarat	60.0	3	52.0	6	112.0	59%	9	6.0	4	Rock embankment, groin, detached breakwater	Rock embankment, groin, detached breakwater	189	
11. Surat Thani	8.0	1	14.8	6	22.8	17%	7	-	-	Seawall	Seawall	138	
12. Chumphon	0.0	0	16.8	10	16.8	8%	10	1.5	2	Seawall	Seawall	215	
13. Prachuap Khiri Khan	1.0	1	42.0	16	43.0	21%	17	7.7	6	Seawall, detached breakwater	Seawall, detached breakwater	208	
14. Phetchaburi	6.5	2	30.0	6	36.5	43%	8	11.5	7	Seawall, detached breakwater, groin	Seawall, detached breakwater, groin	85	
15. Samut Songkhro	0.0	0	6.5	1	6.5	28%	1	1.0	1	Seawall	Seawall	23	
16. Samut Sakhon	0.0	0	6.5	1	6.5	17%	1	1.0	1	Seawall, detached breakwater	Seawall, detached breakwater	39	
17. Bangkok	5.5	1	0.0	0	5.5	100%	1	0.0	0	-	-	5.5	
18. Samut Prakan	30.0	2	0.0	0	30.0	61%	2	-	-	Seawall	Seawall	49	
19. Chachoengsao	9.0	1	0.0	0	9.0	69%	1	0.0	0	-	-	13	
20. Choburi	0.0	0	10.4	5	10.4	7%	5	4.5	2	Seawall, groin, detached breakwater	Seawall, groin, detached breakwater	152	
21. Rayong	4.7	1	21.1	9	25.8	25%	10	15.0	6	Seawall, detached breakwater, groin	Seawall, detached breakwater, groin	103	
22. Chantaburi	16.0	1	3.0	2	19.0	26%	3	3.0	2	Seawall	Seawall	72	
23. Trat	0.0	0	9.8	8	9.8	6%	8	1.4	3	Seawall	Seawall	160	

Andaman Coast
Southern Gulf
Middle Gulf
Upper Gulf
Eastern Gulf

Source: Action Plan for Integrated Coastal Erosion Prevention and Mitigation Management (DMCR)

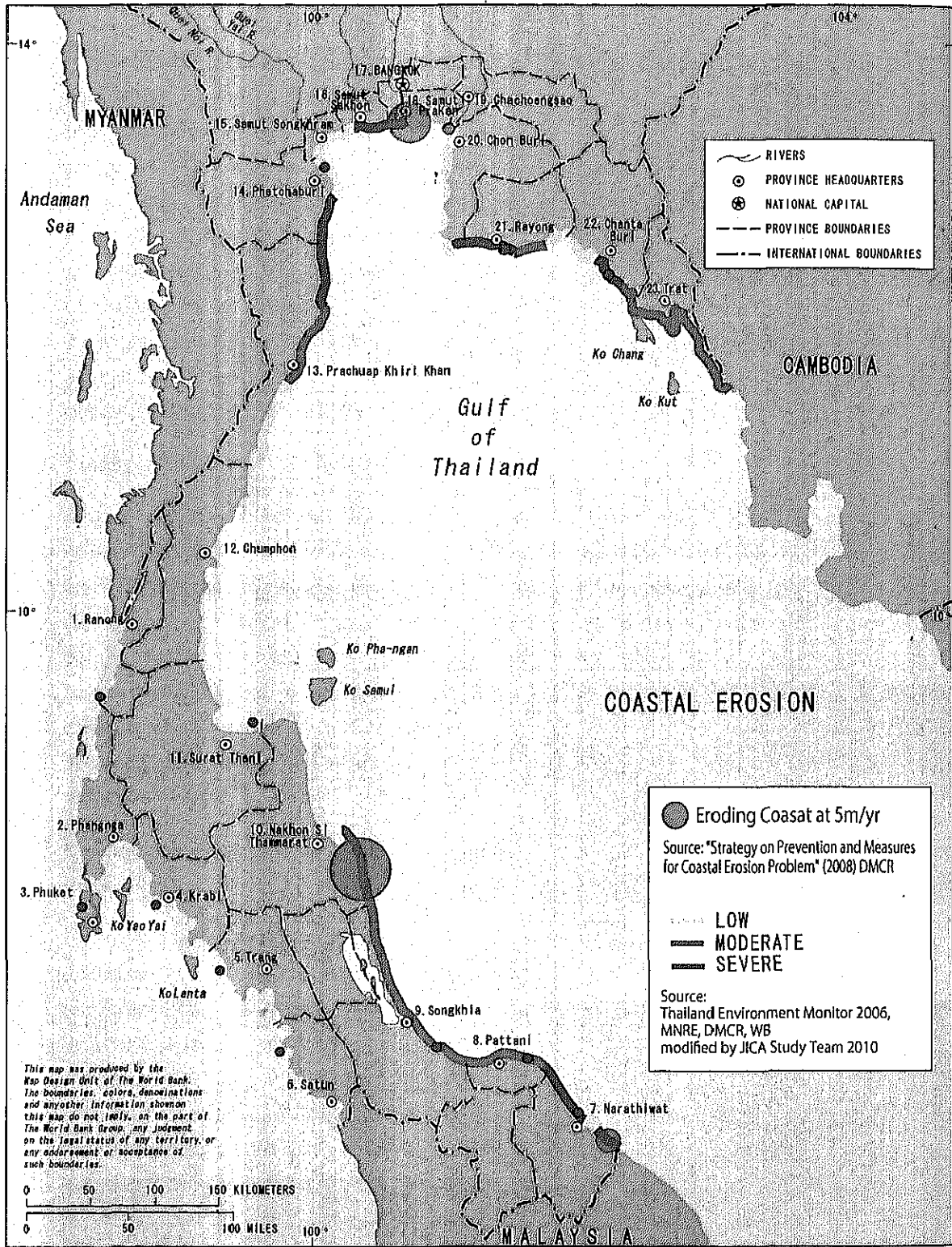


Figure 6.1.1 Location of Eroding Coast

Source : Thailand Environment Monitor 2006 (WB-DMCR); Action Plan for Integrated Coastal Erosion Prevention and Mitigation Management 2008 (DMCR), Modified by JICA Study Team 2010

## 6.1.2 IMPACTS OF COASTAL EROSION AND SEA LEVEL RISE

The expected impacts of climate change along the Thai coastal line are follows.

- 1) Coastal erosion caused by greater waves due to sea level rise and stronger typhoon (impacts on residential area, infrastructures such as road, industries, agriculture, fishery, tourism)
- 2) Flooding of hinterland by sea level rise (Figure 6.1.2, Table 6.1.2)
- 3) Salt intrusion into ground water by sea level rise.
- 4) Degradation of biodiversity, caused by the decreasing of natural shoreline by increasing coastal protection works.
- 5) Degradation of tourism resources, such as the breaching of coral reefs, and the ecosystem surrounding it.

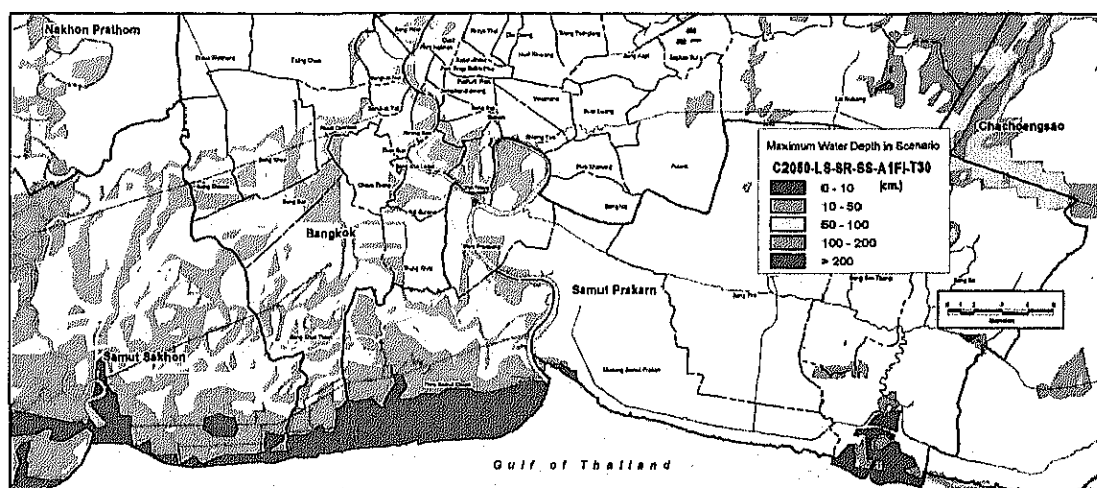


Figure 6.1.2 Prediction of Inundation at Hinterland of Northern Thai Gulf Coast

Source: Options and Strategies in Bangkok, S M Wahid, WB Bangkok CC study, AIT

Table 6.1.2 Applied Sea Level Rise to Prediction (Hatched Yellow)

Case	Flood protection structure	Land Subsidence	Sea Level Rise	SS	Flood scale from Precipitation at Return Period (Year)		
1.	C2008	-	-	-	10	30	100
2.	C2050	Applied	-	-	10	30	100
3.	C2050	Applied	+0.29m (A1FI)	-	10	30	100
4.	C2050	Applied	+0.19m (B1)	-	10	30	100
5.	C2050	Applied	+0.29m (A1FI)	+0.61m	10	30	100
6.	C2050	Applied	+0.19m (B1)	+0.61m	10	30	100

C2008 : Existing flood protection structure

C2050 : Planned flood protection structure by the year 2050

A1FI : Temperature up 1.9°C, precipitation increases 3%, and sea level rises 0.29 m. (from JBIC)

B1 : Temperature increases 1.2°C, precipitation increases 2%, and sea level rises 0.19 m. (from JBIC)

SS : Storm surge: + 0.61 m (Estimated by Watana, 2005) on the crown of the maximum sea level

Source: Options and Strategies in Bangkok, S M Wahid, WB Bangkok CC study, AIT

## 6.2 STRATEGIES, POLICIES AND WORK PLANS FOR CLIMATE CHANGE IN COASTAL EROSION

### 6.2.1 ACTION PLAN FOR COASTAL EROSION

Department of Marine and Coastal Resources (DMCR) proclaimed policy of coastal management in "Action Plan for Integrated Coastal Erosion Prevention and Mitigation Management 2008". The followings are the summary.

#### **Principal 1 : To create database of coastal line for formulation of coastal management plan**

##### 1) Action

- Creation of land morphology database by collecting of present and past erosion data
- Creation of database for coastal disasters of the hinterland in field of economic, social, environment
- Revising the database

##### 2) Subject area

- All the coast of Thailand

##### 3) Related agencies

- DMCR, Department of Mineral Resources (DMR), Ministry of Defense (MD), Department of Public Works and Town & Country Planning (DPT), Local, Geo-Informatics and Space Technology Development Agency (GISTDA), Hydrographic Department, Royal Thai Survey Department (RTSD), Office of Natural Resources and Environmental Policy and Planning (ONEP), The Thailand Research Fund (TRF), National Research Council of Thailand (NRCT), Bureau of Budget (BB)

#### **Principal 2: Promotion of public participation for formulation of coastal management plan for erosion control**

##### 1) Action

- Awareness of knowledge of coastal erosion and providing opportunities for public participation
- Capacity buildings of officials and development of organizations in the responsible agencies

##### 2) Subject area

- All the coast of Thailand

##### 3) Related agencies

- DMCR, DMR, MD, DPT, Local, Department of Environmental Quality Promotion

(DEQP), Ministry of Education (MOE), Ministry of Tourism and Sports (MOTS), DNP, NRCT, TRF, BB

**Principal 3: Formulation of Integrated Coastal Zone Management and strategy of coastal conservation master plan in each area**

1) Action

- Providing information to all stakeholders, and participation for decision making for the common goal
- Formulation of Integrated Coastal Zone Management and design for coastal protection works in areas that require emergency remedies

2) Subject area

- All the coast of Thailand
- Area which need emergency remedies

3) Related agencies

- DMCR, ONEP, DMR, MD, DPT, Local, PNEO, Regional Environment Office (REO), BB, Office of Nation Economic and Social Development Board (NESDB), Department of Water Resources (DWR), Department of Groundwater Resources (DGR), Ministry of Interior (MOI), Department of Fishery (DOF), Royal Forest Department (RFD), MOTS, Department of National Parks, Wildlife and Plant Conservation (DNP), NRCT, TRF

**Principal 4: Securing hinterland, and implementation of measures against coastal erosion**

1) Action

- To identify particular cause of erosion in an area, and selection of counter erosion measures in accord with the characteristics of the environment
- To formulate measures with participation of residents in the hinterland and related organizations, and the formulation of the implementation plan
- Implementation of recovery measures for the natural environment in eroded coast or utilization of the coast.
- Implementation of measures for decreasing coastal disaster's, risks and transforming the hinterland to a disaster resilient area.

2) Subject area

- All the coast of Thailand
- Areas which need emergency remedies
- Prone area for coastal disasters

3) Related agencies

- DMCR, DMR, MD, DPT, Local, ONEP, PNEO, REO, BB, NESDB, MOTS, DOE, RFD, MOI, TRF

**Principal 5: To Establish a system to manage, supervise, evaluate coastal management projects**

1) Action

- Implementation of emergency remedies under present law and also the amendment of operation guideline
- Implementation of strategic coastal management and formulation of evaluation method for the remedies for future erosion predicted by observation and verification.

2) Subject area

- All the coast of Thailand

3) Related agencies

- DMCR, Provincial Statistical Offices (PSO). of MNRE, ONEP, DMR, MD, DPT, BB, NESDB, MOTS

## 6.2.2 REMEDIES TAKEN FOR COASTAL EROSION

Coastal protection measures implemented in Thailand so far are as follows.

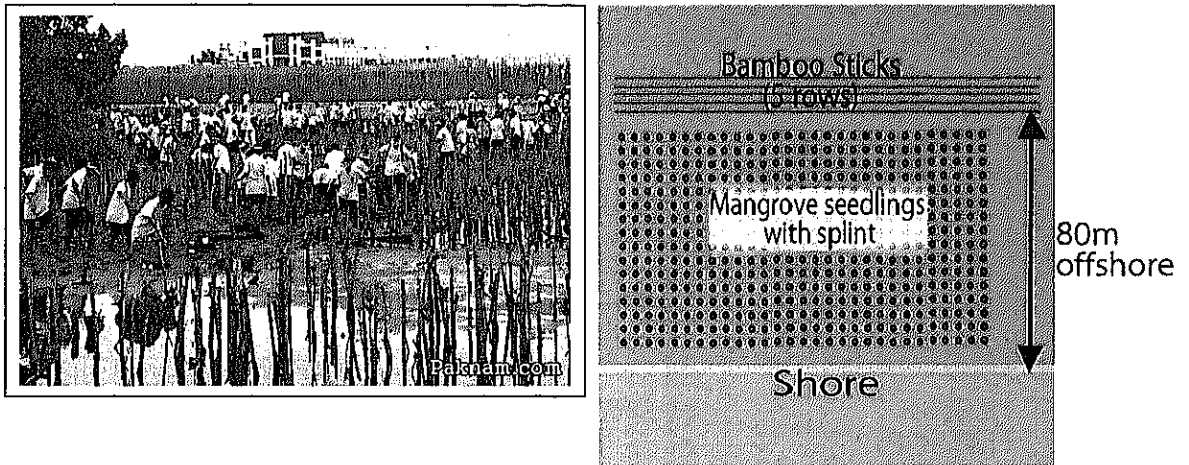
(1) Database formulation

DMCR has produced database of coral and sea grass for all the Thai coast in 2009. According to DMCR, it is planning to modify their database to include mangrove and to indicate the present status of coastal erosion together with the changes. In addition to that, land use planning of all the provinces along the coast are being formulated and will also be incorporated into their database. Land use planning of Prachuap Khiri Khan, Phetchaburi, Samut Songkhram, Samut Sakhon, Chachoengsao, Chonburi Provinces have been done already. DNP is also making database of mangrove and important biologic species in protected area.

(2) Mangrove plantation

DMCR and other organizations are planting mangroves enthusiastically. Mangrove forest is recognized as being an effective means for the prevention/reduction of coastal erosion at mudflat in the Northern Gulf of Thailand. The plantation is being conducted by participation of local residents and provincial government of Chachoengsao, Samut Prakan, Samut Sakhorn, Samut Songkhram provinces.





**Figure 6.2.1 Mangrove Plantation Conducted by communities in Samut Prakan Province**

Source: Paknam.com (Left photo), JICA Study Team 2010 (Right figure)

DMCR is operating mangrove seedling production center in each of the Northern Gulf provinces, and it supplies the seedlings and, at the same time, offering technical assistance for the mangrove plantations to the participants.

(3) Coastal protection

Master plans for coastal management are being formulated by consultants for each region (Table 6.2.1). For the areas which require emergency remedies, a detailed design is conducted (Table 6.2.2). Research, study, design, and construction of coastal structures of all Thailand (except Bangkok) are conducted by Marine Department (MD) of Ministry of Transportation.